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Evaluating Traditional and Alternative Perspectives on Paleoindian Land Use: The View from the Central Plains and Southern Rocky Mountains

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EVALUATING TRADITIONAL AND ALTERNATIVE PERSPECTIVES ON PALEOINDIAN LAND USE: THE VIEW FROM THE CENTRAL PLAINS AND SOUTHERN ROCKY MOUNTAINS

by

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B.A., University of Colorado, 1980

M.A., Colorado State University, 1994

A thesis submitted to the Faculty of the Graduate School of the University of Colorado in partial fulfillment of the requirement for the degree of Doctor of Philosophy

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has been approved for the Department of Anthropology

Douglas B. Bamforth

Catherine M. Cameron

The final copy of this thesis has been examined by the signatories, and we
Find that both the content and the form meet acceptable presentation standards
Of scholarly work in the above mentioned discipline.
Naze, Brian Scott (Ph.D., Anthropology)

Evaluating Traditional and Alternative Perspectives on Paleoindian Land Use: The View from the Central Plains and Southern Rocky Mountains

Dissertation directed by Professor Douglas B. Bamforth

This dissertation addresses the controversy between traditional and alternative views on Paleoindian land use. Traditionally, Paleoindians have been portrayed as organized into individual bands that operated within anomalously large ranges under the rationale that subsistence economy was focused on large-scale hunting of wandering herds of big game animals. More recently, advocates of an alternative view have argued that Paleoindians would have been more like later foragers. If so, land use patterns and social organization would have varied from one environment to the next based on the nature and availability of food and tool stone resources and may have involved aggregation of people to cooperate in communal big game hunting.

The relative validity of the two views was addressed through analysis of an artifact collection from the Jurgens site, as well as review of information available in existing literature. In the late 1960s and early 1970s, an artifact assemblage dating to the Cody period was recovered by the CU Museum during excavation of multiple bison bonebeds at the Jurgens site, located on the plains of Colorado. The collection was examined to evaluate how well data on the kinds of artifacts and tool stones present in the assemblage conform to expectations developed under each theoretical approach. In a similar fashion, data from existing literature on artifact collections from sites in a study area encompassing parts of the Central Plains and Southern Rocky Mountains were compared to the differing expectations of the contrasting views regarding the relative amounts of local and nonlocal stone to be expected.
The results of the study favor the alternative view as a more theoretically robust model of land use and social interaction. The dissertation makes a contribution to the field of American archaeology by doing much to resolve the controversy over Paleoindian land use. More importantly, however, the dissertation provides a means by which tool stone availability and social interaction may be adequately taken into consideration when theorizing land use patterns of prehistoric foraging peoples in all times and all places. Therefore, the dissertation may prove to be of utility to the field of archaeology in general.
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CHAPTER 1
THE CONTRASTING VIEWS AND THE DISSERTATION PROJECT IN BRIEF

Ever since a group of the eminent archaeologists of the day examined a Paleoindian bison kill site near Folsom, New Mexico and proclaimed in 1927 that humans have been in the Western Hemisphere since the days of now-extinct megafauna, American archaeology has portrayed Paleoindians as big game hunters whose dependence on roaming herds of game animals dictated that they be highly nomadic. Later archaeologists working under this school of thought have sourced the types of stone present in collections of projectile points, as well as entire assemblages, and concluded that Paleoindian bands moved about within immense areas that were many times the size of the ranges documented for ethnographically studied bands of hunter-gatherers (e.g. Amick 1996, Campbell 1968, Emery and Stanford 1982, Yellen 1976). These findings have been bolstered by other analyses of artifact assemblages asserting that Paleoindian lithic technology permitted a highly mobile lifestyle by always maintaining substantial amounts of quality stone to be on hand as a result of extremely frugal consumption of stone (e.g. Goodyear 1989; Hofman 1992). Fortified by tool stone sourcing of select assemblages and lithic technology studies, Kelly and Todd (1988) constructed an influential theoretical model seeking to explain not only the anomalous geographic extent of Paleoindian land use, but also the irregularity of land use implied by characterizations of Paleoindians as nomadic. The thinking of earlier archaeologists suggesting reasons why Paleoindian land use strategies would not have been analogous to later foraging peoples was incorporated into the model. For example, Kelly and Todd suggest the possibility that Paleoindians operated under circumstances of unusually low population density because they
were the first people on the land. They further suggest that the movement of bands were influenced by Pleistocene environmental conditions that were very different from those of today.

The thinking that Paleoindians were highly nomadic big game hunters not only has a long history in American archaeology, it is potentially relevant to larger anthropological questions that can only be answered through archaeology. Because this school of thought has formed the basis for a long-standing tradition in American archaeology that spans more than 80 years, it will be simply called the “traditional view.” If indeed low population density contributed to a unique land use strategy and social organization, further study of the Paleoindian situation would be warranted because of its potential to elucidate larger questions regarding the manner in which modern humans spread throughout the world. Furthermore, if indeed the very different environmental conditions of the times were a factor influencing unique Paleoindian land use and social organization, further study would again be warranted on the grounds of its relevance to larger questions concerning the cultural responses of hunter-gatherers to the Pleistocene.

In contrast to the traditional view, other archaeologists began in the 1980s to develop an alternative way of thinking about Paleoindians that denies the universal applicability of the idea of highly mobile big game hunters. This theoretical approach instead asserts that the efforts of Paleoindian archaeologists must be redirected toward producing a more accurate understanding of these ancient people by building theory capable of recognizing and explaining all variation evident in the archaeological record that reflects land use practices. The school of thought is here simply labeled the “alternative view.” Working under this school of thought, Meltzer (1988) sourced the types of stone present in fluted point assemblages in eastern North America and hypothesized that Paleoindian bands living in different environments may have had land use patterns that varied in their geographic extent. Another early proponent of the alternative view is Bamforth (1988). He argues that
environmental changes documented for the Southern Plains would have theoretically brought about predictable changes in forage and bison distributions, causing corresponding changes in Paleoindian land use patterns and social group size. The work of Bamforth and Meltzer illustrates what I would characterize as a major goal of the alternative view; that being development of a body of theory capable of identifying and explaining geographic and temporal variation in land use patterns as a means of developing a more accurate view of the potentially diverse subsistence economies and forms of social organization that are presumed to have existed during the late Pleistocene and early Holocene. Archaeology has made similar grand promises regarding the potential of archaeology to contribute to general-level anthropological theory on the nature of hunter-gatherer adaptations (e.g. Binford 1980); promises that have met with limited success. How then does the theory building proposed by alternative thinkers offer any brighter prospect? To this I would say that contrary to earlier attempts which relied solely on developing theory from the ethnographic record, alternative thinkers advocate developing theory by drawing on a broader range of sources for hypotheses intended to explain archaeological variation. These sources include not only carefully considered ethnographic analogy, but also principles of human ecology (Bamforth 1988; Meltzer 1988) and the archaeological record itself (Bamforth 2009a). Thus, further development of the alternative view of Paleoindians is warranted because of its potential to provide an example of archaeology successfully contributing to the development of general anthropological theory.

Both theoretical views can claim to be worthy of further study on the grounds of their relevance to larger anthropological goals and the issue is of even greater importance to those specialists concerned with advancing Paleoindian studies, so the question then becomes one of determining the manner in which the relative validity of the two views can be best assessed. The careful reader will have noted that proponents of both approaches cite evidence from the sourcing of tool stones present in Paleoindian collections to support their
differing viewpoints. This speaks to what I would characterize as another major goal of the alternative school: the development of methods capable of unambiguously identifying the cultural and natural factors that affected the tool stone composition of assemblages so that prehistoric land use and social interaction may be more accurately portrayed. If Paleoindian archaeologists are successful in these efforts, then they and other archaeologists studying prehistoric hunter-gatherers should be able to provide interpretations related to land use and social organization that are less open to differing interpretations. In agreement with the traditional view, proponents of the alternative approach concur that the movements of Paleoindians was influenced to some extent by the distribution of food resources (Bamforth 1988), and thus may have had some affect on tool stone composition (e.g. Meltzer 1988). In sharp contrast to the traditional view, however, the alternative school maintains that the movements of Paleoindians was also influenced by the distribution of tool stone and by social factors, such as the aggregation and dispersal of groups, and the activities of more broadly ranging individuals, some of whom may have been involved in trading relationships with other social groups (Bamforth 1985, 1991a, 2009b). Properly evaluating the nature of Paleoindian land use through analysis of the tool stone composition of assemblages therefore demands that archaeologists develop methods that consider not only the possible affects of food resource distribution, but also the important effects of tool stone availability and social interaction.

OVERVIEW OF DISSERTATION

The purpose of this dissertation will be to evaluate the relative validity of the opposing views with evidence from Paleoindian sites in a study area located in a portion of the Central Great Plains and adjoining parts of the Southern Rocky Mountains. Following a discussion of the theoretical distinctions between the two approaches, the history of the two
schools of thought will be outlined to illustrate the genesis of both points of view, and more importantly, to identify the major points of disagreement between the views which will then be encapsulated in four major research questions.

The first of these will ask, “Is the nature of the environments in which Paleoindians lived knowable and, if so, under what environmental conditions did they live? To characterize the environmental context of a past society may seem like a rather basic task common to all prehistoric archaeology, yet in the world of Paleoindian studies, the question has been a divisive one. Some proponents of the traditional view essentially maintain that the nature of the late Pleistocene and early Holocene environments in which Paleoindians lived was so unlike those of today that any attempt by alternative thinkers to understand subsistence economy, social organization, and land use by using concepts of human ecology combined with careful ethnographic analogy is doomed to failure because modern environments and peoples are simply not good analogs. The matter will be addressed by considering the current state of knowledge regarding Plains Paleoindians as well as by reviewing paleoenvironmental evidence for the study area and adjoining parts of the Great Plains.

The second research question will address the matter of whether Paleoindians of the study area coalesced into larger social groups for communal hunting. Based on the current state of knowledge regarding Plains Paleoindian archaeology, proponents of the alternative school suggest that people seasonally aggregated into larger social groups to cooperate in communal big game hunts (Bamforth 1988; 1991a). Population aggregates would have provided the labor necessary to meet economic requirements for survival, but also may have been motivated by a desire for periodic social interaction. In contrast, the traditional view of mobile big game hunters suggests that Paleoindians social organization was comprised of individual bands capable of killing and processing herds of bison while operating on their own. A research design will be developed to assess the relative validity of the two views
using data on the tool stone composition of the assemblage from the Jurgens site, a late
Paleoindian site near Greeley, Colorado with bonebeds representing a large-scale bison kill.
At risk of oversimplifying, the traditional view of Plains Paleoindian bison hunting basically
maintains that individual bands moved from one bison kill to the next and selectively visited
sources of high-quality tool stone to enable this highly mobile lifestyle. In contrast, the
alternative view asserts that people aggregated into larger groups to cooperate in bison drives
and “geared up” for the event at one or more sources of quality tool stone. The contrasting
views produce differing expectations regarding the tool stone and artifactual composition of
an assemblage recovered from a site associated with a bison kill. Data relating to the tool
stone sources represented in the Jurgens assemblage, the distances to these sources, and the
artifactual form in which these tool stones occur will be compared to the expectations under
each view in order to assess which view is better supported.

The third research question will assess the traditional view’s argument that
Paleoindian lithic technology was specially designed for frugal consumption of quality tool
stone as a means to permit a highly mobile lifestyle. One component of the frugal technology
concept asserts that Paleoindians selected microcrystalline tool stones for tool manufacture
over granular ones like orthoquartzites (Goodyear 1989). The rationale behind this claim is
that microcrystalline stone could be more easily flaked without breaking in an unwanted
manner, thus allowing for a greater number of episodes of tool resharpening. Furthermore, it
was suggested that a tool of microcrystalline stone would have a better chance of being
successfully “recycled” by flaking it into a tool with a different function. Another element of
the argument asserts that Paleoindian technology greatly emphasized production of tools
through bifacial reduction as opposed to production of tools from blocky cores, based on the
understanding that bifacial reduction is a more frugal way to use stone because more useable
edge is produced per volume of stone. Data from the Jurgens site will be used to evaluate the
frugal technology concept. The site is located in an area where an orthoquartzite was used
prehistorically. The amount of orthoquartzite in the assemblage will be compared to that of microcrystalline stone to evaluate the traditional expectation that stone of the later variety should occur in much greater frequency. Furthermore, the assumption that microcrystalline stone is always preferable to stone like orthoquartzites will be considered by comparing the tool stones in the assemblage by another quality that would affect knapping success, that being the prevalence of flaws in the raw material. Artifacts in the Jurgens assemblage representing bifacial reduction and reduction of blocky cores will be quantified to evaluate the traditional expectation that artifacts in the former class should dominate the collection.

The fourth and final research question will seek to determine which theoretical approach to land use is best supported by the current body of Paleoindian literature. This will be assessed using data on the tool stone composition of assemblages from sites in the study area. One of two aspects of land use to be assessed is the geographic extent of band movements. Under the alternative view, the geographic extent of Paleoindian land use may not necessarily have been any greater than that to be expected for later hunter-gatherers. If so, the local to nonlocal tool stone composition of assemblages under certain conditions of tool stone availability should have varied depending on whether the assemblage was produced by a relatively small group or an aggregation of people who had coalesced into a larger group for the purpose of communal hunting. Based on the understanding that sites with large-scale bison bonebeds or game drive structures may sometimes represent communal game drives where people from different areas aggregated to form larger groups to cooperate in the event, the artifact assemblages of sites with such features will be compared to assemblages from other kinds of sites. As mentioned, the alternative view asserts that the availability of tool stone in the local environment had an affect on the tool stone composition of assemblages. Thus, assemblages from sites in environments with locally available sources of quality stone will be compared to assemblages from sites in environments lacking quality local stone. Under the traditional view, the tool stone composition of assemblages should not
vary according to site type since Paleoindians are thought to have operated solely in individual bands. Also, variability in tool stone composition should not correlate with availability of quality tool stone in the local environment because Paleoindians would have always had substantial amounts of quality stone from nonlocal sources in their tool kits as a result of their frugal lithic technology. Actual tool stone composition of assemblages as presented in available literature will be compared to expectations developed under both theoretical perspectives to assess their relative validity.

The second aspect of Paleoindian land use to be assessed is its regularity. Under the traditional view, the movement of Paleoindian bands was relatively irregular. Archaeologists working with from the concept of a frugal lithic technology present an image of Paleoindian bands moving in an irregular fashion in response to the unpredictability of bison herd location, assisted by a frugal lithic technology that conserved tool stone until another stone source was reached (e.g. Hofman 1992). The immense size of band ranges suggested by other traditional archaeologists incorporates multiple sources of quality stone (e.g. Emery and Stanford 1982). If indeed the movements of bands within huge areas with multiple sources of stone was determined by irregular movements of game within the area, it is expected that the proportions of the various tool stones in Paleoindian assemblages would vary greatly from one assemblage to the next, such that assemblages from two or more nearby sites would have very different proportions of tool stones and perhaps would even have different sets of tool stone sources represented in the assemblage. Thus, under the traditional view, it is expected that the tool stone source representation in assemblages from clustered sites with bison bonebeds should vary greatly. This expectation would also apply to the model of other traditional archaeologists who maintain irregular band movements was actually in response to unique environmental conditions during the transition from Pleistocene to Holocene climates; conditions that required bands to switch to an entirely new range on the order of every “few years” to every “decade” (Kelly and Todd 1988:234-237). In contrast, some alternative
theorists suggest that the nature of communal bison hunting involved a degree of regularity in that bison herds were usually slaughtered by people from the local band or from both local and neighboring bands who travelled to the places where herds could normally be found at a certain time of the year. If Paleoindian land use was comparable on a general level to many ethnographic hunter-gatherers in that bands occupied the same tracts of land over the course of generations and aggregated with neighboring bands for communal hunts, then it is expected that assemblages from clustered Paleoindian bonebeds of different ages will have similar tool stone sources represented. To evaluate the competing views on land use regularity, the tool stone composition of assemblages from clustered sites will be compared to the differing expectations of each view.

Having sketched the basic contents of the two views and outlined a program of study designed to evaluate their relative validity, I now turn to identifying the essential differences between the views. It is only by fully appreciating these differences that efforts designed to reconcile the conflicting views can be taken.
CHAPTER 2
IDENTIFYING ESSENTIAL DIFFERENCES BETWEEN THE VIEWS

Having outlined differences between the two theoretical camps as well as dissertation research designed to judge their relative merit, it may seem odd to now ask if the distinction is real. If the distinction must put all Paleoindian archaeologists into one camp or the other, then the distinction is not real. In the course of discussion, I have mentioned many aspects of Paleoindian cultures in a general sense, including environmental setting, population density, subsistence economy, land use, social organization, and social interaction through trade. Examples can be found in the literature of an archaeologist who is identified with one school of thought expressing an opinion about an aspect of Paleoindian culture that is more in line with the opinions of the other theoretical view. Bamforth (2009b), who many would consider a pioneer of the alternative view, theorizes that trade among Plains Paleoindians was a factor that moved quality raw material far from its source and that individual mobility may also have been important. Meltzer (1988), who I have also identified with the alternative school, offers his opinion that stone was not exchanged among Paleoindian groups in eastern North America, while Hofman (1992:198), whose work as a whole places him firmly in the traditional school, agrees that stone was traded among Plains Paleoindians. (However, he qualifies his concurrence with the assertion that only small amounts were traded and thus his stance that highly mobile bands procured tool stone through actual visits to the sources remains unchanged). Though examples such as the above can be cited where an archaeologist of one school of thought expresses the views typical of the other in regard to
some cultural aspect, I nonetheless maintain that the theoretical divide between 
archaeologists active in developing theory on Paleoindian ways of life is real.

DIFFERENT WAYS OF BUILDING THEORY AND REASONING 
THROUGH ANALOGY

A watershed time in the divergence of theoretical thinking regarding Paleoindian 
arcaeology was the year 1988, which saw the publication of three models that together 
present two dramatically different views of land use. On one hand was an influential model 
by Kelly and Todd (1988) which presented Paleoindian land use as very different from later 
hunter-gatherers and attempted to explain the supposed difference using a more overarching 
theory of hunter-gatherer land use by Binford (1980). The Kelly and Todd model 
incorporated long held beliefs of the traditional view regarding the nature of Paleoindians, 
including the thinking that these early inhabitants of the Americas lived during a time of low 
population density, subsisted by means of hunting herds of big game animals, and had land 
use strategies that involved a geographically extensive use of the landscape. On the other 
hand were the models developed by Meltzer (1988) and Bamforth (1988) which portrayed 
Paleoindian land use as more like later hunter-gatherers with the difference being partially 
understood through application of ecological theories predicting how hunter-gatherer land use 
is affected by food resources. Bamforth’s work also recognizes that social organization is an
aspect of land use because it models how environmental changes would bring about 
corresponding changes in the size and distribution of human groups involved in communal 
hunting.

Meltzer’s (1988) dissertation project focused on investigating land use of fluted point 
makers of eastern North America. Ecological and foraging theory form the overarching body 
of theory from which Meltzer models Paleoindian land use. The environment of the time is 
considered to have differed from that of today and yet is believed to be knowable through
analogy to modern ecozones. Paleoenvironmental data demonstrate that during early
Paleoindian times, a number of ecozones existed in eastern North America that varied with
latitude. Much of the eastern United States was forested, but with a mix of deciduous and
boreal species. North of the forest was the tundra ecozone and farther north still was the
retreating Laurentide Ice Sheet. In Meltzer’s model, the nature of Paleoindian subsistence
economy and land use is believed to be analogous to what may be expected of foraging
people in general as understood through application of foraging theory and ethnographic
analogy. The subsistence economies of Paleoindian foragers inhabiting the two ecozones are
believed to have been analogous to what may be theorized for human foragers in general who
live or have lived in forested and tundra environments. To aid in theorizing Paleoindian
subsistence economy and land use, Meltzer invokes the concept of human forager subsistence
practices being arrayed along a continuum between generalized and specialized diets.
Forested environments in general have a diversity of species with low numbers of individuals
per species. Dense forests do not contain large grazing areas and this limits the size of the
herds of grazing animals that might inhabit the ecozone. Given these ecological conditions,
human foragers living in forested regions would be expected to have a generalized
subsistence economy dependent on a diversity of food resources. Tundra environments are
characterized as having low species diversity with an abundance of individuals of a single
taxon (caribou). Given these ecological conditions, modern human foragers inhabiting tundra
environments would be expected to have a subsistence economy that specialized to some
extent on the hunting of caribou.

Meltzer theorizes that the geographic extent of land use patterns would have differed
between the two ecozones. He reasons that mobility within large ranges was probably not
characteristic of foragers of the forest. On the other hand, people inhabiting the tundra may
have been mobile within larger ranges because of their theoretical specialization on caribou
hunting.
Meltzer’s argument regarding the expected differences in the land use of Paleoindians of the two ecozones may be described as linear in that direct causal relationships are thought to link three variables in each ecozone. According to the model, the forested environment “caused” or influenced the development of a generalized subsistence economy among the Paleoindian inhabitants which in turn influenced the adoption of land use patterns of relatively small geographic extent. Similarly, the tundra environment influenced adoption of a specialized subsistence economy reliant on caribou which in turn influenced the adoption of land use patterns of comparatively large geographic extent.

Importantly, some archaeological evidence is cited in support of the hypothetical differences in subsistence practices thought to have existed between inhabitants of the two ecozones. Indirect evidence for a more diverse subsistence economy in forested regions is garnered by recovery of grinding slabs, manos, wooden mortars, and stone pestles suggestive of plant food processing from both Paleoindian and Early Archaic sites (Meltzer and Smith 1986). According to the authors, better preserved floral remains from Early Archaic sites suggests that Paleoindian diet may have similarly included a diversity of plant food resources, such as oak acorns, hickory nuts, black walnuts, and hackberries. The better preserved faunal remains from Early Archaic sites are cited to further suggest that Paleoindian diet may have included a similar mix of small game species including turkey, beaver, muskrat, squirrel, raccoon, cottontail rabbit, as well as large game, such as white tail deer and elk. Finally, some evidence of mastodon hunting by fluted point using groups of the forest is noted (Meltzer 1988:22-24). Evidence suggesting that the subsistence economy of people inhabiting the tundra included reliance to some extent on caribou hunting comes from various sites in northern states of the eastern U.S. Generally speaking, bone preservation in these now-forested states is not as good as is the case on the Plains. Nevertheless, some evidence for caribou hunting is preserved in the form of bone recovered from a rockshelter and other faunal material from open sites that was protected from deterioration by having been calcined
through exposure to fire (Spiess et al. 1985). Evidence for hunting of caribou comes from sites in Michigan, New Hampshire, New York, and Massachusetts.

Supporting archaeological evidence is also provided for the part of the model asserting that the geographic extent of land use would have differed between the two ecozones. Data on the tool stone composition of 26 assemblages are presented by Meltzer (1988:Table IV). Most of the seven assemblages from sites in unglaciated regions are composed primarily of tool stones from local sources. On the other hand, a majority of the 19 assemblages from formerly glaciated regions to the north consist principally of nonlocal tool stone. The above data are offered to support the theoretical assertion that land use would have been relatively less geographically extensive in forested regions compared to the glaciated regions which presumably would have been blanketed with tundra vegetation as the Laurentide ice sheet retreated northward in early Paleoindian times.

The important point to be stressed here is that Meltzer attempts to bolster the model with archaeological data that arguably relates to those parts of the model that may be reflected in the archaeological record — namely the nature of the subsistence economy and the geographic extent of land use. As discussed below, other factors apart from the geographic extent of land use may affect the tool stone composition of assemblages. My intent here is not to evaluate the credibility of the model’s assertions regarding land use or subsistence economy, but rather to note that use of archaeological evidence to provide some support for parts of the models is an inherent characteristic of Meltzer’s model.

Another investigation that was carried out from the alternative theoretical perspective, but used methods differing from Meltzer, was Bamforth’s (1988) dissertation project which addresses the topic of land use on the Southern Plains throughout the entire Paleoindian period. The overarching theories that Bamforth uses to model changes in Paleoindian land use also derive from the field of ecology and include optimal foraging theory and evolutionary ecology. The specific aspect of land use considered was aggregation
of human groups for communal big game hunting. Specifically, the dissertation examined how environmental changes throughout the Paleoindian period should have theoretically affected the size of human aggregations as well as the environmental settings in which aggregations of foraging people would have taken place. The stated purpose of developing such an ambitious theoretical model was to counter the prevailing conception among archaeologists that Paleoindian social organization must have been fairly uniform throughout the millennia. To the contrary, Bamforth asserts that the substantial environmental changes that occurred during the Paleoindian period should have brought about changes in human organization in regard to communal hunting; changes that should be demonstrable in the archaeological record. His work may be characterized as intending to demonstrate how archaeologists might go about the difficult task of eliciting changes in land use and human organization related to communal hunting through the application of ecological theory.

A basic understanding underlying Bamforth’s work is that the behavior of Paleoindians would have been analogous to what would be expected for later pedestrian foragers of the Plains. Bamforth’s model of land use assumes Paleoindians would have been analogous to later Plains foragers in that the population would have aggregated to form larger groups for communal hunting. Furthermore, the model is based on the understanding that given a knowledge of paleoenvironmental changes, it should be possible to theorize temporal changes related to aggregations of people involved in communal hunting (such as changes in the relative size of aggregations). This belief is based on the understanding that the behavior of Paleoindians would have been analogous to that predicted by foraging theory for hunter-gatherers in general.

Bamforth’s model is also based on the understanding that the environment of Paleoindian times, though differing from that of today, was analogous to the contemporary environment to the extent that an appreciation of how the environment differed should enable the environmental effects on land use to be discerned. This is possible because the same
ecological principles that shape the environment today were at work in the past and because
the ways in which environmental conditions shape hunter-gatherer land use patterns is
knowable through application of foraging theory. Paleoenvironmental data are reviewed to
support a reconstruction of environmental change based on the understanding that warming
and drying of the climate throughout the Paleoindian period would have brought about
predictable changes in vegetative forage and big game animal density, distribution, and
predictability. These changes in the big game animal food resource would have caused
corresponding changes in the size, distribution, and regularity of human aggregations that
formed to engage in communal hunting.

As with Meltzer’s model, Bamforth constructs his by using a linear argument
consisting of a series of causal links. Climatic changes are linked to modifications of the
vegetative forage which in turn are correlated with adjustments to big game herds. Finally,
changes to big game herds are believed to have brought about corresponding modifications to
human aggregations amassed for communal hunting.

In effort to support the model with archaeological evidence, Bamforth notes that
changes in the size and distribution of Paleoindian sites of various ages may be interpreted as
having resulted from predicted changes in the size, distribution, and regularity of human
aggregations that formed for communal hunting. Thus, part of what is considered necessary
to produce a land use model is to support it to some extent with at least some archaeological
evidence. Though evidence is presented, Bamforth (1988:182) admits that the model has yet
to be rigorously tested.

A model of early Paleoindian land use developed from the traditional theoretical
perspective by Kelly and Todd (1988) shares some similarities with the above models
proposed by alternative thinkers, but in other respects, it is dramatically different. The Kelly
and Todd model is similar in that it was developed by reasoning from an overarching body of
theory. Another similarity is that the model is based on the understanding that Paleoindian
behavior would have been analogous to what would be expected of all hunter-gatherers according to the concepts of the overarching theory. Among the differences between the models produced from the alternative perspective and the Kelly and Todd model is the observation that the later does not consider the early Paleoindian environment to have been analogous to modern conditions to the extent that ecological principles may be used to understand the nature of the Paleoindian environment and the relationship between the ancient environment and foraging peoples. Another important difference is that little to no firm archaeological evidence is offered to support the Kelly and Todd model.

Like the models of Meltzer and Bamforth, the Kelly and Todd model was developed by referring to an overarching body of theory that guided the theorists in their construction of the model. The models developed from the alternative perspective were guided by an understanding of how hunter-gatherer land use would have been influenced by the environments in which they lived as expressed by principles of ecology. Construction of the Kelly and Todd model was instead influenced by an understanding of hunter-gatherer land use directed by Binford’s (1980) overarching theory, known as the forager-collector continuum. This theoretical construct claims to illustrate causal relationships between the environmental on a global scale of analysis and various characteristics of hunter-gatherer adaptations, including land use.

The Kelly and Todd model differs greatly from those proposed by alternative-minded scholars in regard to the model contending that the environment during Paleoindian times was not at all analogous to that of today. According to the model, the environment during early Paleoindian times was not partitioned into various ecozones as it is today. Rather, so-called climatic equability (which involved reduced seasonality) produced a more mosaic distribution of vegetation. As a result, the fauna of the time was composed of “disharmonious” associations, where species that today inhabit separate ecozones were instead living in the same environment. The ecological relationships between climate, flora, and fauna that
alternative theorists use to model the Paleoindian environment also explain in large part how
various species of plants and animals characteristic of the differing modern ecozones have
evolved to adapt to the climatic and other conditions of the differing ecozones. However,
since the Kelly and Todd model is based on the understanding the Paleoindian environment
was nothing like that of today, the ecological relationships that hold true today should not be
used to model the Paleoindian environment. Furthermore, alternative thinkers use foraging
theory to model how hunter-gatherers of the past would have responded to various
environments by adopting a particular diet, subsistence economy, land use pattern, and
through population aggregation and dispersion. In contrast, the Kelly and Todd model would
seem to be based on the understanding that although foraging theory may help to explain the
behavior of foraging animals and people living in modern ecozones, it may not be directly
applied to explain how early Paleoindians responded to the totally different environments in
which they lived. Since environmental conditions of Paleoindian times were completely
unique in comparison to those of modern times, Paleoindian cultural responses to the
environment may have been totally unique in comparison to those of modern hunter-
gatherers. The Kelly and Todd model suggests that Paleoindian cultural responses to their
unique environment can only be understood by using a body of theory (namely the forager-
collector continuum) that can explain how hunter-gatherers in general respond to
environmental conditions in order to theorize the cultural responses of early Paleoindians to
their environment.

According to the Kelly and Todd model, another way in which the circumstances of
early Paleoindians may not have been analogous to that of modern foragers concerns
population density. Unlike an ethnographic band of foragers that commonly was surrounded
by neighboring bands with which it could cooperate in economic activities, Kelly and Todd
suggest that population density during the time when Paleoindians were first populating the
Americas may have been such that bands could not rely on their neighbors. Rather, it is
suggested that a unique social organization that arose in response to the unique environmental
and demographic conditions of the times was that early Paleoindians operated as independent
bands that would not have necessarily have had regular contact with neighboring bands.

The way in which Kelly and Todd’s model is structured differs to some degree from
models proposed under the alternative view. In the models of Meltzer and Bamforth, there
seems to be a greater concern with clearly identifying a series of causal relationships in what
might be called a linear argument. In Bamforth’s model in particular, each step in the linear
argument is considered a variable and the manner in which variability in one step of the
argument affects variability in the next step down the line is made explicit. Climatic
variables of temperature and precipitation are known to relate to the amount and nutritional
quality of vegetative forage, which theoretically correlate with game animal density,
distribution, and predictability. Variable qualities of big game herds in turn hypothetically
articulate with the size, distribution, and reliability of aggregations of people for communal
hunting. In the Kelly and Todd model, a series of relationships between aspects of the
supposedly unique environmental and demographic conditions of early Paleoindian times and
various characteristics of Paleoindian culture are outlined, but the manner in which one
element of the model would necessarily cause or influence another proposed element of the
model is often implicit.

Rather than being a linear argument, the basic structure of the Kelly and Todd model
may be likened to a flow chart that attempts to illustrate causal relationships between unique
environmental and demographic conditions and the unique forms of subsistence economy,
social organization, and land use that early Paleoindians supposedly adopted in response.
Unique environmental and demographic conditions encouraged early Paleoindians to adopt a
unique social organization involving bands operating independently from one another. A
unique subsistence economy that focused on hunting herds of big game is said to have been
fostered, based on the unelaborated assertion that hunting of big game is often a more
efficient means of subsistence. Independent bands focusing on the hunting of big game herds would have resulted in a land use strategy unlike any known to ethnography where the band in essence moved from one big game kill to the next within their range (Kelly and Todd 1988:236). Early Paleoindian land use would have been geographically extensive because bands would have had to relocate from their range to an adjoining tract of unoccupied land on the order of every “few years” to “a decade” due to overhunting (Kelly and Todd 1988:235, 237).

Though Kelly and Todd propose that Paleoindian responses to the unique environmental and demographic conditions of the times would have involved unique forms of subsistence economy, social organization, and land use, their model is based on the implicit understanding that the behavioral responses of Paleoindians is knowable because their behavior would have been analogous to what would be expected of all hunter-gatherers as expressed in the forager-collector continuum. This body of theory will be reviewed in greater detail in the following chapter, but suffice to say here that it in part purports to correlate variability in environmental conditions on a global scale to hunter-gatherer land use patterns the world over (Binford 1980). Hunter-gatherers in equatorial regions are classified as “foragers” whose land use is characterized as moving camp to locales with unexploited food resources. This strategy of land use is referred to as “mapping-on” in reference to people “mapping” the location of available food resources and moving to an unexploited area. Foragers produce a limited variety of kinds of sites, including residential bases and “locations” at which food resources are procured. Hunter-gatherers in polar regions are categorized as “collectors” whose land use involves moving food resources to camp. This basic land use strategy is referred to as “logistics.” Sites produced by collectors are more varied and also include field camps, stations, and caches. Kelly and Todd cite Binford’s forager-collector continuum as the theoretical basis for their assertion that Paleoindian land use would have involved bands moving camp from one large-scale kill of big game animals
to another. In the parlance of Binford’s model, early Paleoindian land use would entail simply moving from one residential base at a big game kill to another. The model is again invoked to suggest that early Paleoindian land use would have been somewhat like the logistical strategy of modern collectors as Paleoindians made foraging trips in the vicinity of the kill, presumably to encounter game and bring back fresh meat to camp (Kelly and Todd 1988:238). When logistical parties located game at a long distance from the residential base at the kill, camp would be moved to a new kill or resource area in a manner analogous to the mapping-on strategy of foragers (Kelly and Todd 1988:236, 238-239).

The early Paleoindian land use pattern suggested by Kelly and Todd may be rational, but it is important to note that the overarching body of theory on which it was based does not incorporate any proven concepts or principles that allow it to be applied uniformly. Therefore, the body of theory may be criticized because it allows for widely varying interpretations of land use that are not very replicable and therefore not very scientific. The conceptions of Paleoindian land use presented by Meltzer and Bamforth are based on known ecological relationships, theoretical principles from the field of foraging theory, or (in the case of Meltzer’s work) the understanding that the food resources exploited by a group of hunter-gatherers would have had expected effects on the geographic extent of land use. These relationships and principles allow a reader to follow Meltzer’s and Bamforth’s reasoning as they characterize the nature of Paleoindian land use through a consideration of environmental conditions. Also, another researcher using the same information and data available to Meltzer and Bamforth and guided by the same understanding of the ecological relationships and principles would be expected to come to the same or similar conclusions regarding the nature of Paleoindian land use in eastern North America and the Southern Plains. To the contrary, the forager-collector continuum does not integrate proven relationships between variables or sound theoretical concepts. How the suggestion that early
Paleoindian land use would have involved moving camp from kill to kill necessarily follows from the ideas developed in the forager-collector continuum is not apparent.

The extent to which the Kelly and Todd model is bolstered by supporting evidence also differs from those produced from the alternative perspective. Archaeological evidence presented by Meltzer in an effort to bolster his model includes evidence on Paleoindian diet offered to support the contention that subsistence economies differed between the two ecozones of concern. Also, data on the relative abundance of local to nonlocal tool stone in Paleoindian assemblages from both ecozones is presented in an attempt to support the assertion that the geographic extent of land use was relatively greater on the tundra. In effort to support his model of the temporal changes in the size and distribution of human aggregations, Bamforth offers quantified data as well as more general evidence relating to the changes in site size and distribution through time. In contrast, little archaeological evidence is offered by Kelly and Todd to support their contention that early Paleoindian land use would have involved bands moving from one large-scale big game kill to another. It is noteworthy that to really demonstrate that any field camps, stations, or caches made by hunters foraging from a residential base at a kill were all contemporaneously occupied, one would need to find refitting or conjoining flaked stone artifacts at the sites. Identifying refitting or conjoining flaked stone artifacts would also be necessary to demonstrate that two residential bases at kills were sequentially occupied. The point to be stressed here is that the ability to demonstrate contemporaneous or sequential occupation of the kinds of sites characteristically produced by Paleoindians is almost unheard of in hunter-gatherer archaeology. The nature of early Paleoindian land use proposed by Kelly and Todd is thus not readily verified or refuted with archaeological evidence.

To bolster their characterization of early Paleoindian land use, Kelly and Todd observe that in comparison to Late Prehistoric camps at bison kills, which have produced evidence of meat storage by means of pemmican production, Paleoindian bison bonebeds
have not yielded comparable evidence for food storage. Some Paleoindian bonebeds even have articulated carcass segments, indicating a less than complete utilization of available meat. Kelly and Todd (1988:236, 238-239) suggest that the indications of limited utilization of some of the slain animals might be considered to be evidence supporting the contention that early Paleoindians moved camp from one kill to the next if indeed the articulated carcass segments represent instances where meat from a previous kill was abandoned to move camp to a new kill.

A critical review of the suggested supporting evidence for the proposed early Paleoindian land use pattern reveals a number of reservations about the reliability of the evidence. First, among the Paleoindian bison bonebeds cited in support of the possibility that early Paleoindian land use would have been unique in response to unique environmental and demographic conditions is the Horner site in Wyoming, a late Paleoindian site with a partially articulated bison present in the bonebed. Also, the real reason for the greater degree to which bison were processed during Late Prehistoric times in comparison to the Paleoindian period may be better explained as a result of intensification of bison utilization in the later time period, as elaborated in the following chapter. In light of the above, the reader is left with the dissatisfying feeling that much effort was put into constructing a complex model asserting that early Paleoindian land use involved the unique quality of moving from one large-scale kill to another, but little to no firm evidence was offered to support the contention that this was actually the land use pattern followed.

Some would say that the Kelly and Todd model should be placed in historical context and be recognized as having been intended to demonstrate how archaeologists might go about theorizing adaptations of prehistoric hunter-gatherers that may not be represented in the ethnographic record. Publication of papers by anthropologists attending the seminal “Man the Hunter” symposium (Lee and DeVore 1968) helped to establish what has been termed the generalized foraging model which has since been commonly used by archaeologists as a
means to interpret the nature of prehistoric hunter-gatherers, even though the model often is not a good source of analogy. The model is largely based on the influential work of Richard Lee among the Bushmen and it also incorporated earlier thoughts on the nature of hunter-gatherer societies (Kelly 1985:14-23). In reaction against indiscriminant use of the generalized foraging model, archaeologists in the late 1970s and the 1980s were intent on developing models for prehistoric hunter-gatherers through testing the reliability of ethnographically derived models with archaeological data and by developing theory using archaeological data alone (Wobst 1978). During this same time period, the influential work of Binford (1980) sought to develop a model of hunter-gatherer land use using ethnographic sources that would prove generally applicable to foraging people, both recent and prehistoric. It was in this intellectual milieu that two of Binford’s students developed their model of early Paleoindian land use (Kelly and Todd 1988).

The model is not only elegant and internally consistent, but also neatly incorporates long held beliefs about Paleoindians and offers an explanation as to why the subsistence economy, social organization, and land use would have been so different from that of ethnographically documented people. The long held beliefs that Paleoindians subsisted by hunting herds of big game and lived during a time of low population density are maintained in the model. The idea that Paleoindians lived during a time of low population is expressed in the model by the assertion that people would have operated in independent bands that did not use the resources of a particular range for long before moving on. Furthermore, a band would not necessarily have aggregated with neighbors to cooperate in communal hunting because early Paleoindian bands may not have had any neighbors. In contrast to the hypothetical early Paleoindian situation, ethnographic records give the impression that hunter-gatherer societies were commonly composed of bands operating in defined ranges with surrounding land divided into the ranges of neighboring bands, a situation that Kelly and Todd (1988:234) refer to as “regional packing of bands.” Also, the ethnographic record
demonstrates that social organization of recent hunter-gatherers commonly entailed aggregation of band members or coalescence of the local band with neighboring people to provide the labor necessary to exploit concentrations of food resources available on an annual or longer term basis (e.g. Steward 1938). In conformity with the long-standing view of Paleoindians as mobile within areas much larger than ethnographic people, Kelly and Todd imply that bands would have frequently relocated to a neighboring unoccupied range. Thus, the long held belief that Paleoindian land use was geographically extensive is also maintained in the Kelly and Todd model. However, instead of this characteristic of land use simply being the result of Paleoindians following the wandering herds of big game, it is now considered to be a quality of a land use strategy that was unlike any known to ethnography and yet attributable to Paleoindians in light of the very different environmental and demographic conditions in which they lived.

From the above, some would suggest that the Kelly and Todd model was meant to serve merely as an example of how archaeologists might go about using general theory (e.g. the forager-collector continuum) to develop explanatory models of the land use of ancient hunter-gatherers. Be that as it may, the model proved very influential and remains the intellectual framework from which some archaeologists continue to develop their thinking about Paleoindians (Amick 1996:411; Hofman 1991:335, 1992:197; Ingbar 1992:174).

Thus, it is necessary to determine how well the model is supported by archaeological data so that its relative worth as an explanatory tool may be compared to models developed under the alternative view. As mentioned, implications of the model itself are seemingly not amenable to testing with archaeological evidence, which raises the question of the usefulness of the model for advancing what is known about Paleoindians. However, the model is based on three theoretical foundations and the empirical soundness of these may be evaluated to varying degrees. These theoretical foundations include the belief that the environments in which Paleoindians lived were not at all analogous to those of today, that the subsistence
economy was focused on the hunting of herds of big game, and that human population density was unusually low because the land was first being populated. The extent to which these theoretical foundations are supported by paleoenvironmental and archaeological data is reviewed in the following chapters. Furthermore, the model is founded on the belief that the forager-collector continuum is an accurate and useful model for explaining the land use patterns of hunter-gatherers in all times and places. Therefore, the theoretical soundness and utility of the forager-collector continuum will also be reviewed.

In regard to the difficulty of the Kelly and Todd model and indeed many other archaeological models to produce implications that are testable with archaeological data, Bamforth (2009a) suggests that all hunter-gatherer archaeologists would do well to integrate archaeological data into future efforts to model land use. He endorses what he refers to as the bottom-up approach where land use theory is constructed by starting with archaeological data collected to measure specific variables of land use and then working toward eventually synthesizing these data into better supported land use models. Building theory by reasoning from an overarching body of theory to what the archaeological test implications of the theory may be has been used in the past by archaeologists working from both theoretical perspectives. Bamforth’s basic concern with this way of building theory seems to be that it can be relatively easy to construct a rational theoretical model, but then is often difficult to support it in a thorough and convincing manner with archaeological evidence. Being an advocate of the alternative view, he characterizes the Kelly and Todd model (which was constructed by reasoning from overarching theory) as grand storytelling (Bamforth 2009a:86). It is safe to say that he would consider his early work at developing an alternative model of land use (which was also constructed by reasoning from overarching theory) as providing helpful insights into the nature of land use, but he does admit the model has not been rigorously tested (Bamforth 1998:182). In order for Paleoindian archaeologists of either theoretical persuasion to produce models that are better supported by archaeological
evidence, Bamforth (2009a) now advocates use of the bottom-up approach. He cites the work of Chatters (1987) as providing good examples of land use variables that archaeologists should strive to objectively measure with evidence from the archaeological record. To paraphrase Chatters, land use variables would include the size of the range used by site occupants, the regularity of land use (as measured by such things as the amount of site reoccupation), the purpose of site occupation, duration of occupation, group size and composition, and seasonality of movements.

By and large, the bottom-up approach to land use modeling is in its infancy. Some evidence is available in existing literature to at least begin the process of synthesizing data relating to particular land use variables. For example, ample data on the season during which bison bonebeds of the Plains and intermontane basins were laid down is available to address the issue of the seasonal timing of large-scale bison hunting. On the other hand, needed evidence relating to the other variables is limited or nonexistent. For example, Bamforth notes that methods to assess age and sex composition of groups occupying sites are underdeveloped and he wonders if this is even possible in a scientifically rigorous manner. Yet he concludes that only by adopting a bottom-up approach and acknowledging what is and is not currently known can needed work be directed toward producing more empirically sound land use models.

**HOW BIG AN AREA IS “VAST”?**

The efforts of some archaeologists working under the traditional school of thought are not especially useful for clarifying the differing theoretical outlooks, but rather are helpful because they allow the size of Paleoindian band ranges contemplated under the traditional view to be quantified so that this can then be compared to the extent of land use thought to be likely under the alternative approach. Based on his study of collections of Folsom points,
Amick (1996) develops a model of early Paleoindian land use for the Southern Plains and adjacent portions of the Southwest. That Amick’s model is founded upon the theoretical underpinnings of the traditional view is evident in his statement that “[l]ow human population densities and reliance on hunting mobile bison herds may have expanded the scale of Folsom land use to vast proportions [emphasis added] (1996:423).” In his opening sentence, Amick (1996:411,423) cites the Kelly and Todd model for his inspiration. Amick’s model further conforms to the traditional view in that Folsom land use is suggested to have also involved irregular movements. Amick proposes that, during historic times, bison herds wintered in intermontane basins of the Southwest along and near the Rio Grande and in the spring and summer, migrated out onto the Southern Plains in eastern New Mexico and western Texas. It is further suggested that the bison migration pattern would have extended back into prehistory such the Folsom bands would have followed the migrating herds over this vast area. Amick goes on to devise a fairly involved model of Folsom land use. However, the entire model is based on the proposed bison migration pattern and there is no good evidence that historic and earlier bison that wintered in the basins of the Southwest actually migrated all the way out onto the plains of western Texas. Therefore, the theoretical basis of the model is of questionable validity.

Leaving the shortcomings of Amick’s model aside, it nevertheless provides a means to quantify the size of the area that traditional thinkers have in mind. To support his model, Amick (1996:Table 1) presents data indicating that small percentages of points in collections from the Tularosa Basin, the Jornada del Muerto, and the Albuquerque Basin (a.k.a the Central Rio Grande Valley) are made from Edwards chert, which is available throughout a broad source area in central Texas (Hofman, Todd, and Collins 1991:Figure 1). In a separate document, the raw material is identified as a particular variety of Edwards chert that occurs between Sterling City and Abilene, Texas (Amick ca. 1995:6). From the above information, the Folsom bands of Amick’s model would have moved about within an area measuring 700
km east-to-west, as measured from Abilene, Texas to the Rio Grande west of the Jornada del Muerto near Truth or Consequences, New Mexico. The north-to-south extent of the area envisioned would measure roughly 400 km, as measured from the northern end of the Central Rio Grande Valley as defined by Judge (1973:Figure 1) and a point south of the Tularosa Basin, near Las Cruces, New Mexico.

Another good example of the size of Paleoindian ranges contemplated under the traditional view is seen in the work of Emery and Stanford (1982) who report on the initial excavations at the Cattle Guard site, a Folsom site in the San Luis Valley of Colorado that is associated with large-scale bison hunting. The Rio Grande River heads in the San Luis Valley and flows southward through or near the intermontane basins of Amick’s (1996) study area. Through sourcing the tool stones in the assemblage, the site investigators provide an explicit description of the area through which site occupants are thought to have traveled prior to arriving at the site:

Nearly completed [point] preforms were brought to the San Luis Valley from widely dispersed geographic areas, including western New Mexico and Texas. The majority of utilized raw materials, however, are found principally in Colorado, especially in the South Park and Colorado Springs areas. This fact, along with estimates of quantities of exotic raw materials, leads to speculation that this band of hunters may have had a seasonal round that ranged from New Mexico eastward across the Rio Grande onto the Plains of Texas, then northward along the western fringe of the Plains up to the Arkansas River, from there into South Park, Colorado, and then south, crossing Poncha Pass into the San Luis Valley [Emery and Stanford 1982:18].

This hypothetical reconstruction demonstrates the assumptions characteristic of the traditional view. Included are the assumptions that the site was produced by the activities of a single band, that tool stones in the assemblage were acquired by the entire band actually visiting the source of each tool stone, and that the range exploited by the band may be determined by simply drawing a line around the locations of the tool stone sources plotted on a map. Furthermore, the reconstruction has the implicit understanding that quantifying the amount of tool stone from each source should allow the basic travel route of the band to be determined. The statement that the suggested route outlines a seasonal round is, however, not
in line with others working under the traditional view, who assert mobility strategies were not only extensive, but involved irregular movements.

Nevertheless, the explicitly stated nature of the reconstruction allows the size of the area hypothetically used by a Paleoindian band to be quantified. Reports on later site excavations by Jodry (1987, 1999) indicates that the tool stone found in the Colorado Springs area is Dawson petrified wood (a.k.a. Black Forest silicified wood) from primary sources in the Palmer Divide area between Colorado Springs and Denver. Furthermore, the tool stone from New Mexico is identified as Washington Pass chalcedony from the Chuska Mountains in the northwestern part of the state, near the Arizona line. Tool stone from the plains of Texas includes Alibates agate from the panhandle and Edwards chert from the central part of the state. Based on these source identifications, the hypothetical range of the Folsom band thought to have occupied the Cattle Guard site would have been 800 km along a basically north-to-south dimension, based on measuring from the Palmer Divide to the northern edge of the Edwards chert source area. The range would have been 700 km in an east-to-west direction, based on measuring the distance between the sources of Washington Pass chalcedony and Alibates agate as mapped by Cameron (1984:Figure 2) and Shelley (1984:Figure 1).

A final example of the traditional view of land use extent is derived from the site report on the Hudson-Meng bison bonebed, a late Paleoindian site of the Cody time period located on the plains of western Nebraska. Points of the so-called Alberta type were recovered in a bonebed representing an estimated 600 bison thought to have been dispatched in two separate kill events (Agenbroad 1989:27; Huckell 1989:175). Tool stones in the assemblage were sourced by the excavation project director with the understanding that, “[a]n analysis of the quarry areas, at least to general geographic location, gives some idea as to the range of travel and exploitation that characterizes a group of prehistoric people” (Agenbroad 1989:73). Sources of stone represented in the assemblage lie to the north and northwest of
the site and include the “Flint Hill” orthoquartzite source in the southern Black Hills of South Dakota, the Knife River flint source area on the plains of western North Dakota, the source area of Ft. Union porcellanite on the plains of northeastern Wyoming and southeastern Montana, and a source of Phosphoria chert from the Big Horn Mountains of north-central Wyoming (Agenbroad 1989:72-75; Huckell 1989:167-170). The traditional view’s stance that the above sources indicate a huge area used by a highly mobile human group is shared by the project’s lithic analyst, whose statements also reflect the traditional view of Paleoindian land use involving irregular movements and selective use of high-quality stone. According to the lithic analyst, “[t]he Alberta flintknappers apparently used materials from this wide geographic range, and therefore had ample opportunity to pick and choose from a variety of sources… in the course of their movements… It may be safely said that the continual search for high quality lithic raw materials led these people to sample a wide variety of cherts, and that these sources were capitalized upon whenever and wherever they were found” (Huckell 1989:170).

If the area indicated by the tool stone sources does reflect the area within which the people who occupied the site would have traveled and exploited stone resources, then this area would have been 500 km in maximum extent, as measured along a basically north-to-south line from the site to the Knife River flint source area as defined by Ahler (1986: Figure 2). The east-to-west dimension of the area traveled would have been roughly 350 km in extent, as measured from the north-south line between the site and Knife River flint source area and a source of Phosphoria chert near Shell, Wyoming mentioned by Huckell (1989:169).

The above examples illustrate that the geographic extent of Paleoindian land use contemplated under the traditional view truly was vast in comparison to that of later foragers. Based on the tool stone sourcing described above, it can be said that Folsom bands in a
portion of the Southwest and adjacent parts of the Southern Plains are thought to have operated within an area measuring 700 km in maximum dimension. Furthermore, the particular Folsom band that occupied the Cattle Guard site is thought to have a range measuring 800 km in maximum dimension. Finally, the human group of the Cody time period that was present at the Hudson-Meng site is believed to have moved about within an area measuring 500 km in maximum extent. Thus, under the traditional view, Paleoindian band ranges in the Great Plains and adjacent areas of the Southern Rocky Mountains are thought to have ranged from 500 to 800 km in maximum extent.

The size of band ranges contemplated by some alternative thinkers is potentially much smaller. Although advocates of the alternative view insist that ethnographic analogy be used with care, they do not object to the ethnographic record being used as a means to ponder Paleoindian land use in a general way. It may even be used as a concrete basis for comparison to Paleoindians, if the validity of such a comparison can be supported with archaeological evidence. Keeping this in mind, one might compare the size of the areas used by ethnographic bands to those proposed for Paleoindians as a means to further appreciate the distinction between the views. Bands of modern and historic foragers that have been studied in sufficient detail to give an estimate of the maximum extent of the range used by the band form a very limited data set. These data will be discussed in detail below, but suffice to say here that ethnographic band ranges vary from a low of 22 km in maximum dimension to a high of 143 km (Campbell 1968:Figure 2, Yellen 1976:Map 2.2). To understand how one group of archaeologists can reason that Paleoindian ranges were between 500 and 800 km in maximum dimension while other archaeologists are comfortable entertaining the thought that ranges may have been as low as 22 to 143 km in maximum extent, it is necessary to appreciate another distinction between the views, that being a methodological difference concerning the proper way in which to think about prehistoric land use patterns.
DIFFERENT CONCEPTIONS OF LAND USE

Archaeologists who study foraging people often are charged with the difficult task of “bringing to life” an entire prehistoric culture by using information derived solely from the “stones and bones” typically left at a site. Often the goal is ideally to provide a dynamic image of the ancient people much in the way that an ethnographer would characterize the annual round of the site inhabitants. It is common for ethnographies to demonstrate how a foraging people responded to seasonal changes in the distribution of food resources by moving to various parts of their land to acquire different kinds of food during the times of year when those food resources were available (e.g. Steward 1938). From this stems the concept of the annual round, which incorporates the idea that people made use of the food resources of a particular tract of land by following a pattern of movement that took place year after year. As discussed below, predictability in the location of food resources may cause the regularity of human movements across the landscape to vary from being highly regular to seemingly random. Nevertheless, the idea that annual variation in environmental conditions, including food resources, would have caused groups of foragers to normally be in certain places on the landscape at one time of year and at other places during other seasons is a useful concept.

To help with efforts to illuminate the annual round of a group of prehistoric foragers, archaeologists have found utility in the concept of land use, which can be simply defined as the way that a people move about the land in order to acquire its resources and interact with others. To begin the process of illuminating prehistoric annual rounds, American archaeologists working in the time period from the late 1960s to the early 1980s placed much emphasis on considering the possible effects that food acquisition and storage would have on the land use patterns of prehistoric hunter-gatherers (e.g. Binford 1980). Furthermore, initial attempts at developing middle-range theory that ultimately aim to give archaeologists the
tools to illuminate land use patterns through tool stone sourcing also began during this period (Gould and Saggers 1985; Binford and Stone 1985; Binford 1985; Gould 1985).

The conception that land use can be thought of as people moving about the land solely to acquire food resources was compatible with the traditional view that Paleoindian land use was principally shaped by people following the wide-ranging and irregular movements of big game herds. As mentioned, the idea that following herds of game animals was the prime determinant of land use has been a feature of Paleoindian archaeology since its inception. Later, the possibility that low human population density may have allowed for a unique subsistence economy focused on big game hunting was taken into consideration. Later still, the Kelly and Todd model incorporated the above thinking into a more complex theoretical construct, placing Paleoindian subsistence economy within the context of a hypothetically unique environment. The model is nevertheless still comparable to the earlier formulations in so far that it takes the stance that land use can be revealed by considering the movements of people across the land as being solely directed toward acquiring food, albeit in a unique environment. Subsumed under the Kelly and Todd model is the earlier thinking that a frugal lithic technology allowed Paleoindians to remain on the hunt for big game with only occasionally stopping off at a source of high-quality stone. Thus, the need to acquire stone would have had only a subordinate effect on land use patterns. Proponents of the traditional view therefore believe that Paleoindian land use can be largely understood by theorizing the ways that specialized procurement of big game as a food resource would have influenced the movement of Paleoindians across the land.

Acquisition of food resources remains a strong factor influencing the movement of foraging peoples under the alternative view, though it is suggested that archaeologists broaden their thinking to consider how biotic resources other than foodstuffs would have affected the movements of people across the landscape. Consideration of the affect of food resource distribution on land use is seen in Bamforth’s (1988) predictions of how changes in
climate, forage, and bison herd distribution should have had corresponding effects on the
distribution and size of Paleoindian groups engaged in communal bison hunting. Movements
directed toward acquiring adequate food would have been an important factor affecting land
use, but one might suggest that the land use factor of food resources be broadened to include
biotic resources in general, since people moved about the land to acquire not only food but
other necessities of life, such as clothing and shelter. For example, large-scale bison kills
would have not only provided an ample supply of meat, but also an opportunity to acquire
hides to be processed into clothing and tent covers. That land use patterns of traditional
foragers would have been affected by concerns other than food is seen in the example of the
Chipewyan who hunted caribou on the tundra in August and September for their hides, which
were in prime condition for use as clothing or tent coverings (Smith 1978:71). Later, in
October and November, as the caribou migrate southward into the boreal forest, the
Chipewyan traditionally engaged in communal hunting with the use of corrals and snares
constructed along the migration routes in order to put up stores of food for the winter.

Though staunch proponents of the alternative view do consider the importance of
biotic resources when theorizing land use patterns, they are distinguished from traditional
theorists in their insistence that the effects of tool stone availability also be considered. The
assertion that the distribution of tool stone sources effected forager land use is supported by
limited ethnographic accounts dealing with the effect of tool stone distribution on hunter-
gatherer land use. An example is seen in Campbell’s (1968) consideration of the effect of the
geological environment and tool stone distribution on the movements of members of a band
of Nunamiut, as reconstructed for a five year period prior to 1875, when a traditional way of
life was still being followed:

Nearly all exposed bedrock is of sedimentary or meta-sedimentary origin. The
limestones contain chert and chalcedony, which were important to the Tuluaqmiut for
tool making. Other rocks used in tool manufacture included chalcopyrite, basalt,
obsidian, micaceous schist, slate, dolomite, quartz and steatite. In addition, hematite was
used as a pigment; oil shale was occasionally used as fuel; and a certain clay was eaten.
All of the above rocks and minerals occurred at various places in or near Tuluaqmiut territory, and their exploitation in part determined the ranging and settling patterns of the band [Campbell 1968:5].

Campbell’s statements demonstrate that forager land use is affected not only by the distribution of stone for tool manufacture, but also by the distribution of minerals with other uses. With this in mind, it is relevant to note that hematite was used by Plains Paleoindians and its acquisition would therefore have had some effect on land use. An example is seen in a source of hematite in the Hartville Uplift of southeastern Wyoming which was quarried as a source of ochre throughout the Paleoindian period (Stafford 1990; Tankersley et al. 1995). From the above information, it can be stated that Paleoindian land use patterns would have to some extent been affected by the distribution of tool stone and other minerals.

Yet the limited nature of the information on tool stone use by foragers of modern times may obscure a true appreciation of the degree to which raw material availability may have influenced prehistoric land use patterns. In the case of the Nunamiut band of recent times studied by Campbell, stone was available in or near the range habitually exploited by the band for food resources. Therefore, sourcing stone artifacts left at a site by the entire band or smaller social groups may provide a fair estimate of the range exploited for food resources. However, large expanses of the Great Plains are devoid of quality stone and yet would have had adequate food resources for foraging peoples. People native to such areas would have to cope with this situation by importing stone into the area by some means. One way of dealing with a lack of quality local stone would have been to simply go and get it from one or more distant sources. Individuals or small task groups could go and collect a supply of stone rather than the entire social group having to make the journey. If this were the case with Paleoindians, the land use pattern of a group native to an area devoid of quality stone would have involved the acquisition of food resources within an area that may not have been especially large in comparison to ethnographic ranges, but would also have entailed
procurement of quality stone from sources within an area that would be of a size far larger than any ethnographically recorded range.

Artifact assemblages from the Lubbock Lake site on the plains of Texas serve to illustrate this point. The site is located at a wet area along a meander of Yellowhouse Draw that was dredged in the 1930s to make a reservoir. A sequence of nine occupations indicative of the processing of small-scale bison kills extending from Folsom to late Paleoindian times were excavated. The site is located in a portion of the Southern Plains devoid of quality stone. In all nine assemblages, three quality tool stones augment the locally available, low quality tool stones. The quality tool stones comprise a total of 40 percent of the entire site assemblage (Bamforth 1985:Table 4). Based on the site location in relation to published plots of the quality tool stone source areas, Alibates agate is available 190 km to the north, Tecovas jasper occurs 100 km to the northeast, and Edwards chert is 130 km to the southeast (Bamforth 1985:Figure 1; Hofman, Todd, and Collins 1991:Figure 1; Shelley 1984:Figure1). Considering that proponents of the alternative view insist that the effect of raw material availability be considered when modeling Paleoindian land use, these data could be interpreted as evidence of task groups and individuals visiting sources of quality stone within an area measuring about 300 km north-to-south and bringing it back to an area of unknown dimension in the vicinity of Lubbock Lake which was habitually exploited for food resources. In contrast, advocates of the traditional view analyze the tool stone composition of assemblages with the understanding that quality tool stones in Paleoindian assemblages were acquired by bands during visits to sources as part of a land use strategy shaped principally by a highly mobile big game food resource and thus would conclude that the very same data is actually evidence that bands operated within an area measuring 300 km north-to south at the very least.

The two theoretical views also differ greatly because staunch supporters of the alternative view further insist that any attempts to understand land use of a prehistoric people
must consider the affects of interaction with neighboring human groups. The ethnographic record indicates that in response to seasonal changes in food resource availability, land use patterns of foragers commonly involve dispersal of people into small groups at certain times of the year and aggregation into large groups at other times. With this in mind, alternative minded archaeologists intent on considering the effect of tool stone availability and social interaction would caution that in a situation where multiple bands arranged to meet in an area lacking quality stone in order to cooperate in a communal hunt, they would necessarily have had to bring in stone. This would produce an artifact assemblage with a disproportionate amount of stone from distant sources.

To illustrate, one might imagine a situation where a communal hunt is to take place in the range of a local band and neighboring bands from habitual ranges lying to the north and south are also planning to attend. First, let us assume the bands operated within ranges comparable to the largest ethnographically recorded ranges, so we will use the maximum range dimension of 143 km reconstructed by Campbell (1968:Figure 2) for a particular band of Nunamiut in the interior of Alaska. Let us also assume that the communal kill took place in the center of the middle band’s range and that the bands procured stone in their respective ranges in preparation for the event. In this situation, stone brought to the communal kill could derive from sources within an area measuring 429 km in maximum dimension (143 km X 3). If an archaeologist operating under the traditional view were to source tool stones present in an artifact assemblage from a Paleoindian bonebed and find the stone derives from an area measuring 429 km in maximum extent, he or she would feel justified in concluding that a large number of animals were killed by a band of hunters operating in a huge area. However, an archaeologist operating under the alternative view would also feel justified in reasoning that another possible explanation for the tool stone composition of the assemblage is that it simply results from the aggregation of neighboring Paleoindian bands that operated
within home ranges that were not necessarily larger than the size of ranges recorded for ethnographic foragers.

SOURCES OF INFORMATION FOR THEORIZING LAND USE

Besides the contrasting conceptions of land use, another methodological distinction between the views concerns a difference of opinion as to what are the appropriate sources of ideas for understanding Paleoindian land use. The alternative school does not agree with the notion that environmental conditions of Paleoindian times were so unique that analogy to modern environments and ethnographic hunter-gatherers cannot serve as a source of ideas for theorizing land use. Therefore, it makes use of the ethnographic record as a potential source of knowledge.

Steward’s (1938) study of the foragers of the Great Basin and Snake River Plain is relevant to this discussion for two reasons. First, it demonstrates how foragers adapt to the environment and its seasonal changes by means of the subsistence economy and through means of social organization. Foraging peoples that North American ethnographers have grouped into culture areas were similar in large part because they lived within the same ecological zone. Ethnographic studies of culture areas such as Steward’s document the influence of plant and animal species of the region on the subsistence economy of inhabitants and also the effect of seasonal changes in food availability on social organization. In response to such changes, the size of forager groups commonly varied throughout the year with people dispersed into small groups during certain seasons of the year and aggregated into larger groups at other times. Secondly, Steward’s work demonstrates how the ethnographic record can illustrate variation in land use patterns and suggest ways that variation in prehistoric land use strategies may be theorized through ethnographic analogy.
The ethnography demonstrates how the land use trait of range size varied with changing environmental conditions. For example, environmental conditions in the Owens Valley of southern California permitted bands of Paiute to be largely sedentary while making a living from relative small ranges distributed along streams flowing down the Sierra Nevada. Roughly 200 people living at a permanent habitation site known as Fort Independence foraged within a home range measuring only 32 km by 6 km (Steward 1938:Figure 7). In contrast, groups of Shoshone living in the extremely arid region in the vicinity of the Kawich Mountains of south central Nevada necessarily had to cover a much larger area in order to make a living off of the land. These groups were very dependent on harvests of pine nuts for survival and the location of available nuts could vary greatly depending on the annual rainfall pattern. Information provided by Steward (1938:110-113, Figure 8) suggests that under drought conditions, people in the area of the Kawich Mountains had to forage within a range measuring about 120 km in maximum dimension.

Variation in the regularity with which foragers moved about within their habitual ranges is also evident. In arid areas of the Great Basin where the Shoshone were dependent upon gathering seeds of grasses during the early summer months, bands dispersed into family units whose movements were highly irregular because the non-uniform distribution of rainfall changed the areas in which edible plants could be found from year to year (Steward 1938:19-20, 232-233). In contrast, the distribution of food resources in the Snake River Plain of southern Idaho caused Shoshone families living in that area to have a highly regular land use pattern at least in the sense that it involved converging every summer on a restricted number of convenient fishing places were quantities of Chinook salmon migrating up the Snake River from the Pacific Ocean could be procured (Seward 1938:42-43, 234).

As with modern environments in the Great Basin, those of Paleoindian times varied to the extent that each had a differing set of available food resources (Beck and Jones 1997). From this, it may be reasoned that environmental differences across the Great Basin and
Snake River Plain in Paleoindian times may have contributed to the development of variations in the land use patterns followed by foraging peoples.

Variation in protohistoric land use patterns in the Great Basin and Snake River Plain is likely not reflected in projectile point morphology and this has bearing on the validity of the belief that makers of Paleoindian point types possessed a land use pattern that was distinctive from later time periods. In protohistoric times, the Desert Side-Notched point would have been in use by all peoples throughout both regions (Heizer and Hester 1978; Holmer 1986). Many of the Paleoindian point types of these regions are also widespread in distribution. Under the traditional view, makers of Paleoindian point types would have a subsistence economy focused on big game hunting that dictated an irregular and geographically extensive land use pattern. Steward’s ethnography strongly suggests that makers of the widespread Desert Side-Notched point would have possessed a great diversity of land use patterns. An implication of the above observations is that the presumption that projectile points are always reliable indicators of a particular kind of subsistence economy or land use pattern is unjustified.

Limited archaeological evidence relating to Paleoindian subsistence economy in the Great Basin supports the possibility that land use patterns may have been somewhat similar to that of ethnographic people. Ground stone artifacts in Paleoindian levels of Danger and Hogup caves in the eastern Great Basin suggest that the subsistence economy relied to some extent on harvesting of plant foods, especially pickleweed seeds, but also prickly pear and other plants (Beck and Jones 1997). There is a possible problem with the dating of the Paleoindian components at the sites because even though the levels have associated radiocarbon dates, few lanceolate Paleoindian points were recovered. Furthermore, notched types that usually are dated to the following Archaic period elsewhere in the Basin-Plateau region also occur in the levels, implying that a certain amount of stratigraphic mixing has taken place. A further difficulty is that there is currently not a reliable way to assess how
important seed gathering was to Paleoindian subsistence. For the sake of discussion, however, it may be pointed out that if seed gathering proves to have been important to Paleoindian subsistence in this area of the Basin-Plateau region, one would be justified in theorizing, based on ethnographic analogy, that Paleoindian land use during the summer months may have involved irregular movement of groups across the landscape.

Limited archaeological evidence on Paleoindian diet from the Snake River Plain supports the possibility that land use in the region may have been regular to the extent that it involved returning to convenient fishing places along the river in order to harvest anadromous fish during their annual migrations. In the 1990s, the remains of a 17 to 21 year-old woman were found along the Snake River in Idaho (Green et al. 1998). The human remains were radiocarbon dated to 10,675 ± 95 B.P. and were recovered in association with a stemmed Paleoindian point and other artifacts. Stable carbon isotope analysis of a bone sample suggests that the diet of the woman was based on continental terrestrial or aquatic animal food resources supplemented by anadromous fish. Given that ethnographic foragers living along the Snake River annually returned to the same spots to harvest salmon, it may be theorized that Paleoindian land use in this portion of the Snake River Plain may have also involved a certain amount of regularity.

The above discussion is meant to serve as a heuristic exercise to illustrate the ways that alternative thinkers use ethnographic analogy in conjunction with archaeological evidence to theorize Paleoindian land use patterns. The assumption that widespread point types are reliable indicators of a geographically extensive subsistence economy or land use pattern was found to be questionable. Archaeological evidence relating to diet and subsistence economy, however, should provide a more reliable basis from which to infer variability in land use. If the diet and subsistence economy of Paleoindians can be better defined, knowledge on how particular kinds of plants and animals affected the land use...
patterns of ethnographic foragers may serve as a source of testable ideas to build theory on prehistoric land use.

As discussed above, proponents of the alternative view further assert that the archaeological record itself is also an important source of evidence for building theory on Paleoindian land use. Wobst (1978) has pointed out there must have been forms of prehistoric hunter-gatherer adaptations that have no good ethnographic analog. To encourage using archaeological data in its own right to develop land use theory, Bamforth (2009a) promotes the bottom-up approach to theory development.

Traditional-minded archaeologists also necessarily, though implicitly, maintain that ideas for theorizing land use must come from the archaeological record itself, but the basic method of doing so is different. While alternative thinkers may use ecological principles and ethnographic analogy to guide the process of building theory to explain variability in aspects of land use, staunch advocates of the traditional view would be less inclined to use these methods if indeed environmental conditions were not at all analogous to those of recent times. Instead, they interpret the archaeological record as best they can and reference the forager-collector continuum as the theoretical basis for the interpretation. However, there is no principle in the forager-collector continuum to guide the interpretations produced in the same manner that known ecological relationships and principles of foraging theory and behavioral ecology have guided the conclusions of alternative-minded theorists. This arguably leaves the traditional view open to the criticism that their methods of investigation are less replicable and therefore not as objective.

Many alternative-minded archaeologists are further doubtful of the ability of traditionalists to do objective research because their basic mode of operation seems to be to use archaeological evidence to prove the conclusion that Paleoindian bands moved about in an irregular fashion throughout huge areas. This basic approach is an ill-advised way of trying to do objective research because setting out to prove an idea is correct can often lead to
investigators focusing on a limited and therefore biased range of evidence. Rather, proponents of the alternative view recommend that researchers should strive to recognize all variation in the archaeological record that potentially relates to land use and then develop models capable of explaining the full range of variation.

CHAPTER SUMMARY AND CONCLUDING REMARKS

An outline has been provided of the essential differences between the ways that the two views go about building theory on Paleoindian land use. Models of land use produced from the alternative perspective by Meltzer (1988) and Bamforth (1988) were constructed by reasoning from an overarching body of theory concerning the relationship between the environment and foraging peoples. Principles of foraging theory and behavioral ecology, as well as known ecological relationships in specific study areas, guided construction of the theoretical models which may be described as linear arguments composed of a series of causal relationships between variables, beginning with environmental variables and ending with variables related to human land use. In contrast, Binford’s (1980) forager-collector continuum, which examines the relation between the environment and hunter-gatherer land use on a global scale, is the overarching theory from which Kelly and Todd (1988) develop their model of early Paleoindian land use from the traditional perspective. The forager-collector continuum does not incorporate guiding principles such that the Kelly and Todd model may be described as a linear argument. Rather, the model is likened to a flow chart that attempts to link theoretically unique environmental and demographic conditions to the supposedly unique subsistence economy, social organization, and land use of early Paleoindians.

Models of Paleoindian land use differ in their use of analogy to construct theory. In the models constructed from the alternative view, environmental conditions are seen as
differing from those of today, yet analogous in that ecological principles that govern the
world today may be used in conjunction with paleoenvironmental data to model the
Paleoindian environment. Furthermore, it is understood that Paleoindian behavior would
have been analogous to the theoretical behavioral responses of foraging people in general to
given environmental conditions. The behavioral responses may be modeled based on an
understanding of paleoenvironmental conditions, ecological relationships, and principles of
foraging theory that would have affected the behavior of foraging peoples in the study area
throughout prehistory. In the model developed from the traditional view, the environmental
and demographic conditions during early Paleoindian times are not at all analogous to
conditions during ethnographic and modern times. These unique conditions would have
brought about unique cultural responses by early Paleoindians. Nevertheless, the behavior of
Paleoindians would have been analogous to what may be expected for hunter-gatherers in
general, given the theoretical understanding of the relationship between the environment and
human adaptations as outlined in the forager-collector continuum.

The two views also differ in the extent to which archaeological evidence is offered in
support of the land use models developed. Meltzer’s (1988) model proposes that early
Paleoindian subsistence economies in eastern North America would have varied between
forest and tundra ecozones, as would the geographic extent of the land use pattern. Evidence
relating to Paleoindian diet is presented to support the purported difference in subsistence
economies. Data on the differing proportions of local to nonlocal tool stones in assemblages
from the two ecozones are presented to bolster the claim that the geographic extent of land
use varied between regions. Bamforth’s (1988) land use model predicts that environmental
changes influenced the size and distribution of aggregations of people for communal hunting.
Evidence relating to temporal changes in site size and distribution is offered in support of the
model. In contrast, Kelly and Todd construct a model that characterizes early Paleoindian
land use as having essentially entailed independent bands moving from one large-scale big
game kill to another. However, archaeological evidence offered to support this contention is weak.

In effort to strengthen the degree to which land use models are supported by archaeological evidence, Bamforth (2009a) more recently has advocated a bottom-up approach. He urges that archaeological evidence related to land use variables be collected to produce models from the ground up that are better supported by the archaeological record.

A major difference in the way the two views conceptualize land use was identified and discussed. Because of this difference, the two views consider differing factors when modeling land use. Traditionalists consider only the availability of food resources, but alternative thinkers assert that one must also consider raw material availability and social interaction between groups.

The differing conceptions of land use were illustrated through a discussion of the contrasting opinions on the size of Paleoindian band ranges envisioned by proponents of the two views. Traditional archaeologists assume that stone was procured by bands during visits to high-quality sources. Therefore, drawing a line around the sources represented in an artifact assemblage is believed to be a potentially reliable method of approximating the range exploited by a band. This method has produced estimates of Paleoindian ranges varying from 500 to 800 km in maximum dimension. To illustrate the potential affect of raw material availability on the tool stone composition of assemblages, alternative thinkers point out that in areas lacking quality sources of tool stone, people would have to acquire stone somehow, such as through sending task groups to go and get it from outside the habitual range, or via trade. Using the line-drawing method in this situation would falsely give the appearance of bands operating in huge ranges. To illustrate the need to consider the potential effects of social aggregation on the tool stone composition of an assemblage, advocates of the alternative view point out that if an assemblage from a bison bonebed in a region lacking stone resulted from aggregation of peoples who brought stone with them to a large-scale
bison hunt, the line-drawing method would again erroneously give the impression of
Paleoindian land use involving band movement within huge ranges.

Finally, the two views differ in the sources of information utilized to construct theory
on prehistoric land use. Alternative-minded archaeologists make use of careful ethnographic
analogy as a source of ideas for theorizing land use. Since the ethnographic record does not
illustrate all the ways the hunter-gatherers of the past may have adapted to environmental
conditions through subsistence economy, social organization, and land use, alternative
thinkers are also cognizant of the need to use evidence from the archaeological record itself in
order to develop models capable of explaining all the variability involved in Paleoindian land
use. Traditional archaeologists use only the archaeological record to model land use.

According to the Kelly and Todd model, the environment in early Paleoindian times was so
different from more recent times, ecological principles and generalizations about hunter-
gatherers from the ethnographic record must not be used to interpret the archaeological
record. Because traditionalists do not use principles to guide their interpretations, they are
open to criticism that their efforts are not replicable and therefore not as objective as they
should be. Moreover, since the mode of operation of some traditional archaeologists seems
to be to prove that Paleoindian land use entailed bands moving in an irregular fashion within
huge ranges, the work is again open to the criticism of being an insufficiently objective
method of investigation.

So it is that an intellectual rift has formed that separates Paleoindian archaeologists
into two distinct camps. To be fair to both factions, it must be pointed out that archaeology is
by its nature an ambitious pursuit where stories are often told about the past based on
precious little evidence and this is particularly true in the world of Paleoindian archaeology.
Still, members of both factions uphold the belief that such stories can be produced in an
objective manner and both value efforts designed to produce a more accurate understanding
of the past. Therefore, with this shared ideology in mind, I will in the following two chapters
turn to the task of further dissecting how a group of people with similar ambitions have come to hold such different views and how the disagreement might be resolved.
CHAPTER 3
HISTORICAL DEVELOPMENT OF THE OPPOSING VIEWS
AND PROBLEMS WITH TRADITIONAL THEORY

The purpose of this chapter is threefold. First, I will review the historical development of thinking related to Paleoindian land use. Special attention will be placed on the literature of the Great Plains, for this region has long been the scene of Paleoindian research. The review is intended to demonstrate that development of the state of knowledge in Paleoindian studies, as in any field, is based on prevailing schools of thought and the evidence available at the time. Furthermore, the review is intended to suggest that archaeologists, like specialists in other fields, are strongly influenced in their thinking by their academic training or what may be called their intellectual pedigrees. Since the initial discovery of Paleoindians at the Folsom type site on the plains of New Mexico, archaeologists have offered rational interpretations of the meaning of what they have uncovered in excavations and documented as surface remains encountered on surveys. These often straightforward explanations were couched in anthropological thinking prevalent in the early years of Paleoindian archaeology and were seemingly bolstered by later theoretical developments during the years of the “New Archaeology.” Nevertheless, the same basic reasoning that has been put forward to characterize Paleoindian land use that has its roots in the archaeology of the 1930s is essentially the same rationale with which many archaeologists maintain the traditional view to this day. Least the reader interpret the last statement as implying that old ideas are necessarily in need of improvement or replacement, it should be pointed out that much of the theory in use today to explain modern biological variation and
posit changes in life forms through time had its beginnings in the mid-nineteenth century. However, a review of the historical development of Plains Paleoindian archaeology will also demonstrate more recent evidence that is simply not consistent with the traditional view. The second goal of the chapter will therefore be to identify the main theoretical problems with traditional thinking and to summarize the evidence from the Plains upon which alternative-minded archaeologists base their call for revision. The third goal is to assess the validity of the claim for unique environmental conditions during Paleoindian times. This is an issue that must be addressed at the onset because if Paleoindians lived in an environment that is not at all analogous to that of today and they responded to these conditions with unique subsistence strategies and forms of land use that had no analog to ethnographic or modern foragers, then the alternative view would not be defensible. This school of thought is dependent in part on the understanding that principles of human ecology developed from the study of recent peoples and environments along with cautious use of ethnographic analogy may be helpful in constructing testable models of Paleoindian land use.

The historical development of thinking related to Paleoindian land use will be traced using three stages that partly follow developments in American archaeology (Willey and Sabloff 1974). During a stage labeled the “Early Years” (1927 to the mid-1960s), Paleoindian archaeology was concerned with the tasks of accumulating enough information to make basic defining statements about Paleoindians, establishing a chronology of projectile point types, and providing absolute dates for the types with radiocarbon dating. In the following stage, here termed “The New Archaeology and Other Influences” (mid-1960s to early 1980s), the field of Paleoindian archaeology was shaped by an intellectual movement intent on directing archaeological inquiry toward addressing questions of concern to anthropology as a whole. Efforts were made to develop methods that would allow archaeological evidence to be used to elucidate how prehistoric cultures operated and changed through time. Paleoindian archaeologists and others concerned with hunter-
gatherers of the past tried to develop means by which archaeological remains primarily
recovered from excavation of individual sites could be used to elicit a broader picture of the
way that foragers made use of the land and its resources. In the ensuing period, here called
the “Rise of Alternative Thinking” (early 1980s to present), proponents of this view have
called into question the theoretical foundations of the high mobility model and, based on
evidence not consistent with traditional thinking, have begun to construct alternative models
of land use.

THE EARLY YEARS (1927 TO THE MID-1960s)

Emphasis on Sites Associated with Large-Scale Kills

From its inception, Paleoindian archaeology has focused on the excavation of sites
associated with large-scale kills and in doing so has dealt with archaeological remains that
may elucidate but one aspect of Paleoindian subsistence economy. Meltzer (1988:3)
correctly points out that a focus on kill sites was initially a necessity in Paleoindian studies.
Prior to the advent of radiocarbon dating, the only way to prove that humankind made its first
appearance in the New World sometime in the later part of the Pleistocene was to
demonstrate the direct association of artifacts with now-extinct animals. This was first done
in 1927 at Folsom, New Mexico where points and tools were uncovered within a bonebed
comprised of the remains of a form of bison considerably larger than the modern variety.
Then, in 1932 on the plains of Colorado, the first specimens of what would later be named
Clovis points were excavated from a bonebed representing the remains of a minimum of 15
mammoths (Wormington 1957:43-44; Brunswig 2007). The large number of mammoths at
the site served to bolster the thinking that Paleoindian subsistence economy very much
emphasized big game hunting. Haynes (1966:110-111), for example, would later suggest the
mammoths were killed in a single event by driving them over a cliff. Emphasis on
excavation of kill sites continued even after the initial need to demonstrate the contemporaneity of humans with extinct animals, as a substantial number of kill sites were excavated throughout the early years (Wormington 1957). One these sites is known as Olsen-Chubbuck and is essentially a filled-in ancient arroyo where it is estimated that 193 bison were slaughtered by Paleoindians on the plains of southeastern Colorado in a single kill event (Wheat 1972). The site was excavated in 1958 and 1960 and its publication in the popular scientific literature (Wheat 1967) did much to justify the assessment of Plains Paleoindians as capable big game hunters.

**Widespread Point Types**

Even after the contemporaneity of people with Pleistocene animals was established, Paleoindian archaeologists continued to excavate sites related to large-scale kills in part because this kind of site can yield numbers of projectile points. Documenting diachronic changes in this class of artifact was a means of establishing a basic chronological ordering of the archaeological record. During the period extending from the late 1920s to well into the 1960s, American archaeology was concerned with defining artifacts types in time and space with the understanding that this work will help to define prehistoric cultures. American anthropology during this time period considered culture to be a set of shared norms and ethnographers of the day were intent on defining a list of traits or “culture elements” for the peoples they were studying with the understanding that shared traits may document cultural connections across time and space. At universities in the United States, where archaeology was and is an integral part of anthropology departments, archaeologists were influenced by their colleagues in cultural anthropology to the extent that archaeology was intent on defining the spatial and temporal distribution of artifact types in order that such information could be used to define the geographic extent and historical relationships of prehistoric cultures. It was through the excavation of sites associated with large-scale kills that archaeologists were
able to establish a basic chronological ordering of the Paleoindian period, even in the absence of absolute dating methods. Paleontologists of the day had established that following the extinction of the mammoth, bison became progressively smaller in body size and with this information, Plains Paleoindian archaeologists established that fluted Clovis points were used to hunt mammoth in the time prior to the days when fluted Folsom points were used to hunt giant bison. In turn, Folsom points were in use before various unfluted later Paleoindian point types were used in the hunting of somewhat smaller bison. The extinction of the mammoth, horse and camel in the Clovis period was the basis for the hypothesis that Paleoindians were indeed capable hunters who had overhunted certain species to the extent that they became extinct (Martin 1967). Beginning in the 1950s, the introduction of radiocarbon dating confirmed the basic chronology established via the study of point types recovered from bonebeds, but the resolution of radiocarbon dating is such that chronological questions remain.

It was only toward the end of the period in question that other kinds of sites first attracted the attention of archaeologists and even then a main motivation for investigating sites without bonebeds was simply to clarify the understanding of prehistoric chronology. In the late 1940s and early 1950s, deeply stratified Paleoindian sites in the Medicine Creek drainage of Nebraska were excavated as part of reservoir salvage work (Wedel 1986:66-71). In the mid to late 1960s, stratified Paleoindian levels at the Hell Gap site complex in Wyoming were excavated by Harvard (Knudson 2009). From work at Hell Gap and elsewhere, a radiocarbon dated chronology was produced. For the reader unfamiliar with Paleoindian archaeology of the western Plains, Table 3-1 presents the basic temporal framework and gives the approximate time range associated with the various point types expressed in uncalibrated radiocarbon years. The typology of Plains Paleoindian points is discussed in detail in Chapter 8.
Table 3-1. Paleoindian Time Periods of the Western Portion of the Great Plains Defined on the Basis of Projectile Point Types.

<table>
<thead>
<tr>
<th>Broad Temporal Unit</th>
<th>Named Period on the Southern Portion of the Plains</th>
<th>Named Period on the Northern Portion of the Plains</th>
<th>Estimated Age in Uncalibrated Radiocarbon Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Paleoindian:</td>
<td>Clovis</td>
<td>Clovis</td>
<td>11,500 – 10,950 BP</td>
</tr>
<tr>
<td></td>
<td>Folsom</td>
<td>Folsom, Midland, and Plainview (^a)</td>
<td>10,950 – 10,250 BP</td>
</tr>
<tr>
<td>Late Paleoindian:</td>
<td>Plainview (^b)</td>
<td>Agate Basin</td>
<td>10,250 – 9900 BP</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hell Gap or Milnesand (^b)</td>
<td>9900 – 9500 BP</td>
</tr>
<tr>
<td></td>
<td>Cody (^c)</td>
<td>Cody (^c)</td>
<td>9500 – 8500 BP</td>
</tr>
<tr>
<td></td>
<td>various named terminal Paleoindian point types</td>
<td>various named terminal Paleoindian point types</td>
<td>8500 – 8000 BP</td>
</tr>
</tbody>
</table>

\(^a\) Sites producing unfluted points variously assigned to the Midland, Plainview, or Goshen periods are considered by some to be coeval with sites yielding fluted Folsom points. See text for further discussion.

\(^b\) The Plainview period follows Folsom on the Southern Plains, according to the chronology established at the Lubbock Lake site, but according to others, Agate Basin and then Hell Gap or the poorly known Milnesand period may follow Folsom. See text.

\(^c\) On the western Central Plains, the Cody point is partially contemporaneous with poorly defined concave-base lanceolate types of the eastern Central Plains. See text.
An important observation in the above discussion is that the very act of establishing a “culture chronology” based on point types tended to promote the notion that point types are reliable archaeological indicators of cultural groups and that by creating a chronology of point types, a succession of wide-spread prehistoric cultures has been identified. In the previous chapter, it was suggested that the last stone arrowhead type in use throughout the Great Basin was used by groups of people that are recognized as belonging to distinct cultures, namely the Shoshone, the Utes, the Paiutes, etc. Depending in part on environmental conditions, the subsistence economy and land use patterns of these cultural groups varied considerably even though they all presumably equipped their arrows with Desert Side-Notched projectile points. In light of this, alternative-minded archaeologists suggest that it is prudent to think of a sequence of Paleoindian point types as indicative of changes in hunting technology due to cultural processes that are as yet not fully understood, rather than definitely representative of a succession of cultures. Yet it is not uncommon to find publications today written in a traditional vane that refer to Clovis points, for example, as representative of a continent-wide cultural group with essentially the same subsistence economy, land use strategy, etc. (e.g. Kelly and Todd 1988). The origin of this thinking appears to be in the cultural anthropology of the early 1900s. Being dated does not necessarily mean that a particular line of thinking is wrong, but by the same token it cannot be said that the traditional concept that point types equate to cultural groups has been thoroughly and critically evaluated.

Later documentation of variation inherent in Paleoindian point types was to demonstrate that point types in fact are not uniform throughout huge areas. For example, distinctly different, named varieties of points that conform to the general Clovis type have been defined and illustrated in the eastern U.S. The geographic distribution of these varieties is still poorly defined, but seems to involve a considerable amount of overlap. Named varieties of Clovis points include Cumberland and Quad (Bell 1960:22, 80, Plates 11, 40),
Redstone (Perino 1968:74, Plate 37), and Ross County (Perino 1971:86, Plate 43). Another example is seen in what may be considered to be the many named varieties of points assigned to the Cody complex on the Plains and adjoining regions (Bamforth 1991b).

The meanings to be ascribed to variation in point types is a complex and poorly understood subject in need of further study, but suffice to say here that such research is relevant and necessary to a careful consideration of Paleoindian land use. A study of point variation among the Bushmen of southern Africa has demonstrated that real stylistic differences in points become very evident at a certain level of social structure, specifically that of groups of bands that inhabit certain areas and share the same dialect (Weissner 1983). In light of this, it reasonable to suppose that geographic variation in Paleoindian point types may be relevant to land use and social organization if it can be shown to reflect social groups that occupied certain areas and possessed certain similar items of material cultural that served to reflect group membership. Alternatively, in an effort to develop theory on Plains Paleoindian society, Bamforth (1991b, 2009b) hypothesizes that expert flintknappers among Plains Paleoindians mass produced many of the points used by hunters in large-scale bison hunts and that points may have been transported great distances in trade networks. From this, one might reason that geographic variation in point types may not specifically reflect land use, but rather in part result from patterns of trade in products produced by expert flintknappers. More will be said about this in a later chapter developing a specific research design, but it is sufficient here to note that research subsequent to the earliest years in Paleoindian archaeology has shown that geographic variation in point styles does exist and could prove useful to achieving a better understanding of Paleoindian land use and social organization.
Inception of the Idea of Large Paleoindian Ranges

In regard to why Paleoindian studies in the early years concluded that the first inhabitants of the North American continent were necessarily nomadic within huge ranges, the answer appears to be rooted in the widespread distribution of early sites. Based on the presumption that the presence of similar projectile points meant that widely separated sites were produced by the same prehistoric cultural group, it was thought that members of the hunting and gathering culture would necessarily have been very mobile. This line of reasoning first appears in Paleoindian literature as early as the 1930s as seen in Roberts’ (1939:541) consideration of the nature of Folsom groups in one of his reports on excavations at the Lindenmeier site, located on the plains of Colorado.

The widespread distribution of Paleoindian sites was also the empirical basis for another inference related to land use; that being the conclusion that population density must have been low relative to later time periods. Bolstering this line of thought was the understanding that Paleoindians were the first people to settle a previously uninhabited land. The logical extension of this view in regard to its implication of land use patterns is that Paleoindians would have lived in a land that permitted long-distance movement over huge ranges without being encumbered by having to be concerned about neighboring groups.

Influence of Neo-Evolutionary Thinking

The above ideas on Paleoindian population density, land use, and the way in which prehistoric cultures might be identified archaeologically developed throughout the earlier part of the period in question and were later codified in a publication intended to summarize what was believed to be known at the time about the development of human societies through archaeological studies. The document was a result of a conference attended by leading American archaeologists operating under what was then the dominant cultural anthropological school of thought: the neo-evolutionary perspective (Beardsley et al. 1956).
Contributors to the conference included a panel of prominent archaeologists like Betty Meggars, Alex Krieger, and Preston Holder, among others. Cultural anthropology of the time was concerned with identifying broad trends in the development of complexity in human societies. To place Paleoindians into an evolutionary scheme covering all humanity, ranging from the least socially complex to empires, early Paleoindian “community patterning” was typified as “free wandering” while later Paleoindian complexes were cited as archaeological examples of “restricted wandering.”

Passages from the report on the conference’s conclusions are worth citing at length.

In discussing free wandering, the authors offer the following:

Definition: A community that moves frequently and without restriction, the direction and continuousness of wandering and the amount of territory covered being conditioned only by the movement of large game and the local abundance of food resources.

…Territoriality exists among nonhuman primates, and man could have evolved with such a concept. This being the case, as long as he remained in the area of his origin, territorial restrictions would probably have been observed. However, it seems likely that such restrictions were temporarily waived when increasing numbers, increased human adaptability, or environmental changes such as retreat of glaciers made man’s geographical expansion possible. Such reasoning indicates that this was at most a temporary stage, transcended when population in the new area became well distributed and sufficiently dense, but it seems to be the best explanation for the rapid dispersal of the human species at certain periods… A free wandering community pattern is not characteristic of any intact culture today. …In the New World, the distribution of Clovis points over the greater part of North America may provide a comparable example, whereas Folsom points, being of much more restricted distribution, may represent a transition in the direction of the next community type: Restricted Wandering [Beardsley et al. 1956:135-136].

In regard to their concept of restricted wandering, the panel provides the following elaboration:

Definition: Communities that wander about within a territory that they define as theirs... Movement within the territory may be erratic or may follow a seasonal round, depending on the kind of wild food resources utilized. …Ethnographic examples: South American groups whose community pattern is Restricted Wandering include Ona, Yahgan, and Guayaki; in North America, the sub-Arctic Athabaskans, Chippewa, Shoshone, Paiute, Apache, and Coahuiltecs belong to this type. …Archaeological examples: Most of the sites and cultures identified as “Paleo-Indian” belong here, such as Frontier, Red Smoke, Plainview, Sulphur Springs, Chiricahua, Eden, and Cody [Beardsley 1956:136-137].

Finally, in reference to central-based wandering, the authors expound as follows:
Definition: A community that spends part of each year wandering and the rest at a settlement or “central base,” to which it may or may not consistently return in subsequent years. Ethnographic examples: The South American tribes characterized by a Central-Based Wandering pattern all seem to be incipient agriculturalists, whose environment or food growing technology is inadequate to make domestic plants a year-round food resource. Such tribes are sedentary in the rainy season and wandering in the dry season. Examples include the Sirionó, Timbira, and Caingang. North American groups, among them the Northern and Central California tribes, Interior Salishan tribes, and the Eskimo, make use of wild food resources. …Archaeological examples: …Krieger’s (1953) “Food Gathering” [stage] embraces Restricted Wandering as well as does Willey and Phillips “Archaic” [Beardsley 1956:138,140].

The above passages appear to be the origin of the thinking that early Paleoindian land use may not have been analogous to later hunter-gatherers, but a careful reading shows this was originally applied only to the makers of Clovis points under the rationale that their situation may have been unique as settlers of an uninhabited land and thus may have been mobile within huge ranges not comparable to later foragers. Later, the idea that Paleoindian land use was unique was expanded by Kelly and Todd (1988:239) to include the Folsom period and by citing evidence from Late Paleoindian sites to support their model, they imply unique land use patterns extended even later in time. They further transform the original suggestion of unique Paleoindian land use by asserting the cause was not due to the role of Paleoindians as colonizers, but also because of unique environmental conditions of the time.

The above passages also apparently are the genesis of the characterization of Paleoindian land use patterns as irregular, but careful reading again shows erratic movement originally was attributed to big game hunting foragers, both prehistoric and ethnographic, and the presumed irregular Paleoindian land use was not touted as a trait unique to this time period. It was only later that Paleoindian land use, specifically Folsom, was asserted to be uniquely irregular in comparison to later foragers (Hofman 1992).

From the above, it can be stated that the already existing view of Paleoindian land use as entailing movement within anomalously large areas was accepted into the then current anthropological theory (neo-evolution) of the 1950s and modified by further asserting that the land use of Paleoindians also entailed irregular movements. Again it must be stated that just
because ideas are dated doesn’t mean that they are no longer valid, but it is relevant to note that the practice of classifying all societies along an evolutionary continuum has rightly been called into question and the above passages suggest that construction of the types of “community patterning” discussed may have been influenced by a desire to suggest an apparently inevitable evolutionary scenario where “free wandering” foragers, when experiencing an increasing population, develop into “restricted wandering” foragers who, with further population growth, become “central-based wandering” foragers who are partly sedentary and described as being commonly “incipient agriculturalists.” One might suggest that characterization of Paleoindian land use may be flawed by the influence of a now discredited school of thought, but the crux of the matter seems to be how well the theoretical model is supported by archaeological evidence. Once again, a careful reading of the relevant passages demonstrate that the only archaeological evidence offered in support of the evolutionary scheme is the largely continental distribution of Clovis points and the more restricted distribution of Folsom and later point types. Considering that the use of points as indicators of the distribution of prehistoric cultures is on shaky epistemological footing, the critical reader is left to the conclusion that the idea of unique Paleoindian land use patterns is still very much a hypothetical proposition with little supporting evidence.

Origin of the Concept of Frugal Lithic Technology

The early years of Paleoindian studies, however, did see the beginnings of thought that would, in later years, lead to the development of other methods intended to provide evidence bearing on the nature of land use. In the subsequent period, traditional thinkers were to develop the concept of a lithic technology designed for the frugal use of tool stone as an archaeological indicator of high mobility. It is relevant to note that comments asserting that Paleoindians were conservation-minded in their consumption of tool stone appears early in Paleoindian literature. This suggested characteristic of Paleoindian lithic technology might
possibly have influenced the thinking of later theorists who propose a causal link between a conservation-minded lithic technology and high mobility. In a report on investigations at the Lindenmeier site, Coffin (1937:15) entitled one section “Frugal Folsom” and makes the following statements: “That frugality was a virtue of our early Coloradoan is shown by the many points and discarded fragments which definitely indicate that after a tip was broken a concerted effort was made to re-point the blade by resharpening. Thus it might be restored without removal from the shaft. Other finds represent instances where a base was re-formed after the blade had been broken near the base. The uniform thickness of the point would allow its resetting in the same shaft after its reconstruction. Many other ill-formed points indicate that attempts to restore them to their usefulness were not successful.”

The Promise of Tool Stone Sourcing

Later in the period, archaeologists realized that sourcing stone used in artifact manufacture offered a method to elucidate the geographic extent of land use. As mentioned, the Olsen-Chubbuck site in southeastern Colorado was excavated in the late 1950s and early 1960s. By the time the site report was published in the early 1970s, only some of the tool stones in the assemblage could be sourced (Wheat 1972:126-127). Wheat observed that the identifiable sources indicated trade or travel throughout a huge area of the Plains, extending as far north as North Dakota, southward into Texas, and reaching as far west as the Rocky Mountains. Wheat’s statement mentions an epistemological problem with the method, that being how to differentiate stone procured by site occupants via visits to lithic sources from that obtained through trade with other people. However, such problems were a moot point at this time because not enough was known about the various tool stones and their sources to make the method a viable one. For the period in question, only two of the major lithic source areas of the Plains were reported in archaeological publications. Knowledge of the quarry sites at the Spanish Diggings orthoquartzite source area in Wyoming were known through a
series of popular and academic publications beginning as early as the late 1800s and continuing through the period in question (see references in Reher 1991:258-262). Also, the period saw the publication of an article on the now-famous quarries of Alibates agate in the Texas Panhandle (Shaeffer 1958).

THE “NEW ARCHAEOLOGY” AND OTHER INFLUENCES (MID-1960s TO EARLY 1980s)

Beginning in the 1960s, the effects of a new intellectual movement intended to improve the ability of archaeology to “bring to life” past societies in all their complexity took hold in American archaeology. From the 1930s on into the 1980s, American cultural anthropologists working from a functionalist perspective strove to demonstrate the manner in which cultures operate and change through time. Motivated by a desire to outline the processes affecting what must have been equally complex and dynamic cultures of the past, archaeologists of the day collaborated in a rather ambitious movement to do just that using archaeological data and for this they are also referred to as “processual archaeologists.”

I think it is fair to say that some processual archaeologists thought of themselves as the cultural anthropologists of the past, with some specializing in certain geographic areas, as would an ethnographer, and others working to establish cross-cultural generalizations or explanations of cultural change, much like an ethnologist. The intent of such comparisons was, of course, not to disavow limitations of the archaeological record, but to foster thinking about ways that archaeological evidence might be used to portray past cultures in a more dynamic way as formerly living societies. Cultural ecology and a materialist perspective that viewed culture as man’s non-somatic means of adapting to the environment were prevalent in American cultural anthropology of the time. In part, this development may have been influenced by the earlier work of ethnographers of the early 1900s whose work was largely
descriptive but which nonetheless demonstrated through the definition of various “culture areas” that environmental conditions of the various North American physiographic regions seemed to have an influence on the kinds of material culture, subsistence economy, and to some extent, the forms of social organization common to those areas. So it was that a voluminous literature was created, organized into various culture areas, such as the Great Plains and the Great Basin. Later ethnographers working from a functionalist perspective were interested in further investigating the apparent causal connections between environmental conditions, subsistence economy, land use patterns, and social organization to present a more dynamic view of the culture in question. Steward’s (1938) richly detailed ethnography of Great Basin peoples serves as a good example. Considering that the “stones and bones” of hunter-gatherer archaeology can most easily provide data relevant to elucidating particular aspects of culture, like technology and subsistence economy, as well as addressing research questions into cultural ecology, archaeologists interested in studying foraging peoples found themselves in the forefront of developments in archaeology as many of them optimistically set off to produce models of prehistoric foragers as detailed as Steward’s ethnography of Great Basin peoples.

Somewhat paradoxically, at the same time new archaeologists were charged up and ready to make more detailed and dynamic reconstructions of past cultures, they also were keen on promoting the use of methods intended to improve the objectivity of research (Watson, LeBlanc, and Redman 1971). To achieve a more scientific approach, it is characteristic of processual archaeology to design research in such a way that some cultural activity or process hypothesized to have occurred is tested by first developing expectations as to the kinds of patterns to be expected in archaeological data and evaluating how well the data conforms to expectations. The use of statistics to confirm that some pattern in the data thought to reflect a cultural activity is real and not due to chance alone first became commonplace in archaeology during this era.
Ecological Modeling and Methods Based on Ethnographic Analogy

As processual archaeologists pondered methods that might serve to elucidate prehistoric cultures in a more scientific way, a division formed in the discipline with one group believing that methods derived from the science of ecology would prove to be of most utility in the study of prehistoric foragers. Within this camp, optimal foraging theory was found to be of value to the study of past hunter-gatherers (e.g. Winterhalder and Smith 1981). Furthermore, the work of Jochim (e.g. 1976) in particular is noteworthy because his ecological approach to interpreting the archaeological record was influential in a basic way on his student, Douglas Bamforth (1988), who later was to publish extensively in Paleoindian studies.

Another methodological approach had the goal of developing theory intended to explain the variability in prehistoric hunter-gatherer adaptations based on ideas obtained through ethnographic analogy, especially ethnoarchaeological studies of living peoples. This approach was pioneered by Lewis Binford, (e.g. 1978a) who was an influential personality. Among his many students were several who went on to work in the realm of hunter-gatherer archaeology and Paleoindian studies in particular. Included are E. James Judge, Daniel Amick, Charles Reher, Lawrence Todd, Robert Kelly, and Jack Hofman.

The Forager-Collector Continuum

Of his many projects, one that proved to have great impact on a great many hunter-gatherer archaeologists was Binford’s (1980) development of the theoretical concept of the forager-collector continuum. After reviewing the ethnographic literature on the surviving hunter-gatherer cultures the world over, Binford presented his thinking on the nature of hunter-gatherer adaptations to the environment which he conceptualized as a continuum with “foragers” typifying hunter-gatherers of equatorial regions and occupying one end of the conceptual continuum and “collectors” typifying polar regions and positioned at the opposite
end of the conceptual continuum. As presented, the forager-collector concept suggested causal links between the environment and various aspects of culture, some that seemed observable in the archaeological record and some that are much less so. Included were aspects of subsistence economy, mobility patterns, food storage, and artifact curation. In a following section, I will level some serious criticisms at the concept and question its utility. However, there is no doubt that for the period in question, the concept was wildly influential to a broad audience of archaeologists hungry for conceptual tools promising to provide insight into hunter-gatherer adaptations using but the meager remains commonly left in the archaeological record of foraging peoples.

Shortly before the publication of Binford’s forager-collector continuum, an article by Wobst (1978) appeared that made a point relevant to Binford’s work, as well as any others attempting to explain the archaeological record with ethnographic data. Wobst’s basic message was a caution that the range of subsistence economies, social organizations, etc. demonstrated by surviving hunter-gathering societies recorded in ethnographies was only a limited range in comparison to the diversity that likely occurred in the past. In consideration of this, anyone intent on building a theoretical model for a certain area that hopes to accurately portray hunter-gatherer adaptations in the past would do well to have an open mind to the possibility that the archaeological record may hold clues to forms of subsistence economy, social organization, etc. that are simply not recorded in the ethnographic literature.

Embedded Procurement and the Line-Drawing Method

Apart from the forager-collector continuum, another of Binford’s efforts at building theory relevant to prehistoric hunter-gatherers that proved influential to the work of his students and others is his ideas on the manner in which foraging peoples acquire tool stone as expressed in his concepts of embedded and direct procurement. During ethnoarchaeological study of foraging people in northern interior Alaska and to a lesser extent in Australia,
Binford developed the concept of “embedded procurement” which he set apart from what he labeled as “direct procurement.” He asserted that direct procurement was a misleading notion that other hunter-gatherer archaeologists of the time had inappropriately used to characterize tool stone procurement among foraging peoples:

Raw materials used in the manufacture of implements are normally obtained incidentally to the execution of basic subsistence tasks. Put another way, procurement of raw materials is embedded in basic subsistence schedules. Very rarely, and then only when things have gone wrong, does one go out into the environment for the express and exclusive purpose of obtaining raw materials for tools. …Most analysts of lithic remains assume a direct set of procurement strategies for lithic materials; that is, parties going out for the expressed and exclusive purpose of obtaining lithic raw materials [Binford 1979: 259-260].

From this, Binford reasoned that embedded procurement of stone by prehistoric hunter-gatherers has implications for both the proportions of tool stones typically left during occupation of a site was well as for the way that archaeologists should interpret the presence of stone from far off sources:

My experience with the Eskimo, and a limited but enlightening experience with the Alyawara of the central desert of Australia, has convinced me that variability in the proportions of raw materials found at a given site is primarily a function of the scale of the habitat which was exploited from the site location, possibly coupled with a founder effect resulting from discard on the site of items which had been manufactured previously at some other location… From my perspective, the presence of exotic cherts may simply be a fair measure of the mobility scale of the adaptation appearing as a consequence of the normal functioning of the system, with no extra effort expended in their procurement [Binford 1979: 260-261].

If the above statements apply to all foragers in all times and all places, and if we leave aside the complicating factor of reoccupation of a site producing mixed assemblages, then it becomes apparent that defining the range within which a band moved about to acquire adequate food resources would simply involve plotting the sources of the tool stones present in the assemblage on a map and drawing a line around these sources. For the purpose of discussion, I will simply refer to this as the “line-drawing method.”

In the next section, a number of criticisms will be leveled at the line-drawing method, but for the purposes of outlining important developments during the period in question, there
can be no doubt that the concept of embedded procurement was influential in shaping the thinking of many archaeologists of the day, including those of his students who continued on in the field of Paleoindian studies. The line drawing method is essentially the mode of operation that Amick (1996) followed to support his model of geographically extensive Folsom land use patterns in parts of the Southern Plains and adjacent Southwest. Also, the line drawing method was the basic approach of Hofman (1991) who also concluded that Folsom land use on the Southern Plains covered huge areas. Although the work of these scholars was based on sourcing collections of projectiles points rather than entire collections, Binford’s (1979:261) belief that “the presence of exotic cherts may simply be a fair measure of the mobility scale” is clearly an intellectual foundation of their method for investigating the geographic extent of land use.

Middle-Range Theory

Having outlined elements of Binford’s thinking that later proved controversial, it is just as important to review other aspects of his work falling under the rubric of “middle-range theory” that I believe has proved to be of value in pointing out the methodological difficulties that archaeologists must address if they wish to elucidate land use patterns of mobile prehistoric hunter-gatherers. In an article concerning epistemology in archaeology, Binford and Sabloff (1982:137) consider how archaeologists attempt to know the past through “the various ways that dynamic cultural processes can be linked with the static archaeological record.” In other words, to address grand research ambitions, such as modeling how a prehistoric culture operated and changed through time, it is first necessary to develop theory on how specific aspects of a culture, such as land use patterns and trade, may be identified and differentiated in the archaeological record. Theory developed to elucidate these more specific aspects of culture is what Binford has coined “middle-range” theory to set it apart from the higher level theory intended to characterize how societies operate and
change and presumably also from lower level theory dealing with such empirical concerns as accuracy and replicability of measurements.

The need to develop middle-range theory to better understand the archaeological remains of hunter-gatherers was the main motivation behind Binford’s research program among the Nunamiut. During various times of year, Binford observed the Nunamiut involved in activities at places on the landscape and recorded the material correlates of the activities to characterize the land use pattern and understand the ways that the material record present at individual sites may reflect regional land use.

Reoccupation of sites at differing times of year by groups of people involved in inherently different kinds of activities was found to be a serious complicating factor for archaeologists wishing to reconstruct the operation of a prehistoric land use pattern (Binford 1982). It is for this reason that much space will be dedicated below to assessing the number of occupations represented by the artifact assemblages from the study area as part of what is considered necessary to use the site collections to begin to construct a clearer picture of Paleoindian land use. Thus, Binford’s pioneering work on improving methods of archaeological inquiry through development of middle-range theory has relevance to Paleoindian archaeological research today, but it should be noted that Binford himself is not a Paleoindian specialist and that the bulk of actual investigation of Paleoindian sites during this period was being conducted by others.

**Bison Bonebeds, Social Aggregation, and Gearing Up**

Much of the field research into the Paleoindian period at this time was focused on large-scale bison kill sites of the Northwest Plains in Wyoming where George Frison was pursuing a long-standing interest in large-scale bison procurement. Many kill sites of the Paleoindian, Archaic, and Late Prehistoric periods were excavated in the 1970s and 1980s by Frison and his colleagues and students at the University of Wyoming (UW) (Frison 1978).
Paleoindian sites excavated included the Casper site, Carter – Kerr McGee, Horner, and Agate Basin. Many hunter-gatherer archaeologists who later earned a doctorate degree studying under Binford, including Reher, Todd, and Hofman, had earlier studied at UW where they gained field and lab experience working on bison kill sites. Todd and Hofman were later to pursue careers as Paleoindian archaeologists with Todd focusing on faunal analysis of bison kills (e.g. Todd 1987, Todd et al. 1996) and Hofman principally working with Folsom bison bonebeds and artifact collections from the Southern and Central Plains (e.g. Hofman 1992, 2003; Hofman et al. 1989). Reher’s research interests were to prove more varied, but his work dealing with Late Prehistoric kill sites and tool stone sourcing is especially relevant here.

The work of Frison and Reher was in some ways in step with the goals of archaeological research typical of the era. Archaeological assemblages from the Northwest Plains commonly are composed of stone tools used to kill and process game animals, but also sometimes include the bones of slain game animals. Given this, it is understandable from a practical point of view that investigating the lives of prehistoric people would begin with addressing the topic of subsistence economy. Exploring the ways that people acquire food from their environment was also in conformity with the emphasis in anthropology of viewing present and past cultures as adaptations to their environment. Excavation of kill sites thus began to elucidate prehistoric subsistence economy, albeit by focusing on but one aspect of the economy. Early on in their investigation of kill sites, Frison and Reher (1970) collaborated on developing a technique for determining the season-of-death for the bison killed at the Late Prehistoric Glenrock buffalo jump in Wyoming through analysis of tooth eruption and wear patterns evident on mandibles. Determination of the season-of-death for bison killed at the Glenrock and the Wardell sites in Wyoming (Frison and Reher 1970; Reher 1973) was the beginning of many years of research leading to Frison (1982a) hypothesizing that large-scale bison hunting in Wyoming was in large part conducted during
the fall in historic and Late Prehistoric times in order to put up stores of dried meat to survive
the winter months. Development of the technique for determining season-of-death permitted
bison kills to be viewed as a cultural adaptation to the environment of the Northwest Plains
where winter is a time of food scarcity. Thus, the work of Frison and Reher is again in
keeping with the larger research agendas of the day which emphasized study of the
interaction between prehistoric cultures and their environments.

However, Frison and Reher’s work was ahead of its time because it acknowledged
that the social organization of hunter-gatherers can be a means by which foraging people
adapt to their environment. This realization was nothing new to ethnographers such as
Steward (1938) who documented how groups of people would form larger aggregations in
times of food resource abundance or to cooperate in game drives. Perhaps most hunter-
gatherer archaeologists of the era tended to be less cognizant of social organization as means
of adaptation to be incorporated into models of land use because archaeological evidence for
social organization is not as obvious as is that for subsistence economy. However, Frison
(1978:243-248) has long referred to large-scale kill sites as “communal kills,” which to his
way of thinking meant that they are the result of multiple groups cooperating to supply the
labor necessary to organize a bison drive. Moreover, Frison interpreted large bison bonebeds
of all time periods as communal kills and did not consider Paleoindian bonebeds to be
different in having been produced by individual bands operating on their own.

In their analysis of the tool stone composition of the artifact assemblage from the
Vore site, a Late Prehistoric bison kill in the northern Black Hills in northeast Wyoming,
Reher and Frison (1980) take the idea of the communal kill one step further by providing
archaeological evidence to support the hypothetical aggregation of bands. Between roughly
A.D. 1600 and 1850, herds of bison were periodically driven into a sinkhole, resulting in the
accumulation of 22 identifiable bonebeds. Artifact assemblages from the bonebeds were
found to be composed of tool stone from four main sources located at considerable distances
from the site and situated in various directions from the site. Cultural deposits were
exhumed in ten one-foot-thick excavation levels, numbered consecutively from top to bottom.
The two lowest levels produced few artifacts, but larger samples amenable to comparison
were recovered from the eight overlying levels, ranging from 27 to 230 artifacts per level
(Reher and Frison 1980: Table 20). Nine tool stone types were defined, but four account for
the bulk of the total site assemblage. Spanish Diggings orthoquartzite is the most prevalent
tool stone and comprises between 46 and 84 percent of the collection of artifacts from Levels
1 through 8. Sources of this material are located about 220 km to the south-southwest. The
next most common raw material category includes porcellanite and non-volcanic glass from
the Ft. Union formation which accounts for nine to 21 percent of the collections, except for
Levels 4 and 5 where its presence dropped to three percent and less that one percent,
respectively. This raw material is believed to have been acquired from sources within a
broad area lying between 70 and 230 km to the west-northwest. Flint Hill quartzite
comprises between 4 and 13 percent of the artifacts from the levels, except for levels 6 and 8,
where it is absent. This raw material was obtained at a source in the southern Black Hills that
is located 140 km to the south-southeast. Knife River flint comprises between one and 13
percent of the collections and is absent from Level 7. Sources of Knife River flint
(commonly abbreviated “KRF”) lie between 320 and 350 km to the north-northeast. The
above data suggest that on at least 22 occasions throughout the course of roughly two and
one-half centuries, a bison drive was conducted at the Vore site and throughout this time
period, one or more cultural mechanisms operated in a fairly consistent manner to transport
artifacts to the site from surrounding regions. Some interruptions in the supply of artifacts of
the main tool stones did occur, however. Reher and Frison interpret the tool stone
composition of the Vore site as representative of a land use pattern whereby bands occupying
the surrounding regions would periodically aggregate into a larger social group to conduct a
bison drive at the Vore site.
To support their interpretation of the Vore deposits as resulting from the actions of an aggregated group, Reher and Frison develop the concept of “gearing up.” According to the authors, “[p]eople tended to ‘gear up’ at a quarry to provide sufficient amounts of superior quality material for numerous projectile points and large knife blanks. This activity results in kill site assemblages usually made up of several large ‘blocks’ of distinctive lithic types, apparently representing the aggregation of separate social segments… Given some degree of potential error, it seems especially feasible to use kill site lithics for territorial and other inferences” (Reher and Frison 1980:122). Upon review of the information presented by the authors in support of the concept of gearing up, the concept does seem to have considerable potential for explaining the tool stone composition of bison kill sites. The fact that sources of the four main tool stones lie in differing directions from the site is particularly intriguing. Considering that Flint Hill quartzite and KRF comprise 6 and 7 percent of the assemblage, it would seem that perhaps tool stones acquired for gearing up need not always account for “large blocks” of the assemblage, but rather just be present in at least substantial amounts.

An important element of the concept of gearing up is that lithic sources visited will have tool stone with three qualities conducive to the successful manufacture of large quantities of artifacts. First, the stone should be of good quality for knapping such that a number of artifacts may be produced without losing a large percentage to breakage during manufacture. Though not explicitly mentioned by Reher and Frison, a second quality of stone at sources used for gearing up is that it should be present in abundance so that an adequate supply of stone may be quickly located without having to collect it over vast areas. Finally, the stone should be available in large enough pieces so as to produce sizable bifacial artifacts, such as the “large knife blanks” mentioned by Reher and Frison (1980:122) as being typical of tools used as a bison kill. Also, in contrast to the small arrow points of Late Prehistoric bison kills, points from Paleoindian kill sites are generally larger and would have been manufactured from larger bifacial blanks. Many of the Alberta points from the Hudson-
Meng site in Nebraska provide exceptional examples of the large size of some Paleoindian points (Agenbroad 1989: Figures 23-26). Based on information in available literature, most of the lithic sources suggested by Reher and Frison as places suitable for gearing up operations meet the requirements of having raw material that is of good quality for knapping, as well as being present in abundance and in suitably large pieces.

The source area of Spanish Diggings orthoquartzite in the northwestern portion of the Hartville Uplift of southeastern Wyoming definitely meets the three requirements. This material is said to be composed of “exceptionally fine [sand] grains” (Reher and Frison 1980:124) and therefore is of “unusually high quality” (Reher 1991:258) for knapping. The quartzite is present in abundance and is available at an estimated “30 to 40 major quarry pit complexes” Reher (1991:272). A map of one of the larger quarry sites, known as the Barbour quarry, shows about 134 depressions representing pits or trenches (Reher 1991:Figure 16.3). The tool stone in the Spanish Diggings source area was formed through silicification of a sandstone in lenses that can be quite thick and massive and therefore can be broken apart in big pieces (see photographs in Reher 1991).

The Knife River flint quarry area also meets the three criteria for a source area suitable for gearing up. Knife River flint is said to have “excellent flaking properties” (Ahler 1986:1) and is available in abundance. Ahler (1986: Figures 2-3) discusses but one of multiple quarry complexes in a source area measuring 73 by 33 km. Within the study area, 65 quarry pit areas were plotted within an area encompassing 13 sections (33.7 km²). The tool stone is available in fairly large pieces. According to Ahler (1986:3), “[a]ll known KRF occurs as weathered, secondary pebbles, cobbles and boulders which are usually flattened or blocky and subangular in form… Cobbles vary in size up to 60 cm in diameter, but cobbles having a maximum length of between 10 and 20 cm are thought to constitute the materials most commonly recovered in KRF quarry operations.”
Based on information available in published literature, it is less certain, but nevertheless likely, that sources of the other two tool stones meet the criteria expected for stone sources suitable for gearing up. The qualities of non-volcanic glass from the Fort Union formation are not discussed in the literature. Porcellanite is said to produce sharp edges, but they are not durable because the material is relatively soft. Thus, this material was used to produce points used at the Vore site, but avoided for manufacturing butchering tools (Reher and Frison 1980:126). Sources of tool stone outcropping from the Fort Union formation occur throughout a broad area encompassing much of the Powder and Tongue River drainages in northeast Wyoming and southeast Montana. As will be elaborated in the chapter on tool stones, a search of the Wyoming site files produced site forms for a number of porcellanite sources in northeast Wyoming, but none of the forms note that the sources produce tool stone in particular abundance or in large pieces. It is possible that a large source of this material has yet to be found and recorded. Still, in reference to this tool stone, Frison (1982b:177) notes that “[i]t is plentiful…”, often comprising nearly 100 percent of flaked stone assemblages from the Powder River Basin. The dominance of Ft. Union formation materials among projectile points from four Archaic bison kills in Powder River Basin suggests they may indeed have been used in gearing up operations (Reher and Frison 1980:Table 25). In regard to the orthoquartzite from Flint Hill in the southern Black Hills, Frison (1982b:175) notes that “[a]lthough the texture of some Flint Hill quartzite appears coarse, it flakes well…” No mention is made of whether it occurs in large pieces, but its abundance is implied in Frison’s (1982b:174-175) comment that it occurs in a thick stratum that caps a large butte.

The above discussion suggests that the concept of gearing up is to some extent supported by archaeological evidence and may prove useful for elucidating land use of prehistoric bison hunting peoples in the future. However, it will need to be applied along with other considerations, including an understanding of the geographic extent of
ethnographically recorded band ranges and an assessment of the likely means through which each tool stone used in gearing up was acquired. Reher and Frison (1980:123,128-129) assert that the group that aggregated for bison driving at Vore formed what they term a “centralized band” and they imply that people may have traveled as a group to the lithic sources during the gearing up season. If the intent was to meet at the Vore site for a bison drive, traveling as a group to gear up at the widely dispersed lithic sources prior to going to the kill site would be very inefficient. A much more efficient way of preparing for the event would be for each individual band to procure adequate supplies of stone from the nearest source suitable for gearing up and then to meet with the other bands in the vicinity of the bison jump. If this were the case, it would imply a much more limited area utilized by each band.

Also, it must be kept in mind that drawing a line from a source used for gearing up to a bison bonebed may or may not be an accurate indication of the distance and direction traveled by the band to the bonebed. If the source used for gearing up was in between a band’s location and the bonebed, then drawing a line between the source and the site may to some degree reflect the band’s travel route. However, if, for example, a band was situated due north of the location where a bonebed would later be produced and the closest source was located even farther away to the northeast, then it may have been most efficient for the band to acquire stone by sending a task group to go and get it or by acquiring it through trade, rather than traveling to the source as a group. If this were the case, then drawing a line between the source and the bonebed would drastically overestimate the distance traveled by the band and give a somewhat inaccurate indication of the direction from which the band arrived. As will be discussed in detail below, having a conception of the size of ethnographically documented band ranges is useful for thinking about forager land use in the past. With this in mind, one might suggest here that the distance to the Knife River flint quarries (320 to 350 km) is so far away from the site that it is unlikely that all members of a band annually moved about within a range that incorporated both the site and the quarries.
This distance is over twice that of the largest ethnographically recorded band range. It is true that the ethnographic record is limited and therefore does not offer a complete understanding of the potential range of variation in hunter-gatherer cultural adaptations. However, this does not preclude one from referring to the ethnographic record to judge what is and is not a reasonable interpretation of past human behavior.

A final way that the concept of gearing up may need to be modified to improve its explanatory potential is that in cases where the participants of a bison kill planned to process hides for clothing, robes, tent covers, or other leather goods, gearing up would have involved not only the production of numbers of bifacial artifacts but also quantities of unifacial artifacts, particularly end scrapers. Apart from the modifications suggested above, the concept of gearing up as espoused by Reher and Frison stands as a potentially useful concept for investigating the role of aggregation in the land use patterns of foraging societies on the Great Plains.

Finally, it is relevant to note the willingness of Reher and Frison (1980: 130-135) to compare Paleoindian and later assemblages in terms of data thought to reflect the geographic extent of land use. The authors do not assume that Paleoindian bands differed from later foragers in having operated independently, rather bands of all time periods were assumed to have aggregated for communal hunting and based on this understanding, they compare the tool stone compositions of projectile point collections from two Paleoindian, five Archaic, and three Late Prehistoric bison bonebeds located in east Wyoming and in southeast Montana. Reher and Frison (1980:Table 25) list the tool stone types present in the collections and give distances to the tool stone sources. However, it is not possible for their readers to fully evaluate their work because it is unclear where many of the tool stone sources are. Nevertheless, their data demonstrates that the distances to sources represented in point collections from Paleoindian bonebeds are not always greater than distances to sources represented in point collections from later sites. This should have suggested to traditional
thinkers of the day that the idea of anomalously large Paleoindian land use patterns was at best an overgeneralization and at worst, completely wrong.

Given the fact that Frison’s work emphasized the importance of considering the potential effects of social aggregation when theorizing prehistoric land use strategies, and seeing as though results of research on the Vore site assemblage was not in conformity with the idea of extensive Paleoindian land use, it may seem surprising that many of his students that specialize in Paleoindian studies were to champion various aspects of traditional thought. One of Frison’s students was to later question the traditional view of Paleoindian subsistence economy as especially focused on bison hunting (Kornfeld 1988), but Todd and Hofman were to publish in support of the traditional view of Paleoindians as mobile big game hunters (e.g. Kelly and Todd 1988; Hofman 1992). One might suggest that a reason that these students and hundreds of others who went through the University of Wyoming field school program during the period in question did not doubt the traditional way of thinking is because they were not seeing any evidence to the contrary. As mentioned, Paleoindian kill sites excavated during this time period included the Casper site, Carter – Kerr McGee, Horner, and Agate Basin. These sites are located in environments lacking a locally available tool stone source suitable for gearing up and thus people participating in the kill would necessarily have brought in artifacts of stone acquired from nonlocal sources. Thus, these sites produced high proportions of artifacts of nonlocal stone and this conformed with the view of Paleoindians as highly mobile big game hunters. Another factor to consider is that during this period the traditional thinking was very much the dominant view— not many archaeologists were questioning the status quo in a vocal manner. Frison and Reher’s thinking on communal kills and gearing up was not in line with traditional thinking, but they did not emphasize this in print, rather they went about their business using concepts related to communal hunting to interpret kill sites of all ages. In light of these considerations, there is no reason to suppose
that graduate students receiving their training at UW during this period should have had a compelling reason to adamantly reject conventional thinking.

**Initial Questioning of Traditional Thinking**

Only a small number of scholars working in archaeology at this time published their thoughts that challenged traditional thinking. One noteworthy example is a brief article by Michael Kunz (1969) of the Paleo-Indian Institute at Eastern New Mexico University which addresses the question of the extent to which Paleoindian subsistence economy relied on big game. Although Kunz (1969: 28) does not present a lot of actual evidence bearing on the matter, he reasons that, “animals that were killed through driving and related techniques were in all probability a proportionally small number” and he goes on to say that Paleoindians “probably depended no more upon big game… for the majority of their food that did the pre-horse Indians of the Plains…” In summary, Kunz (1969: 27) asserts that, “[i]t seems rather unlikely that the Paleo-Indian would have relied on big game to the extent that popular opinion seems to indicate…” Something else that seems “rather unlikely” is that Kunz’s thoughts were well received by the “popular opinion” of archaeologists in the United States... his thoughts were published in the Anthropological Journal of Canada.

The work of John Albanese (1977), a geomorphologist who has worked extensively on Paleoindian sites, is also deserving of mention for its relevance to the question of Paleoindian land use. In an insightful article, Albanese reviewed the literature on 30 excavated Paleoindian sites in Colorado and Wyoming, grouped the sites into various geomorphic settings, and considered the geological processes that led to their preservation. Sites in dune fields, for example, are highly susceptible to destruction by wind deflation. The four sites in dune fields were preserved fortuitously when they were sealed by either later soil formation or cementation of overlying sand via calcium carbonate deposition from an interdunal pond. Sites located along rivers were also found to offer what is likely a highly
underrepresented sample of the sites originally present. Due to lateral stream erosion and
downcutting, the number of Paleoindian sites preserved in riverine settings is likely but a
small fraction of the number once present. The importance of this observation is made clear
by Albanese (1977:39): “How many Paleoindian sites were destroyed along valley floors
cannot even be guessed at, though the number was probably large. Wedel (1963) points out
the attractiveness of river bottoms to historic Plains Indians, particularly as locales for winter
camps. They were probably also attractive camping areas for prehistoric Indians.” Thus,
Albanese aptly points out the need for those interested in investigating prehistoric land use
patterns to adequately deal with biases in the archaeological record caused by geological
processes that have served to differentially destroy certain kinds of Paleoindian sites.

Though not brought out my Albanese, his observations on site preservation illustrate
another issue related to the study of Paleoindian land use and that is the matter of population
density. Since the early years, Paleoindian population density has been considered to be low
relative to later time periods because of the comparative rarity of the older sites. The
presumably lower human population densities of Paleoindian times has long been cited as a
reason that would encourage or at least allow for the larger ranges thought to have been
utilized by Paleoindian bands. However, the older a site is, the greater are its chances of
having been destroyed by on-going geological processes, such as wind deflation in dune
fields and lateral stream erosion and downcutting in river valleys. Paleoindian sites as a
whole may therefore be rare in large part because they are less preserved in the
archaeological record and not necessarily because human population was especially low
compared to later time periods.

The discussion by Albanese of six Paleoindian sites known from rockshelters has
bearing on the question of population density. Two of the six are large rockshelters in north
central Wyoming, namely Mummy Cave and the Medicine Lodge Creek site. According to
Albanese (1977:30): “Mummy Cave contains 38 cultural levels ranging in age from 9,200 to
400 radiocarbon years BP; 18 of these are Paleoindian levels (Wedel et al., 1968). The Medicine Lodge Creek site contains over 60 cultural levels ranging from 9,940 ± 350 radiocarbon years BP to historic times. Thirty-four Paleoindian levels have been encountered to date… ” There are many rockshelter sites in north central Wyoming containing only Archaic and Late Prehistoric levels (Frison 1978). However, it is not clear if these shelters contain Paleoindian-age sediments without evidence of human occupation. It could be possible that these sites do not have Paleoindian levels because sediments of the appropriate age are not preserved in the rockshelters. When Paleoindian-age sediment is present, as is the case with the two shelters described above, the archaeological evidence would suggest that for the later Paleoindian time periods at least, population density was not necessarily lower than that of subsequent time periods.

**Improved Knowledge of Sites and Sources**

The period in question first saw increased levels of archaeological surveys which contributed to advancing the study of Paleoindian land use by improving the database on known sites and tool stone sources. Due in large part to the passage of the National Historic Preservation Act in 1969, the areas to be affected by federally funded projects involving earth disturbance were examined for archaeological sites. This greatly increased the number of known Paleoindian sites. The act also established a procedure whereby federal land managing agencies were required to consult with state historic preservation agencies on the potential effect of proposed construction on archaeological sites, thus necessitating that states begin keeping records on the archaeological sites present within their boundaries. With more and more land being surveyed for sites, and state site files in place to serve as central databases on recorded sites, a more complete picture of the kinds and numbers of known Paleoindian sites began to emerge.
Though not conducted as part of a federal undertaking, a survey for Paleoindian sites in the Middle Rio Grande Valley in New Mexico discussed by Judge (1973) serves as a good example of data on the kinds and frequencies of Paleoindian sites produced by on-going survey work during this period. The survey recorded 29 Folsom sites, none of which were classified as kill sites. Three sites are the large multicomponent campsites discussed in more detail by Dawson and Judge (1969). These sites produced a relative abundance of Folsom material. Twelve sites were represented by more moderately sized surface collections, and fourteen were places where relatively few artifacts were found. Judge (1973: 199, 203-204) labeled the large camps as “base camps” and classified the moderately sized assemblages as “armament sites” and “processing sites” based on perceived differences in artifact type frequencies and hypothesized that the former may represent places where “activities centered around equipping implements in anticipation of a hunt” and the later may result from “activities centered around weapon renewal and hide-working, presumably in the aftermath of a successful hunt.” Later consideration of the assemblage data refutes the validity of Judge’s site types, concluding instead that the diversity of artifact classes in the assemblage is related to assemblage size (Shott 1989). In other words, the greater amount of time a site is occupied, the greater the range of activities that are likely to occur on-site and be represented among the discarded artifacts. Regardless of the best way to classify the sites and interpret the activities represented, the fact remains that Judge’s site data did not conform to the strict traditional expectation that most Paleoindian sites are large kill sites. Rather, the observation that most sites are small or moderate in size with some large camps in favorable environmental settings suggests the possibility that Folsom land use and that of later foragers may be comparable on a basic level.

Apart from an expanding database on Paleoindian sites, knowledge of tool stone sources was growing as well. In regard to the Great Plains, publications discussing both the major and lesser known lithic source areas on the Plains appeared throughout the period. For
example, publications appeared during the period discussing the Knife River flint source area on the Northern Plains (Clayton, Bickley, and Stone 1970) and a source of Edwards chert on the Southern Plains (Tunnell 1977). Other publications expanded knowledge on known source areas. For example, as part of Harvard’s project at Hell Gap, an archaeological reconnaissance of the Hartville Uplift was completed by the project geologist and the uplift was found to include not only sources of the Spanish Diggings orthoquartzite, but also numerous sources of chert (Saul 1969). Getting a geologist involved in tool stone studies pointed out the need for archaeologists to identify which formations produce which kinds of tool stone and to acknowledge analytical problems arising from similar looking tool stone occurring in geographically separated outcrops of the same formation. The point to be made here is that the stage was being set for Plains Paleoindian archaeologists to identify most, if not all, of the sources represented in assemblages available for study and to grapple with discerning land use patterns from data on the tool stone composition of assemblages.

Developing the Frugal Lithic Technology Concept and Associated Problems

Yet knowledge of sources was still incomplete and it was under these circumstances that traditional archaeologists turned to the study of Paleoindian lithic technology with the understanding that a mobile lifestyle may be reflected in a technology especially designed for frugal consumption of tool stone. The basic idea of frugal use of tool stone was expressed in print early on but it was now that archaeologists first made hypothetical statements about the concept that could be tested with archaeological data.

Originally published in 1979, a hypothesis formulated under the concept of a frugal technology asserted that Paleoindians selectively used microcrystalline or “cryptocrystalline” tool stones over the more granular tool stones like orthoquartzite (Goodyear 1989). Kinds of microcrystalline tool stone include materials such as chert, chalcedony, jasper, and agate. Goodyear does not list examples of coarser grained tool stones, but presumably he is referring
to materials such as orthoquartzite, metaquartzite, silicified siltstone, basalt, etc. The theoretical model starts out by asserting that microcrystalline tool stone is superior to coarser materials for artifact manufacture because it can be more easily shaped during the knapping process. Thus, all hunter-gatherers would have preferred microcrystalline to more coarser grained materials if the former was available. Goodyear goes on to observe that all hunter-gatherers must solve the basic problem of the incongruence in the distribution of food resources and the distribution of tool stone sources by somehow acquiring suitable stone, manufacturing it into tools, and moving the tools to where they can be used to extract food resources. Goodyear implies that the large geographic areas over which Paleoindians ranged would have encompassed widely spaced quality sources of microcrystalline tool stone along with sources of coarser grained materials. Having access to microcrystalline stone, Paleoindians selectively visited these sources and designed their lithic technology to make efficient and frugal use of it, rather than having to use sources of coarser stone. Goodyear asserts that the tool stone composition of Archaic assemblages contrasts to that of Paleoindians in containing more local and coarse-grained materials and he suggests that this is a reflection of decreasing mobility and habitat size resulting from increasing population. Since microcrystalline stone is more easily shaped, tools made of this material can be more successfully maintained through resharpening. Furthermore, broken tools of high quality microcrystalline stone could be more readily reworked into a tool of an entirely different function, thereby essentially “recycling” the tool stone into another phase of use. More successful resharpening and recycling of tools would mean that stone supplies would be used more frugally. In summary, during a time when tool stone sourcing was not yet fully developed due to an incomplete knowledge of sources, Goodyear’s hypothesis offered a way to test the idea of geographically extensive Paleoindian land use with archaeological data.

However, around the time that Goodyear published his hypothesis, data on the tool stone composition of assemblages from sites associated with large-scale bison kills on the
Northwest Plains suggested problems with the empirical basis of the hypothesis by noting that Paleoindians did not differ from later people by avoiding the use of orthoquartzite to manufacture artifacts. The year following publication of Goodyear’s hypothesis, the presence of very fine-grained Spanish Diggings orthoquartzite noted in levels at the Vore site had been interpreted as representing gearing up for bison hunting by Late Prehistoric peoples (Reher and Frison 1980:Table 20). A few years later, Craig (1982) reported on the tool stone composition of the Folsom and Agate Basin assemblages from the Agate Basin site complex on the plains of Wyoming. Folsom and Agate Basin levels at the site contained bison bonebeds. A fine-grained quartzite described as being light gray to light blue with small black inclusions accounted for 17 percent of the tools (by weight) in the Folsom assemblage and 27 percent of the tools (by weight) in the Agate Basin assemblage (Craig 1982:62, Table 1). The material outcrops from the Morrison formation of Jurassic age and exposures of the formation ring the Black Hills to the northeast of the site. A plausible interpretation of the presence of tools of fine-grained quartzite in the Folsom and Agate Basin assemblages is that Paleoindians used this quality quartzite to gear up for bison hunting. But the composition of assemblages from Agate Basin further demonstrated that even coarser-grained materials were used by Paleoindians. A coarse-grained quartzite that is not present among tools, accounts for 17 percent of the debitage (by weight) in the Folsom assemblage and 4 percent (by weight) of debitage in the Agate Basin assemblage. In sum, the above information suggests that in order to gear up for large-scale bison hunting, both Paleoindian and later foragers used fine-grained granular tool stone for manufacturing artifacts. Furthermore, in some situations, Paleoindians also made use of very granular tool stone to manufacture artifacts.

Though problems were found to exist with the microcrystalline hypothesis based on tool stone sourcing, the concept of a frugal technology was used by others working in this period as the theoretical basis for proposing the hypothesis that Paleoindian technology was based on the use of bifacial cores as opposed to blocky cores. For simplicity, this is here
referred to as the bifacial core hypothesis or simply the biface argument. An early instance of this idea is found in MacDonald’s (1968) report on a fluted point site in Nova Scotia known as Debert. In the site report, MacDonald suggested that Paleoindian technology was reliant on bifaces as cores for the production of flake tools because flakes removed from a biface tend to have a higher edge-to-weight ratio than flakes removed from blocky cores. The implication of this suggestion is that mobile Paleoindians would not have to carry around as much stone with them if their supplies of raw material were in bifacial form as opposed to being blocky cores.

The fact that flakes removed from bifaces have a relatively high edge-to-weight ratio may be relevant to a flintknapper intent on making as many cutting tools as possible from a given amount of stone, but unifacial tools were also needed and many such tools are best made from flakes removed from blocky cores. In particular, end scrapers were commonly used to scrape hides and needed to have blunt edges. Therefore, they commonly were manufactured from thick flakes struck from blocky cores.

Another source for later development of the bifacial core hypothesis is a single large biface found on a Folsom site in the Blackwater Draw site complex on the plains of New Mexico variously known as Frank’s Folsom site or the Mitchell Locality (Stanford and Broilo 1981). The site is described as a “surface campsite” (Stanford and Broilo 1981:1). An unusual artifact found at the site is a huge bifacial core of Edwards chert, a microcrystalline tool stone with excellent flaking quality from sources in Texas. The artifact measures about 27 cm long, 17 cm wide, and 4 cm thick. Illustrations of both faces are provided, as well as views of edges from proximal, distal, and left and right lateral vantage points. These support the classification of the artifact as an immense bifacial core because edges are ragged when viewed in planview and from the side. Also, flake scars on both faces demonstrate that large, flat flakes were struck off of the bifacial core. Judging from the scaled illustration, the largest flake removed measured about 20 cm long by 10 cm wide and another measuring 17 cm long
by 8 cm wide was struck from the opposite face. In describing and interpreting the artifact, the authors comment as follows: “At least three or possibly four large flakes have been removed which would not have had cortex material and would have been large enough to be reduced to either a Folsom or Midland projectile point. Large preform flakes were removed from both faces of the core… medium size flakes, which are more curved in long section, have been removed. These flakes may have been used for the manufacture of tools other than projectile points. Several would produce plano-convex scrapers” (Stanford and Broilo 1981:10).

The authors do not explicitly state that all the kinds of artifacts that were needed by Paleoindians could be produced from a bifacial core, but their suggestion that plano-convex scrapers (e.g. end scrapers) could have been made from the smaller curved flakes seems to be the basis upon which Hofman (1992) later suggested that the bifacial core was the centerpiece of all Folsom technology. As indicated, this would seem to be an untenable position given that Paleoindian tools types include both those made through bifacial reduction as well as those made through retouching flakes struck from blocky cores.

Stanford and Broilo go on to suggest the significance of the artifact for understanding Paleoindian lithic technology is that it allowed for flexibility in the kinds of artifacts that could be produced, but they stop short of concluding that flexibility was needed as part of a highly mobile life, as other archaeologists were to claim in later publications: “The fact that this large piece of stone was transported over a great distance suggests that these Paleo-Indian knappers were interested in maintaining a degree of flexibility in the types of tools that might be required for various future tasks. In other words, if they were only bringing blanks and/or preforms for projectile points and other specific tool types onto the site, they would be somewhat limited in their options as to which tools could be procured as the need arose” (Stanford and Broilo 1981:11).
Yet all the arguments and counter arguments about whether or not the huge biface is characteristic of all Folsom technology seem potentially moot when one considers that the biface may not even be affiliated with the Paleoindian time period. According to the authors: “There were in fact three artifacts from different [non-Paleoindian] time periods found at the site area, including two broken projectile points (Late Plains and Archaic) and a fragment of a late prehistoric four bevel knife. However, in as much as the rest of the cultural inventory is typical of Folsom collections, these three specimens are considered intrusive and those people who left them in their passing did not utilize the site area to any extent” (Stanford and Broilo 1981:3-4). This conclusion seems unwarranted and thus the reader is left with the uneasy feeling that much of the theorizing about a bifacial core-based technology for Plains Paleoindians that was to come is based on a single specimen of a large bifacial core that can not even be emphatically said to be of Paleoindian affiliation (LeTourneau 2000).

THE RISE OF ALTERNATIVE THINKING (EARLY 1980s ONWARD)

It was with such critically minded evaluations that a new generation of archaeologists began to seriously question the traditional view. Though the historical review up to this point shows that the notion of highly mobile Paleoindian bands is based on a rationale that has deep roots in archaeology, many archaeologists in the early 1980s seriously began to doubt conventional wisdom. Perhaps the influence of the New Archaeology was having an affect. Archaeology claimed to be a science capable of empirically demonstrating what ancient societies were like based on their artifacts, etc. and yet archaeologists were having difficulties providing a convincing demonstration of the traditional view based on artifact assemblages. Perhaps it was time to critically evaluate the middle-range theory in use at the time, in other words, the concepts used to interpret past behavior with material remains; concepts like embedded procurement. Moreover, it was also time to do some critical thinking at the level
of general theory – in this case the theory that Paleoindians in all times and all places were mobile big game hunters.

**Problems Stemming from the Embedded Versus Direct Procurement Debate**

A requirement of building alternative theory of Paleoindian land use is that the rigor and utility of existing theory be critically evaluated and in this regard it is necessary to review Binford’s theoretical stance that all hunter-gatherers engaged in “embedded procurement” of tool stone. This concept involves two questions. The first is whether acquisition of tool stone by hunter-gatherers involved “direct procurement” or “embedded procurement.” Recall that direct procurement involves tool stone being procured in a direct manner by making trips to the source for the sole purpose of obtaining tool stone and bringing it back to a habitation site to be worked into tools. Embedded procurement is where acquisition of tool stone is embedded in subsistence activities, in other words, tool stone was procured incidental to trips intended to obtain food from the environment. The second question entailed in the concept of embedded procurement is what method or methods are appropriate to define the range used by a band for food acquisition. If all hunter-gatherers engaged in embedded procurement, then defining the range used by occupants of a camp site would be a simply matter of drawing a line around the tool stone sources represented in the assemblage, as suggested by Binford (1979:261).

Regarding the first question, posing the matter of the nature of tool stone acquisition as a question of being either embedded or direct is misleading because it oversimplifies what was likely a range of possible behavioral responses that hunter-gatherers could have chosen in any given case in order to solve the basic problem of acquiring adequate amounts of both food and stone resources from the environment. Solely for the purposes of illustration, we might divide this range of possible behavioral responses into four classes. 1) In some situations, foragers may take trips intended to just procure food resources. 2) In other cases,
foragers might take trips principally intended to procure food, but stone could be acquired incidentally if circumstances allow (Binford’s “embedded procurement”). 3) Other situations may be such that foragers take trips primarily intended to procure stone, but some food acquisitions is done if the opportunity presents itself. 4) Finally, there might be situations where foragers may make trips intended to just procure stone resources (Binford’s “direct procurement”). By posing the question in terms of whether stone procurement was embedded or direct, one incorrectly suggests that the correct answer has to one or the other of two basic classes, when hunter-gatherers in general likely used both ways, as well as others.

Support for the contention than the range of behavioral responses is more complex than the embedded versus direct procurement debate would suggest is seen in evidence that the Nunamiut engaged in both embedded and direct procurement. To provide support for use of embedded procurement by the Nunamiut, Binford (1979:259) describes a situation where a fishing party camped at a lake finds the fishing to be slow, so some of the men visit a stone quarry 3.75 mi (6.0 km) away on a mountain, gather some stone, and reduce it to transportable cores while watching for game animals from atop the mountain. If the fishing remains slow and none are caught, the party is able to return to the habitation site with tool stone in lieu of food resources. From the way the story is presented, it is uncertain if this is something that Binford actually observed or whether he is relating the story for illustrative purposes. In any case, there seems to be little reason to doubt that available tool stone might be procured by the Nunamiut or other hunter-gatherers on a trip primarily intended for food acquisition, if circumstances allowed.

However, the work of John Campbell (who ironically got Binford interested in studying the Nunamiut from an ethnoarchaeological perspective) suggests that much of the stone used by the Nunamiut was acquired through direct procurement. Through interviews with elders, Campbell (1968) reconstructed the traditional range, land use pattern, and settlement types of the Tuluaqmiut band of the Nunamiut people for the period of 1870 to
1874. According to Campbell’s classification, the Type I settlement is the site where the entire band would aggregate during the spring and fall caribou migrations, as well as at other times, Type II settlements are camps occupied by two or more families after the seasonal disbanding of the Type I settlement, Type III settlements are hunting or fishing camps, and Type V settlements were established outside the Tuluaqmiut range for purposes of courting, visiting, or trading. Regarding Type IV settlements, Campbell states: “Type IV settlements…, also usually characterized by a single shelter, resulted in the main from non-food collecting activities. Typical examples included camps established for obtaining chalcedony, spruce wood, caribou calf hides, or gyrfalcon feathers. Because of their diverse purposes, Type IV settlements were in use at nearly all times of the year. They originated from any of the first three settlement types and were occupied by one to eight individuals, usually males, for typically one to four days (Campbell 1968:17). Also, Campbell (1968:5) notes that various kinds of tool stone, not just chalcedony, were used by the Tuluaqmiut band, so we can reasonably presume that multiple tool stone sources were exploited through direct procurement.

A map of the Tuluaqmiut band’s range with sites of the various settlement types plotted shows the most outlying sites along the northernmost and southernmost portions of Tuluaqmiut range are Type IV settlements (Campbell 1968:Figure 2). From the above discussion, we can conclude that much of the tool stone acquired by the Nunamiut was secured via direct procurement of stone with some amount obtained by embedded procurement. Of the stone acquired by direct procurement, much was apparently obtained from sources within the range exploited by the band for food resources but some may have been acquired from sources outside of the area used for hunting and gathering.

Ethnoarchaeological studies of the Australian aborigines further suggest that forager lithic acquisition was more complex than the embedded versus direct procurement debate would suggest. These studies demonstrate that the range of behavioral responses to the
necessity of having to obtain both food and stone from the environment included situations where trips were made primarily to secure stone, but food resources were obtained as well. Gould and Saggers (1985:120, Table 1) documented 12 cases from the Western Desert of Australia where Aborigine men working by themselves, or in groups of up to five, directly procured tool stone or red ochre from sources up to 45 km away. These instances of stone and mineral acquisition are essentially direct procurement because the men stated that the primary goal of the trip was to acquire tool stone or ochre, however, the men would “always avail themselves of any edibles along the way” (Gould and Saggers 1985:120). Furthermore, in regard to his efforts to quantify the effort expended by Aborigines on various tasks, Gould (1978:819) states, “I found it impossible to make accurate calculations of the time spent by individuals in obtaining lithic raw materials at quarries, mainly because this behavior was combined with other activities such as hunting and visits to sacred sites.” The 12 cases observed by Gould document the activities of acculturated Aborigines who used motorized vehicles to access any sources over 2.5 km away. If these trips were made on-foot by Aborigines living a traditional lifestyle, one could more confidently conclude that they would likely represent direct procurement of stone from sources within an area of the size that foraging people are known to exploit for food resources.

Gould (1978:831) also documents that some Aborigine men living on reservations possessed stone tools of materials from far-off sources. He also observed male task groups making trips over hundreds of kilometers from their home areas to visit sacred sites and the members of local patrilineages controlling those sites (Gould and Saggers 1985:122). From the above, he suggests that stone may have been procured by men from sources outside their home areas during long-distance trips, but he reads a lot into his observations by suggesting that stone was always procured in small amounts as part of trips principally intended for visiting sacred sites and establishing social networks with surrounding groups as a form of adaptation to regional droughts (Gould 1978; Gould and Saggers 1985). Leaving this
reservation aside, the ethnographic record of the Aborigines can be said to further confirm my assertion that tool stone acquisition by foragers included a broader range of behavior than embedded or direct procurement alone. Furthermore, as with the Nunamiut, Australian aborigine stone procurement evidently involved use of stone from sources both inside and outside areas normally used for food acquisition.

Yet evidence relating to tool stone procurement from the ethnographic record alone probably provides a limited view of tool stone acquisition by male task groups because evidence from the archaeological record suggests that hunter-gatherers may also have visited lithic source areas in larger groups, such as individual bands. This is suggested by examples of sites near lithic sources that produced assemblages demonstrating that substantial amounts of subsistence activities and other activities occurred along with production of blocky cores and bifaces of the local stone. Johnson’s (1984) study of sites located near sources of Ft. Payne chert in the Yellow Creek portion of the Tennessee River drainage of northeastern Mississippi provides support for this contention. Tool stone procurement-related sites in this area, especially those situated on flat terrain adjacent to streams that would be suitable for camping, produced assemblages with substantial quantities of projectile points (classified as “stemmed bifaces”) and end scrapers (Johnson 1984:Table 12.4). The streamside sites are dated to the Late Archaic, Woodland, and possibly the Mississippian periods. The kinds of artifacts present at the streamside sites are less in keeping with the view of task groups spending a few days in the area procuring stone than with the scenario of groups of people engaged in protracted stays during which time tool stone is procured and worked, but also on-going subsistence activities involving hunting and possibly hide processing were performed.

Evidence from the Allen site in the Medicine Creek drainage on the plains of Nebraska suggests that the above scenario of visitation of source areas by human groups composed of men, women, and children involved in other activities besides just tool stone procurement may have also occurred on the Plains in Paleoindian times. This interpretation
is based on faunal, artifactual, and other evidence which suggests that not only were initial stages of stone tool manufacture carried out on-site, but so too was a range of subsistence and other activities that were performed by groups that arguably were composed of both sexes as well as people of differing age. The site is located along Medicine Creek, a permanent tributary of the Republican River. Roughly one meter of cultural deposits present at the site is interpreted as principally representing a midden associated with a residential site that was repeatedly occupied throughout the Paleoindian period (Bamforth 2007). The Medicine Creek drainage is a source area for Smoky Hill jasper and the opportunity for human groups to resupply depleted inventories of tone tools using the locally available raw material was one attractive aspect of the site’s environmental setting that likely encouraged repeated occupation. Though outcrops of jasper were likely not exposed at the site during occupation, stone apparently was available from sources reported as close as 1.5 km from the site (Davis 1962:67, Figure 2).

Artifacts recovered from the Allen site are indicative of a range of manufacturing and subsistence activities. That stone tool production using the local jasper was an important activity performed at the site is demonstrated by the numbers of chunks, blocky cores, and unfinished bifaces that are made from this tool stone. These artifact classes total 111 of the 281 worked pieces of flaked stone or 39.5 percent (Bamforth and Becker 2007:Table 10.1). The remainder of the collection of worked pieces of flaked stone (170 artifacts or 60.5 percent) are tools demonstrating that various activities related to subsistence or the production and maintenance of non-lithic material culture were also important site activities. Included in this group of artifact classes are stage 4 bifaces (which likely functioned as knives), points, point preforms, beveled tools (which principally were used to scrape hides), perforators, edge-modified flakes, and a few miscellaneous or indeterminate classes. A variety of ground stone artifacts were also present, including grinding slab fragments and manos. Also recovered was a selection of bone artifacts that included artifact classes such as
needles and awls that arguably were used in the manufacture of clothing and other items of leather.

The faunal collection from the site is suggestive of animal procurement activities intended to obtain a diverse array of animals by various means to serve as sources of food and raw materials (Hudson 2007). Small-scale hunting of big game, including bison, deer, and antelope, is represented. A wide variety of small game species of mammals and birds is also represented, the most common of which were jackrabbits, cottontail rabbits, and prairie dogs. Many of the small game species may have been acquired not through hunting, but by more passive means such as trapping. Finally, some fishing and collection of shellfish is also indicated.

Based on the range of subsistence activities represented in the faunal collection, it has been argued that the site was occupied by relatively small groups of people composed of men, women, and children. Bamforth (2007:238) reasons that, “hunter-gatherer societies typically divide labor along age and sex lines, with large-mammal hunting virtually always the province of adult males and the hunting or other acquisition of other species sometimes carried out by men but more often carried out by women and children. If we are willing to assume a similar division of labor in Paleoindian society, the range of species taken at the site implies that it was occupied by men, women, and children.” The division of labor in subsistence activities among ethnographic hunter-gatherers is summarized by Kelly (1995:262-270). Finally, the presence of a deciduous human tooth at the Allen site supports the assertion that groups composed of both adults and children occupied the site (Bamforth 2007:191).

Evidence that Plains foragers may have visited quarry sites in large groups formed through the aggregation of multiple bands comes from the Barbour Quarry, located in the Spanish Diggings orthoquartzite source area in Wyoming. A map of a camp area adjacent to the quarry shows 161 tipi rings (Reher 1991:Figure 16.3). Even when the possibility that the
site could be an accretion of multiple occupations is taken into consideration, it is clear that the number of tipi rings suggests that the size of the human group or groups camped at the quarry was quite large. Given the numbers of people comprising ethnographic bands of hunter-gatherers, it seems reasonable to suggest that the site may have seen occupation by groups composed of multiple bands. At first, it may seem surprising that bands participating in a bison kill would gear up as a group. However, when possible effects of the distribution of raw material on land use are considered, it makes sense that this may have occurred in some situations. In many cases where the kill was planned in an area lacking suitable stone sources, gearing up for a large-scale bison kill would have involved bands acquiring tool stone in their home ranges and subsequently aggregating with others in the vicinity of the planned event. However, in cases where the planned bison kill was located close to a quarry suitable for gearing up, bands may not have geared up in their home ranges. Rather than bring stone and finished artifacts with them, it may have involved less effort for participating bands to meet in the vicinity of the quarry and then gear up as a group at the quarry before setting out on a large-scale bison hunt. The involvement of large groups in quarrying operations, as suggested by evidence from the Barbour Quarry, serves as a good illustration of the need to consider evidence from archaeological sources when developing ideas on the range of situations in which tool stone acquisition can occur for a particular region.

Evidence from the Benz site in North Dakota further expands the range of possible circumstances under which tool stone was procured by Plains foragers. The site is a workshop in the Knife River Flint source area. Concentrations of debitage on the site, designated as features, arguably represent debris produced by single flintknappers during visits to the KRF source. Root (1997) estimated the kinds and amount of artifact manufacture represented in archaeological samples from the concentrations by comparing those samples to experimental samples produced during various kinds of operations, such as prepared core reduction, bipolar core reduction, skilled bifacial thinning, expert bifacial thinning, etc. He
also measured the skill of the prehistoric knappers using a ratio of successfully completed and exported bifaces (based on production estimates) to the total number of bifaces produced (the sum of exported bifaces plus bifaces broken or otherwise rejected during manufacture).

Three features affiliated with the Cody period and one of pre-Cody age indicate that large numbers of bifaces were produced by expert knappers. Root estimated that 100 bifacial blanks were produced at one of the features of Cody age and a total of at least 40 were produced at the other two. The pre-Cody feature represents the production of 40 to 60 bifaces. In contrast to the above debitage concentrations, others of Paleoindian affiliation (including two of Cody affiliation) demonstrate more modest production amounts and skill levels. Root interprets these features as evidence of knappers of moderate skill who visited the lithic source to gather stone and make tools for household use. Based on the large numbers of bifaces in the former category of knapping features and the level of skill with which those bifaces were produced, Root reasons that Paleoindian stone procurement in some cases involved visits to lithic sources by skilled knappers who produced bifaces in quantities far above what would be needed to meet household needs. From this he concludes that mass production of quantities of tools for exchange occurred in Plains Paleoindian societies.

Another activity that would be expected to have produced significant numbers of bifaces is gearing up for communal hunts, but any case, the Benz site offers compelling evidence that acquisition of stone and its production into tools by foraging peoples of the Plains in some cases involved mass production by skill knappers.

Based on the above discussion, the answer to the question of whether tool stone procurement among hunter-gatherers was embedded or direct seems to be both, but more important is the observation that the question is but one of a number that need to asked by archaeologists as they develop theory on prehistoric land use applicable to their particular geographic areas of interest. Other relevant questions pertain to the relative size of the human group engaged in raw material procurement, as well as whether the tool stone was
acquired as part of meeting the needs of the minimal social group or the more voluminous needs of an aggregation of bands or an exchange network.

As to the question of whether the line-drawing method suggested by the embedded concept would accurately define the range used by occupants of a site, the answer seems to be sometimes “yes” and sometimes “no.” Recall that if all tool stone procurement is indeed embedded in subsistence activities, then it logically follows that simply drawing a line around the sources of tool stone represented in the assemblage should provide a fairly accurate reflection of the range habitually used by the band to acquire food resources. (For the sake of discussion, we will assume that the minimal social unit of the prehistoric foragers in question was the band). However, the preceding discussion gives ample reasons to believe that the distribution of food resources was but one of the main factors affecting hunter-gatherer land use patterns. Two other important factors were the distribution of stone resources and the distribution of neighboring bands.

To illustrate that the line-drawing method would sometimes not accurately reflect the range of a band, the Vore site is an apt example because bison bonebeds form a large part of the available set of investigated Paleoindian sites. When one considers how the distribution of food resources may have affected prehistoric land use, it becomes apparent that the area around the sink hole at Vore periodically supported enough bison for large-scale bison kills to be organized at the site. Recall that in regard to the distribution of stone, there apparently are no sources suitable for gearing up close to the site. Consequently, bands participating in the bison kill would necessarily have to bring stone to where they met, either in the form of completed artifacts, or in unfinished form, or both. Lastly, one must consider the site in the context of social groups inhabiting surrounding areas. Very large numbers of bison are represented by the bonebeds at Vore. Exact numbers of bison killed during the jumps are not available because only a small portion of the deposits in the sink hole have been excavated. At the Glenrock Buffalo Jump in southeast Wyoming, the minimum number of bison
represented in the excavated portions of the lower of two bonebeds present may be estimated at 111 individuals, based on the number of axes (second cervical vertebrae) recovered (Frison 1970:Table 2). Frison and Reher (1970:53) estimate that only 20 percent of the bonebed has been excavated. The entire lower bonebed may therefore contain the remains of 555 bison. Whether the bonebed represents multiple uses of the jump is unknown, but the point to be made by the above observations is that the large numbers of bison implies that the cooperation of multiple bands would in some instances have been required to successfully handle driving that many bison and process the meat and hides procured from such large kills. Thus, bison kills of the size suggested by the Vore site bonebeds would necessarily require the participation of multiple bands from areas surrounding the site. In light of the above, applying the line-drawing method to the Vore site or to similarly large Late Prehistoric bison kills would (contra Binford) greatly overestimate the range used by a band. The question of whether Paleoindian bison kills were of a size that would require aggregation of multiple bands is therefore one that must be addressed.

In other cases, the line drawing method may accurately define the range habitually used by a band. If an artifact assemblage derives from occupation of a site by an individual band when not participating in a communal hunt, and if a few sources of good quality stone are available within the area the band normally exploited for food resources, then the line-drawing method may roughly define the area encompassed by the band’s range. Since it seems clear from the investigation of kill sites that bands of foragers on the Plains occasionally aggregated to cooperate in large bison kills, one might qualify that the line-drawing method in some cases could define the home range of a band, since the existence of large kill sites would suggest that in some cases, bands occasionally entered the home ranges of surrounding bands to participate in bison kills.
Problems with the Forager-Collector Continuum

Apart from the idea of embedded procurement, another of Binford’s (1980) concepts that proved to be very influential on his students and many others is the notion of the forager-collector continuum. Binford used ethnographic data the world over to propose causal relationships that were believed to hold true for both modern hunter-gatherers and those of the past. The resulting model implied that causal relationships existed between the environment, on the one hand, and various aspects of human adaptation, on the other. These elements of adaptation include the kind of subsistence economy, patterns of mobility, kinds of occupation types employed in settlement systems, presence or absence of storage, and presence or absence of artifact “curation” (Binford 1980). Hunter-gatherer groups living in environments near the equator were characterized as “foragers” who have a land use pattern called “mapping-on” (Binford 1980). This entails people making day trips from the “residential base” to hunt and gather wild food resources during day trips. When food resources start to decrease, the residential base is moved a relatively short distance to position it in an area with untapped resources, thereby mapping onto resources. As will be seen below, archaeologists who have tried to apply Binford’s model have added to the proliferation of new terms by referring to a land use pattern involving mapping-on as “residential mobility.” Binford cites the much-studied Bushmen of southern Africa and the Australian aborigines of the Central Desert as hunter-gatherer groups who would be classified as “foragers” by the model. In contrast, hunter-gatherer groups living in environments near the poles were characterized as “collectors” who have a land use pattern organized by “logistics.” This involves task groups traveling out from the residential base to acquire food resources at resource-extraction sites termed “locations” and bringing back food to the larger social group back at the residential base. Task groups were involved in food acquisition for multiple days and would make temporary residence at a “field camp.” Archaeologists working with Binford’s model have referred to a land use pattern involving logistics as
“logistical mobility.” An example of a group of hunter-gatherers that would be classified as collectors in Binford’s model is the Nunamiut of interior Alaska.

Though the forager-collector continuum was widely used by archaeologists in the 1980s and 1990s to characterize prehistoric land use patterns, others have criticized the approach. Bamforth (1997, 2009a) casts serious doubt on the purported ability of the model to encapsulate and explain all variation in hunter-gatherer adaptations the world over. Furthermore, he points out the difficulty involved in testing the model with archaeological evidence. Following Bamforth, the accuracy of the forager-collector continuum as a model of forager adaptations will be critiqued and its utility to the archaeologist will be assessed by examining examples of its application to the question of Paleoindian land use.

If, for the sake of discussion, we assume the model of land use is valid, it can hardly be said to be a model that explicitly states what is to be expected for hunter-gatherers living in all kinds of environments. Since the model is presented as a continuum with the equatorial end characterized by a “forager” type adaptation and the polar end described by a “collector” type adaptation, one is left wondering what to expect of hunter-gatherers living in temperate regions between the extremes of the continuum. For example, how are foragers of the Great Plains living at mid-latitudes to be classified? We might consider large-scale bison hunting using the surround technique as a specific example and consider how it would fit into the forager-collector continuum. Plains ethnography indicates that one hunting technique employed in large-scale bison hunting involved groups of men, women, and dogs acting in concert to surround and kill a herd (Arthur 1974:65-66). Presumably this was followed by the initial butchering of the bison in the field and further processing back at a camp. Such a land use pattern conforms to neither residential mobility (where task groups made day trips to acquire food for people at the residential base) nor to logistical mobility (where task groups take multi-day trips to procure food for people at the residential base). However, Binford (1980:10) chooses to force bison kill sites such as this into his logistical mobility category,
citing the Olsen-Chubbuck site as an example of a “location” where a task group acquired food for people back in the residential base. As will be elaborated upon in the following chapter, the amount of work needed to field dress an estimated 179 bison killed at the site before the meat would spoil strongly implies that a comparatively large human group was involved in the kill. Thus, the ethnographic record of the Great Plains in this case provides a more suitable analogy for interpretation. It is much less likely that a relatively small task group killed and butchered that many bison and transported the meat back to a larger group waiting back at a residential base as asserted by Binford.

Another problem with the forager-collector continuum is that it glosses over the amount of variation in hunter-gatherer adaptations in various parts of the world. For example, foragers living in equatorial regions are characterized as lacking food storage, but one can find examples of pygmies in equatorial regions of Africa drying elephant meat to preserve it for storage (Bailey 1989:676-677). Binford (1977) anticipates that curation of artifacts is causally linked with a logistical land use strategy. His concept of a curated, as opposed to expedient, artifact assemblage includes a number of qualities, among which are tools that are: 1) effective for a variety of tasks, 2) maintained through a number of uses, and 3) recycled to other tasks when no longer useful for their primary purposes (Bamforth 1986:38). One again does not have to search too hard to find examples of curated artifacts among peoples classed by Binford as foragers who are supposedly best characterized as having a residential mobility pattern and an expedient stone tool technology. Gould (1978:817) classifies tools of the Australian aborigines, who would be considered foragers in Binford’s scheme, into a few categories, including “multipurpose tools.” One example of a multipurpose tool is “the Western Desert spear-thrower, which serves not only for throwing spears but also for firemaking, as a percussion instrument at ceremonies, as a mixing tray for pigments and tobacco, and as a woodworking instrument using the stone adz hafted to the handle…” (Gould 1978:817). These examples of where the model may not be entirely
accurate may seem trivial to some who would defend it as a model in the realm of general
theory that is meant to characterize the tendencies in hunter-gatherer adaptations.

So perhaps it is best to now turn from the question of the model’s accuracy to its
utility. If the forager-collector concept is indeed meant to have value as a scientific model
with the ability to elucidate past adaptations using archaeological evidence, then
archaeologists who apply the model to archaeological cultures should come up with identical,
or at least similar, results.

A number of archaeologists have tried to address the question of the nature of early
Paleoindian land use using the forager-collector continuum, but have come up with very
different conclusions. When speculating about early Paleoindian land use, Kelly and Todd
(1988:234) state, “If the ethnographic data on hunter-gatherer mobility (Kelly 1983) have
been interpreted correctly, then heavy dependence on terrestrial game also would have led to
high residential and logistical mobility… among Paleoindians.” From my reading of Binford
(1980), residential mobility is thought to characterize a land use pattern of hunter-gatherers in
equatorial regions while logistical mobility is found among hunter-gatherers living near the
poles. With this in mind, I am perplexed by Kelly’s claim that his ethnographic data suggests
that some ethnographic hunter-gatherers have both residential and logistical mobility since
Binford’s model is intended to encapsulate all hunter-gatherer adaptation the world over and
presents the two kinds of land use as inherently different. Kelly and Todd (1988:238) assert
that early Paleoindian land use can be characterized as having some aspects of foragers and
some aspects of collectors:

“Rather than putting up long-term stores after a kill, the most secure tactic would have
been to begin an almost immediate search for further resources. As long as foraging trips
in the vicinity of a kill encountered game, a residential group could remain in the area,
using products from the kill and perhaps making additional kills. Logistic trips would
have increased in frequency and duration as frequencies of local game encounters
decreased… When logistic parties located game, perhaps at a long distance from the
residential camp, survival security could be enhanced by moving the entire group to the
new resource area, perhaps taking along only processed, easily transportable foods and
abandoning foods and unused products from the previous kill.”

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Thus, Early Paleoindians are said to have had a land use strategy that was like collectors in that it involved logistical mobility where task groups would go out from the residential base and acquire meat for people at the residential base. Their land use was also comparable to foragers because once local game populations dropped and more game animals were located outside the area that task groups could easily reach from the residential base, the entire band mapped onto food resources by moving to where game could still be found. To support this scenario, Kelly and Todd (1988:236) note that “[i]n the western U.S., Folsom [camp] occupations are sometimes found next to bison kills, for example, at the Agate Basin site… and may be indicative of a system in which residential groups moved from kill to kill.” Thus, after laying out a rather detailed scenario of what early Paleoindian land use must have been like in terms of Binford’s model, no convincing evidence from the archaeological record is offered to demonstrate how Paleoindian land use is supposed to have been sort of a hybrid between the so-called “forager” and “collector” land use patterns.

Surovell (2000) considers the matter of Clovis land use as it relates to fertility and comes to the differing conclusion that people during this early period had high residential mobility, meaning that they moved around a lot, but not necessarily very far. To support his assessment, Surovell (2000:504) notes that Clovis occupations “tend to be rather ephemeral” and that “[l]ithic assemblages are usually small.” Again, the model is invoked to interpret prehistoric land use, but the observations offered in support can hardly be said to be convincing evidence that Clovis groups “mapped-on” to food resources with relatively short moves of the residential base in the manner described by Binford (1980).

Finally, Amick (1996) used Binford’s model to arrive at yet another conclusion for the Folsom period, suggesting that land use during this time period involved logistical mobility during part of the year and residential mobility during other seasons. As mentioned in Chapter 2, Amick bases his model on the assertion that modern bison overwintered in the
foothills and intermontane basins of the Rio Grande drainage in central New Mexico and dispersed out onto the Southern Plains of eastern New Mexico and western Texas during the spring and summer. Amick examined collections of Folsom points from various sites on the Southern Plains and in the intermontane basins and documented a predominance of Edwards chert from central Texas at sites on the plains of western Texas and eastern New Mexico, while various tool stones from relatively closer sources dominated the point collections from the intermontane basins of the Rocky Mountains. Amick interpreted this difference in the tool stone use between the two regions as follows:

The reliance on Edwards chert on the Southern Plains thus suggests a system of planned logistical mobility (as defined by Binford 1980), with procurement and transport taking place via extended mobility. In contrast, tool stone use in the Basin and Range does not approach the scale of Edwards movement. In part, this difference may reflect a more residential land-use strategy (also as defined by Binford 1980) while groups were in the intermontane areas. During the summer, bison migrated onto the plains where they were distributed in clumps. Folsom responses to this pattern might include increasing group size while engaging in logistical hunting. Bison and other game animals were common in the intermontane basins and foothills during the winter. An expected response might be to limit group size and conduct residentially based hunting by individuals [Amick 1996:415-416, 421-422].

As pointed out in Chapter 2, Amick’s model is founded on the credibility of the claim that bison abandoned the plains in winter for the foothills and intermontane basins and subsequently traveled all the way eastward to the plains of western Texas in spring and summer. Since there is little support given for this, the entire model is suspect for that reason alone. However, at issue here is the matter of how well the characterization of Folsom land use in terms of Binford’s model is supported by archaeological evidence. That distances to tool stone sources are less for point collections from the intermontane basins than for collections from the Southern Plains is offered as evidence for residential mobility in the basins and logistical mobility on the plains. However, the difference in distances to tool stone sources may largely be a reflection of suitable sources being more densely distributed in the basins in comparison to the plains, as Amick (1996:415-416) himself concedes.
Therefore, there is no unambiguous archaeological evidence to support Amick’s version of how Binford’s forager-collector model might have applied to Folsom land use.

My intent in dissecting the above applications of Binford’s model to Paleoindian land use is to highlight the deficiencies of the model itself, not to be an indictment against the attempts of archaeologists to understand land use through the application of theoretical models. If anything is clear to this point in the discussion, it should be that elucidating land use patterns with the “stones and bones” of hunter-gatherer archaeology is anything but a straightforward exercise. That said, there should be no argument that there is a need to build good models to serve as tools with which to gain some traction in our attempts to finding a way to convincingly elucidate land use patterns with archaeological evidence. A good model should be unambiguous, but how the land use and other adaptations of hunter-gatherers in temperate zones fit into the continuum is unclear. Good models must also adequately explain all the variation evident in whatever the subject matter is that the model is meant to summarize. Yet the model is incapable of dealing with the case of large-scale bison kills and its applicability to Plains archaeology is in serious doubt. Finally, the purpose of a model is to serve as a tool for empirical study of some subject matter and as such, a good model is one that can be supported or refuted with quantified data or at least some form of unambiguous evidence. The failure of the above attempts to consistently apply the model to the matter of Paleoindian land use demonstrates the failure of the model itself to provide a readily apparent way that it can be confirmed or refuted. In consideration of the above, I suggest that the model is not only of limited utility to the study of Paleoindian land use, but it has sidetracked the efforts of many good archaeologists in a very unproductive manner.

Rather than create a body of theory aspiring to describe all hunter-gatherer land use at the global level, beginning to build Paleoindian land use theory at the geographic scale of a physiographic province or smaller region may be more manageable. American ethnography of the early 1900s organized North American native societies into “culture areas” on the
grounds that staple food resources characteristic of the various physiographic regions can influence the development of similar subsistence economies and to some extent, similar forms of social organization. Though environmental conditions are by no means the only class of factors that influenced the development of hunter-gatherer cultures, building models for Paleoindian land use at the scale of the physiographic region or smaller has two advantages over a global approach. First, one is able to propose cause-and-effect ecological relationships between environmental conditions and foraging societies that are more explicit and therefore hopefully will be easier to support or refute. An example is seen in the work of Bamforth (1988) who uses principles of evolutionary ecology to consider the theoretical affect of the spatial and temporal variation in climatic conditions of the Great Plains on forage conditions, game herd size and stability, and corresponding effects on the size, mobility, and social complexity of human groups that could be supported. Though by his own admission, Bamforth does not provide a rigorous test for his model, the support he does give demonstrates how ecological principles can be used to model land use and how archaeological data might be applied to evaluate the model. A second reason that a regional approach is advantageous over a global one has to do with the quantity and quality of ethnographic information available for potentially providing insight into prehistoric land use via ethnographic analogy. When developing a global theory on hunter-gatherer land use, Binford (1980) was forced to use ethnographic studies of contemporary foragers which provide an extremely limited view of the possible range of possible hunter-gatherer adaptations to the environment the world over. Though all ethnographic information is to some extent limited, the relatively voluminous and detailed ethnographies on the Plains and Great Basin, for example, provide much more material for developing fairly detailed ideas on prehistoric land use through the careful application of ethnographic analogy.

Ethnographic analogy, however, is but one method of investigating prehistoric land use; another source of ideas stems from the archaeological record itself. This point is
emphasized by Bamforth (2009a) who points out the deficiencies of the forager-collector continuum as a theoretical model and attempts to illustrate how archaeologists might instead go about developing theory on prehistoric land use. He advocates what he calls a bottom-up approach to theory development where archaeological evidence relating to various aspects of land use is used to build theory seeking to explain variability in prehistoric land use patterns across space and through time. In this way, archaeological evidence forms the basis from which theory is developed. In the forager-collector continuum and other theoretical models constructed from a top-down approach, internally consistent models may be constructed but their utility is of questionable value because there is little to no way of testing their veracity with archaeological evidence.

**Decreased Seasonality in Early Paleoindian Climates?**

Before any progress can be made under an approach founded in part on the belief that the subsistence economy, social organization, and land use of ethnographic foragers can by reason of analogy provide useful ideas about how Paleoindian land use may or may not have differed, the assertion that Early Paleoindian environments and cultural adaptations were not at all analogous to those of ethnographic hunter-gatherers must be addressed. Kelly and Todd (1988) argue that environmental conditions during Pleistocene and early Holocene times were entirely unique in comparison to those of modern times, consequently, early Paleoindian adaptations must have been nothing like those of ethnographically recorded foragers. It is argued that climates of the early Paleoindian period involved less seasonal fluctuations in temperature. As a result, species of plants and animals were not distributed according to broad ecozones as they are today. Rather, vegetation is suggested to have been a more homogeneous mixture. Therefore, the herbivores that fed upon the homogeneous flora formed an association of kinds of animals that today are found in separate ranges.
The source of this line of reasoning stems from the field of Quaternary mammalian paleontology. Axelrod (1967) was the first to suggest that the paleontological record documents association of kinds of animals in the Pleistocene that today inhabit separate ranges and that this ultimately is evidence for a less seasonal climate. Later, Guthrie (1984) was to advance this idea in his discussion of Ice Age mammals of Alaska. Pleistocene fauna reported from Clovis sites on the Plains includes extinct elephants, horses, camel, and bison. Given this, one might suggest the distribution of the above kinds of animals supports the hypothesis of climatic equability during the Pleistocene. Modern elephant species inhabit tropical and supertropical latitudes and zebras are found in the tropics while other wild horse species are known from the temperate mid-latitudes on the steppes of Eurasia. Camels presently inhabit arid regions of the tropics and bison historically inhabited temperate climes in mid-latitude regions of Eurasia and North America.

However, this reasoning is based on the assumption that the above kinds of animals are inherently adapted to certain climatic regimes both now and in the past. That natural selection acting over the course of the Pleistocene may have brought about biological adaptations not immediately apparent from the bones themselves was first noted by Darwin himself when he considered the meaning of discoveries of mammoths and wooly rhinoceroses in Europe: “…adaptation to any special climate may be looked at as a quality readily grafted on an innate wide flexibility of constitution, common to most animals. On this view… the fact of the extinct elephant and rhinoceros having formerly endured a glacial climate, whereas the living species are now all tropical or sub-tropical in their habits, ought not to be looked at as anomalies, but as examples of a very common flexibility of constitution, brought, under peculiar circumstances, into action (1958:140 [1859]).

Contrary to Guthrie’s view of a Pleistocene climate in Alaska involving less seasonal fluctuation than today, rare finds of mummified mammoths preserved in the permafrost of Siberia and Alaska demonstrate that the soft-part anatomy of mammoths living in arctic
regions had evolved biological adaptations to harsh winters that presumably were part of a climate entailing fairly drastic seasonal fluctuations. Such adaptations included the development of long body hair and tusks of a shape that may have been used to remove snow from forage (Lister and Bahn 1994). At risk of commenting on matters outside my field of expertise, the above observations would seem to draw into question the basic reasoning upon which the notion of climatic equability is founded.

Leaving this epistemological concern aside, a review of evidence relating to the seasonal nature of climate on the Plains during early Paleoindian times provides no support for the concept of less seasonality but instead produces strong evidence that climates were in fact seasonal in nature. The argument for less seasonality during the Pleistocene is based on the assertion that an effect of decreased seasonality would be a mixing of the ranges of plant and animal species such that the ecozones of today would not have existed. To the contrary, paleoenvironmental studies indicate that during early Paleoindian times, vegetation zones within the study area were not entirely different from those of today, although the generally cooler and wetter climate may have brought about change, such as the elevation at which the various ecozones were positioned. Paleoenvironmental changes throughout Paleoindian times in and around the study area will be outlined in detail in a subsequent chapter.

Other evidence that bears more directly on the issue of the extent of seasonality in early Paleoindian environments comes from the seasonality studies of bison bonebeds. The technique for determining the season during which younger individuals in a bison herd were killed is based on tooth eruption patterns evident on mandibles of calves, yearlings, and two-year-old animals. Season-of-death determinations for older animals are based on tooth wear patterns. For discussions of the techniques used in aging bison teeth, see Frison (1978), Frison and Reher (1970), and Todd et al. (1990).

The ability to determine the season during which a bison herd was killed is based on the observation that modern bison are born during a fairly brief period in the spring and from
that time forward, the eruption of various kinds of teeth progresses at a fairly constant rate as
does the development of wear patterns on occlusal surfaces when all teeth are in place. To
develop the technique, mandibles from kill sites were compared to specimens of modern
bison mandibles from commercial herds slaughtered at known times of the year. By
convention, the time elapsed since the birthing season is measured in tenths of a year, instead
of months. A bonebed representing a single kill will have animals in age groups separated by
one year. For example a herd killed in late summer will typically be represented by
mandibles falling into age classes of 0.4 yr, 1.4 yr, 2.4 yr, etc.

The timing of the birthing season of bison and other ungulates is thought to be shaped
through natural selection to occur at a time of year when the probability for the survival of the
yearling is the greatest. Within the study area, this occurs in the spring when the chance of
snow storms has diminished and new growth vegetation provides a nutritious diet for both
lactating mothers and calves. The birthing season is expected to vary by latitude and altitude.
Records on the calving season of bison in Yellowstone National Park of Wyoming indicate
that bison calve over a six-week period that includes the last two weeks in April and the
entire month of May (Meagher 1973:75).

If seasonal climates dictate that calves are born in a one and one-half month period, a
single-event bison kill that transpired in a seasonal environment would be denoted by
mandibular dentitions that all fall into single dental ages separated by one year (e.g. 0.4 yr,
1.4 yr, 2.4 yr, etc.), or dentitions that fall into two adjacent dental ages separated by one year
(e.g. 0.4 yr and 0.5 yr, 1.4 yr and 1.5 yr, etc.), or possibly three adjacent dental ages separated
by one year (e.g. 0.3 yr and 0.4 yr and 0.5 yr, 1.3 yr and 1.4 yr and 1.5 yr, etc.). Abnormally
early or late births may result in more than three dental ages being assigned to a single-event
bison kill, but most individuals should fall within at most three dental ages if the bison are
being born within a one and one-half month period as an adaptation to seasonal
environments. Under the hypothesis of climatic equability, it is expected that early
Paleoindian bison bonebeds dating to Folsom times should not necessarily be comprised of individuals that fall into either one, two, or three dental ages. Rather, substantial numbers of individuals may fall into four or more dental ages as a result of relaxation of the environmental constraints that select for birthing to occur during a restricted time of year. However, dental ages assigned to individual bison at all five Folsom large-scale bison kills reported in the literature fall into either one, two, or three dental ages, thereby supporting the view that climatic conditions during Folsom times involved a degree of seasonality that was comparable to that of today (Bement 1999:Table 40; Jodry 1999:218; Todd et al. 1990: 816, 1996:169-179).

Evidence from both archaeological and paleoenvironmental sources thus refute the contention that climates characterized by substantially lower variation in seasonal temperature made for a biotic environment that was radically different from that of today. From this it follows that although environmental conditions and forager adaptations of the late Pleistocene and early Holocene may have differed from those recorded for modern times, both are knowable through the application of careful reasoning by analogy.

**Paleoindians as Big Game Hunters?**

Results of recent studies of Paleoindian diet in the Great Plains and Rocky Mountains refute the traditional idea that subsistence economy was especially focused on big game hunting. Kornfeld and Larson (2008) reviewed data from well over 500 sites. Dense bison bonebeds were present at only two percent of the sites. When considered as a whole, the remaining sites demonstrate that Paleoindian diet included not only big game, but also medium and small sized animals, as well as plants. Perhaps to counter traditional claims for specialized big game hunting, Kornfeld and Larson (2008) suggest Paleoindian subsistence economy may be characterized as broad-spectrum foraging and would therefore be comparable to that of the subsequent Archaic period. However, M. E. Hill (2007, 2008:34)
cautions against thinking about Paleoindian subsistence in terms of having been either specialized big game hunting or broad spectrum foraging, asserting that this has served to create a false dichotomy.

To avoid this, Hill (2007, 2008) instead examined the relative abundance of small, medium, and large animals in 69 Paleoindian faunal assemblages from the Plains and Rocky Mountains. In order to examine how variation in faunal resources available in differing environments affected Paleoindian diet, assemblages from the study area were categorized according to three basic environments. These include the open grasslands of the Plains, riverine settings on the Plains, and foothills or mountainous regions. The degree to which diet was composed of big game animals was found to vary temporally and regionally. In the early Paleoindian period, there was a high reliance on large game in all habitats. Paleoindian environments will be reviewed below, but suffice to say that the wetter climate of early Paleoindian times may have promoted more forage production for game animals. The common occurrence of big game remains in early Paleoindian assemblages may therefore reflect relatively high populations of big game in the environment, rather than a focus on big game hunting that was unique to Paleoindians. With the drying of the climate in Late Paleoindian times, however, Paleoindian reliance on big game remained high on the Plains. Comparative data from later time periods was not reviewed by Hill, so the generally high reliance on big game on the plains may not be unique to Paleoindians, but rather a characteristic of the subsistence economy shared by later Plains foragers as well. The fact that large-scale bison kills are not uncommon on the Northwest Plains for all later time periods except the Early Archaic suggests that this may be true for at least parts of the Plains (Frison 1978). In contrast to the Plains, however, Late Paleoindian assemblages from foothills or mountains record a dramatic decrease in large game exploitation concurrent with an increase in use of game animals classified by Hill as medium sized (e.g. bighorn sheep and
deer). Hill (2007:431, 2008:43) suggests this dietary change in the foothills and mountains may reflect a decrease in abundance of bison outside the Plains proper with increasing aridity.

Evidence of temporal and geographic variation in Paleoindian diet in the Plains and Rocky Mountains is not congruent with the traditional view of subsistence focusing on big game hunting in all times and all places. Rather, large mammal hunting took place throughout the Paleoindian period on the Plains where big game populations remained high. In the foothills and mountains where the availability of large mammals may have decreased through time, Paleoindian subsistence economy responded accordingly by exploiting a greater proportion of medium sized game animals.

**Paleoindians as Pioneering Populations?**

Accumulating evidence relating to prehistoric population density on the Great Plains has led some advocates of the alternative view to doubt the second main reason traditionally given to bolster the claim for high Paleoindian mobility; that being low population density. Obviously, the initial population of North America was very small. At issue is how fast it grew. Proponents of the traditional view maintain that Paleoindian population density remained low enough that bands were able to roam freely. The somewhat implicit rationale behind this belief is that Paleoindian sites are less common than later sites and this is thought to indicate increase in population density through time. Persistence of this thinking is seen in Kelly and Todd’s (1988:234) assumption that population density throughout early Paleoindian times was low and that only at some unspecified later time did hunter-gatherer population density reach a level such that there was “regional packing of bands” analogous to ethnographically documented hunter-gatherers.

However, developments in geoarchaeology that underline the importance of geological processes as factors affecting site preservation have led some alternative-minded archaeologists to reconsider the claim for unusually low population density. Regional
geoarchaeological studies in central and southwest Kansas strongly suggest that the particular sequence of Holocene deposition and erosion on the Central Plains is a major factor contributing to the relative lack of Paleoindian and Early Plains Archaic sites in relation to Middle Plains Archaic, Late Plains Archaic, and Late Prehistoric sites (Mandel 1992). As in many regions of North America, Paleoindian and Early Plains Archaic sites are also less common on the Great Plains than are later sites. In the Kansas study areas, deposits of Paleoindian and Early Archaic age were found to be principally present in stream terraces along larger watercourses in places where they happened to survive destruction by lateral stream erosion and downcutting. Deposits of this age are often deeply buried in terraces and exposed only along terrace edges. Conversely, Paleoindian and Early Archaic-aged deposits are largely absent from extensive upland areas drained by smaller streams. Scouring of sediment from the smaller drainages during drought conditions of the Altithermal climatic period (ca. 7500 – 5000 B.P.) is thought to have destroyed many Paleoindian and Early Archaic sites.

A second line of evidence relating to prehistoric population density that bolsters the alternative view has to do with data on the distribution of radiocarbon dates through time. As the number of radiocarbon dates from archaeological sites increased dramatically as a result of cultural resource management work beginning in the 1970s, the relative numbers of radiocarbon dates falling into various prehistoric time periods could be compared. A graph of over 1,000 radiocarbon dates from Wyoming supports the hypothesis that the relative rarity of Paleoindian and Early Plains Archaic sites is in large part a result of differential geological preservation (Frison 1991:Figure 2.5). Some of the dates in the sample derive from university research projects that were intent on investigating sites of particular ages, but the majority of dates are from sites that happened to be in areas to be affected by planned construction activities and thus the sample of sites falling into various time periods can be considered to be fairly representative of all sites. Minor undulations in the bar graph are
evident and may reflect factors that affected the numbers of sites produced or preserved. However, the graph shows that numbers of radiocarbon dates remain at low levels throughout the Paleoindian period as well as into the Early Plains Archaic period when numbers of dates rise to a somewhat increased level. The frequency of dates remains at this level with minor fluctuations until around 500 B.C. when the numbers of dates increases dramatically. The point to be stressed here is that if the frequency of radiocarbon dates is partly a reflection of prehistoric hunter-gatherer population density and partly a reflection of geological processes that differentially preserved sites, then the two levels evident in the bar graph prior to 500 B.C. may indicate that the population density of hunter-gatherers on the Plains was basically stable from sometime early in Paleoindian times to 500 B.C. The rise in the number of dates to a higher level which occurred in Early Archaic times might be attributed to destruction of Paleoindian and some Early Archaic sites through erosion during the Altithermal. If such an interpretation of the bar graph is accurate, then the data on radiocarbon dates can be said to complement geoarchaeological evidence by suggesting that the idea of unusually low Paleoindian population density may not be accurate.

An Alternative View of Subsistence Economy and Social Organization

Based on evidence that post-Clovis Paleoindian subsistence economy and population density on the Plains may not have been as dissimilar to that of foragers living during the following 5,000 years, some alternative-minded archaeologists have recommended that ideas on Paleoindian subsistence and social organization be rethought, particularly in regard to the role of seasonal aggregation for communal hunting. This research question is the most immediate need for the purposes of this dissertation because assemblages described in published literature and therefore available for analysis are primarily from bison bonebeds. However, the alternative view acknowledges that bison bonebeds constitute but a small percentage of all sites and therefore archaeologists must be aware that future work should
focus research on other kinds of sites to provide a more holistic characterization of Paleoindian subsistence and social organization. If large-scale bison kills represent an element of Plains subsistence economy requiring the cooperation of relatively large groups intent on big game hunting at a certain time of year, then one might expect that subsistence economy and social organization during the remainder of the year would have involved smaller groups subsisting via a greater range of food resources that included not only big game, but also small game and plant foods. Variations of the above statement have been made in print by Plains archaeologists in reference to the Late Prehistoric period since the late 1970s (Keyser 1977; Reher 1977:34), but only with the rise of alternative thinking have similar suggestions been made in regard to Plains Paleoindians (e.g. Bamforth 1991a).

A number of archaeologists have used data on the season of large-scale bison kills as a springboard from which to contemplate Paleoindian subsistence in a more holistic manner. These data demonstrate a tendency for Paleoindian large-scale bison kills in the more northerly portion of the Plains to have occurred in the fall and winter (Bamforth ca. 2000:Figure 2; McCartney 1990:Figure 7.5). If post-Clovis Paleoindian subsistence economy was indeed focused on large-scale bison hunting as traditionally thought, one might expect that large hunts on the northern portion of the Plains would have continued unabated during the warm weather months. It is further expected that summer should be the time when the largest herds should have been killed by the largest aggregations of human groups because this is the time when bison herds should have been at their largest. Based on ecological studies of modern herding animals in Africa, summer is the time of year when forage conditions allow the largest concentrations of animals to form and it is expected that this basic ecological principle would have applied to bison herds on the Great Plains as well (Bamforth 1988). Congregating for the purpose of reproduction is another factor expected to have encouraged the formation of the largest herds in summer because the height of the mating season for bison occurs around late July to early August. If Paleoindian subsistence
economy focused on hunting herds of big game the year around, then summer should have been a time of intense hunting for Paleoindians in the more northerly parts of the Plains, but this was not the case.

The fact that Paleoindian large-scale bison kills in the northern portion of the Plains tended to occur in the fall and winter is more in keeping with the thinking that the cold-season would have been a time of year when non-big game food resources were not available or at low levels and foraging people living at a subsistence level of existence would have had to cooperate in large bison hunts in order to survive. This would have been particularly true for the more northerly portions of the Plains where the cold-season is a time where non-big game food resources are limited because plants and insects are dormant, many small game species are hibernating, and many kinds of birds have migrated south. But big game animals can also be hunted individually or by small groups of hunters, so the propensity for communal hunting during the cold season is an important question. Driver (1990) suggests the answer lies in the greater chances for success that communal hunting may confer. Though hunting of bison can be accomplished by smaller human groups, failure to make a kill at a time of year when alternative food resources are limited could prove disastrous.

To this point in the discussion, only a rudimentary understanding of the role of large-scale bison hunting in Plains Paleoindian subsistence economy has be suggested based on an understanding of seasonal changes in available biotic resources of the environment in which they lived. To evaluate the assertion that communal hunting served to ensure survival during a lean time of year for Paleoindians on the northern part of the Plains, one might turn to the ethnographic record knowing that much of it must be considered not applicable because of changes to native cultures brought about by contact with European settlers. Introduction of the horse brought about changes in hunting practices where bison could be simply run down. Also, trade with Euro-American groups may likely have affected the intensity and timing of large-scale bison hunts. Given these precautions, Arthur (1974) reviewed the literature for
the Northern Plains for references to instances of driving bison into wooden pounds during early historic times to gain insight into the time of year when similar large-scale bison hunts may have occurred in pre-contact time. His findings must be approached with caution because many of the references he summarizes are of groups that had acquired the horse and were involved in trading relations with Euro-Americans. Given these reservations, however, it is noteworthy that Arthur (1974:106) concludes that bison drives tended to occur in the fall and winter, but some instances are recorded of large-scale hunts at other times of the year. It may be comforting to know that the timing of early historic large-scale bison hunts on the Northern Plains was similar to that during Paleoindian times on the Northern and Northwest Plains. However, this similarity is by no means a rigorous test of the hypothesis that Paleoindian large-scale bison hunts occurred on the northern Plains during the cold-season because this was a characteristic of subsistence economy of Plains foragers of the northern Plains in general.

To better evaluate the hypothesis that large-scale bison hunting by Paleoindians was a subsistence-level activity, one must turn to archaeology to compare a sample of data on the seasons during which Paleoindian bison kills took place to the larger database on the timing of Late Prehistoric kills which arguably played a role in both the subsistence and exchange economies of native peoples (e.g. Bamforth ca. 2000). Whereas large-scale bison kills by Paleoindians may have served to meet the subsistence needs of the group, bison kills in much of the Late Prehistoric may have played a dual role of not only feeding and clothing native people, but also serving to supply them with bison meat and hide products to be used as commodities in exchange networks that extended across the Plains into surrounding regions (Bamforth 2011; Brink and Dawe 1989)

A characteristic of Late Prehistoric bison kills that supports the above hypothesis is that bonebeds dating to this period generally demonstrate more intensive hunting of bison than is evident in earlier periods. Driving bison herds over cliffs is a hunting technique that
evidently was used most commonly in the Late Prehistoric. In comparison to other techniques of killing bison en masse, such as the surround, or driving a herd into a wooden “pound” or natural trap, the technique of driving bison over a cliff is thought to result in the death of larger numbers of bison. Frison (1978:229) notes that driving small numbers of bison over a cliff is difficult because the lead animals recognize the danger in time and balk or change course. He goes on to reason that operation of a jump requires the momentum of a large herd of stampeding bison in order to force the leading animals over the edge and cause the others to follow to their demise. Bonebeds associated with jumps are often truly large and typically are only sampled by excavations. Thus, exact numbers of bison killed in jumps are generally not available. As discussed above, however, the number of bison that could have been killed in a single event or a series of closely spaced events by running a herd over a jump can be quite large, as demonstrated by work at the Glenrock Bison Jump in southeast Wyoming, where the number of bison represented in the lower bonebed numbers in the hundreds. In contrast, other techniques may have more commonly resulted in the death of smaller numbers of bison. Fairly plentiful ethnographic literature documents that trapping of bison can result in the capture of as little as a few bison (Arthur 1974:101-103) to herds of up to 240 animals (Hind 1859:56). In those rare instances where cliffs saw use during both Archaic and Late Prehistoric times (e.g. Brink and Dawe 1989; Frison 1970), the Late Prehistoric bonebeds are thicker, implying more intensive use of bison during the later period that may have presumably entailed larger groups of people gathering and driving larger herds of bison over the cliff. Considering that the frequency of radiocarbon dates from all kinds of sites in Wyoming shows a dramatic increase beginning in the waning centuries of the Late Plains Archaic and extending into the Late Prehistoric, it would seem reasonable to speculate that the necessity of feeding greater numbers of people on the Plains was one possible factor contributing to the apparent intensification in bison hunting.
Ideas on why population apparently increased dramatically in Wyoming during this time will be only summarized here in order to confirm that the social context in which large-scale bison hunting occurred during Late Prehistoric times differed from that of Paleoindian times. The apparent rise in prehistoric population within what is now Wyoming began in the Late Plains Archaic around 200 B.C., peaked around A.D. 800, and extended to around A.D. 1200 (Frison 1991:Figure 2.5). It is relevant to note that the spike in Wyoming population is coeval with evidence for an increase in population concurrent with development of more complex societies in the Eastern Woodlands (Meggars 1973; Neuman 1975). In the early part of the period in question, the Hopewell culture arose based on exploitation of wild food resources with little dependence on cultigens. Hopewell burial mounds provide testament to this once flourishing society thought to have been organized into individual chiefdoms. The following Mississippian culture is believed to have been a stratified society based on an agricultural economy founded on corn, beans, and squash. Platform mounds at population centers like Cahokia and Spiro stand in testament to the stratified chiefdoms of the Mississippian period. It has long been thought that a long distance exchange network existed between the chiefdoms of the Eastern Woodlands and foragers of the Plains, based primarily on the presence in burial mounds of high-status grave goods made of stone from sources on the Plains and Rocky Mountains (Jennings 1977:28-30). More recently, it has been suggested that these perishable artifacts are archaeological indicators of the former existence of an extensive trade network that primarily involved exchange of bison meat and hide products from the Plains for plant foods and tobacco (Brink and Dawe 1989:291-303).

In light of the above evidence for increased human populations east of the Plains during the period of concern, as well as evidence for some form of contact and exchange between peoples of the Eastern Woodlands and Great Plains, one might suggest that the apparent increase in bison exploitation on the Plains may have been not only to feed an increased population on the Plains, but also to supply people living in regions surrounding the
plains with foodstuffs derived from dried bison meat. Consequently, before archaeologists use comparisons between Paleoindian bison kill sites and those of the Late Prehistoric period as a means of gaining insight into how Paleoindian subsistence economy may have differed from later periods, it is important for archaeologists to fully consider the possible affects of population size and inter-regional trade in bison products on the archaeological record of Paleoindian and Late Prehistoric periods. The above discussion suggests that Paleoindian large-scale bison hunting is best conceived of as an activity to meet the subsistence needs of foraging populations on the Plains which were low in comparison to those of Late Prehistoric times. In contrast, large-scale bison hunting during Late Prehistoric times may have been intended to not only meet the subsistence needs of a much larger population of Plains foragers, but to also produce bison meat products as a commodity to be used in trade with large populations in surrounding regions. In other words, large-scale bison procurement in Paleoindian times may have been basically subsistence-level hunting, whereas large-scale bison hunting in Late Prehistoric times might best be characterized as both subsistence hunting for the native population and production of commodities for exchange.

Apart from greater numbers of bison being taken, Late Prehistoric bison kills also differ from those documented for Paleoindian times by demonstrating evidence for pemmican production. In historic times, pemmican was produced by drying meat, pulverizing it, and adding grease rendered from animal bones, sometimes along with dried berries, to make a nutritious, flavorful, and storable foodstuff. Production of pemmican prehistorically is thought to be represented in the archaeological record by certain kinds of features, artifacts, and faunal remains, as is epitomized by those present at the Piney Creek site on the Plains of northeastern Wyoming (Frison 1978:237-239). The site consists of two areas, including a kill site where bison were driven over a steep bank onto the floodplain of the creek as well as a processing area located 50 meters downstream. Pottery found at the processing area is of Crow affiliation. Three kinds of features are present on the site. Large pits with charcoal are
surrounded by more numerous, smaller pits lacking charcoal. Small, above-ground rings of stone comprise a third kind of feature. Large anvil stones are present surrounded by heaps of broken bone and hammerstones, indicating that bones were broken open to extract fat in the form of bone marrow.

Bison long bones contain cavities with marrow in colloid form that can be extracted by cracking open the bone, but other kinds of bones, such as ribs, vertebrae, and pelvises contain marrow within the small interstices of cancellous bone within their interiors. Fat can be rendered from these bones only by crushing them into small fragments and adding the fragments to boiling water. This causes the marrow to be boiled out of the interstices and collect on the surface of the water in the form of “bone grease.” The process of bone grease manufacture has been documented ethnographically and bone grease is believed to have been an ingredient used in the production of pemmican. Frison interprets the larger pits with charcoal as features where rocks were heated in preparation for stone boiling. The smaller pits and the small rings of stone are thought to have been lined with green hides or bison paunches to serve as containers of water. Piles of crushed and broken bones that were presumably boiled for grease are present around the edges of the smaller pits, supporting Frison’s interpretation of these features as stone-boiling pits. Other sites interpreted as locales where bone grease was manufactured often have sherds present, leading to the suggestion that ceramic pots also served as containers of water for stone boiling of crushed bone as part of the process of bone grease production (Vehik 1977).

If the above archaeological evidence for bone grease production can be taken as reliable indicators of pemmican manufacture, then it can be stated that pemmican was commonly made in Late Prehistoric times. Evidence for the earliest manufacture of pemmican on the Plains would date the inception of this food product to sometime in the middle of the Archaic time period (Bamforth 2011).
Food from bison kills can be preserved for later consumption without going through the rather involved process of pemmican manufacture and one might expect that these methods would have been in use prior to the advent of pemmican and likely continued to some extent after the invention of pemmican. Ethnographies of the Plains illustrate that meat from bison killed during the warmer months of the year could be preserved by cutting it into thin slices and drying it to make jerky on wooden racks fashioned by lashing wooden poles together (e.g. Wedel 1986:Plate 10.2) Thus, in contrast to the fairly obvious archaeological signature of pemmican manufacture that includes a scatter of bone fragments and related features and artifacts, preservation of meat by means of jerky making would be expected to leave comparatively little trace. Jodry (1998, 1999:195-212) hypothesizes that so-called ultrathin knives known from Folsom assemblages may have been used to cut meat into thin slices as part of the process of preserving meat and discusses supporting evidence from use wear analysis of specimens from the Cattle Guard site. Muniz (2005) notes that similarly thin knives were also made as late as Cody times. Preservation of meat by making jerky is not possible during extremely cold weather because the meat will not dehydrate. A limited amount of ethnographic information suggests that bison meat procured in communal drives during the height of cold weather on the Northern Plains may have been preserved in a frozen state (Arthur 1974).

Unlike jerky and pemmican, which will keep even when stored for long periods, fat by itself is not amenable to being preserved through dehydration and thus tends to spoil, especially in warmer weather. Therefore, prior to the advent of pemmican manufacture, fat would not likely be preserved, unless weather conditions during the height of the cold season in some areas allowed it to be frozen solid. Sources of fat available for immediate consumption would have included the fattier portions of the bison, which are often cited in historic writings as having been considered the choicest parts of the bison by Plains peoples. These include the hump, brisket, and tongue (Wheat 1972:98-103). Depending on the
condition of the bison, subcutaneous deposits of body fat may also be available. As a general rule, however, the meat of bison and other game animals is lean in comparison to modern breeds of cattle that have been artificially selected for fat content and in the U.S. are raised to maximize their fat content for taste. Thus, a major source of fat content for immediate consumption in bison would have been marrow extracted from long bones. That Paleoindians exploited bone marrow as source of fat is seen at a number of bonebed sites where limb bones were broken open to extract marrow. Bonebed sites with evidence for marrow consumption include Cattle Guard in Colorado, Clary Ranch in Nebraska, Casper and the Folsom and Agate Basin components at Agate Basin in Wyoming (M. G. Hill 2001; Jodry 1987; Jodry and Stanford 1992).

Given the above information, one might reason that in the earlier part of Plains prehistory, large-scale bison hunting generally provided meat and fat for immediate consumption as well as the potential to store large amounts of lean meat over the long-term via drying. During the height of the cold season in the more northerly latitudes of the Plains, periods of extreme cold may have permitted storage of meat as well as fat in frozen caches. During later periods in prehistory, this same basic pattern of bison utilization could have continued in some instances. However, certain processing areas dating to the later period definitely demonstrate the more involved method of putting up long-term stores of meat and fat in the form of pemmican and explaining the reason for this change is important for understanding the changing role of large-scale bison hunting in the economy of Plains foragers.

As suggested by Brink and Dawe (1989:291-303) and Bamforth (2011), it may be relevant to consider the role that pemmican may have played in the long-distance trade networks hypothesized to have existed in later periods of Plains prehistory. Pemmican would have been an ideal food commodity for use in trade for a number of reasons. First, pemmican is in a compact form. Drying meat decreases its weight by 90 percent (Frison 1978:302) and
transforms it into a compact, easily transported form. Second, pemmican can last for years and thus is well suited for use as a food commodity in a long-distance trade network. If indeed pemmican produced on the Northern Plains was traded to the Eastern Woodlands, it would seem reasonable to suppose that a number of exchanges between people would be involved and the time required to transport goods across this distance would be considerable. Furthermore, pemmican provides a balanced food source, providing both protein (the lean meat) and fat (the bone grease). Also, adding fat to dried lean meat improves its taste, thus making pemmican a more desirable trade good. As suggested by Brink and Dawe (1989:299) dietary deficiencies common to the Plains and Eastern Woodlands may have been a motivating factor in established trade between the two areas, as “the need for carbohydrate content in the diet of hunters and gatherers may have promoted exchange of bison materials (hides, fat, meat) for plant foods rich in carbohydrate.”

From the above discussion, it should be apparent that in order to best explain changes in large-scale bison hunting through time, it is imperative to consider the possible effects of increased population and trade. The argument for the traditional view advanced by Kelly and Todd (1988) fails to do this and instead assumes that the archaeological record of Late Prehistoric large-scale bison hunting is a reflection of subsistence-level bison hunting. From this assumption, differences between the Late Prehistoric and Paleoindian archaeological record relating to bison hunting are noted and seemingly plausible explanations of the observed differences are offered that are in keeping with the traditional view. For example, the tendency for known Late Prehistoric kill sites to include a higher proportion of bison jumps in comparison to Paleoindian kill sites is said to reflect less intimate knowledge of the landscape by highly mobile bands of Paleoindians. In other words, Kelly and Todd (1988:235, 239) imply that since the landscape was yet to be filled up with bands of hunter-gatherers, roaming Paleoindian bands were less knowledgeable of the location of topographic features (such as cliffs) that could be used to procure bison *en masse* and so such features
were less used by Paleoindians. As discussed previously, however, the greater use of jumps in the Late Prehistoric is best explained as reflecting the intensification in large-scale bison hunting known to have taken place at this time. This explanation has the added advantage of being supported by other lines of evidence for intensification, those being evidence for increased population in the Late Prehistoric and evidence for an increase in trade as well.

Based on the assumption that the archaeological record of Late Prehistoric bison hunting as a whole represents subsistence-level hunting, Kelly and Todd (1988:238-239) also note that early Paleoindian subsistence strategies did not include pemmican production and from this apparent less intense use of bison carcasses, they reason that the difference reflects a highly mobile land use strategy that involved little food storage. The foregoing discussion would argue that an alternative explanation for the occurrence of pemmican production in Late Prehistoric times (and lack of such evidence in the Paleoindian period) has to do with increased levels of trade hypothesized for later time periods in Plains prehistory. Paleoindians may have engaged in food storage involving drying and freezing, as suggested above for Plains foragers prior to the advent of extensive trade networks.

Having questioned the reasons proposed to date for the observed differences between the archaeological record of Paleoindian and Late Prehistoric large-scale bison hunting, alternative-minded archaeologists are now charged with providing a better theoretical model to explain these differences in detail. A good way to start is to look at actual data on the season of bison kills for the Paleoindian and Late Prehistoric periods.

Bamforth (ca. 2000) compared data on the timing of Late Prehistoric kills on the Northern and Northwestern Plains to that of Paleoindians kills from the same area. A bar graph of the timing of large bison hunts by month for the Late Prehistoric period is distinctly bimodal (Bamforth 2000:Figure 1). From the lowest frequencies of bison hunts in June and July, the frequency of bison hunts rises in August and September to peak in October when the frequency of bison hunting was at its greatest frequency for the year. Thereafter, bison
hunting decreases in frequency in November and December to a low in January. This part of
the bar graph forms a fairly normal distribution centered on the month of October. Thus, the
first mode of large-scale bison hunting appears to have begun in mid-summer (August),
peaked in early fall (October) and subsided in early winter (January). The second mode in
bison hunting apparently did not entail quite as much hunting, nor was the hunting as
concentrated around a single month as in the first mode. Nevertheless, substantial numbers
of large-scale bison hunts began in mid-winter (February) and continued to mid-spring
(May). In interpreting the bimodal distribution of the bar graph, Bamforth (ca. 2000:7-8)
suggests the first mode represents efforts to amass food stores for the winter. He goes on to
suggest that the second mode of bison hunting may represent hunts conducted once food
stores had been exhausted and to support this possibility, he notes that spring was often a time
of food shortage on the Plains. In light of the evidence for trade during the Late Prehistoric,
archeologists seeking to developing testable models of land use during this period should
consider the possibility that the second mode of bison hunting might represent hunting
intended to amass bison food products, particularly pemmican, to be traded at a rendezvous
later in the summer. In contrast to Late Prehistoric times, Bamforth’s (ca. 2000:Figure 2) bar
graph on the timing of large-scale bison hunting during Paleoindian times appears to form
more of a unimodal distribution with most kills tending to occur in the fall and winter.

The above comparison of the timing of bison kills bolsters the thinking that large-
scale bison hunting played differing roles in the economic life of people during the two
periods. In the Late Prehistoric, kills in the late summer and fall may have been principally
intended to provide food stores for the upcoming cold-season by making jerky and
pemmican. The intent of the second period of Late Prehistoric kills in late winter and early
spring is still problematic because it is unknown whether the second pulse of hunting was to
meet subsistence needs or to amass a commodity for trade, or both.
It is relevant to note that the second pulse does not appear to have had a counterpart in Paleoindian times. In contrast to the Late Prehistoric pattern, the timing of Paleoindian large-scale bison kills on the Northern and Northwestern Plains occurred during the height of the cold-season. Many of the sites in Bamforth’s bar graph have dental ages of N + .6 yr or N + .7 yr, meaning that the bison died at a time of year that was .6 or .7 years after the calving season. As will be discussed in detail below, the technique of determining dental age of bison is based on the timing of the bison calving season on the plains of eastern Wyoming which occurs around the first of May (Frison and Reher 1970:46). If this time is used to estimate the calving season on the Northern and Northwestern Plains during Paleoindian times, the above dental ages would indicate that many kills occurred sometime during the time of year beginning in early November, extending through December, and ending in mid-January. If climatic conditions during Paleoindian times were even somewhat comparable to those of today, storage of meat by drying would often have been difficult or impossible during this time period. Thus, storage of meat and marrow by means of freezing may have occurred during this time of year, as first suggested by Frison (1982). This is a noteworthy observation, since most references to food storage in the ethnographic literature of the Plains describes instances of drying meat to make jerky or pemmican. Preservation of meat by drying could have been accomplished when the weather was sufficiently warm and one bison kill that occurred during warmer months is known from the Northwestern Plains (Todd et al. 1996). However, the important point to note is that during the height of the cold-season, which arguably was lean a time of year for Plains foragers in general, Paleoindians on the northern Plains principally responded by engaging in large-scale bison hunting and apparently preserving food obtained from the kills by freezing. This in turn implies that Paleoindians were doing what was minimally required to survive the lean part of the year. Large-scale bison hunting during the height of the cold season was apparently reliable enough that Paleoindians could anticipate making a kill and preserving meat via freezing. For
foragers with a subsistence-level economy and low populations relative to later foragers, going through the added processing effort of making jerky and pemmican during the fall prior to the onset of the height of the cold-season was apparently not necessary for survival.

However, the seasonal timing and food storage techniques involved in Paleoindian large-scale bison hunts would be expected to vary across the Great Plains in response to differing climatic regimes (Bamforth ca. 2000). Paleoclimatic evidence indicates that in comparison to modern weather patterns, cold-season temperatures during Paleoindian times were colder on the northwest Plains, similar to modern conditions on the Central Plains, and above-freezing on the Southern Plains (Bamforth 2000:12-14). Since freezing as a means of food preservation would not likely have been an option in areas where cold-season temperatures normally remained above-freezing, putting up stores of food as a strategy for surviving the relatively lean time of year would necessarily require that meat be preserved through drying when the weather is sufficiently warm and thus large-scale bison hunts would be expected to have been held prior to the height of the cold-season. In support of this hypothesis, it may be noted that Bamforth (ca. 2000:15-17) observes that many of the Paleoindian large-scale bison kill sites on the Southern Plains, which happen to be Folsom sites, were produced during this time period. Most of the dental ages assigned to the bison mandibles from the sites to which Bamforth refers range from N + .3 yr to N + .5 yr (Bement 1999:Table 40; Todd et al. 1996:169-171). In order to maintain a basis for comparison with dental ages from the Northern and Northwestern Plains, the height of the calving season on the plains of eastern Wyoming (the first of May) may again be used to define the beginning of the dental age scale. The actual timing of calving season on the more southerly latitudes of the Plains under modern conditions would be expected to occur somewhat earlier in the year. In sum, even though the calving season on the Plains of Wyoming is less than ideal, it should provide a reasonable approximation of the seasonal timing of Folsom kill sites on the Southern Plains and this estimate is from mid-July to the first of November. Thus, existing
evidence strongly suggests that the subsistence economy of Paleoindians living on the Southern Plains involved surviving a lean time year during the height of the cold-season by putting up stores of dried meat during the months prior to the lean time, when the weather was sufficiently warm to dehydrate meat.

Apart from the seasonality of large-scale bison kills, the actual hunting techniques employed has bearing on the nature of Paleoindian land use. Archaeologists have long surmised that Paleoindian bison bonebeds represent locations at or near natural or manmade trap. To the contrary, Bamforth (2011) finds little to support such an interpretation, citing lack of any firm evidence for construction of hunting facilities such as drive lanes or wooden pounds. Furthermore, with few possible exceptions, Bamforth sees no convincing evidence for reuse of the same kill site as is common at Late Prehistoric sites. As an alternative explanation, he proposes that many Paleoindian bonebeds have characteristics analogous to hunting camps of the Pawnee who are thought to have killed bison *en masse* using the surround technique. An implicit rationale for interpreting many Paleoindian bonebeds as the actual location where the kill occurred seems to be the presence of partial skeletons of bison, which people would not be able to carry very far. However, abundant ethnographic evidence documents that prior to introduction of the horse, Plains peoples possessed dogs principally as beasts of burden (e.g. Ray 1974:161). Evidence that Plains Paleoindians also possessed large dogs that were between the size of a wolf and a coyote has been known since the early 1980s, but its significance to development of an alternative view of land use has been overlooked (Walker 1982; Walker and Frison 1982). By using dogs equipped with travois, Paleoindians could have transported segments of bison carcasses from a location where bison were killed in a surround to their camp for further processing. If the kill was conducted in more northerly parts of the Plains when weather conditions were below freezing, meat could be stored in a cache. If the kill took place on the more southerly portions of the Plains where storage by freezing was not an option, meat could be stripped from the bones for drying and
the bone discarded in a concentrated area. The archaeological consequences of both
scenarios would be the production of bison bonebeds. Considering the kinds of bones that
would tend to be left at the actual kill site as opposed to bones that would be transported to
camp is one way to begin to evaluate the credibility of the surround as a hunting technique
common to Plains Paleoindians.

The preceding summary of the literature on large-scale bison hunting provides a
detailed view of but one aspect of Plains Paleoindian subsistence economy, and in doing so, it
also presents a highly biased perspective because little is known about the lives of these early
foraging peoples of the Plains during those times of the year when they were not engaged in
large bison hunts. The evidence available to date suggests that large-scale bison hunting was
an important part of the subsistence economy that enabled Plains foragers to survive a lean
time of year. The amount of work necessary to process a large number of bison implies that
people were aggregated into bands or multi-band groups at this time of year. Evidence
collected to date suggests that during the remainder of the year, the subsistence economy
involved the use of a mix of the available food resources that generally included plant foods,
birds, small and medium sized mammals, and big game animals that apparently were hunted
individually or in small groups (Bamforth 2007, Hill 2007, 2008). There is even evidence for
utilization of reptiles, fish, and shellfish. Evidence for the formation of large human groups
during this time of year is generally lacking and presumably the population was dispersed
(Bamforth 1991a).

Possible evidence for harvesting of plants by Plains Paleoindians comes in the form
of manos and grinding slabs that arguably were used to process plant foods. The possibility
that these artifacts actually functioned as plant processing tools is not certain because no
attempts were made to recover any pollen or phytoliths that may have been adhering to the
grinding surfaces. On the other hand, it should be noted that were the artifacts found on
Archaic or Late Prehistoric sites, few would balk at the suggestion that they are plant
processing artifacts. Frison (1978:106-107, Figure 3.17) illustrates a mano from the Colby site of Clovis affiliation, located in the Bighorn Basin of Wyoming. Two of the artifacts from the collection of ground stone artifacts from the Lindenmeier site that apparently were recovered from the Folsom stratum are also labeled as manos (Wilmsen and Roberts 1978:Table 53). Finally, definite grinding slabs and handstones that may have functioned as manos were in use during Cody times, as demonstrated by specimens from the Jurgens site on the plains of Colorado (Wheat 1979: 129-130).

Certain Paleoindian sites lacking bison bonebeds excavated to date produce evidence for the use of a broader range of animal food resources, as exemplified by the Allen site, located on the Central Plains of Nebraska (Hudson 2007). The Allen site is located along Medicine Creek, a permanent stream lined with a gallery forest. The forest and the stream itself form a riparian environment that is home to a diverse array of plants and animal species relative to the surrounding grasslands. Aggrading sediments at the site produced thick cultural deposits that document occupation of the site throughout essentially the entire Paleoindian period. A diversity of animals is represented in the faunal assemblage with 49 taxa represented (Hudson 2007:Table 12.1). Species that were likely introduced to the site as the main food resources of the site’s occupants include bison, deer, antelope, jackrabbits, cottontails, and prairie dogs. During the early occupations, the number of bison taken is greater than the total quantity of deer and antelope. By the end of the Paleoindian period, this trend is reversed with the combined number of deer and antelope outnumbering bison. Other species that may represent human food remains include a variety of birds, particularly waterfowl, and aquatic animals (including beaver, turtles, freshwater mussels, and catfish). The variety of species present is suggestive of a number of methods of procurement. Some of the small mammals, including jackrabbits, cottontails, and prairie dogs may have been snared rather than hunted. Bones of large game animals were not found in dense bonebeds.
suggestive of large-scale hunting. Rather, hunting of individual animals or small groups is suggested.

Of the relatively few excavated Plains Paleoindian sites that are not large-scale kills, some are basically locations representative of small-scale bison hunting. A good example is the Lubbock Lake site, which is located at the location of a former spring-fed wet area along Yellowhouse Draw on the Staked Plains of northwest Texas (Bamforth 1985). Aggradation of sediment along the draw preserved a series of occupations layers containing faunal remains thought to represent small-scale bison kills dating to the Folsom and Cody periods. The site suggests that small-scale bison hunting was a component of post-Clovis Paleoindian subsistence economy during times of the year when people were not engaged in large-scale bison hunting.

Work needs to be dedicated toward developing a more representative view of Paleoindian subsistence. Of the over 500 Paleoindian sites in the Plains and Rocky Mountains reviewed by Kornfeld and Larson (2008), only two percent have dense bison bonebeds, but thoroughly investigated and reported sites that are not bison bonebeds comprise but a small fraction of the sites discussed in publications. A major problem with testing the reasoning that sites like Allen and Lubbock Lake are representative of Paleoindian subsistence economy when people were not involved in large-scale bison hunting is that the season during which such sites were occupied is often difficult determine in a precise manner. Unlike the well-developed and fairly precise techniques for determining season of occupation from analysis of bison teeth, techniques for assessing seasonality of site use that are based on other kinds of faunal remains are not as well developed, nor do they usually permit as precise an estimate for season of occupation. It is only though venturing into this less comfortable arena and grappling with the methodological problems to be encountered that archaeologists can hope to rectify the currently lopsided view of Paleoindian subsistence.
The Need for an Alternative View of Land Use

If Plains Paleoindian land use involved annual aggregation and dispersal (and therefore shared a basic characteristic in common with virtually all hunter-gatherers), then making other comparisons to hunter-gatherers in general may be one way to start developing better theory on land use. Just such an approach was taken by Andrews et al. (2008) who compared the areal size of known Folsom sizes with the size of 68 sites produced by various modern hunter-gatherers, including groups of Inuit, Bushman, and Australian aborigines.

The ethnographic sample was comprised of many small special activity sites (including kill sites, transient camps, and hunting overlooks), relatively few medium-sized sites (consisting mostly of single-band sites), and few large sites (including mostly multi-band sites). Sizes of Folsom sites were shown to compare well with the tri-modal distribution of ethnographic site sizes. Furthermore, in both Folsom and ethnographic samples, small sites were much more common than medium and large sites. This implies that foragers living during the Folsom period produced the same basic kinds of sites and in comparable frequencies. More importantly for the purposes of this dissertation, it implies that land use during Folsom times was comparable at a basic level to that of ethnographic people. Evidently, foragers during Folsom times were producing a lot of small sites where presumably resource procurement and other activities were being conducted, as well as a few sites representing camps of groups about the size of individual bands and a few sites representative of camps of multi-band groups or camps occupied by a single band on multiple occasions. Furthermore, the comparison implies that land use of ethnographic peoples and Paleoindians was similar to the extent that measurable aspects of ethnographic land use can reasonably be used as tools with which data relating to Paleoindian land use can be analyzed and interpreted.

From the above, one might suggest that development of the alternative view should proceed by demonstrating that the geographic extent of Paleoindian land use was similar to what would be expected for hunter-gatherers in general. A first step would be to get some
conception of the size of ranges utilized by ethnographic bands to have a basis for comparison. Any attempts to develop a model that demonstrates a basic similarity in the geographic extent of ethnographic and Paleoindian land use would need to examine the effect that raw material availability is expected to have had on the geographic extent of land use. This might be done by defining the study area so that it includes sites in regions where quality sources of stone are locally available as well as sites in regions where such sources are not available. The model should also demonstrate how the geographic extent of Paleoindian land use in the study area reflects changes in population aggregation and dispersal in a manner similar to that expected of all hunter-gatherers whose subsistence economy responded to seasonal changes in the environment. This could be done by defining the study area so as to include sites that arguably represent the work of aggregated human groups (specifically sites related to large-scale kills) as well as other kinds of sites that do not demonstrate evidence of having been produced by large groups of people. Unfortunately, camps produced by small groups of Paleoindians not engaged in large-scale bison hunting have not been the focus of research to date and thus assemblages from them are rare.

However, Paleoindian research on the Plains has focused on sites at source areas and therefore methods are needed to elucidate the extent of land use patterns using assemblages from these kinds of sites. Since artifact manufacture was an emphasized activity at such sites, they typically produce plentiful artifacts and this has likely been a factor promoting their disproportionate study by archaeologists. This has added to the biased nature of Paleoindian sites reported in the literature, but fortunately for the purposes of this dissertation, such sites can be helpful for understanding prehistoric land use and trade. During the period witnessing the rise of the alternative view, assemblages from such sites on the Plains and adjacent intermontane basins to the west were analyzed and findings were published. These projects include analysis of assemblages from Medicine Creek, Nebraska (Roper 2002), Hell Gap, Wyoming (Larson et al. 2009), the Knife River Flint quarries (e.g. Root 2000; Shifrin and
William 1996; William 2000), and Barger Gulch in Middle Park of Colorado (Kennedy et al. 1998; Naze 1994; Surovell et al. 2003; Waguespack et al. 2006). The previous discussion on the various ways that hunter-gatherers are known to have procured tool stones during visits to sources (e.g. via small task groups, individual bands, multi-band groups) at least offers a basic theoretical basis for thinking about land use from the vantage of sites by sources.

In regard to using the tool stone composition of assemblages from sites by sources as a means to study land use, an article by Gramly (1980) seemingly provides some encouragement. In reporting on an Archaic assemblage from a site near a lithic source in Maine, Gramly notes that tools discarded at sites by sources that are worn out from use or broken during use should give some idea of the range used by site occupants prior to occupying the site, since any motivation to curate tools would cease once the lithic source is reached. Thus, while the debitage and tools broken in manufacture would be dominated by the local stone, the remaining collection of tools has the potential to provide some conception of geographic extent of the land use pattern of the site occupants. Sites and assemblages produced by task groups intent on mass producing tools for trade or gearing up (e.g. the Benz site at the KFR source area) would be expected to differ in basic ways from those associated with individual family groups or bands visiting a source while continuing to perform subsistence-related activities (e.g. possibly the sites in the Yellow Creek drainage of Mississippi). These sites would in turn differ from sites produced by a multi-band group gearing up for a communal hunt planned near the lithic source (e.g. possibly the tipi ring site at the Barbour quarry in the Spanish Diggings source area). The point to be made here is that if archaeological investigations at sites by sources allow the basic nature of the occupation to be assessed in the ways suggested above, this information can be used to interpret the meaning that nonlocal sources represented in the tool collection may have regarding prehistoric land use.
Apart from exploring the geographic extent of land use patterns, research needs to begin to evaluate the idea that the regularity of Paleoindian land use would also have been comparable to what would be expected for all hunter-gatherers. More specifically, future research should be directed toward beginning to construct a framework for eventually testing the idea that Paleoindian social groups operated within habitual ranges and that they periodically aggregated with neighboring social groups to carry out subsistence activities that required a communal effort. For the purpose of discussion, let us assume that the minimal social unit of organization for Paleoindians in the period and area of concern is the band. For sites located in areas where tool stone is locally available, sourcing of assemblages from sites that arguably represent individual bands should be helpful for starting the process of defining ranges used by individual bands. For assemblages from sites produced by single bands operating in areas where good sources of stone are not locally available, tool stone sourcing should again contribute toward the process of elucidating land use by identifying which nonlocal sources were visited by task groups to supply the local band. As mentioned, however, sites representing the occupation of single bands intent on general food procurement activities are not well studied.

Artifact collections from sites associated with large-scale kills that are clustered within a restricted geographic area may offer one way to elucidate the nature of land use regularity through analysis of currently available collections. In her discussion of the problems and prospects of investigating Plains Paleoindian land use through tool stone sourcing of assemblages from the Agate Basin site complex in Wyoming, Carolyn Craig (1982:Table 1) presents data on the occurrence and prevalence of various tool stone types in the Folsom and Agate Basin assemblages. The site complex is located south of the Black Hills in the drainage of Moss Agate Creek, a tributary of the Cheyenne River (Frison 1982:Figure 1.5). Folsom and Agate Basin artifacts sourced by Craig derive from partly superimposed strata preserved along an eastward flowing segment of a buried arroyo with a
permanent spring located nearby (Frison and Stanford 1982; Albanese 1982:Figure 5.2). Folsom artifacts derive from Area 3, as well as from 75 m downstream to the east in Area 2, where artifacts occur in association with the bones of 11 bison killed in the late winter, five antelope, as well as a variety of smaller animals (M. G. Hill, 2001:65-66; Walker 1982). Agate Basin artifacts derive from Area 2 where they are associated with a bonebed comprised of the bones of 53 bison killed in late fall or early winter (M. G. Hill 2001:126). Frison (1982) interprets the bonebed as the remains of a frozen meat cache that had been opened and used, causing the bones to be strewn about. Artifacts assigned to the Agate Basin component also derive from 40 m further downstream in Area 1 where another bison bonebed was uncovered. Unfortunately, the excavation was carried out at various times by artifact collectors and archaeologists working in the 1940s when documentation and collection of bones was not standard excavation procedure. Therefore, the nature of this bonebed currently remains speculative. Given the available information, however, it can be said that many of the artifacts in the collection evidently were deposited along with bones of bison processed as a result of large-scale bison hunts. Some of the artifacts, however, were apparently recovered far from any bonebed and their assignment to large-scale bison hunting is less secure.

With this background information in mind, consideration of the tool stone data presented by Craig supports the notion that Paleoindian land use entailed a certain amount of regularity and as such was not entirely different from that of later hunter-gatherers. Substantial amounts of tools in the Folsom assemblage are made of three tool stones. The first is a quartzite comparable to the Flint Hill source in the Cheyenne River drainage at the southern edge of the Black Hills, located about 30 km east-northeast of the site. The second raw material is a dendritic chert that poses a problem for positive identification because similar sources are known from limestone formations that ring the Black Hills as well as from sources in the Hartville Uplift in the North Platte drainage, located from 70 to 110 km southwest of the site. The third tool stone is Knife River flint from sources in North Dakota.
located between 450 and 480 km north-northeast of the site. Purely for the sake of illustration, one might suggest that an archaeologist working from the alternative view might hypothesize that the bison killed somewhere in the vicinity of Agate Basin during Folsom times were slaughtered by an aggregated human group composed of the local band of the Cheyenne River drainage (represented by the Flint Hill quartzite), a band from the North Platte drainage to the south (represented by the dendritic chert, possibly from the Hartville Uplift), and a band from the Belle Fourche drainage, north of the Black Hills (represented by Knife River flint). If indeed this hypothetical scenario reflects the actual social organization of the human groups that participated in the large-scale bison hunt during Folsom times, then it is relevant to note that the same set of tool stones occur in the Agate Basin assemblage from Agate Basin, only in somewhat different frequencies. This could reflect a fairly stable land use pattern that lasted over a time frame best measured in centuries wherein bands habitually occupied certain ranges and coalesced with neighboring groups to participate in large-scale hunts.

Another aspect of the tool stone data that supports the idea of a fairly regular land use pattern during Paleoindian times is that a relatively large number of tool stone types that individually comprise a small amount of the assemblage are present in the Folsom collection and most of these types also occur in the Agate Basin assemblage in equally small amounts. There are eighteen of these types and each comprises less than 5 percent, with some present in miniscule amounts. Eight of the types are known to archaeology as coming from three or four regions in Wyoming and the adjoining state of South Dakota and these source areas lie in various directions from the site (Craig 1982). The remaining ten tool stones are from sources that are as yet unknown to archaeology. Of the eighteen minor tool stone types, only five are represented in one Paleoindian assemblage, but not the other. The above information in total presents a picture of Paleoindians being familiar with and using not only the major sources of stone, but most of the minor sources as well. Furthermore, this familiarity and
usage of what may be most of the available tool stones in regions surrounding Agate Basin evidently continued over a long period of time because the time that elapsed between the Folsom and Agate Basin use of the site for processing carcasses from large-scale bison kills is one that is probably best measured in centuries.

A final character of the assemblages from Agate Basin evident in Craig’s tool stone data that has relevance to the issue of land use is that the tool stone type comprising the largest percentage of debitage in both Folsom and Agate Basin assemblages is the moss agate for which the Agate Basin site is ultimately named. According to Frison (1982b:178), this material is locally available in fist-sized pieces and is not of good knapping quality. If it occurs only in the size indicated, it would not be suitable for manufacturing the full array of artifacts found at the site, but even if it is less than ideal for knapping, the fact that it accounts for 39 percent of the Folsom debitage by weight and 62 percent of the Agate Basin debitage would argue that Paleoindians considered it to be an adequate tool stone for some purposes (Craig 1982:Table 1). The excellent artifact photographs in the Agate Basin report suggest that cobbles of this material were commonly flaked into blocky cores from which flakes were struck to produce a variety of retouched flake tools (Frison and Stanford 1982). Less commonly, bifacial tools of moss agate, such as projectile points, are illustrated.

The apparently large amount of blocky core-derived flakes and informal retouched flake tools in the collection has implications for the geographic extent and regularity of land use. If the artifacts are associated with occupations of the site by people involved in large-scale hunts, then perhaps the artifacts represent use of lower quality local stone to augment the supply of the better quality material present in the form of completed artifacts and unfinished raw material. If this is the case, then it is possible that people associated with the hunting party were staying in the site area for a sufficiently long time that trips were made to gather tool stone resources from the local environment, a situation that would imply that the land use included use of a geographic area of relatively limited geographic extent.
Considering that, in the case of the Folsom component, some of the artifacts were uncovered from as far away as 75 meters from the area where faunal remains were prevalent, an alternative hypothesis is that artifacts of the local moss agate were deposited during one or more occupations of the site by Folsom groups who were not involved in large-scale bison hunting and thus left artifacts on the site of a kind not generally associated with bison hunting. If this was the case, then use of the locally available stone implies a limited geographic extent for the area of land exploited by site occupants for stone and food.

A number of points are raised by the prevalence of the local moss agate in the Agate Basin components. First, to gain a complete view of land use evident in artifact collections, it is imperative to examine all artifacts, not just select classes. Second, the above discussion illustrates how the issue of whether the site was reoccupied or not can play an important role in how land use is interpreted from artifact assemblages. Therefore, the matter of whether the site was reoccupied needs to be carefully considered when interpreting land use patterns from site collections, although this is indeed a difficult problem because reoccupation of sites may leave no obvious indication in the archaeological record. Lastly, the apparent common occurrence at Agate Basin of waste flakes and flake tools deriving from blocky cores made from cobbles of what is characterized as lower-quality local stone is not congruent with arguments for high Paleoindian mobility based on the concept of a frugal lithic technology that supposedly emphasized the use of high-quality stone in the form of bifaces.

To summarize, by the 1990s, proponents of the alternative view were faced not only with good reasons to acknowledge a certain amount of commonality between the land use of Paleoindians and hunter-gatherers in general, but also a certain amount of doubt regarding the validity of archaeological constructs claiming to uphold the long-held view of a unique Paleoindian land use strategy. Evidence could be cited to support the assertion that Paleoindian land use may have been comparable on a basic level to all hunter-gatherers both in terms of the geographic extent and the regularity of land use related to the aggregation and
dispersal of groups involved in large-scale bison hunting. With good reasons to believe that
the traditional view is in error, alternative minded archaeologists began in the 1990s to
critically evaluate the support offered for traditional thinking by those working under the
concept of a frugal technology.

**Frugal Paleoindian Lithic Technology?**

I previously suggested that archaeologists in the 1960s lacked the ability to directly
study Paleoindian mobility through tool stone sourcing and therefore turned to study of
assemblages using the concept of a frugal technology in order to provide archaeological
evidence in support of the traditional view (e.g. MacDonald 1968). Building on
MacDonald’s initial claim that Paleoindian technology emphasized bifaces as an adaptation
to a mobile life, the work of Parry and Kelly (1987) served to give the bifacial core
hypothesis a certain amount of theoretical credibility by noting very real differences between
the lithic assemblages of hunter-gatherers and farmers. Through comparison of assemblages
produced by foragers and farmers in the Midwest, the Southwest, as well as in Mesoamerica,
Parry and Kelly demonstrate a clear tendency for forager assemblages to be dominated by
bifaces whereas assemblages produced by farmers have a tendency to contain a prevalence of
blocky cores. Assuming that bifaces in the collections examined in large measure served as
bifacial cores, Parry and Kelly argue in essence that differences in the mobility of foragers
and farmers is reflected in the greater reliance of foragers on bifacial cores over blocky cores.
The reader will recall that emphasis on bifacial cores would theoretically enable mobile
people to transport smaller amounts of tool stone. In comparison to the relatively thick flakes
struck from blocky cores, flakes removed from bifaces would provide for a more frugal use
of tool stone by producing more cutting edge per unit of stone. However, a seemingly fatal
flaw with the argument was pointed out by Bamforth (2003) who used data from the Allen
site to assert that most Paleoindian bifaces probably did not serve as cores, but rather are manufacturing rejects for bifacial tools.

Yet the difference in the proportion of cores to bifaces in assemblages of foragers and farmers is real and may prove to be relevant to the research into Paleoindian mobility proposed herein. Bamforth and Becker (2000) note that curation of blocky cores as sources of flakes for future tool production, combined with the lesser amounts of time that foragers typically occupy sites in comparison to sedentary peoples, may be an important factor contributing to the observed difference between the assemblages of foragers and farmers. In their view, the lithic technology of foragers and farmers may both involve comparable proportions of blocky cores and bifaces with the difference in assemblages due to foragers occupying sites for less periods of time than farmers who, because of their more sedentary lifestyle, are more likely to exhaust blocky cores as sources of flakes and thus will discard them in a residential site in proportionally greater numbers than mobile foragers. However, Parry and Kelly (1987:297) note that the shift to assemblages dominated by blocky cores is coincident in all areas they examined with the first emphasis on maize as a major staple in the diet of each area. If the subsistence economy was more reliant on cultigens with decreased emphasis on hunting, one might also suggest that this may affect the lithic technology such that farmers may have produced relatively few bifacial artifacts needed in hunting, such as points and knives, and comparatively larger amounts of blocky cores from which flake tools could be produced for use in general subsistence tasks as well as non-subsistence activities. This possibility has bearing on the research proposed herein. Artifacts produced when gearing up for a large-scale bison hunt may be expected to include many bifacial artifacts (like points and knives for killing and butchering bison) as well as unifacial artifacts retouched from thick flakes struck from blocky cores (like end scrapers for processing hides obtained as a result of the bison kill). As suggested by the assemblages from Agate Basin, artifacts produced by Paleoindians not engaged in large-scale bison hunting could be
dominated by simple flake tools struck from blocky cores made of local stone. Thus, this basic distinction between tool kits dominated by points, knives, and end scrapers and those comprised primarily of flake tools appears to be a theoretically sound and empirically justifiable conceptual tool for analysis of assemblages and its utility in the study of Paleoindian land use will be explored herein during analysis of the Jurgens collection.

Leaving aside the potential analytical utility of Parry and Kelly’s (1987) work, it is relevant to note that their theoretical construct was used as the rationale for traditional-minded archaeologists working in the 1990s to advance Stanford’s bifacial core hypothesis as evidence for high mobility among Plains Paleoindians (e.g. Boldurian 1991; Boldurian and Hubinsky 1994). However, review of the existing literature on the prevalence of blocky cores and bifaces in Paleoindian assemblages by Bamforth (2002a) basically demonstrates that the bifacial core hypothesis is simply not defensible when all kinds of Paleoindian sites are considered. Yes, bifacial artifacts dominate assemblages associated with large-scale bison hunting, but the reasons for this have to due with the kinds of artifacts needed at such sites, not because Paleoindian technology was uniquely based on the use of bifaces. The then recent analysis and reporting of Paleoindian assemblages from sites near sources played an important role in undermining the credibility of the bifacial core hypothesis (e.g. Root et al. 1993; Root and Emerson 1994).

The assertion that Paleoindian technology focused on the use of microcrystalline tool stones in order to provide for more successful resharpening and recycling of tools as a cultural means of enabling high mobility is another argument based on the concept of frugal technology that has been discredited by recent work, though not to the extent that the bifacial core hypothesis has. If points of microcrystalline tool stones from distant sources were indeed travelling with the band and in use longer than points of microcrystalline stone from local sources, points from distant sources should be demonstrably shorter due to having been subjected to more resharpening. However, Bamforth (2009b) showed that Cody points from
the Horner site made of stone from relatively distant sources are not shorter than those from closer sources, casting some doubt on the microcrystalline hypothesis.

Based on the above discussion, it can be stated that whereas the traditional view saw Paleoindian lithic technology centered on the use of bifaces and high-quality microcrystalline stone, an alternative perspective portrays Paleoindian technology as having been shaped by the same factors that affected the technology of later foragers. These factors include the anticipated activities for which stone tools were manufactured as well as economizing behavior. To reiterate, in regard to assemblages associated with large-scale bison kills, the need to gear up for the upcoming event would produce tool kits dominated by bifacial tools like points and knives for killing and butchering bison, but also unifacial tools like informal retouched flake tools, useful for a variety of tasks related to bison processing. Also, many end scrapers would be needed if processing of hides was planned. Stone selected for gearing up would be of high-quality to facilitate mass production of tools and would be selected on the basis of suitable knapping quality, irrespective of the granularity of the stone (i.e. microcrystalline or orthoquartzite). As suggested by the Agate Basin assemblages, in areas lacking high-quality sources, assemblages produced as a result of large-scale bison hunting and ensuing processing and camping might demonstrate economizing behavior as the supply of high-quality stone is augmented by visits to local sources producing stone of sizes and knapping qualities unsuitable for gearing up. Conversely, if the Agate Basin assemblages are admixtures of occupations related to large-scale bison hunting and those that are not, economizing behavior would again be suggested by the substantial use of the local stone for general subsistence activities and other activities not requiring site occupants to gear up with stone from far-off sources.
CHAPTER SUMMARY AND CONCLUDING REMARKS

Review of the historical roots of thinking related to the traditional view has resulted in good reasons to doubt the validity of this school of thought. The widespread occurrence of point types was initially the rationale behind the idea of highly mobile cultural groups, but geographic variation in point types does exist and has yet to be fully investigated. The relative rarity of Paleoindian sites was at first considered evidence for low population density, a situation which was reasoned to have permitted a nomadic lifestyle. Geomorphological studies, however, conclude that the relative rarity of Paleoindian sites may simply be a bias of site preservation. The working of geological processes is such that the older a site is, the greater its chances of being destroyed by ongoing erosion or made less visible to archaeologists as a result of deep burial. Review of evidence based on relative numbers of radiocarbon dates per time period strongly suggests that Paleoindian populations on the Plains are best conceived of as but the first part of an 8000-year-long period of relatively low population density prior to a dramatic rise beginning in the waning centuries of the Late Plains Archaic and extending into the Late Prehistoric to around A.D. 1200.

Another reason behind early claims for widely ranging Paleoindian bands is the belief that subsistence economy focused on the hunting big game animals. Review of information on the faunal assemblages from sites in the Plains and Rocky Mountains does demonstrate that big game animals formed an important component of the subsistence economy practiced by early Paleoindians in the Plains and Rocky Mountains. However, reliance on big game by early Paleoindians may simply be due to wetter conditions of the times having led to increased forage production and greater availability of big game animals. Reliance on big game continued among Late Paleoindians of the Great Plains but this may not be a unique characteristic of Paleoindians in comparison to many later Plains foragers. In the Rocky Mountains, reliance on the largest big game species dropped significantly during
Late Paleoindian times with the importance of smaller sized mammals, such as bighorn sheep and deer, increasing correspondingly. This observation further strengthens the case that Paleoindian subsistence was largely shaped by the available resources, rather than having been uniquely focused on big game in all times and all places.

Finally, long-standing justification for the belief that Paleoindian land use patterns involved irregular movements are founded on the understanding that the subsistence economy entailed following the movement of roaming herds of big game. However, data on the tool stone composition of assemblages from clustered bison bonebeds indicative of large-scale hunting suggest that land use patterns could perhaps be considered to have involved a certain amount of regularity in so far that it appears people may have geared up at the same lithic sources through the centuries and brought tool stones from these sources with them to the area where they formed larger groups to participate in large-scale bison hunting.

A recent incarnation of traditional thinking maintaining that Paleoindians were widely ranging and irregular in their movements as an adaptation to a unique Pleistocene environment without contemporary analog was also found to have serious flaws. Possible problems were identified with the paleontological theory on which the concept of decreased seasonality in Pleistocene times is based. Furthermore, the fact that bonebeds representing large-scale kills are composed of individuals in tightly clustered age groups distributed one year apart is strong evidence for a calving season of limited duration and this in turn is an indication that bison during Paleoindian times possessed a behavioral adaptation to a seasonal environment.

In light of the preceding problems with the traditional view, the need to develop an alternative view of land use is acknowledged and some basic ideas on how to go about doing this were presented. Theoretical problems with the traditional view led to testing of claims made in support of conventional thinking based on the concept of a frugal Paleoindian technology. The bifacial core hypothesis and the microcrystalline hypothesis were found to
have problems, but some further evaluation is warranted. Since current indications suggest that Paleoindian land use may not have been as dissimilar to later foragers as traditionally thought, some alternative-minded archaeologists have compared ethnographic data on the size range of occupation areas to archaeological data on site sizes and the two data sets were found to compare well. From this, the potential utility of comparing ethnographic data on land use with archaeological data designed to be relevant to Paleoindian land use was suggested. With an improved database on tool stone sources archaeologist now have the capability to elicit the geographic extent and regularity of prehistoric hunter-gather land use in ways that have not been previously possible. Due to the legacy of Paleoindian research having focused on certain kinds of sites, archaeologists intent on developing an alternative view of land use must devise methods that will allow characteristics of land use patterns to be revealed through sourcing of assemblages from sites associated with large-scale bison kills and sites by lithic sources.

The historical review basically pointed out what went wrong with past efforts to develop methods to study land use, but also highlighted, in a general way, what needs to be done now. In the Early Years, the traditional view considered only the possible effects of the biotic (specifically big game) resources of the environment on land use, along with possible effects of demographic conditions (presumed low population density). Although the reasoning used was rational and suggested a plausible explanation given the state of knowledge about Paleoindians at the time, the accumulation of evidence since then demands that more empirically sound ideas on the biotic and demographic factors affecting land use now be developed.

Attempts at building land use theory during the days of the New Archaeology suffered from an approach that was too limited in that it focused solely on environmental influences affecting land use, but also not limited enough in regard to its desire to develop land use theory on a global scale. For these and other reasons, the concept of the forager-
collector continuum was determined to have little practical utility. The notion that all tool stone procurement among hunter-gatherers was embedded in subsistence activities and the resulting “line-drawing method” of defining the range utilized by site occupants were shown to provide too limited a view of the possible ways that foragers acquired needed supplies of stone from the environment.

To begin the process of rethinking the biotic and demographic factors affecting Paleoindian land use, the state of knowledge concerning the subsistence economy and demography of Plains foragers was reviewed to the extent necessary. Conceptualizing Paleoindian population density as being comparable to the relatively low densities common to the first several millennia of Plains prehistory is suggested to be a more accurate way to start thinking about the land use patterns of these early people. Furthermore, thinking about Paleoindians in terms of established bands surrounded by neighboring bands is a reasonable way to begin contemplating land use. Characterizing large-scale bison hunting of Plains Paleoindians as a largely seasonal and subsistence-level activity that made use of the surround is also suggested to be a reasonable way to start thinking about the affects of subsistence economy on land use patterns.

In light of previous chapters, any efforts to develop models of Paleoindian land use must adopt a broader view of the environmental factors affecting land use. Consideration must be given to not only such factors as the distribution of biotic resources, but also the availability of tool stone resources.

Moreover, to avoid the deficiencies of traditional land use theory as well as that offered during the days of the New Archaeology, social aspects affecting land use patterns simply must be incorporated into developing theory. Toward this end, exploring the applicability of the notion of seasonal population aggregation and dispersal seems to be an obvious first step and using the concept of gearing up to develop methods of evaluating this idea also seems to have potential. The concept of gearing up proposes that as part of
preparing for a communal hunt, people would have procured a large amount of tool stone from one or more high-quality sources where an ample supply of good raw material is available in sufficiently large pieces.

After deconstructing a faulty theoretical framework, we are left with the realization that we don’t know very much about Paleoindian land use and that much needs to be done to construct better theory. We can begin by identifying immediate research needs and thinking in a general way about how to go about addressing them using the database available to us.
CHAPTER 4
DEVELOPING AN ALTERNATIVE VIEW OF LAND USE
AND SUGGESTED AREAS OF RESEARCH

Research needed to further evaluate the traditional theoretical perspective and to begin the process of developing an alternative view of land use will be outlined below. Need for research into ethnographic sources to compile good data on the size of ranges used by hunter-gatherers of the modern era is needed for use as a basis for comparison with archaeological data relating to land use extent. Thoughts on how the hypothesis of aggregation and dispersal of bands among Paleoindians may be evaluated using data from museum collections and published site reports will be presented. Furthermore, a means of adequately taking the affect of raw material availability into consideration when using tool stone composition of assemblages to elicit prehistoric land use patterns will be suggested. Finally, the above thinking will be integrated into a research strategy intended to assess the relative validity of competing views on the geographic extent and regularity of land use via analysis of the Jurgens site assemblage and interpretation of data on assemblages from published sites in a carefully chosen study area.

FURTHER TESTING THE NOTION OF FRUGAL TECHNOLOGY

Additional evaluation of the traditional view’s concept of a frugal Paleoindian technology is needed and interpretation of data from the Jurgens collection is able to provide such an assessment. Data pertaining to whether flakes and flake tools were removed from
bifaces or blocky cores can be used to further evaluate the traditional view of Paleoindian reliance on bifaces. These data may also be used to evaluate the alternative view’s position that analysis of many of the bifacial and unifacial tools should support a scenario of gearing up in advance of large-scale bison hunting. More importantly, however, the Jurgens collection is able to allow evaluation of the traditional view of selective use of microcrystalline stone because the site is situated in an area where an orthoquartzite is a common, locally available tool stone. Goodyear’s (1989) hypothesis maintaining that Paleoindians selectively used microcrystalline tool stones as part of a frugal technology can be assessed by simply comparing the amount of artifacts made of the local orthoquartzite with those made of various types of microcrystalline stone. Furthermore, data from the site can be used to evaluate the generalization upon which Goodyear’s hypothesis is based: microcrystalline tool stones are better quality raw materials for successful knapping than more granular materials. Data on the kind and amount of flaws in the orthoquartzite and microcrystalline tool stones may be compared to assess this generalization.

BEGINNING TO BUILD AN ALTERNATIVE MODEL OF LAND USE

Having established reasons to seriously doubt claims for a highly mobile Paleoindian land use pattern based on a critique of traditional theory and partial evaluation of the concept of a frugal lithic technology, advocates of the alternative view now are charged with producing a better model of land use. Though daunting, the archaeological database currently available should allow advances to be made in this regard. Earlier, I suggested that archaeologists in the era of the New Archaeology turned to developing the frugal technology concept as a means to investigate land use during a time when knowledge of available high-quality tool stone sources was still inadequate. However, major lithic sources are now sufficiently known to enable tool stone sourcing to aid in building a better model of land use.
A good place to start would be to develop a better understanding of the geographic extent of ranges habitually used by bands while at the same time acknowledging the real limitations on the ability of archaeological evidence to precisely define ranges in all situations. It should be humbling to realize that beginning efforts to define ranges frequented by bands is the same place hunter-gatherer archaeologists were over three decades ago when the debate over embedded versus direct procurement led to the realization that definition of band ranges will not be a straightforward exercise. On the other hand, archaeology has learned in the intervening years that if raw material availability as well as population aggregation and dispersal are adequately taken into consideration, there really is no good reason why archaeologists can not now make some real progress on this matter with renewed effort.

Having identified the definition of ranges used by bands as a goal to begin the study of mobility patterns, archaeologists would do well to also keep in mind that hunter-gatherer land use patterns involved the movements of not only entire social groups, but also individuals and small groups of people. In some circumstances, the mobility of individuals may not have had much affect on the tool stone composition of assemblages, such as in areas where quality stone is available locally. However, in areas where it is not, people would have to go and get it or acquire it via trade. If stone was acquired directly from a source located far from a band’s habitual range, it is most reasonable to suppose that the band would send a task group to procure the stone, rather than to suggest that the entire band would make the journey. Therefore, in areas lacking quality stone, the mobility of individuals or small task groups could potentially have great effects on the tool stone composition of an assemblage. In all circumstances, however, it is advisable for the archaeologist to keep in mind that it may have been common among bands of hunter-gatherers dependent on a stone tool technology for at least small numbers of artifacts of nonlocal stone to be transported across sometimes great distances as a consequence of individuals or small groups visiting relatives, friends, and
prospective spouses in neighboring social groups. Though there is no reason to suppose that Plains Paleoindians engaged in the kind of reciprocal exchange network studied by Weissner among the Bushmen of southern Africa (1977:Table 11, Map 3), her documentation of the long-distant transport of small numbers of artifacts exchanged as part of the *hxaro* network suggests how individuals and small groups equipped with stone tools and raw material moving between social groups for any reason having to do with social interaction would be expected to have transported small amounts of artifacts over great distances. On-going tool manufacture, maintenance, and use by individuals operating outside their habitual range would have resulted in the production of waste flakes and the wearing out or breakage of tools would have led to their subsequent discard. Using the limited ethnographic data available on the distances that men in foraging societies travel to find wives in surrounding bands, MacDonald (1999) theorizes that unmarried men moving between Paleoindian bands would be one way that artifacts of nonlocal material would have been transported great distances across the Plains. Since there is good reason to suppose that some communal large-scale bison hunts in Paleoindian times would have been periodic subsistence activities that were also social events that brought men and women from different bands together into a large gathering, it is reasonable to hypothesize that small numbers of points of stone from very distant sources reported from sites associated with large-scale bison kills may be ultimately attributed to the courtship activity of single men. By being cognizant of the manner in which the mobility of individuals and small groups in all foraging societies can move stone artifacts far from their place of origin, Paleoindian archaeologists will do much toward avoiding the problems associated with the “line drawing method” used in the past.

Something that is difficult to avoid in the pursuit of defining band ranges, however, is using assemblages derived from sites associated with large-scale bison kills, so incorporating data from this kind of site into planned research is necessary and advisable. Much thought
has gone into the study of such sites and applying useful methods of analysis learned through the study of later prehistoric bison bonebeds would be one way to begin efforts to define the geographic location of Paleoindian social groups. With some modification, Reher and Frison’s (1980) method of identifying large blocks of stone in assemblages associated with large-scale kills as a way to begin defining band ranges should be applicable to assemblages from Paleoindian sites. However, staunch advocates of the traditional view simply do not accept the premise that Paleoindian bands aggregated into larger groups to conduct large-scale bison kills. Rather, blocks of stone in assemblages from bison bonebeds are seen as representing sources visited sequentially by a band in its widely ranging travels. Efforts to develop an alternative view of Paleoindian land use thus do not proceed very far before being confronted with the realization that the disagreement over whether aggregation and dispersal was a feature of Paleoindian land use patterns must first be resolved.

REGIONAL PACKING OF BANDS AND THE RATIONALE FOR FOCUSING ON POST-CLOVIS ASSEMBLAGES

The question of whether Paleoindian bands aggregated for communal hunting is related to the matter of whether the social landscape was composed of bands operating within habitual ranges with surrounding bands using adjacent ranges, a social setting that Kelly and Todd (1988:234) refer to as regional packing of bands. If Paleoindian society was characterized by regional packing of bands, then it would reasonable to expect that occasionally bands may have aggregated into larger groups to cooperate in communal hunts. On the other hand, as Dixon (1999) has cogently argued, the earliest occupation of the land by Paleoindians would likely have involved colonizing groups establishing themselves in previously unoccupied terrain followed by a period during which the population would increase to the carrying capacity of the land. During the period of initial peopling, one can imagine a situation where an individual band, for example, may have established itself in a
range where there were either no neighboring bands present in surrounding lands or perhaps only the parent band was present in an adjacent range. In this situation, Paleoindian land use may not have been analogous to that of ethnographic foragers. This is not to say that Paleoindian land use would have been completely unlike that of later people in the manner envisioned by Kelly and Todd (1988). However, land use would necessarily have differed to some extent from that documented during ethnographic times. For example, relatively large communal kills may not have been carried out because neighboring bands would not have been present to supply the necessary labor. If band membership was of sufficient size, large-scale hunts that resulted in the acquisition of a surplus of meat may have been conducted, but the very largest kills, that would have required the labor of multiple bands, may not have been possible during initial colonization. Since there is reason to believe that the very earliest Paleoindians would have possessed land use practices that did not include aggregation of bands for large communal hunts because population density was below carrying capacity, it is advisable to theorize when regional packing of bands would have occurred and exclude assemblages produced prior to this time from analysis. To theorize when regional packing would have occurred, it is necessary to develop an understanding of when the first people arrived and how long it would take for regional packing to come about. I will address the issue of population aggregation and other land use matters through analysis of Paleoindian assemblages from a study area that is situated principally on the Central Plains, but also includes parts of the adjoining Southern Rocky Mountains. The question of when the first foragers arrived in the study area will be addressed, but it will be necessary to place the study area within the broader context of the New World to demonstrate that the initial settling of the Americas occurred at different times in different places and, therefore, the time when regional packing of bands took place would have also varied geographically.

As alluded to in the previous chapter, it is widely accepted that the earliest Paleoindians on the Plains were those who made the Clovis type of projectile point during a
period dating from 11,500 to 10,950 B.P. (Table 3-1). The best known Clovis sites are the
spectacular mammoth bonebeds and caches of artifacts consisting of points and large bifaces.
One such bonebed in the study area is the famous Dent site, located on the Plains of
northwest Colorado south of Greeley, where the remains of 15 mammoths were recovered
(Brunswig 2007; Wormington 1957:43-44). Three Clovis caches are known from the study
area. The Drake cache includes 13 complete Clovis points (Dixon 1999:220). Two other
caches contained no projectile points, but for a number of reasons, are believed to be date to
the Clovis period. The caches include a variety of artifacts, most notably very large bifaces.
One is known as the Busse cache (Dixon 1999:220-221), the other is the recently discovered
Mahaffy cache from Boulder, Colorado (Douglas Bamforth, personal communication 2008).

Some archaeologists claim that several sites in the study area provide evidence of
Paleoindians living on the Plains during pre-Clovis times. These sites are located on the
plains of Colorado and Nebraska. Included are Lamb Spring, Dutton, Selby, La Sena, and
Jensen (Dixon 1999:69-73). The sites are comprised of deposits containing bones of late
Pleistocene mammals, most notably mammoth remains. According to Dennis Stanford and
Steven Holen, some of the bones are broken or otherwise modified in a manner suggesting
that they may have been butchered by humans. Many archaeologists are skeptical of the
claims made for a pre-Clovis occupation of the Plains. A main problem for the acceptance of
the purported pre-Clovis sites is that no flaked stone tools were recovered in indisputable
association with the bones. Skeptics of the idea of a pre-Clovis occupation find it difficult to
believe that there would not have been any stone tools discarded along with the bones that are
thought to have been butchered by humans. To this, proponents of a pre-Clovis occupation
note that some of the sites have produced flakes of bone that advocates argue were produced
by humans for use as butchering tools. In response, skeptics note that the bone flakes might
possibly result from natural causes, such as having been produced when bones were trampled
by heavy animals or through the bone breaking and gnawing activities of large late
Pleistocene carnivores. Until more convincing evidence can be garnered for the thinking that people inhabited the Plains prior to the Clovis period, a more conservative interpretation of available evidence would reason that the first people to populate the Plains were equipped with a flaked stone technology that included the Clovis point. For the purposes of this dissertation, I will accept the premise that initial peopling of the Plains occurred during the Clovis period.

To place the study area and the Plains in general in a broader geographic context, it is important to note that the first peopling of the Western Hemisphere in general occurred in pre-Clovis times. In the 1960s, the idea that the first people to colonize and settle the New World were makers of Clovis points who had come from northeast Eurasia via the Bering Land Bridge was first proposed (e.g. Haynes 1966). Excavations of Clovis sites with mammoth bone deposits on the western Plains served to bolster the thinking that the first Americans were big game hunters whose subsistence to some extent relied on the hunting of late Pleistocene elephants. It was thought that during Clovis times, the larger Laurentide ice sheet, centered on what is now Hudsons Bay, was not joined with the smaller Cordilleran ice sheet, which was situated over the Northern Rocky Mountains. Rather, an ice-free corridor would have existed which would have funneled people equipped with Clovis points onto the northern portion of the Plains and from there, the peopling of the Americas could proceed. More recently, the accumulated evidence on the peopling of the New World suggests that makers of Clovis points were not the first to travel over the Bering Land Bridge. A review of sites in northeast Eurasia by Dixon (1999) revealed a complete lack of evidence for the use of Clovis points. Also, more recent geological studies in the vicinity of the former ice-free corridor conclude that the passage would not have been completely ice-free until ca. 11,000 B.P. The time range for Clovis points (ca. 11,500 to 11,000 B.P.) would place the makers of this type of projectile point on the Plains south of the conjoined ice sheets prior to the opening of the ice-free corridor (Dixon 1999).
Also, the presence of sites in Central and South America where non-Clovis points are found in direct association with the remains of Pleistocene elephants serves to question the concept that the makers of Clovis points were the earliest people to colonize the Americas. Sites producing non-Clovis points in association with remains of late Pleistocene elephants in Central America include the remains of two mammoths found less than a half-mile from one another near Santa Isabel Ixtapan (Wormington 1957). Sites in South America producing non-Clovis points in association with remains of mastodon include Taima-Taima, situated near the coast of Venezuela, and Monte Verde, located close to the coast of Chile. The points from the Central and South American sites are lanceolate specimens with convex lateral edges that commonly have convex basal edges. They may be generally described as laurel-leaf in shape. Wormington (1957:97) refers to the Central American specimens as Lerma points. Points from Taima-Taima are assigned to the El Jobo type (Dixon 1999:98). Two points from Monte Verde are slender midsections with missing bases. Nevertheless, the points are definitely not Clovis points and are generally comparable to the laurel-leaf points. The points were recovered from a well defined cultural level producing the remains of seven mastodons (Dixon 1999:101-103). Most sites producing Pleistocene elephant bones and laurel-leaf points are not precisely dated, but the points from Monte Verde are from a cultural level that is well dated with multiple radiocarbon dates averaging ca. 12,500 B.P. It is generally agreed that the initial peopling of the Americas proceeded from North America to Central America and finally to South America. From this, it follows that if the people camped at Monte Verde were hunting mastodon around 12,500 B.P., fully 1,000 years before the first Clovis points were used to kill mammoths on the Plains of North America, makers of Clovis points can not have been the first inhabitants of the New World. Rather, Clovis points constitute a point type that likely originated in North America.

An updated model of the peopling of the New World argues that foragers would have first arrived by progressing southward down the Northwest Coast of North America and
proceeded to settle coastal regions of the Americas prior to colonizing the differing ecological regions of the interior (Dixon 1999). Paleo-environmental evidence suggests that in the period from 13,000 to 11,000 B.P., large areas along the western flank of the melting Cordilleran ice sheet would have provided ice-free refugia for plants and animals. Humans could have traveled from one refugium to the next by watercraft. Alternatively, the interpretation of other paleoenvironmental evidence asserts that an ice-free corridor was present along the coast. The newer model of the peopling of the Americas is summarized by the following passage:

This …model proposes that initial human colonization of the Americas began around 13,500 B.P. along the southern margin of the Bering Land Bridge and then continued southward along the Pacific Coast of the Americas. With the use of watercraft, possibly skin boats, the human population moved rapidly southward along the coastal-intertidal Pacific biome… Although evidence of this early migration may have been obscured by rising sea level at the end of the last Ice Age, evidence might be expected to be found in adjacent areas of the interior, such as Monte Verde, which is located along a river drainage only 15 km (9 mi) northeast of the Pacific Ocean… Although the initial colonization along the continental margins of the Americas may have occurred rather quickly, subsequent colonization of interior environments may have occurred more slowly. People probably moved inland from the coast along rivers. As population increased and people gradually adapted to interior environments, they possibly advanced inland along river systems… Given this scenario, the western plains of North America may have been among the last places to be settled… (Dixon 1999:247, 249-250).

Relevant to this discussion is the observation that Dixon’s model illustrates the differential timing of the initial peopling of various ecozones of the New World and from this, it may be suggested that the time when human population density attained regional packing of bands may have differed geographically as well. If people were living along parts of the coast one to two thousands years before venturing onto the Great Plains, it seems reasonable to suppose that population density along portions of the coast would have risen to the carrying capacity of the environment such that regional packing of bands occurred on the coast long before it did on the Great Plains.

Another feature of Dixon’s model that is here considered to be a more realistic characterization of the process of the peopling of unoccupied lands is that it is based on the
understanding that populating the land up to carrying capacity would have been a gradual process that took place over a time period perhaps best measured on the order of hundreds of years. A model of the peopling of the Americas that became first prominent in the 1970s asserts that the earliest Paleoindians were such proficient hunters, and Pleistocene large mammals were so unaccustomed to human predation, that human population rose quickly and overhunting soon led to the extinction of the late Pleistocene elephants, horses, camels, and many other genera. Shortly after colonization, human population pressure would have caused bands to fission and splinter groups to move into adjacent unoccupied country. In this way, the earliest Paleoindians are believed to have spread from the Bering Land Bridge to the southern tip of South America in little over a thousand years. Dixon (1999:34-37) refers to the above as the “Bow Wave” model in reference to the uniform wave of new immigrants being pushed along by population pressure caused by Paleoindians essentially being too successful at big game hunting. In contrast, Dixon (1999:39) proposes that the process of peopling formerly unoccupied lands would have been more gradual and involved what might be thought of as a series of stages. First, unoccupied lands adjacent to a settled area would have been explored. Secondly, the parent population would fission and a viable breeding group would migrate into virgin country to colonize. It is relevant to note here that during colonization, land use patterns of foraging peoples may indeed have differed from those recorded during ethnographic times. For example, early in the process of colonization of the Great Plains, a particular band may have been socially isolated from neighboring bands to the extent that there was only one neighboring group living somewhere downriver, or perhaps there was not another band living in an adjacent area. In this situation, larger communal hunts involving the labor of multiple bands may not have been possible. Through gradual population growth, colonization eventually leads to complete settlement of the land, the condition where human population has risen to the carrying capacity of the land. Dixon (1999:39) suggests that, “[g]radual and more efficient adaptation to the… environment could
conceivably take hundreds of years or more following colonization before the carrying capacity of a specific territory is reached.” In other words, it may have taken hundreds of years before regional packing of bands was established.

If it is reasonable to assume that people first arrived on the Great Plains early in the Clovis period, application of Dixon’s model would suggest that regional packing of bands may have been attained sometime in the later portion of Clovis times, which lasted 500 radiocarbon years. To use the terms of the model, exploration and initial colonization would have taken place early in Clovis times and settlement of the land may have been complete before the end of the Clovis period. In discussing his research into Paleoindian land use on the Southern Plains, Bamforth (1988:159) agrees with the Kelly and Todd model in that a pioneering stage would have occurred sometime during Clovis times as the land was settled. However, Bamforth (1988:159) objects to Kelly and Todd’s (1988) characterization of Folsom groups as pioneers. According to Bamforth’s model, environmental conditions in Folsom times would have permitted the largest aggregations of people for communal hunting in comparison to any other time in the Paleoindian period. Implicit in this statement is the understanding that by Folsom times, population density would have reached carrying capacity.

Limited archaeological evidence exists to bolster the assertions made above regarding the nature of population density on the Plains during early Paleoindian times. The relative rarity of Clovis sites in comparison to those of subsequent Paleoindian times may be cited as possible evidence that the Clovis period as a whole was characterized by relatively low human population density as the Plains were first settled. In the Central Rio Grande Valley, an intermontane basin west of the Southern Plains, a regional survey of Paleoindian sites reported by Judge (1973:Table 1) provides reasonably reliable data on the relative frequency of sites from the various Paleoindian time periods. If the smaller Paleoindian cultural manifestations that Judge refers to as localities are included with the larger “sites,”
then the number of sites falling into the various Paleoindian time periods may be compared. These data are as follows: sites of the Clovis period (500 years duration) = 2, sites of the Folsom period (700 years duration) = 29, sites of the Late Paleoindian period (2,200 years duration) = 22. If the above data reflect relative population size of Paleoindians during the various time periods, it may be stated that the apparently low frequency of Clovis sites in comparison to later sites might possibly be a result of a low human population during the time when the Plains and intermontane basins were first colonized.

Possible evidence that population had risen to carrying capacity by the end of Clovis times comes from the Dent site, a mammoth bonebed located in the study area. A sample of mammoth bone originally treated with an organic preservative (shellac) in the 1930s, was chemically treated by George Agogino in the 1960s to remove the preservative. Conventional radiocarbon dating of the purified sample of bone produced a date of 11,200 ± 500 B.P. (Cassells 1997:62, 270-271). Bone samples from the site were again dated in the late 1980s to early 1990s when the more accurate technique of radiocarbon dating with accelerated mass spectrometry (AMS) was first being developed (Brunswig 2007:Table 3.1). Eight AMS dates on proteins extracted from mammoth bone collagen average 10,745 B.P., a date which is younger than the range considered as acceptable Clovis dates. It has since been determined that bone collagen samples treated with XAD resin produce the most accurate AMS dates. Of the eight AMS dates, an assay of 10,980 ± 90 B.P. on XAD hydrolysate would appear to be the most acceptable date. If accurate, the date would place the occupation of the Dent site at the end of the Clovis period. The remains of 15 mammoths were recovered from the site (Brunswig 2007:101). Study of the dentition of three mammoths suggests that at least two kills are represented in the bonebed, one in fall and one in early winter (Fisher and Fox 2007). If continued research into the number of occupations represented at the Dent site determines that multiple mammoths were slaughtered at the same time, this would be suggestive of a kill carried out by a large group of people, based on the understanding that the
participation of many persons would be required to butcher and process the meat from multiple mammoths. From this admittedly tentative evidence, one might suppose that some mammoth kills carried out in the Clovis period may have involved multiple bands coalescing from throughout an area that had been populated up to carrying capacity such that there existed regional packing of bands.

Better evidence for regional packing of bands comes from the Folsom period. As will be further discussed in Chapter 8, the number of bison represented in three bonebeds at the Cooper site in Oklahoma along with geological evidence relating to the deposition of the bonebeds suggests that they are representative of a minimum of 67 bison killed during a single event. Based on the understanding that the amount of labor required to butcher and process the meat from at least 67 bison suggests the presence of a large, possibly multi-band human group, evidence from the Cooper site may be cited to support the thinking that the Paleoindian social landscape by Folsom times involved regional packing of bands that occasionally came together to cooperate in communal hunts.

The above discussion leads to a number of conclusions relating to how the question of aggregation of Paleoindian bands should be addressed. In early Clovis times when the Plains were first being colonized, low population may have meant that a particular band might only have had one neighboring band, if any. This social situation would conceivably foster a land use pattern that was unlike that of ethnographically documented foragers in that aggregation for the largest communal hunts may not have involved the coalescence of more than one or two bands. By late Clovis times, it is reasonable to suppose that population density would have risen to the point that there was regional packing of bands and therefore certain mammoth kills may represent communal hunts carried out by larger multi-band groups. By Folsom times, the theoretical assertion that some large-scale bison kills represent the work of aggregations of multiple bands is more defensible, although the supporting evidence as stated above would be considered equivocal by a number of Paleoindian
archaeologists. Since it is reasonable to theorize that forager land use on the Plains in much of the Clovis period may have differed from that known for ethnographic times, I will focus on the analysis of post-Clovis assemblages from the study area. It is through tool stone sourcing of Folsom and later Paleoindian assemblages that the often contentious question of whether bands aggregated for communal hunting can best be addressed in an empirical manner.

THE CONTROVERSY OVER POPULATION AGGREGATION AND DISPERSAL

Hofman (1994) provides a thorough discussion of the question of whether Plains Paleoindians regularly aggregated and dispersed and concludes that there is currently no convincing evidence for variation in group size. He objects to previous characterizations of the Lipscomb site in Texas by Frison (1978:114, 247) and Bamforth (1991a:358, 1991b:Table 1) as a site representative of communal bison hunting. In the 1930s, paleontologists from the Nebraska State Museum excavated the remaining portion of a bonebed exposed in a cutbank that was initially referred to as the Lipscomb Bison Quarry. Recent analysis of the collected bones by Todd et al. (1990) has determined that a minimum of 55 bison were recovered. Hofman (1994:357) explains his objection to the classification of the Lipscomb site as a communal kill in the following manner:

Bamforth (1991a:360) suggests that, ‘The questions of what happened when people were not hunting communally and of whether or not Paleoindian social groups periodically dispersed and reformed are clearly matters for empirical investigation….’ While I agree with this in part, I do not think that communal hunting has been empirically demonstrated for Folsom or perhaps for any Paleoindian bison bonebed site. This, too, is a matter for comparative analysis and interpretation rather than a justified conclusion simply because some sites contain a large number of animal remains…

Hofman (1994:348) suggests that “cooperative hunting by several individuals of the same family group” could be responsible for the bonebeds representing a large number of bison killed on a single occasion, rather than communal hunting, which in his definition involves
the temporary aggregation of groups of people. It is relevant to note that an implicit understanding of the concept of communal bison hunt when earlier used by Frison and Reher (1980) was that aggregation of multiple bands would be required to supply the necessary labor.

For Bamforth (ca. 2000) and Driver (1990), however, the term “communal hunting” is defined as hunts with an explicit prior plan of action that organizes variable numbers of people — it does not require or assume social aggregation. The Bamforth and Driver definition, therefore, does not attempt to relate communal hunting to the kind or size of social group supplying the necessary labor. This definition of communal hunting will be used herein. That said, it is my intention to begin to explore how the social organization of Paleoindians may (or may not) be denoted in the archaeological record of bison bonebeds and the artifact assemblages they produce. Toward this end, it is noteworthy that the band has been shown to be a real social unit common to ethnographically recorded foragers (Kelly 1995:209-213). Furthermore, bands are known to have operated within habitual ranges, although the degree to which ranges were defended against intrusion would have theoretically varied based on food resource density and predictability (Kelly 1995:181-193). Based on the above information, I assert that it is reasonable to assume that Paleoindian social organization also was organized into bands that operated within habitual ranges. With this in mind, one may theorize that the variable size of dense bison bonebeds potentially reflects different human group size. More specifically, the larger bonebeds may represent the work of a group composed of multiple bands that aggregated for a hunt. Conversely, smaller bonebeds may result from the efforts of a single band or even a subunit thereof, if the group contained enough people to carry out a communal hunt. Depending upon whether a Plains Paleoindian band operated as a social unit throughout the year or regularly dispersed and reformed, aggregation of social groups may or may not have occurred in the context of single-band communal hunts.
Hofman goes on to discuss the ways that archaeologists may be able to evaluate whether aggregation occurred among Plains Paleoindians. He suggests that identification of aggregation sites will require at least two levels of analysis, site-specific and regional. A number of methods are discussed whereby site-specific analyses may be able to test whether a large site was produced by a large group formed via aggregation of smaller groups or as a result of multiple occupations by small groups. Regional level analyses suggested by Hofman include examining the kinds of sites in a region and looking for variation in qualities such as size and environmental setting that would allow one to evaluate the proposition that the larger sites represent group aggregation. To this I would add that examining the variation in tool stone source representation in assemblages from various kinds of sites should prove helpful. This will be discussed in greater detail below.

While Hofman is right to require that aggregation be proven, it would seem that considering the number of bison killed in a single event at select sites would indeed be a good way to begin to explore the topic using the “comparative analysis and interpretation” which he advocates. As pointed out by Frison (1978:303), bison and other big game must be field dressed by removing the windpipe, internal organs, and intestines soon after death in order to prevent the meat from spoiling. This is true during any time of year, but is particularly crucial during warm weather when the threat of meat spoilage is exacerbated. Therefore, completely excavated bonebeds produced as a result of bison kills that arguably occurred in warm weather reflect a certain amount of work that had to be accomplished soon after the death of the animals and therefore should also be representative of the size of the human group that would have had to be present in order to accomplish the work quickly. The range in number of bison represented at small and large bonebeds therefore should provide some basis for theorizing the size range of human groups present at bison kills. Although the Lipscomb bonebed represents a warm-weather kill, its incomplete character means that the actual number of bison killed during the hunt cannot be accurately estimated. However, the
Mill Iron site in Montana and the Olsen-Chubbuck site in Colorado are completely excavated bonebeds that arguably represent kills that took place in warm weather with the former representing the lower end of the size range of such sites and the later being at the upper end. Since these bonebeds represent a certain amount of work that had to get done soon, estimating the number of people in a band of average size that would be involved in field dressing and the amount of time needed for each person to field dress a bison should allow one to interpret whether each bonebed represents the work of single or multiple bands.

The Mill Iron site on the plains of Montana is representative of a Folsom-age large-scale bison kill where a minimum of 35 bison were slaughtered using so-called Goshen points during warm-weather months (Frison 1996). The site is located on a steep-sided flat-topped butte and is composed of two main areas, including a pile of stacked single bones measuring 4.5 m in diameter and a second area termed a “camp-processing area” situated about 45 m away. The majority of bison remains from the site are assigned a dental age of N + .1 yr. As will be explained in Chapter 8, this dental age indicates that the kill occurred sometime in the period from early May to early June. During this time of year, meat would have had to be preserved by drying, rather than freezing. Thus, the camp-processing area may have served as an area where meat removed from partial carcasses was processed into jerky. The pile of bones may be interpreted as a place where bones were discarded once meat had been stripped from them.

Given that 35 bison were field dressed, we can now estimate how long it would take an average-sized band to complete this task and the first step would be to estimate the number of people who would be involved in the activity. The number of people per band in a sample of 17 nomadic hunter-gatherer bands compiled by Kelly (1995:Table 6-2) ranges from a low of 15 to a high of 75 and averages 28. None of the foraging societies in Kelly’s sample is an ethnographic Plains group and there is no firm basis on which to suggest what the average number of people in a Plains Paleoindian band might have been. Be that as it may, the
average number of people per band will nevertheless be used for heuristic purposes in an attempt to evaluate whether the range in the number of bison represented in Paleoindian bonebeds can in turn suggest the relative size of human groups involved (i.e. single bands or multi-band groups). From a figure of 28 people in an average-sized band, the number of very young people who would not likely be of much help in field dressing must be subtracted. One might suggest these people would include those who are not yet nine years old (kindergarten age). Due to high infant mortality, young people are common in stable populations of pre-industrial societies, with individuals less than 15 years old comprising between 30 and 50 percent of the population (Hewlett 1991). If we use 40 percent to estimate the proportion of people less than 15 years of age, then by applying algebra, we can estimate the number of people less than nine years old at 24 percent. Using the figure of 24 percent, we can estimate the number of people in the band who are less than nine years old at seven individuals. Subtracting this number from 28, we can calculate the number of people in an average band who would be able to help with field dressing at 21 people. Of these people, those in their early teens may not be proficient at field dressing, but they could help by holding legs out of the way, pulling on hide while someone else is cutting, etc.

The next step is to estimate the amount of time it would take a person to field dress a bison with stone tools. This estimate is provided by Gary Collins, an archaeologist with the Bureau of Land Management in Craig, Colorado who participated in experimental field dressing of an adult bull bison with stone tools. Field dressing was accomplished by a team of three people using a number of stone tools. One person would be cutting, another would be assisting by holding legs out of the way, etcetera, and when not also assisting with the actual activity of butchering, the third person would be resharpening tools dulled from use. In total, it took 1¾ hours to field dress the bison. If working in teams is the most efficient way to field dress a bison, we can safely assume that Paleoindians would have worked in groups as well. For purposes of estimation, we can calculate the time it would take each
person to field dress a bison (and yet consider them to be working as efficiently as they would if working as part of a team) by multiplying $1\frac{3}{4}$ hr by three to arrive at an estimate of $5\frac{1}{4}$ hr total time for a person to field dress an adult bison using stone tools.

The final step would be to estimate the time it would take for an average band to field dress the 35 Mill Iron bison in order to assess if the bonebed represents the work of one or more bands. Calves, yearlings, and two-year-olds are substantially smaller than adult bison and presumably would take less time to field dress. Having a lot of younger animals represented in the bonebed would introduce error into the calculation. However, of the 35 bison, only five individuals are in this younger set. Thus, the calculated time should not greatly overestimate the actual time required. Furthermore, the fact that bison in Paleoindian times were substantially larger than the modern form would tend to counteract to some extent any overestimation due to the presence of sub-adult individuals among the Mill Iron bison. Multiplying 35 bison by $5\frac{1}{4}$ hr per bison gives the total time necessary to field dress the Mill Iron bison as $183\frac{3}{4}$ hr. Dividing this amount by 21 people in an average band able to help in field dressing results in a total time of $8\frac{3}{4}$ hours for the band to field dress the Mill Iron bison. This suggests that an average-sized band could have field dressed the 35 bison before the meat would begin to spoil if the kill occurred sufficiently early in the day. We now turn to considering if the large bonebed at Olsen-Chubbuck could represent the work of multiple bands.

On the plains of Colorado, sometime during the Cody period on a summer day, a group of people stampeded an estimated 193 bison into an arroyo that would later become known as the Olsen-Chubbuck site (Wheat 1967, 1972). The estimated total number of bison killed is the sum of the minimum number of 143 obtained during excavation of the site by the University of Colorado Museum plus an estimated 50 bison uncovered by the artifact collectors for whom the site is named. Originally, the bison were said to have been killed in the spring, but an analysis of teeth eruption and wear patterns by Frison (1974:18) determined
that dental ages range from $N + .3$ yr to $N + .4$ yr. As will be explained in Chapter 8, this range of dental ages indicates that the bison were killed sometime in the period from mid-July to late September, which is a time of year that can produce hot weather. That daytime temperatures reached well above freezing around the time of the kill is indicated by the presence of partial skeletons with vertebral columns that are bent in a way that would not be possible were there frozen muscles still attached (Wheat 1972:Figures 17-18). The implication of these partial skeletons is that if temperatures were well above freezing such that muscles could be stripped from partial skeletons, the weather was hot enough that all the animals that were to be butchered for meat would likely have been field dressed soon after death to prevent spoilage. Fourteen essentially complete skeletons were present and almost without exception, were found in the very bottom of the arroyo (Wheat 1967:47-48; 1972:29, Figures 13-14). Many appear to have been wedged into a narrow inner channel at the bottom of the arroyo and may not have been able to be moved into a good position for butchering and so were abandoned. Subtracting these bison from the total of 193 leaves 179 bison that were field dressed at the site.

With the above information, we can now perform some calculations to assess if an average-sized band would likely have been able to field dress 179 bison before the meat spoiled. Based on the experimentally derived estimate of $5\frac{1}{4}$ hr to field dress a bison, it would take $939\frac{3}{4}$ hr to field dress the 179 Olsen-Chubbuck bison. It is estimated that there are 15 hr of daylight at the site during the time of year when the bison were killed. I will assume that the people worked for 12 hours and took three hours off to eat and rest. The maximum number of bison that a person can field dress in a day can be calculated by dividing 12 hr of work by $5\frac{1}{4}$ hr to field dress each bison to get a result of 2.29 bison per day. If it is assumed that the Olsen-Chubbuck bison were killed at dawn, then the number of bison that an average-sized band could field dress in one day is calculated by multiplying 2.29 bison per day by 21 people in an average band able to help with field dressing. The calculation reveals
that an average-sized band could field dress only 48 of the 179 bison before sundown. Thus, in order to field dress the 179 bison before the meat spoiled, there would have to be multiple average-sized bands present.

One might then ask if the amount of work that needed to be completed before meat would begin to spoil could have been accomplished by a band of a size comparable to the largest ethnographically recorded band. Kelly’s (1995:Table 6-2) compilation of the sizes of nomadic bands of foragers lists the largest ethnographically recorded band at 75 people. The number of people in a band of this size under the age of nine and not likely to be of help in field dressing is estimated to be 24 percent, or 18 people. By subtracting 18 from the 75 persons in a large band, the number of individuals who would have been able to help with field dressing is calculated to be 57. Multiplying 57 people by 2.29 bison field dressed per person per day results in 131 bison field dressed by a large band per day. Dividing 131 bison into the 179 bison that were field dressed results in an estimate of 1.37 days for a large band to field dress the Olsen Chubbuck bison. As to the question of whether a large band could field dress the 179 bison before spoiling, the estimate of 1.37 days does not lend itself to providing a definitive answer. According to data presented by Wheat (1967:48), 57 percent of the bison were adults, 34 percent were immature animals, and 8 percent were calves. Based on these figures, 42 percent of the bison killed were smaller than adult-sized animals and presumably would have taken less time to field dress. Whether or not this would allow all 179 bison to be field dressed by a large band thus becomes debatable.

The above exercise illustrates an important point regarding how archaeologists should go about resolving the aggregation controversy at the site-specific level of analysis. From a practical standpoint, it would be advisable to test for aggregation of Paleoindian groups by sourcing an artifact collection from one of the larger bonebeds located in an area lacking quality sources of stone. Tool stone sourcing of an assemblage from a small bonebed in an area lacking local stone may very well demonstrate that much stone from a single
distant quality source was utilized. Although the assemblage may actually have resulted from aggregation of a single band that had geared up at the source via a visit by a task group, the archaeological result of this scenario could also be interpreted by traditional-minded archaeologists as evidence that Paleoindians operated in single bands that were highly mobile. In contrast, artifact assemblages from large bonebeds in areas lacking stone would more likely be the work of multiple bands and as such would be more likely to have artifacts assemblages composed of blocks of tool stones thought to reflect gearing up by participating bands at quality sources in their home ranges, as is hypothesized for Late Prehistoric occupants of the Vore site. Although proponents of the traditional view may very well assert that the sources represented were visited sequentially by a single highly mobile band, the logical implications of the different views suggest that there should be differences between an assemblage produced as a result of aggregation of bands that geared up in anticipation of the event and an assemblage produced by a widely ranging band with a frugal technology that visited the sources sequentially. For example, the two views would differ in their expectations regarding amounts of tool stones from various distances present in the assemblage. Under the alternative model of gearing up by aggregated bands, there may be a noticeable fall-off between the amounts of tool stone from distant sources visited to gear up and the amounts from very distant sources that could represent the mobility of individuals or trade. Under the traditional view, stone from very distant sources is present in an assemblage because the band actually visited those sources at a relatively distant time in the past. Consequently, here should not necessarily be a noticeable drop-off in amounts of tool stone with increasing distance from the site. More will be said about the differing expectations of two views in regard to artifact assemblages from bonebed sites in Chapter 8. Suffice to say here that differences between the opposing views should be most evident in assemblages from large bonebeds.
The assemblage from the Jurgens site was considered a good candidate to be examined for evidence of aggregation for multiple reasons. First, evidence suggests that bonebeds present at the site resulted from a single-event kill of a large herd of bison that would have required the labor of multiple bands for processing. Located on the plains of Colorado near Greeley, the site is associated with a bison kill dating to the Cody period. Faunal remains and artifacts were found at the site in three widely separated areas. Analysis of the bison bones determined that the minimum numbers of individuals represented in the three areas are as follows: 31 bison in Area 1, two animals in Area 2, and 35 individuals in Area 3 (Wheat 1979:17, 34, 56). As will be discussed in detail in the chapter on the Jurgens collection, various lines of evidence support the conclusion that a single episode of large-scale bison hunting is represented in all three areas. Considering that the bonebeds in all areas were not completely excavated and that the minimum number of bison in the three areas represent animals killed in a single event, the minimum number of bison present at the entire site would be somewhere between the minimum number for Area 3 (n = 35) and the sum of the minimum numbers for all three areas (n = 68). The three bonebeds at the Jurgens site in combination thus likely represent a fairly large bison kill. Secondly, information given in the site report suggests the possibility that gearing up may be represented in the assemblage. The site is located in an area without a high-quality source of tool stone in the immediate area. Furthermore, stone from multiple sources located in different directions from the site evidently had been brought into the site (Wheat 1979:123). Stone from known sources mentioned in the site report include Flat Top chalcedony from a source to the east in the South Platte drainage and stone from sources in the Hartville Uplift, located to the north in the North Platte drainage. In light of the available information, the artifact assemblage from the Jurgens site appeared to be well suited to evaluating the relative validity of the two views on land use.
Having selected a Paleoindian site that is like Vore in a number of respects and thus may allow aggregation of bands to be demonstrated is but the first step of many that will be required to evaluate the alternative view. The reader will recall that one of the tool stones present in appreciable amounts in the Vore assemblage is Knife River Flint, a quality raw material whose source area in North Dakota lies at a distance from the site that is greater than the maximum dimension of the largest ethnographically recorded band range. Based on this observation, it was suggested that Knife River Flint may have been acquired by a task group making a long-distance trip to the source or through means of trading with people living closer to the source area. Seeing as though a basic theoretical stance for much of the alternative view is that Paleoindian land use would not necessarily have been more geographically extensive than what is to be expected for later hunter-gatherers, it should by now seem apparent that a needed area of research for theory development is compilation of reliable comparative data on the geographic extent of ethnographic band ranges.

THE RELEVANCE OF ETHNOGRAPHIC RANGE SIZES

Good data on the size of ethnographic band ranges can serve as a tool with which to build alternative theory on Paleoindian land use. Archaeologists would like to compare the size of Paleoindian ranges to that of later peoples living in the same environments. However, for the case of the Great Plains, available ethnographic information is not detailed to the extent that the size of ranges used by foraging peoples is available. Therefore, in order to compare archaeological data thought to reflect the geographic extent of Paleoindian land use (distances to sources of tool stones) with data on the sizes of modern hunter-gatherer band ranges, it is therefore necessary to turn to the ethnographic record in general. Since the specific research question facing proponents of the alternative view asks if Paleoindian range size was much larger than that of ethnographic foragers, the largest ethnographic band range
used by pedestrian foragers will be held to be the basis from which to compare archaeological
data on the tool stone sources represented in Paleoindian assemblages.

Since the intent of comparing data on the geographic extent of ethnographic foragers
with archaeological data on tool stone sources represented in site assemblages is to determine
if Paleoindian land use conforms to what would be expected of hunter-gatherers in general, it
is necessary to try and make archaeological units of analysis be fairly equivalent to the
ethnographic basis of comparison. The size of the largest ethnographic band will be used as
the basis for defining tool stone sources as “local,” with the understanding that if Plains
Paleoindian bands operated within ranges comparable in size to that of ethnographic people,
then bands living in an area with quality stone locally available will of course meet their tool
stone needs by supplying themselves with local stone acquired during visits to the sources by
the entire band or via trips made to the source by task groups. To further illustrate how
archaeological units of analysis are defined based on an understanding of how Plains foragers
in general may have operated, we might consider the case of a site associated with a large kill
where multiple bands participated and sources of quality stone were available in the ranges of
all participating bands. Under this scenario, an assemblage produced at a bonebed site
representing large-scale hunting by an aggregation of bands would be expected to be
comprised of substantial amounts of local stone collected by the local participating band.
“Distant” stone could be defined as that from sources located within a range of distances that
together would approximate the home range inhabited by a neighboring band. Much stone in
the assemblage would be from distant sources and would represent stone in finished or
unfinished form brought to the site by neighboring bands. Lastly, all stone from sources
beyond the distances used to define distant stone would be labeled as “very distant stone.”
Small amounts of stone from very distant sources would be expected in the assemblage as a
result of exchange or individuals from very distant bands traveling far from their home range
to visit friends, family, or prospective spouses within the social context of a communal bison
hunt.

Of course, the above example of a large-scale kill site was carefully selected to
present an optimistic scenario wherein the aggregation of neighboring bands is easily
illustrated. In reality, however, the above discussion has demonstrated that the archaeological
record in sum is a complex mixture of refuse from different activities produced by human
groups of varying sizes. To complicate matters further, the availability of local raw material
will also affect the tool stone composition of site assemblages. Nevertheless, if hunter-
gatherer archaeologists are ever to sort out and understand the sources of variation in the
archaeological record well enough to be able to do something as basic as to assess whether or
not Paleoindians were more mobile than later foragers, then efforts must be made to begin to
grapple with this complexity.

ASSESSING GEOGRAPHIC EXTENT OF LAND USE WITH
EXISTING LITERATURE

So as not to become too downhearted about the likelihood of being able to elucidate
prehistoric land use patterns, it is good to note that the variety of Plains Paleoindian sites
excavated and reported upon in the literature to date should be sufficient to demonstrate if
land use entailed the use of tracts of land that were tremendously larger than that of
ethnographic people. If Paleoindians behaved in a manner to be expected of all Plains
foragers whose subsistence economy relied in part on aggregation of groups for large-scale
bison hunting, then assemblages from large bonebed sites in areas lacking local stone would
be expected have tool stones from nonlocal sources in greater amounts than assemblages
from other kinds of sites. Ideally, the “other kinds of sites” to be compared with bonebed
sites would be the camps produced by the bands or the sub-band-level groups in which Plains
Paleoindians theoretically operated during the times of year when not engaged in large-scale bison hunting. However, since Paleoindian archaeology has almost universally ignored such sites, the research was designed to examine assemblages reported from sites by lithic sources instead. At the time the research began, Bamforth (2002b) had presented a strong case arguing that one of the Medicine Creek sites (the Allen site) functioned as a camp not associated with large-scale bison hunting and that two nearby sites by outcrops of tool stone (Red Smoke and Lime Creek) are more accurately described as workshops at which limited residential activities occurred. The faunal assemblage from the Red Smoke site was known to be dominated by bison, but the collection had yet to be studied in detail. The existing reports on the other sites by sources basically characterized the sites as campsites. It was thought that if Paleoindian land use was comparable on a basic level to what would be expected for all foragers, then collections of finished tools from camps at lithic sources not related to large-scale hunting should generally be made of tool stone from closer sources than bonebed sites if indeed sites at sources were produced by members of the local band. Analysis of the sites at sources proved this assumption to be in error, for most are now thought to be associated with large-scale hunting, as will be explained below.

Of course, another factor expected to introduce variability into the tool stone composition of assemblages from all kinds of sites produced by hunter-gatherers is the availability of quality stone. All sites by sources obviously have quality stone locally available. Within the study area, sites of all prehistoric time periods that are indicative of large-scale hunting of big game include bison bonebeds on the Plains and in the intermontane basins, as well as high-altitude sites with game drive structures. For foraging societies in general, large-scale big game hunting would have taken place in environments with local sources of quality stone suitable for gearing up as well as in environments lacking such sources. Therefore, the study area was chosen to include sites in areas with high-quality sources of stone as well as sites in areas lacking quality sources of stone. A set of...
expectations for the tool stone composition of assemblages from sites related to large-scale kills stated in terms of the relative amounts of stone from local versus nonlocal sources may be proposed for hunter-gatherer sites in general. Factors that reasonably can be expected to have affected the tool stone composition of assemblages from sites related to large-scale hunting include whether the site was produced by a single band or multiple bands and whether the game animals could or could not be predictably found in close proximity to a quality source of tool stone. Based on this theoretical understanding, a set of expectations for the tool stone composition of sites related to large-scale hunting that applies to foraging societies in general was produced. Actual data on the tool stone composition of Paleoindian assemblages from sites associated with large-scale hunting that are located in the study area was then compared to the expectations in order to assess whether or not Paleoindian land use patterns were geographically more extensive than what would be expected for all hunter-gatherers.

ASSESSING LAND USE REGULARITY WITH EXISTING LITERATURE

The regularity of Paleoindian land use patterns in the study area can also be addressed with data from existing literature. The study area includes five clusters of sites, three of which are located at or close to source areas of high-quality stone. Included in the later category are sites in the drainage of Medicine Creek, a tributary of the Republican River drainage in Nebraska where sources of Smoky Hill jasper were exploited by occupants of the Allen, Lime Creek, and Red Smoke sites (Bamforth 2002b). Also included are several localities at the Hell Gap site complex in the North Platte River drainage of Wyoming where Hartville Uplift chert procured from nearby sources was made into stone tools (Larson et al. 2009). Finally, the study area includes two sites in the Barger Gulch site complex in Colorado’s Middle Park where stone tool manufacture using Kremmling chert obtained from
nearby outcrops was an emphasized site activity. As will be discussed further in the chapter on the specific research design to be followed, there is variability in the degree to which the tool stone composition of assemblages from sites at sources has been studied and reported in the available literature. Therefore, the review of literature relevant to a discussion of land use regularity will focus on selected sites. At all three source areas, sites or “localities” show use throughout much of the Paleoindian period and thus are demonstrative of a certain amount of regularity in land use patterns. However, it may be noted that even under the traditional view, the high-quality material available in the three source areas would be expected to attract repeated use and occupation by Paleoindians.

Therefore, similarities in the sources and amounts of tool stones present in assemblages from clustered sites associated with large-scale kills would perhaps be a better indicator of regularity in land use. As pointed out by Bamforth (2011), the only aspect of Plains Paleoindian land use that may have been irregular was large-scale bison hunting in the sense that aggregated groups of Paleoindians would have moved to an area where bison could be found, but once in that area, the exact location of herds would be largely unpredictable and therefore somewhat irregular movement of the group may be required. However, land use patterns of the participating groups may still have been regular in the sense that the same long-standing social groups geared up and came together to participate in large-scale hunts. The reader will recall that evidence that this kind of regularity in land use related to large-scale hunting occurred during Late Prehistoric times is seen in the fact that throughout the 22 bonebed levels at the Vore site that were laid down over the course of roughly 250 years, artifact assemblages associated with these uses of the site contained artifacts from either the same set or similar sets of tool stone source areas (Reher and Frison 1980:1, 124-127). As discussed previously, evidence suggesting that this kind of regularity in land use related to large-scale hunting may also have occurred in Paleoindian times is seen in the similarities in
the tool stone source representation in the Folsom and Agate Basin components at the Agate Basin site complex (Craig 1982).

To further investigate whether land use related to large-scale hunting in Paleoindian times to some extent involved regular movements, the similarity in the tool stone composition of assemblages from the study area that arguably are related to large-scale hunting will be assessed based on available literature. These assemblages come from all five site clusters in the study area.

Four of the five clusters are located in grassland environments at relatively lower elevations in the study area on the Plains and on the floor of Middle Park and are situated in regions where large-scale bison hunting took place. One cluster of three sites is located on plains of Colorado near the confluence of the Cache la Poudre River with the South Platte. The sites occur within an area measuring four km in maximum dimension. It is here referred to as the Kersey cluster, after a nearby town located east of Greeley, Colorado. In this cluster are two sites with bonebeds and a deflated site in an ancient dune field that lacks a bonebed. One of bonebed sites is of Agate Basin age, the other is assigned to the Cody period. The site in the dune field is a Folsom site excavated in the 1930s by an amateur archaeologist. Although little information on the site is available, the possibility that the site is also associated with large-scale bison hunting will be considered in light of what little information is available. The second cluster is the group of sites in the Medicine Creek drainage. Two of the sites there do not contain dense bonebeds, but it will be argued that they nevertheless are associated with large-scale bison hunting. The third cluster consists of four sites in the general vicinity of a pass known as Hell Gap in the Hartville Uplift of southeast Wyoming. Dense bonebeds are not present, but a case will be made that the occupations are related to large-scale bison hunting. The fourth cluster of sites thought to be associated with large-scale bison hunting is located in an expanse of sagebrush grassland in the western portion of Middle Park, an intermontane basin containing the headwaters of the Colorado River. Sites
in the cluster occur in an area measuring 20 km in maximum dimension. The cluster contains two sites with bonebeds, one being a Folsom-aged site that produced so-called Goshen points, the other is a site where Cody points were found along with points of another type. Two other sites are of Folsom affiliation and are at the main source area of Kremmling chert. Though bonebeds are not present, a case will be made that the sites are associated with large-scale bison hunting.

The fifth cluster is comprised of sites situated at or near game drive structures in the high Front Range of Colorado that are thought to be associated with large-scale hunting of non-bison big game animals. The sites are situated at the ecotone between alpine tundra and subalpine forest and are located in an area measuring seven km in maximum dimension. Due to the shallow nature of soils in the high Front Range, no faunal remains are preserved at the sites and the species hunted remains uncertain. Probable target species include elk, bighorn sheep, and mule deer.

CHAPTER SUMMARY AND CONCLUDING REMARKS

Initial thoughts were presented on further evaluating the traditional concept of a frugal technology and development of an alternative view of land use. Ways to assess the validity of thinking related to frugal technology with data from the Jurgens collection, particularly that relating to the supposed avoidance of granular tool stone, were outlined. The need to think about ways in which the archaeological record may and may not allow the ranges of individual bands to be identified was suggested to be a means to begin defining social groups on the landscape. Toward this end, the need to acknowledge and build into theory the complicating effect of the long-range mobility of individuals was discussed.

A major area of needed research into Paleoindian land use relates to the controversy over the issue of population aggregation and dispersal. I propose to address the problem with
detailed analysis of the tool stone composition of a carefully selected site assemblage followed by a regional level of analysis and interpretation of available information on lithic sources represented at sites in a particular study area. Consideration of the amount of labor represented by the size range of single-event bison bonebeds indicative of warm-weather kills led to the conclusion that the regional level of analysis should anticipate that sites associated with large-scale bison kills may include instances where aggregation of an individual band is indicated well as other instances where aggregation of multiple bands into a larger group may be represented.

In order to start thinking about how aggregation of people may be reflected by tool stone source representation in an assemblage, it would be helpful to get an idea of the size of the areas within which foraging people in the modern era would have traveled as they prepared for a communal hunt. Some conception of the size of the area within which dispersed constituents of a band (e.g. family units) would coalesce if a single band aggregated for a communal hunt is needed. Furthermore, some notion of the size of the larger area within which individual, neighboring bands would have aggregated in order to participate in a bigger communal hunt conducted by multiple bands is also necessary.

Assessment of whether the geographic extent of Paleoindian land use was comparable to that characteristic of hunter-gatherers in general would also require some conception of the size of the areas used by ethnographic bands in order that it be used as a basis for comparison to data on distances to tool stone sources that arguably reflect to some degree the area used by prehistoric groups. In order to conduct research into both the aggregation question and the geographic extent of Paleoindian land use, then, it is first necessary to complete preliminary research to collect good data on the sizes of ethnographic band ranges. This data will also be useful for defining good archaeological units of analysis (e.g. local vs. distant vs. very distant sources) that should produce data related to prehistoric
land use that is most appropriate for then comparing the geographic extent of prehistoric and ethnographic land use patterns.

The site assemblage chosen to examine for evidence of aggregation using such archaeological units of analysis derives from the Jurgens site, located on the plains of Colorado. Evidence from the site suggested that the bison herd killed by site inhabitants was of a sufficiently large size to suggest that the labor of multiple bands would have been needed to process the bison. Furthermore, the assemblage included quality tool stone from multiple distant sources situated in different directions from the site. This is suggestive of gearing up at distant sources by participating bands. A general discussion was provided of how the Jurgens assemblage would be expected to differ under the two views of land use.

A study area will need to be delineated so as to further permit evaluation of the two views in regard to a number of topics related to land use by using published data on tool stone composition from sites in the area. First, the study area should be designed to allow the effect of differential tool stone availability to be examined and taken into consideration when using the tool stone composition of assemblages to investigate land use. This will be accomplished by designing the study area so that it includes environments where quality stone suitable for gearing up is locally available as well as environments where it is not. Second, the study should be designed to permit the geographic extent of land use to be assessed. To do this, it will be necessary to examine the affects that social aggregation should theoretically have on the composition of assemblages according to the alternative view. The study area thus should be designed to include a number of sites that presumably may include ones produced through social aggregation (sites associated with large-scale kills) as well as sites that information available in the current literature would suggest are not necessarily products of occupation by large groups of people (the camps at lithic sources reported in existing literature). Finally, analysis of data from the study area will allow the degree of regularity of Paleoindian land
use to be assessed by comparing the amount of similarity in the source representation in assemblages from clusters of sites.

Having designed a study area where analysis and interpretation of the tool stone composition of assemblages from reported sites might help to evaluate between the contrasting views on land use, it is now necessary to acquire a basic understanding of the environmental conditions prevailing within the three regions that comprise the study area and how these conditions differed during Paleoindian times and may have changed throughout the period of concern. With this knowledge, it should then be possible to develop an understanding of the environmental factors that arguably would affect the land use patterns of modern hunter-gatherers and how change in these environmental conditions throughout the Paleoindian period may have affected prehistoric land use. In order to identify environmental factors that affected land use, it is necessary to review the topography, climate, vegetation, fauna, and tool stone resources of the study area both now and during Paleoindian times. The following three chapters will develop this knowledge.
The purpose of this chapter is twofold. First, the three distinct environments of the study area will be described. Secondly, ecological characteristics of the environments that arguably would have shaped forager land use are identified. Specifically, the manner in which the topography, climate, and distribution of floral, faunal, and tool stone resources of each region would have affected forager adaptations and land use will be discussed. With this understanding, a review of relevant paleoenvironmental data in the ensuing chapter will allow prediction, at least in a relative way, of how forager adaptations and land use at various times in the Paleoindian time period may or may not have differed from that expected for hunter-gatherers who possessed a subsistence level economy and lived under modern-like conditions.

The study area was chosen to incorporate three kinds of environments that differ substantially in terms of their floral and faunal resources as well as tool stone availability. This was done with the anticipation that land use patterns and other behavioral responses to environmental conditions would have varied between the regions to the extent that this may be reflected in the tool stone composition of assemblages and other archaeological data. The first kind of environment is comprised of the expansive Plains grasslands and includes portions of the Great Plains and Wyoming Basin. The Plains environment covers by far the largest portion of the study area, comprising an estimated 81 percent. Ten of the assemblages to be considered derive from sites located on the plains. The second kind of environment in
the study is that of the intermontane basins of North, Middle, and South parks. These are essentially flat or gently undulating grassland environments ringed by mountains, some of which rise to heights in excess of 14,000 ft above sea level. In total, the intermontane parks account for an estimated four percent of the study area. Four sites from Middle Park produced assemblages to be used in this study. The remaining 15 percent of the study area consists of mountains, most of which is covered in dense forest or open woodland vegetation. It is in the mountains that the final kind of environment to be considered is found above tree line; that being the grassland-like environment of the alpine tundra. It is estimated that tundra covers about one percent of the study area. This study will evaluate data on assemblages from three sites located at the ecotone between the subalpine forest and the alpine tundra that are believed to be representative of activities directed toward procurement of big game animals grazing in the mountainous terrain above tree line.

PHYSICAL GEOGRAPHY AND GEOLOGY

Discussion of the environment begins with consideration of the varied physical geography in the study area along with a basic description of geology. Topography plays a major role in determining climate in much of the study area. With increasing elevation comes corresponding increase in precipitation and decrease in average temperature. Also, the Southern Rocky Mountains exert a rain shadow effect on the amount of precipitation falling within intermontane basins and areas of the Great Plains leeward of the mountain front formed by the Front Range and Laramie Mountains. In discussion of topography and climate, the elevation of numerous geographic features and weather stations will need to be cited. Considering that most topographic maps of the study area are scaled in feet and that a majority of readers will likely be most adept at thinking about elevation in terms of this unit of measurement, readings will be given according to the English system without reference to
their metric equivalent. The geology of various environments of the study area will be discussed in a cursory manner, especially in regard to the availability of tool stone. Raw material sources and Paleoindian sites will be mentioned here only briefly without detailed discussion and citation for the purpose of situating them in the context of the environments in which they occur. Detailed discussions of tool stones and sites are provided in subsequent chapters.

Plains

A large majority of the study area is comprised of portions of the Central Great Plains and Wyoming Basin. Portions of the study area, including southeast Wyoming, southwest Nebraska, northeast Colorado, and northwest Kansas, are within the Central Plains, as originally defined by Wedel (1961). Frison (1978) includes southeast Wyoming in his discussion of the archaeology of the Northwest Plains, but this portion of the Plains will herein be referred to as the Central Plains, following Wedel. A basic characteristic of the Central Plains is the seemingly endless expanse of flat or gently undulating terrain. A few upland settings of more dissected terrain covered with open pine woodlands stand isolated in a sea of grass. Rivers and streams on the Central Plains generally flow eastward to eventually feed into the Missouri. In some regions, bedrock is comprised of large expanses of marine sedimentary rock deposited in the Cretaceous Seaway that formerly inundated the Great Plains, while other areas are underlain by Tertiary strata shed from the Southern Rocky Mountains during the ensuing Laramide Orogeny.

A large area in the southeastern portion of the study area is within the middle and upper reaches of the drainage basin of the Republican River, which together with the Smoky Hill, Solomon, and other rivers, form the headwaters of the Kansas River (Figure 5-1). The eastern boundary of the study area lies near the town of Red Cloud, Nebraska, located on the Republican River at an elevation of about 1,700 ft. Large expanses of the eastern Republican
Figure 5-1. Map of study area showing major geographic features, tool stone sources, and Paleoindian sites.
drainage are underlain by limestone deposited in the Cretaceous sea that produces quantities of jasper at several known source areas in Kansas as well as one in the Medicine Creek drainage of Nebraska where wooded “breaks” have formed through stream dissection. The Allen, Lime Creek, and Red Smoke sites are clustered within the Medicine Creek drainage in the general vicinity of jasper sources. Lying west of the limestone exposures are the High Plains, an elevated section of the Great Plains underlain by Tertiary strata. The Jones-Miller site is located on the High Plains along a tributary of the Republican known as the Arikaree River. The highest portions of the Republican drainage near Limon, Colorado lie at over 5,500 ft elevation.

The Platte River proper drains a narrow strip of land in the northeastern portion of the study area. Lowest elevation on the river at the eastern boundary of the study area is north of Doniphan, Nebraska at an elevation of 1,880 ft. Heading in a westerly direction, the river splits into the North and South Platte rivers near the city of North Platte, Nebraska at an elevation of about 2,750 ft.

The South Platte drains northeastern Colorado and adjacent portions of Wyoming and Nebraska. From the confluence of the two forks of the Platte, the South Platte River heads west-southwest past Sterling, Colorado to Ft. Morgan, where it turns to head generally west to the city of Greeley, situated at an elevation of 4,600 ft. From Greeley, the river heads basically south-southwest through Denver to the mouth of the canyon through which it descends the east slope of the Front Range. Elevation at the canyon mouth is 5,500 ft. Headwaters of the South Platte arise in South Park and mountainous areas to the north of the park.

Because of its position along the base of the mountain front, an oblong area of the South Platte drainage located on the Plains of Colorado is known as the Colorado Piedmont (Hunt 1974:339). Within the Colorado Piedmont, the area south of the river from Ft. Morgan to Greeley is drained by streams that flow north to the river while the area to the north is
drained by streams flowing southward or southeastward to the river. Snow-fed permanent streams along the east slope of the Front Range flow generally eastward onto the Plains where they drain the western portion of the Colorado Piedmont and eventually join with the South Platte River. Two of these streams are deserving of special mention because of their relevance to Paleoindian land use. The first is the Cache la Poudre River, which upon reaching the Plains, flows southeastward to join with the South Platte near Greeley. The Kersey cluster is situated near the confluence and is comprised of the Jurgens, Frazier, and Powars sites (Figure 5-1). The second stream worthy of mention is Boulder Creek. Travel up the Boulder Creek watershed provides a route to a stretch of the high Front Range that is easily accessed and crossed from both the Central Plains and Middle Park. In this area is a cluster of three Paleoindian sites discussed below. The Colorado Piedmont is in large part congruent with the Denver Basin, a structural depression that began filling with Tertiary sediments as the Rocky Mountains were uplifted during the Laramide Orogeny.

A basic knowledge of the history of sedimentation in the Denver Basin and subsequent erosion of its rock strata by streams of the Colorado Piedmont is important for understanding the distribution of tool stones in this part of the study area. With the draining of the Cretaceous sea and uplifting of the Rocky Mountains in the Tertiary period, sedimentary rock strata were tilted and exposed in steep north-south aligned “hogback” ridges along the base of the Front Range. As sediments were first shed off of the Rocky Mountains in the Paleocene, the Denver Basin began to fill. Following an apparent hiatus during Eocene time, stream transport and deposition of sediment from the mountains continued during the Oligocene and Miocene epochs, augmented by thick accumulations of volcanic ash in the Oligocene.

Formations of the White River Group of Oligocene age were the main source of tool stone procured by prehistoric foragers in the northern portion of the Colorado Piedmont. Erosion of the piedmont is most noticeable along the Colorado-Wyoming border where
segments of the white Chalk Bluffs tower over 200 feet above the plains to the south. The “chalk” is actually volcanic ash of a component of the White River Group known as the Brule Formation. A major source of microcrystalline tool stone is exposed on an erosional remnant of the Brule formation north of Sterling known as Flattop Butte. Cliff-forming exposures of the Brule formation continue sporadically to the west along the state line all the way to the mountain front. Gravel deposits exposed in outcropping formations of the White River Group underlying the Brule are scattered within a broad band lying between the state line and the South Platte and together form an important source of orthoquartzite and microcrystalline tool stone in northeast Colorado.

The area of tilted sedimentary formations forming hogbacks in the vicinity of the Colorado-Wyoming state line is said to contain the sources of a variety of tool stones present at the Lindenmeier site (Figure 5-1). Located within an upland area vegetated with juniper, the site is situated atop one of the south-facing exposures of the Brule Formation that parallel the state line. According to early archaeological literature, the sedimentary rock strata forming the hogbacks west of Lindenmeier are the source of orthoquartzite and microcrystalline tool stone, although the precise location of major sources of these materials have yet to be documented.

Exposures of the older Paleocene rocks in an upland area along the southern border of the Colorado Piedmont form an important source of petrified wood. This area between the cities of Denver and Colorado Springs is referred to as the Palmer Divide and is situated on the topographic divide separating the South Platte and Arkansas watersheds. It is also known as the Black Forest for its stands of ponderosa pine. The petrified wood is principally available from primary sources on the Palmer Divide, but it is also available in lower quality sources located in stream terrace deposits along the South Platte and some of the creeks that drain the southern portion of the Colorado Piedmont.
From its confluence with the South Platte in southwestern Nebraska, the North Platte River heads in a northwesterly direction, acquiring tributaries from throughout a large watershed centered in southeastern Wyoming. Just across the state line in Wyoming and south of the river is a source of a microcrystalline tool stone from the White River Group similar to that from Flattop Butte in the South Platte drainage. Not far upstream and north of the river is the Hartville Uplift, a region of hills averaging 5,000 ft. in elevation that are timbered with pine. This upland region was a major source area of tool stone. Here, Spanish Diggings orthoquartzite derives from silicified Cretaceous sandstone and chert is available from exposures of Paleozoic limestones. The Hell Gap site cluster is situated in the vicinity of a number of these chert sources. West of the plains in southeast Wyoming that are drained by the North Platte lie the Laramie Mountains; a relatively low range extending from 7,000 to 10,000 ft. in elevation. From the northern end of the Front Range, west of Fort Collins, Colorado, the Laramie Mountains form an extension of the Southern Rocky Mountains that continues northward and then trends to the northwest where it terminates south of Casper, Wyoming. Situated on the North Platte, the elevation of Casper is 5,200 ft.

In the vicinity of Casper, the short-grass prairie of the Great Plains, located to the east, is replaced with sagebrush grassland of the generally drier Wyoming Basin, situated to the west and southwest in parts of southwest Wyoming and northwest Colorado. The lowlands north of Casper separate the Middle Rocky Mountains, lying to off to the north, from the Southern Rockies, lying to the south in southeast Wyoming, Colorado, and New Mexico. At Casper, the North Platte gradually bends around the northern end of the Laramie Mountains and then heads south. Although the country south of Casper is technically part of the Wyoming Basin (Hunt 1974), it is basically a flat, expansive grassland and is herein considered part of the “plains” environment of the study area. From Casper, a linear dune field extends far to the west. Now located in the northern part of the city, the Casper site is a
Paleoindian bonebed interpreted as a kill site that was situated within the confines of what was at the time a parabolic sand dune in the eastern end of the dune field.

As one travels south of Casper up the North Platte drainage, off to the east is the Shirley Basin, flanked by the Laramie Mountains to the north and east (Figure 5-1). This lowland basin is drained by the Medicine Bow River which flows westward to join waters of the North Platte at Seminoe Reservoir. Though not well-known, a source of orthoquartzite utilized by Paleoindians of the study area is reportedly situated in the basin. Elevations in the Shirley Basin and surrounding lowlands drained by the headwaters of the Medicine Bow River range from 7,000 to 7,500 ft.

The Laramie Basin is another relatively low-lying geographic area immediately south of the Shirley Basin, although not within the North Platte drainage. Situated between the Laramie Mountains on the east, the Medicine Bow Mountains on the west, and the foothills of the Front Range to the south, the basin contains the headwaters of the Laramie River. Receiving snowmelt from higher elevations in the Front Range and the Medicine Bow Mountains, the Laramie River is a substantial stream that flows north through the basin, then turns east to cross the Laramie Mountains and eventually join the North Platte. Elevations in the basin range from 7,000 to 7,500 ft.

Intermontane Basins

Initially, the environment of intermontane basins in the study area may seem very similar to that of the plains grasslands, but upon closer examination, it becomes apparent that a number of dissimilarities between the two environments exist to the extent that land use patterns between them would be expected to differ as well. The basins are similar to the plains in so far that both are principally covered with grassland vegetation and were inhabited historically by populations of bison. The physical geography of the basins differs from the low-lying Plains because the parks are appreciably higher in elevation and constitute
comparatively small areas that are completely circumscribed by mountains. This topographic situation causes the basins to be more prone to temperature inversions during the cold-season which induce periods of extremely frigid temperatures and present challenges to human habitation not experienced to the same degree on the plains. Furthermore, the often high and rugged mountains surrounding the basins acted barriers that dictated the routes that humans likely followed when traveling into and out of the parks. Finally, the more complex structural geology of the intermontane basins served to expose a greater number of tool stone sources in sedimentary and volcanic formations at the ground surface. For these reasons, the availability of tool stone sources in the intermontane basins is much greater that on the plains as a whole. In light of the above, the physical geography and geology of intermontane basins are expected to impose a differing set of influences on land use patterns than that of the Plains and thus will be given a thorough consideration here, particularly for western Middle Park where four excavated Paleoindian sites are clustered.

The three intermontane parks of the study area are often discussed together in the journals of Euroamerican explorers of the Colorado Rockies because mountain passes permit relatively easy travel between these north-south aligned parks. The modern names of the intermontane basins (North, Middle, and South parks) also are indicative of this geographic connection. Snow-covered peaks surrounding the parks give rise to headwaters of major rivers. Middle Park contains the headwaters of the Colorado River, which drains westward to the Pacific Ocean. Headwaters of the North Platte and South Platte arise in North Park and South Park, respectively, with waters of the Platte feeding into the Missouri and ultimately into the Gulf of Mexico via the Mississippi River. The mountains that flank Middle Park on the north, east, and south are thus along the Continental Divide. Muddy Pass affords an easy travel route between North and Middle parks through a low gap. Hoosier Pass, though high in elevation, provides pedestrian access between Middle and South parks without requiring travel over extremely rugged terrain.
Following the North Platte River from the Wyoming Basin into Colorado provides easy access to North Park, a circular basin rimmed by high mountains. Elevation of the open terrain in the park itself ranges from 7,900 ft where the North Platte leaves the park to 8,400 – 8,700 ft at lower tree line. A hogback formed by the Dakota Sandstone is present along the west side of the park. Silicification of one area along the hogback in the northwest portion of the park produced a high-quality source of an orthoquartzite that was used extensively in prehistory.

South of North Park lies Middle Park, the intermontane basin that gives rise to the headwaters of the Colorado River. East of the park itself are the peaks of the high Front Range, with elevations commonly over 12,000 or 13,000 ft. West of the park is a relatively low, forested segment of the Gore Range with elevations rising to elevations over 10,000 feet. The main stem of the Colorado River flows west across the park, picking up waters from named tributaries flowing in from the north and south (Figure 5-2). The river exits the Park through Gore Canyon, then flows generally southwest across western Colorado.

Creation of Middle and North Parks as parts of the same geologic basin has bearing on understanding the physical geography and topography of the two regions. The beginning of the Tertiary period saw the ushering in of the Laramide Orogeny and the formation of the North and Middle Parks Basin. The basin is formed by Precambrian igneous and metamorphic rocks of the Front and Medicine Bow ranges on the east and the Gore and Park ranges on the west. The northern and southern ends of the basin are defined by uplifted Precambrian rocks. At the northern end lies the relatively minor uplift that created Independence Mountain at the north end of North Park and to the south is an extensive northeast-southwest aligned chain of high mountains. Rock strata in the basin are composed chiefly of Mesozoic formations predating the creation of the basin present as bands of tilted exposures along the west and east edges of North and Middle parks, as well as large expanses of basically flat-lying Miocene formations deposited in the park interiors. Uplift and
Figure 5-2. Map of Middle Park and high Front Range showing major geographic features, tool stone sources, and Paleoindian sites.
volcanism later in the Tertiary formed the Rabbit Ears Range and served to divide the basin into separate drainage networks, forming the modern parks.

Familiarity with the physical geography of the Middle Park drainage in conjunction with knowledge of the distribution of open sagebrush grasslands is necessary for understanding one important aspect of land use, specifically the likely travel routes that humans on foot would have used to move through the largely forested terrain above the park proper and between the park and adjacent intermontane basins. Following rivers and major streams provides easy travel routes through the higher forested terrain in the park because open country tends to follow the watercourses. The largest unbroken expanse of open terrain is in western Middle Park. Less extensive open areas exist in eastern Middle Park and along the Blue River south of Middle Park proper.

Review of the physical geography in eastern Middle Park and the adjoining Front Range is helpful for understanding human movement throughout this mountainous region. Travel between Middle Park and the eastern slope of the Front Range and the Plains lying beyond is afforded by numerous passes. Only the main ones will be mentioned here. From its source in the northeast portion of the Middle Park drainage, the Colorado River flows southward to a large tract of open sagebrush grassland in the vicinity of Granby, Colorado. Here lies the main source of Table Mountain jasper, which is found in association with a basalt flow, although details of its formation are poorly understood. Arapaho Creek originally flowed into the Colorado River by Table Mountain in the area now inundated by the man-made Lake Granby. Travel in a southeasterly direction up the broad, glaciated valley of Arapaho Creek provides the easiest pedestrian travel route over the Front Range between the park and Central Plains via Arapaho Pass and the Boulder Creek drainage (Ives 1942:461). Interviews with elderly Arapaho document use of this pass by native people on horseback in historic times (Toll 1962, cited in Benedict 2000:160). Paleoindian sites are situated on both sides of the pass and a third is located at a neighboring pas to the south.
Access between the uppermost reaches of the Colorado River and the Central Plains via the Cache la Poudre drainage, lying to the north and east of Middle Park, is provided by La Poudre Pass. Travel between this portion of the Middle Park drainage and the Central Plains is also possible via a route over Milner and Forest Canyon passes and then down the Big Thompson River drainage. The southeastern portion of Middle Park proper is drained by the Fraser River which flows north-northwest to join the Colorado River in the open grassland near Granby. Access between the southeastern portion of Middle Park and the Central Plains is provided by Berthoud Pass and the Clear Creek drainage. From Granby, the Colorado River flows west through a comparatively restricted valley with the northward trending Vasquez Mountains encroaching on the valley from the south. The river flows next to Hot Sulphur Springs, now located in a town bearing the same name, at the eastern end of Byers Canyon. The springs were used by the Utes in historic times (Bowles 1869, cited in Benedict 1992:13) and likely attracted use in prehistoric times as well. At Byers Canyon, fairly steeply sloping terrain extends all the way to the canyon edge from the north and south, effectively dividing Middle Park into eastern and western portions. The terrain north of the canyon is fairly open and allows the precipitous terrain in the canyon to be bypassed. West of the canyon lies the great expanse of sagebrush grassland in western Middle Park.

The physical geography of western Middle Park will also be reviewed to facilitate thinking about environmental influences on land use and human movements in this portion of the study area. Travel between North Park and western Middle Park is afforded over Muddy Pass (8,710 ft) at the western end of the Rabbit Ears Range where a corridor of open grassland connects the two parks (Figure 5-2). Near the pass is a high-quality source of orthoquartzite where a silicified portion of the Dakota Sandstone is exposed along a hogback on the Middle Park side. The source was extensively quarried as evidenced by the presence of 182 depressions representing now partially filled-in bedrock quarrying operations. From its headwaters near the pass, Muddy Creek flows generally south through gently undulating,
open terrain to join the Colorado River near the town of Kremmling and directly across from the confluence of the Blue River. Traveling south up the Blue River valley provides the most direct route to South Park, but the Colorado River at its confluence with the Blue is deep and wide. A ford on the Colorado upstream from this location known as Long Riffle is said to have been used as a crossing in historic times (Black 1977:21). The expanse of western Middle Park continues south up the broad valley of the Blue River to about the inlet of Green Mountain Reservoir where the valley becomes more confined by topography and forested terrain, but is still conducive to travel upstream via open areas along the river. In the western expanse of grassland north of the Colorado River, the drainage divide between Muddy and Troublesome creeks is marked by a series of wooded mountains. From south to north, these are mapped as Wolford and Little Wolford mountains, with the northernmost one known locally as Twin Mountain. The Upper Twin Mountain site and the Jerry Craig site are Paleoindian bison bonebeds located in this upland area overlooking the Troublesome Creek drainage to the east. Troublesome Creek flows southward, draining generally flat terrain until it eventually joins the Colorado. Directly across the river lies Barger Gulch which contains the major source area of Kremmling chert and the Barger Gulch site complex. Here, numerous chert outcrops and Paleoindian sites, which are referred to as "localities" are located. An extensive Folsom assemblage was excavated at Locality B. Nearby, the Crying Woman site documents use of the Kremmling source area throughout prehistory and features a buried Folsom occupation. East of Barger Gulch, the final lobe of the expanse of grassland in western Middle Park is drained by the Williams Fork as it flows generally north to join the Colorado River near the town of Parshall.

In comparison to traveling between North and Middle parks, the easiest route between Middle and South parks involves a longer journey over a higher pass. From what is here considered the end of Middle Park proper around Green Mountain Reservoir, the route to South Park entails traveling through open grassland country along the Blue River to around
Dillon Reservoir where the route along the river is hemmed in by forest up to Hoosier Pass, located above tree line at 11,539 ft. From the pass, the route to South Park continues in a generally southerly direction through clearings along a tributary of the South Platte River to the edge of the open grasslands of South Park at the town of Fairplay.

South Park is an intermontane basin containing headwaters of the South Platte River. High mountains border the park on the north. Elsewhere, the park is bounded by lower, forested ranges. Along the southern boundary lie isolated wooded mountains separated by open grassland country. Travel routes leading south from the park provide easy access to the Plains via the Arkansas River.

Though out of the study area, the Upper Arkansas Valley will be briefly discussed because of its proximity to South Park and its importance as a source of tool stone. Located west and southwest of South Park, the Upper Arkansas Valley is a broad valley with open grassland country along most of its length. The Valley begins near Leadville, Colorado and trends in a generally southerly direction to the town of Salida where the river takes a more easterly course through canyons to issue onto the Plains at Cañon City. A major source of jasper is present on the east side of the Upper Arkansas Valley near an easy travel route between the valley and South Park over Trout Creek Pass. Jasper from the source is a common tool stone on sites in both regions.

The High Front Range

The portion of the Front Range specifically of concern here is the area of alpine tundra above tree line located between Middle Park and the Colorado Piedmont section of the Central Plains. The area is an irregularly shaped, basically north-south strip of land that is slightly bowed out to the east (Figure 5-2). It is 87 km long, as measured along the crest of the range from La Poudre Pass, on the north, to Berthoud Pass, on the south. Over 50 game drive sites constructed of local boulders are known from this area (Benedict 1992:4, 1996,
These sites are situated to take advantage of the terrain and evidently made use of artificial drive lines composed of a series of rock cairns or low walls to direct the movement of game animals past hunters waiting in blinds that are currently denoted by circular or U-shaped patterns of piled rocks. In the portion of the Front Range of concern here, tree line occurs around 11,000 ft in elevation. Most peaks rise to more than 12,000 ft, with some attaining heights above 13,000 ft and one (Longs Peak) reaches above 14,000 ft.

The three Paleoindian sites of concern here form a cluster of camps associated with nearby game drive structures located in the alpine tundra at two adjacent passes along the high Front Range. All sites are located at water sources along tree line. Two are situated on opposite sides of Arapaho Pass and the third is located five km to the south at Devils Thumb Pass (Figure 5-2).

A large network of drive lines and blinds is present along a ridge on the east slope of the range that leads up to Devils Thumb Pass and more are present on the crest of the range and extend a short distance down the west slope (Benedict 2000b). The Devils Thumb is a rock pinnacle north of the pass that is visible from the southeastern portion of Middle Park and could have provided a landmark for people traveling to the pass. Projectile points and pottery from sites in the subalpine forest adjacent to the game drive suggest that the structures may have been used for communal hunts during Late Paleoindian, Archaic, and Late Prehistoric times. Differential lichen growth on stone drive lanes at the site indicate the game drive network is the result of episodic construction. The game drive system was documented incrementally over the years and consists of three adjacent recorded sites. The part of the drive on a low east-northeast trending ridge situated in the ecotone between forest and tundra, with cirques to the north and south of the ridge, is referred to by Benedict (2000b) as the Devils Thumb Valley game drive (5BL3440). Here, a radiocarbon dated lithic scatter and projectile point comprise a Late Paleoindian component of the site. To the southwest, the ridge becomes steeper as it rises above tree line and is trending basically northeast. This
portion of the site is recorded as 5BL103. To the west, drive lines and blinds continue up the steep ridge to a prominence along the crest of the range and also extend for a short distance down the west slope from the crest. (Devils Thumb Pass is at this high point along the crest, rather than in a saddle as is usually the case with passes.) This western portion of the drive network is recorded as 5BL20. These later two sites are called the Devils Thumb Pass game drive by Benedict (2000b). I shall refer to all three recorded sites collectively as the Devils Thumb game drive. The terrain west of the pass is drained by the headwaters of Ranch Creek which eventually drains northwest to the Fraser River in Middle Park. East of the pass, Jasper Creek flows generally to the southeast to join the South Fork of Middle Boulder Creek which then flows a short distance east to meet with the North Fork flowing southeast down from Arapaho Pass. From here, Middle Boulder Creek flows generally eastward to issue onto the Plains at the city of Boulder.

Two Late Paleoindian camps are located on each side of Arapaho Pass, which is situated in a saddle along a high east-west ridge along the Continental Divide with South Arapaho Peak to the east and Neva Peak lying to the west-southwest. North of the Pass, Middle Park is accessed by following Arapaho Creek down to the northwest. South of the pass, the Plains may be reached by traveling down the Boulder Creek drainage. Though the pass provided a main travel corridor between Middle Park and the Plains, evidence also exists to support the contention that the area of the pass was at times the end destination for prehistoric human groups intent on conducting large-scale big game hunts. Benedict (1981:8) notes that a game drive site recorded as 5BL114 is present immediately south of the pass. He also reports that rock drive lines exist on slopes above and below Lake Dorothy, a small lake perched high above tree line at the eastern base of Mt Neva. North of Arapaho Pass is the Caribou Lake site, situated on the shore of a lake in the cirque formed at the head of Arapaho Creek. The site is a multicomponent camp with diagnostic points and pottery dating to Late Paleoindian, Archaic, and Late Prehistoric times. Game drive structures mentioned above are
situated nearby at a distance of one to two km in a generally southerly direction. The Fourth
of July Valley site is a Late Paleoindian camp situated southwest of Arapaho Pass along a
tributary of Boulder Creek. From the site, the game drive structures are between one and two
km to the northwest.

The nature of the geology of the high Front Range has bearing on the absence of
high-quality sources of tool stone. Common rock types of the high mountains include granite
and gneiss. Most cherts and orthoquartzites are sedimentary rocks which do not occur high in
the Front Range. Tool stone from high-quality sources would necessarily have been brought
into the high Front Range from lower elevations.

CLIMATE

With an adequate knowledge of the physical geography of the study area, the likely
effects of climate on land use can be now considered. Climate affects land use by strongly
influencing the vegetation present which in turn has a direct bearing on the plant and animal
food resources available to foraging people. Climate further would be expected to have
affected land use because harsh cold-season conditions in parts of the study area would have
posed difficult challenges to foragers who would have had to either develop cultural
adaptations to extreme cold and deep snow or else seasonally abandon these areas. The study
area is located in the temperate zone where the height of the cold-season is a lean time of year
for foraging people in regard to food resource availability. In response, foragers living at any
time in the past would likely have had to develop some means of food storage. The
ethnographic record of the Great Basin (e.g. Steward 1938:166) suggests that winter was a
lean time of year, but so too was the spring, perhaps because by this time of year, food stores
may have become depleted. Seeing as though many of the sites to be considered herein are
indicative of large-scale hunting, it will be helpful to develop theory on how climatic
variability in the study area may have related to the use of differing meat storage methods which in turn would have influenced land use patterns in regard to what time of year people carried out communal hunts.

Developing ideas on the connection between climate, food storage methods, and land use is based on the suggestion, originally made by Bamforth (ca. 2000), that latitudinal variation in climate across the Great Plains may have fostered the use of differing methods of meat storage by Paleoindians engaged in large-scale bison hunting. A climatic gradient exists across the Plains today such that temperatures are coldest in the north and become increasingly warmer towards the south. Asserting that a similar temperature gradient existed in Paleoindian times, Bamforth (ca. 2000) argues that meat storage in the more northerly parts of the Plains involved a method that relied on freezing, while storage in the more southerly portions of the Plains would have required that the meat be dried. Furthermore, use of these differing food storage methods may have shifted through time in response to changing climate.

To lay the groundwork for developing theory on the relationships between climate, methods of meat storage, and land use, one must first understand the climatic conditions necessary for the different methods of storage and then consider if modern temperatures in various parts of the Plains will permit those methods to be used. Simply put, a food storage strategy that involves the use of cold-weather for short-term storage of meat will require that temperatures be adequately cold for sufficiently prolonged periods. Conversely, a strategy that entails drying meat would require that meat be procured during a time of year when daytime temperatures are high enough to dehydrate meat in the sun. Under modern climatic conditions, average temperatures in parts of the Southern Plains are not low enough to prevent spoilage. Therefore, the only viable option for foragers living in a similar climate who are intending to store meat, even for short-term use, would be to dry meat during the warm-season. To support the contention that this climatic effect on food storage applied to
Paleoindian times as well, Bamforth (ca. 2000) notes that Folsom bison bonebeds on the Southern Plains represent kills that occurred in the warm-season. Modern temperatures on the Northern Plains are high enough to permit drying of meat in the warm-season, but also decrease sufficiently during the cold-season to allow for short-term storage of meat.

Bamforth (ca. 2000) notes that some Paleoindian bonebeds in the more northerly sections of the Plains represent kills that occurred during the winter. As will be demonstrated in a subsequent chapter, this is the case with the Agate Basin component of the Agate Basin site complex in eastern Wyoming. The fact that people living in a climate that would allow storage via drying or via taking advantage of cold-weather chose the later option leads one to consider the possible advantage of opting for cold-weather storage over drying. Considering that meat drying requires additional time and effort be spent on slicing and dehydrating the meat, the above would imply that people living in climates that were sufficiently cold to permit meat storage without drying opted for this method simply because it was the more efficient way to store meat in the short-term. The above discussion provides some support to Bamforth’s (ca. 2000) idea that Plains Paleoindian storage methods were adapted to latitudinal variation in temperature. Further evaluation of this idea would be advisable to clarify the nature of Paleoindian land use in the study area. This will be accomplished in a subsequent chapter.

Before further developing the idea of regional variation in methods of meat storage, evidence supporting the claim that Paleoindians in and around the Plains employed different methods to store meat is reviewed. Evidence for storage of meat by freezing came to light in the 1970s and 1980s during investigations in Wyoming. One of the most convincing cases for the use of frozen meat caches comes from the Colby site in the Bighorn Basin of Wyoming. Here, two concentrations of mammoth bones associated with Clovis points are interpreted as each representing caches of frozen portions of three mammoths (Frison 1978; Frison and Todd 1986). Most telling is the presence in one concentration of a set of parallel
ribs which favor an interpretation of the bone concentrations as caches of frozen sections of
carcasses, rather than groupings of de-fleshed bones. Also relevant is the observation that at
the time of occupation, the presumed meat caches were positioned in the bottom of a deep
arroyo with steep sides (Albanese 1978:381-382). Thus, the caches would have been in the
relative cool of the shade during much of the day. Data on the actual season during which the
mammoth were killed is presently lacking. However, a method developed for determining
season of death from analysis of mastodon teeth has recently been found to be applicable to
mammoth remains (Fisher and Fox 2007). Therefore, further support for the thinking that the
Colby site bone concentrations represent the remains of frozen meat caches might someday
be provided if dental analysis is able to demonstrate that the mammoths died during the cold-
season.

Possible support for the idea that post-Clovis Paleoindians also stored meat by
freezing comes from the Agate Basin component at the type site on the Plains of Wyoming.
The Agate Basin bonebed in Area 2 is suggested to represent an area where multiple caches
of frozen bison meat were opened and thawed meat was stripped from the bones that were
subsequently discarded nearby. The bone distribution by itself would not necessarily support
the meat cache interpretation, but the fact that dental studies demonstrate the kill occurred in
winter bolsters the argument because the height of the cold-season in the vicinity of the site is
today sufficiently cold to allow for short-term preservation of meat and winters during Agate
Basin times were arguably colder than the present. To elaborate on the then-novel idea of
prehistoric food storage on the Plains via freezing, Frison’s (1982a:363) scenario of what a
frozen meat cache at the Agate Basin site might have entailed is worth repeating here: “The
animals were skinned, cut into sections, and piled. Protection from carnivores and
scavengers was necessary but this could have been solved in various ways. A hide covering,
reinforced by small timbers, covered with snow, and glazed with ice would have been
effective and would have allowed access by the human group as needed.”

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At other Paleoindian bonebeds, investigators have argued that meat was stored by drying it into jerky. In her analysis of the Cattle Guard site, Jodry (1999) argues that bison meat obtained in a large-scale kill conducted during Folsom times in the San Luis Valley, an intermontane basin in south-central Colorado (Figure 5-2), was preserved by drying. Analysis of dentitions from the bonebed determined that the dental ages range from $N + .3$ to $N + .4$ yr after the calving season. As elaborated in a following chapter, these dental ages indicate that the kill occurred around August. Under modern temperatures, this time of year is more than adequately warm for drying meat, but definitely not cold enough to store meat via freezing. The presence of ultrathin knives is suggested to provide further support to the notion of storage by drying. Jodry (1998) suggests that the unusually thin character of the knives would have facilitated producing thin slices of meat to be dried into jerky. Use wear analysis of ultrathin bifaces from Folsom sites provides possible support for the idea by suggesting that some were used to cut at relatively soft material (Jodry 1999:195-218).

Two basic steps are necessary to construct theory explaining how the various environments of the study area influenced the seasonal timing of Paleoindian large-scale big game kills and the methods employed to store the procured meat. First, it is necessary to understand the effect of modern climatic conditions on the timing of hunts, were foragers to inhabit the study area today. Secondly, the degree to which Paleoindian climate differed from that of modern times must be appreciated. Achieving at least a relative understanding of the difference between modern and Paleoindian climates is important and will be addressed in the following chapter, but of more immediate concern is developing an understanding of the constraints that modern climatic conditions in the study area would impose on the timing of hunts and the methods of meat storage. It is to this need that I now turn by reviewing relevant modern climatic conditions in the three environments of the study area.
Temperature in the study area varies with latitude and elevation. Latitudinal variation is not great in the study area due to its relatively small size. Nevertheless, placing the seasonal temperature changes of the study area within the context of the substantial variation that exists from north-to-south across the Plains is important and is provided below. Greater variation in temperature occurs with changes in elevation. Temperature is generally colder with increasing elevation in both the warm and cold-seasons. A notable exception to the rule is the extremely cold temperatures that occur at lower elevations during the cold-season when cold air sinks to lowest elevations in the intermontane basins during temperature inversions.

To illustrate the variation in temperature and precipitation with elevation in the study area, climatic data from weather stations close to the 40th parallel of north latitude will be presented below. Despite some adoption of the metric system of measurement in the U.S., most people in the country still think about temperature and precipitation in terms of degrees Fahrenheit and inches of rain and snow. Also, climatic data collected by the U.S. government (United States Department of Commerce, National Oceanic and Atmospheric Administration [USDC, NOAA] 2002a) is given in these units of measurement. Therefore, these units will be employed herein when discussing climate, without giving their metric equivalent. The transect along 40° N latitude extends from west-to-east through the open expanse of western Middle Park and continues up the Colorado River drainage to eastern Middle Park. It then proceeds east over the Front Range to the Great Plains at Boulder, Colorado. From there, it cuts across the plains of eastern Colorado, south of the South Platte River, and follows the Nebraska-Kansas state line as it basically parallels the Republican River to the eastern end of the study area.
Middle Park Climate and Its Effects on Food Storage and Land Use

Variation in Middle Park temperatures is evident in weather station data (Tables 5-1 and 5-2). Elevation and topography are important factors affecting Middle Park temperatures. Climatic data is collected at weather stations in the lower elevations in western Middle Park, including one at the town of Kremmling (7,390 ft) and another at Williams Fork Reservoir (7,650 ft), located on the Colorado River tributary of the same name. Higher stations in eastern Middle Park include one at Lake Granby (8,288 ft) and another at the Grand Lake entrance to RMNP (8,720 ft). In Middle Park proper, July highs are in the pleasant 74-80°F range, dropping down to nighttime lows in the chilly 39 to 44°F range. Cooler readings prevail at higher elevations in the Middle Park drainage. In the park proper, January highs are below freezing in western Middle Park where cold air sinks and becomes trapped by topography during temperature inversions when the air is still. The combination of high pressure and an influx of arctic air can cause temperature inversions to occur and this can happen multiple times during each cold-season. Temperature inversions can last several days with extremely cold temperatures in the –40 to –50°F range possible.

Snowfall accumulation in the Middle Park drainage increases with elevation (Table 5-2) and would have affected bison distributions and hunter-gatherer land use patterns accordingly. Although the Kremmling station averages 4.7 ft of snow in a year, melting and ablation results in an average January snow depth of only 6 in. The highest expanses of sagebrush grassland in eastern Middle Park have more snowfall with an average January depth of 15 inches the open tract of sagebrush grassland formerly present at Lake Granby. Snow depth is an important determinant of game animal distribution. Greater snow depths in higher, forested elevations force game animals to lower sagebrush grasslands where less snow requires less energy expenditure to uncover forage. Studies of mule deer distribution in western Middle Park during the cold-seasons of 1965–1966 and 1966–1967 concluded that as snow depth reaches the 1 to 1 ½ ft range, deer move to lower elevations in the park.
<table>
<thead>
<tr>
<th>Weather Station Name</th>
<th>Region</th>
<th>Mean July Daily Maximum Temperature</th>
<th>Mean July Daily Minimum Temperature</th>
<th>Mean January Daily Maximum Temperature</th>
<th>Mean January Daily Minimum Temperature</th>
<th>Months with Mean Temperature Below Freezing, Inclusive</th>
<th>Months with Mean Daytime Hights Below Freezing, Inclusive</th>
<th>Mean July Wind Speed (mph)</th>
<th>Mean January Wind Speed (mph)</th>
<th>Elevation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kremmling, CO</td>
<td>Middle Park</td>
<td>79.6° F</td>
<td>44.0° F</td>
<td>25.8° F</td>
<td>-2.2° F</td>
<td>Nov. – March (5 mo)</td>
<td>Dec. – Feb. (3 mo)</td>
<td>-</td>
<td>-</td>
<td>7,390 ft</td>
</tr>
<tr>
<td>Williams Fork Dam, CO</td>
<td>Middle Park</td>
<td>78.9° F</td>
<td>41.3° F</td>
<td>28.6° F</td>
<td>-3.3° F</td>
<td>Nov. – March (5 mo)</td>
<td>Dec. – Jan. (2 mo)</td>
<td>-</td>
<td>-</td>
<td>7,650 ft</td>
</tr>
<tr>
<td>Grand Lake, 6 mi SSW, CO</td>
<td>Middle Park</td>
<td>74.3° F</td>
<td>41.9° F</td>
<td>27.0° F</td>
<td>0.9° F</td>
<td>Nov. – March (5 mo)</td>
<td>Dec. – Feb. (3 mo)</td>
<td>-</td>
<td>-</td>
<td>8,288 ft</td>
</tr>
<tr>
<td>Grand Lake, 1 mi NW, CO</td>
<td>Middle Park</td>
<td>75.9° F</td>
<td>39.0° F</td>
<td>31.5° F</td>
<td>3.8° F</td>
<td>Nov. – March (5 mo)</td>
<td>Jan. (1 mo)</td>
<td>-</td>
<td>-</td>
<td>8,720 ft</td>
</tr>
<tr>
<td>Berthold Pass, CO</td>
<td>Front Range</td>
<td>61.4° F</td>
<td>38.9° F</td>
<td>21.8° F</td>
<td>2.4° F</td>
<td>Oct. – April (7 mo)</td>
<td>Nov. – March (5 mo)</td>
<td>-</td>
<td>-</td>
<td>11,313 ft</td>
</tr>
<tr>
<td>unnamed. in alpine zone</td>
<td>Front Range (east slope)</td>
<td>54° F</td>
<td>39° F</td>
<td>14° F</td>
<td>3° F</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>25</td>
<td>12,300 ft</td>
</tr>
<tr>
<td>unnamed. in subalpine zone</td>
<td>Front Range (east slope)</td>
<td>66° F</td>
<td>41° F</td>
<td>27° F</td>
<td>11° F</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>14</td>
<td>10,000 ft</td>
</tr>
<tr>
<td>unnamed. in upper montane zone</td>
<td>Front Range (east slope)</td>
<td>77° F</td>
<td>51° F</td>
<td>36° F</td>
<td>15° F</td>
<td>-</td>
<td>-</td>
<td>5</td>
<td>9</td>
<td>8,500 ft</td>
</tr>
<tr>
<td>unnamed. in lower montane zone</td>
<td>Front Range (east slope)</td>
<td>83° F</td>
<td>55° F</td>
<td>41° F</td>
<td>20° F</td>
<td>-</td>
<td>-</td>
<td>6</td>
<td>7</td>
<td>7,200 ft</td>
</tr>
</tbody>
</table>
Table 5-1. Temperature Data for Weather Stations in Study Area Close to 40° N Latitude (Page 2 of 2).

<table>
<thead>
<tr>
<th>Weather Station Name</th>
<th>Region</th>
<th>Mean July Daily Maximum Temperature</th>
<th>Mean July Daily Minimum Temperature</th>
<th>Mean January Daily Maximum Temperature</th>
<th>Mean January Daily Minimum Temperature</th>
<th>Months with Mean Temperature Below Freezing, Inclusive</th>
<th>Months with Mean Daytime Highs Below Freezing, Inclusive</th>
<th>Mean July Wind Speed (mph)</th>
<th>Mean January Wind Speed (mph)</th>
<th>Elevation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boulder, CO</td>
<td>Central Plains</td>
<td>87.2° F</td>
<td>55.9° F</td>
<td>45.7° F</td>
<td>19.2° F</td>
<td>0 mo</td>
<td>0 mo</td>
<td>-</td>
<td>-</td>
<td>5,484 ft</td>
</tr>
<tr>
<td>Greeley UNC, CO</td>
<td>Central Plains</td>
<td>88.7° F</td>
<td>59.3° F</td>
<td>40.0° F</td>
<td>15.6° F</td>
<td>Dec. – Jan. (2 mo)</td>
<td>0 mo</td>
<td>-</td>
<td>-</td>
<td>4715 ft</td>
</tr>
<tr>
<td>Fort Morgan, CO</td>
<td>Central Plains</td>
<td>91.1° F</td>
<td>59.9° F</td>
<td>39.8° F</td>
<td>10.1° F</td>
<td>Dec. – Feb. (3 mo)</td>
<td>0 mo</td>
<td>-</td>
<td>-</td>
<td>4,332 ft</td>
</tr>
<tr>
<td>Akron 4 mi E, CO</td>
<td>Central Plains</td>
<td>88.7° F</td>
<td>56.7° F</td>
<td>38.2° F</td>
<td>11.9° F</td>
<td>Dec. – Feb. (3 mo)</td>
<td>0 mo</td>
<td>-</td>
<td>-</td>
<td>4590 ft</td>
</tr>
<tr>
<td>Wray 2 mi E, CO</td>
<td>Central Plains</td>
<td>91.1° F</td>
<td>59.6° F</td>
<td>42.5° F</td>
<td>11.5° F</td>
<td>Dec. – Jan. (2 mo)</td>
<td>0 mo</td>
<td>-</td>
<td>-</td>
<td>3,530 ft</td>
</tr>
<tr>
<td>Benkelman, NE</td>
<td>Central Plains</td>
<td>91.2° F</td>
<td>61.4° F</td>
<td>40.5° F</td>
<td>11.3° F</td>
<td>Dec. – Feb. (3 mo)</td>
<td>0 mo</td>
<td>-</td>
<td>-</td>
<td>3,025 ft</td>
</tr>
<tr>
<td>Culbertson, NE</td>
<td>Central Plains</td>
<td>90.3° F</td>
<td>61.9° F</td>
<td>38.7° F</td>
<td>11.7° F</td>
<td>Dec. – Feb. (3 mo)</td>
<td>0 mo</td>
<td>-</td>
<td>-</td>
<td>2,600 ft</td>
</tr>
<tr>
<td>McCook, NE</td>
<td>Central Plains</td>
<td>89.9° F</td>
<td>63.4° F</td>
<td>38.7° F</td>
<td>14.0° F</td>
<td>Dec. – Feb. (3 mo)</td>
<td>0 mo</td>
<td>-</td>
<td>-</td>
<td>2,530 ft</td>
</tr>
<tr>
<td>Medicine Creek Dam, NE</td>
<td>Central Plains</td>
<td>88.6° F</td>
<td>61.8° F</td>
<td>37.3° F</td>
<td>11.1° F</td>
<td>Dec. – Feb. (3 mo)</td>
<td>0 mo</td>
<td>-</td>
<td>-</td>
<td>2,387 ft</td>
</tr>
<tr>
<td>Holdrege, NE</td>
<td>Central Plains</td>
<td>87.2° F</td>
<td>62.7° F</td>
<td>34.1° F</td>
<td>12.5° F</td>
<td>Dec. – Feb. (3 mo)</td>
<td>0 mo</td>
<td>-</td>
<td>-</td>
<td>2,320 ft</td>
</tr>
<tr>
<td>Harlan County Lake, NE</td>
<td>Central Plains</td>
<td>89.3° F</td>
<td>63.9° F</td>
<td>36.4° F</td>
<td>11.6° F</td>
<td>Dec. – Feb. (3 mo)</td>
<td>0 mo</td>
<td>-</td>
<td>-</td>
<td>2,000 ft</td>
</tr>
<tr>
<td>Red Cloud, NE</td>
<td>Central Plains</td>
<td>90.5° F</td>
<td>63.2° F</td>
<td>35.4° F</td>
<td>10.3° F</td>
<td>Dec. – Feb. (3 mo)</td>
<td>0 mo</td>
<td>-</td>
<td>-</td>
<td>1,720 ft</td>
</tr>
</tbody>
</table>

*a* Data from USDC, NOAA (2002a, 2002b) for the years 1971 – 2000, except as otherwise noted. Latitudes and longitudes of weather stations are given in Table 5-2.

*b* Weather station located at Lake Granby Pumping Plant.

*c* Weather station located at Grand Lake Entrance to Rocky Mountain National Park.

*d* Data from Paddock (1964:Table II).
Table 5-2. Precipitation and Snow Totals for Weather Stations in Study Area Close to 40° N Latitude. (Page 1 of 3)

<table>
<thead>
<tr>
<th>Weather Station Name</th>
<th>Region</th>
<th>Mean Annual Precipitation Total</th>
<th>Mean Annual Snowfall Total</th>
<th>Mean January Snow Depth</th>
<th>Elevation of Station</th>
<th>Latitude of Station</th>
<th>Longitude of Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kremmling, CO</td>
<td>Middle Park</td>
<td>11.48 in</td>
<td>56.4 in (4.7 ft)</td>
<td>6 in</td>
<td>7,390 ft</td>
<td>40° 03’ N</td>
<td>106° 23’ W</td>
</tr>
<tr>
<td>Williams Fork Dam, CO</td>
<td>Middle Park</td>
<td>14.13 in</td>
<td>-</td>
<td>-</td>
<td>7,650 ft</td>
<td>40° 02’ N</td>
<td>106° 12’ W</td>
</tr>
<tr>
<td>Grand Lake, 6 mi SSW, CO</td>
<td>Middle Park</td>
<td>13.98 in</td>
<td>78.0 in (6.5 ft)</td>
<td>15 in</td>
<td>8,288 ft</td>
<td>40° 11’ N</td>
<td>105° 52’ W</td>
</tr>
<tr>
<td>Fraser, CO</td>
<td>Middle Park</td>
<td>18.13 in</td>
<td>-</td>
<td>-</td>
<td>8,560 ft</td>
<td>39° 57’ N</td>
<td>105° 49’ W</td>
</tr>
<tr>
<td>Grand Lake, 1 mi NW, CO</td>
<td>Middle Park</td>
<td>20.75 in</td>
<td>133.7 in (11.1 ft)</td>
<td>19 in</td>
<td>8,720 ft</td>
<td>40° 16’ N</td>
<td>105° 50’ W</td>
</tr>
<tr>
<td>Winter Park, CO</td>
<td>Middle Park</td>
<td>26.85 in</td>
<td>-</td>
<td>-</td>
<td>9,058 ft</td>
<td>39° 58’ N</td>
<td>105° 46’ W</td>
</tr>
<tr>
<td>Berthold Pass, CO</td>
<td>Front Range</td>
<td>35.52 in</td>
<td>240.6 in (20.0 ft)</td>
<td>-</td>
<td>11,313 ft</td>
<td>39° 48’ N</td>
<td>105° 47’ W</td>
</tr>
</tbody>
</table>
Table 5-2. Precipitation and Snow Totals for Weather Stations in Study Area Close to 40° N Latitude (Page 2 of 3).

<table>
<thead>
<tr>
<th>Weather Station Name</th>
<th>Region</th>
<th>Mean Annual Precipitation Total</th>
<th>Mean Annual Snowfall Total</th>
<th>Mean January Snow Depth</th>
<th>Elevation of Station</th>
<th>Latitude of Station</th>
<th>Longitude of Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>unnamed. in alpine zone e</td>
<td>Front Range (east slope)</td>
<td>24.6 in f</td>
<td>-</td>
<td>-</td>
<td>12,300 ft</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>unnamed. in subalpine zone e</td>
<td>Front Range (east slope)</td>
<td>25.6 in</td>
<td>-</td>
<td>-</td>
<td>10,000 ft</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>unnamed. in upper montane zone e</td>
<td>Front Range (east slope)</td>
<td>21.4 in</td>
<td>-</td>
<td>-</td>
<td>8,500 ft</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>unnamed. in lower montane zone e</td>
<td>Front Range (east slope)</td>
<td>21.2 in</td>
<td>-</td>
<td>-</td>
<td>7,200 ft</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Boulder, CO</td>
<td>Central Plains</td>
<td>19.93 in</td>
<td>84.7 in (7.1 ft)</td>
<td>2 in</td>
<td>5,484 ft</td>
<td>40° 00' N</td>
<td>105° 16' W</td>
</tr>
<tr>
<td>Greeley UNC, CO</td>
<td>Central Plains</td>
<td>14.22 in</td>
<td>43.6 in</td>
<td>2 in</td>
<td>4,715 ft</td>
<td>40° 24' N</td>
<td>104° 42' W</td>
</tr>
<tr>
<td>Ft. Morgan, CO</td>
<td>Central Plains</td>
<td>13.13 in</td>
<td>22.6 in</td>
<td>1 in</td>
<td>4,332 ft</td>
<td>40° 16' N</td>
<td>103° 48' W</td>
</tr>
<tr>
<td>Akron, 4 mi E, CO</td>
<td>Central Plains</td>
<td>16.59 in</td>
<td>32.6 in</td>
<td>3 in</td>
<td>4,540 ft</td>
<td>40° 09' N</td>
<td>103° 09' W</td>
</tr>
<tr>
<td>Yuma, CO</td>
<td>Central Plains</td>
<td>16.52 in</td>
<td>29.8 in</td>
<td>2 in</td>
<td>4,140 ft</td>
<td>40° 07' N</td>
<td>102° 43' W</td>
</tr>
<tr>
<td>Wray, 2 mi E, CO</td>
<td>Central Plains</td>
<td>17.54 in</td>
<td>29.8 in</td>
<td>1 in</td>
<td>3,530 ft</td>
<td>40° 05' N</td>
<td>102° 11' W</td>
</tr>
</tbody>
</table>
Table 5-2. Precipitation and Snow Totals for Weather Stations in Study Area Close to 40° N Latitude (Page 3 of 3).

<table>
<thead>
<tr>
<th>Weather Station Name</th>
<th>Region</th>
<th>Mean Annual Precipitation Total</th>
<th>Mean Annual Snowfall Total</th>
<th>Mean January Snow Depth</th>
<th>Elevation of Station</th>
<th>Latitude of Station</th>
<th>Longitude of Station</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benkelman, NE</td>
<td>Central Plains</td>
<td>19.40 in</td>
<td>29.2 in</td>
<td>2 in</td>
<td>3,025 ft</td>
<td>40° 03'N</td>
<td>101° 33’W</td>
</tr>
<tr>
<td>Culbertson, NE</td>
<td>Central Plains</td>
<td>21.48 in</td>
<td>30.3 in</td>
<td>2 in</td>
<td>2,600 ft</td>
<td>40° 14’N</td>
<td>100° 50’W</td>
</tr>
<tr>
<td>McCook, NE</td>
<td>Central Plains</td>
<td>21-62 in</td>
<td>32.0 in</td>
<td>2 in</td>
<td>2,530 ft</td>
<td>40° 12’N</td>
<td>100° 37’W</td>
</tr>
<tr>
<td>Medicine Creek Dam, NE</td>
<td>Central Plains</td>
<td>21.49 in</td>
<td>20.3 in</td>
<td>2 in</td>
<td>2,387 ft</td>
<td>40° 23’N</td>
<td>100° 13’W</td>
</tr>
<tr>
<td>Holdrege, NE</td>
<td>Central Plains</td>
<td>26.01 in</td>
<td>28.5 in</td>
<td>2 in</td>
<td>2,320 ft</td>
<td>40° 26’N</td>
<td>99° 22’W</td>
</tr>
<tr>
<td>Harlan County Lake, NE</td>
<td>Central Plains</td>
<td>24.03 in</td>
<td>16.4 in</td>
<td>1 in</td>
<td>2,000 ft</td>
<td>40° 05’N</td>
<td>99° 13’W</td>
</tr>
<tr>
<td>Red Cloud, NE</td>
<td>Central Plains</td>
<td>26.33 in</td>
<td>19.2 in</td>
<td>2 in</td>
<td>1,720 ft</td>
<td>40° 06’N</td>
<td>98° 31’W</td>
</tr>
</tbody>
</table>

\* Data from USDC, NOAA (2002a, 2002b) for the years 1971 – 2000, except as otherwise noted.
\*\ Data from USDC, NOAA (2002a, 2002b) for the years 1971 – 2000, except as otherwise noted.
\* Weather station located at Lake Granby Pumping Plant.
\* Weather station located at Grand Lake entrance to Rocky Mountain National Park.
\* Data from Surovell et al. (2003:5).
\* Data from Paddock (1964:Table III).
\* Precipitation in alpine zone strongly influenced by wind; actual amount would be higher, probably comparable to Berthold Pass, according to Paddock (1964:Table III).
In winters with unusually high snow depths, dramatic die-offs of deer occur in Middle Park. Studies of elk and bison in Yellowstone National Park indicate that these larger bodied species are able to clear snow from forage in greater snow depths and routinely overwinter in valleys subjected to snow depths of two to three ft (Meagher 1971:65). The above suggests that under modern conditions, big game species, especially bison and elk, are able to spend the entire cold-season in Middle Park.

Temperature inversions in the park would have been a challenging aspect of climate to which foraging peoples could have responded in one of two ways, but one option would have been easier and less risky and therefore is believed to have been the more likely response. First, mobile foragers could simply have left the park for neighboring areas during the height of the cold-season. Alternatively, hunter-gatherers conceivably could have wintered in Middle Park. This would require construction of substantial housing, putting up stores of food, and preferably locating the habitation structure within the winter range of big game animals. Under modern climatic conditions, snow depths in the sagebrush grasslands of western Middle Park are not excessive and game animals are available as a food resource. Hunter-gatherers may have had the capability of surviving winters in Middle Park. However, when the question of whether foragers would winter in the park or leave is considered in terms of which would be the easiest option, it would seem that less work would be involved in simply relocating to an area with a less harsh winter climate. Furthermore, when the question is contemplated in regard to which option involves less risk of not surviving the winter, simply leaving the park again appears to be the better choice. While an unusually cold and snowy winter in lowland regions may have entailed hardships for foraging people, a bad winter in Middle Park would more likely have led to disastrous consequences for a population of hunter-gatherers. From the above consideration of the modern climatic conditions prevailing in Middle Park, it is reasonable to theorize that hunter-gatherer land use would have responded to the frigid temperatures of the cold-season by simply abandoning the
park at this time. Furthermore, it is reasonable to assume that throughout human prehistory, the park saw seasonal use by foragers who wintered in lowlands to the west of the park as well as those who spent the winter at lower elevations to the east.

The Middle Park climate would impose constraints on meat storage related to large-scale bison hunting, which in turn would be expected to have entered into land use decisions. Middle Park experiences a five-month-long period during which the weather would promote meat preservation because average monthly temperatures are below freezing (November to March) (Table 5-1). The period from December to January or February can experience average daytime temperatures below freezing, depending upon the specific location in Middle Park. Thus, if people chose to winter in Middle Park and engaged in large-scale bison hunting at this time, they likely would have a method for storing meat that involved frozen carcass sections. In contrast, if people chose to engage in large-scale hunts prior to the height of the cold-season, during which time the park was abandoned, meat would have been preserved through drying.

Temperature data from the Kremmling weather station will be used to illustrate this point (USDC, NOAA 2002b). In September, the average monthly temperature is 52° F, nighttime lows are usually just above freezing at 34° F with daytime highs of 70° F. These overall conditions are not cold enough to promote preservation of raw meat. Daytime temperatures would allow stripping of meat from bone and are sufficiently high to allow making of jerky. October average monthly temperature is 41° F, nighttime lows are around 23° F, and daytime highs average 59° F. Under these conditions, daytime highs would allow for stripping muscles from bone as well as the option of preserving meat through drying, though the temperature is less than ideal for this activity. In November, the temperature averages 27° F with nighttime lows about 13° F and mean daytime highs of 40° F. At these temperatures, carcass sections would remain frozen throughout much of the daily cycle. Even though some thawing may be possible during the daytime to allow further carcass
processing by stripping meat from bone, drying meat may no longer be a viable option. Finally, December temperatures average 14° F with nighttime lows of about 1° F and daytime highs of below zero at 28° F. In these conditions, short-term preservation of meat via freezing is the only option.

For people intent on leaving the park after participating in a bison kill, December conditions are such that people would be well advised to have already left the park. Daytime highs do not rise above freezing and thus carcasses would be frozen solid on days following the kill and be difficult to impossible to process further by stripping meat from bone. Furthermore, assuming that people would have transported meat from the kill out of the park to winter quarters, the best time to do so may have already past. Although it is conceivable that raw meat could be transported, making jerky reduces weight by 90 percent (Frison 1978:302) and daytime temperatures in December are usually below freezing and do not permit dehydration. Timing of the first deep snows varies by year, but people needing to travel over high passes would be well advised to have left by the first of December. In light of the above, foragers with a subsistence-level economy and a land use strategy that made seasonal use of Middle Park for the purpose of communal bison hunting followed by abandoning the area for the winter months would have seen bison hunts carried out sometime during the months prior to the height of the cold-season. In other words, hunts could have taken place in the summer or the early part of fall until around the beginning of November. Any meat from the hunts preserved for later consumption would have been dried for ease in transporting it out of the park.

The High Front Range Climate and Its Effects on Food Storage and Land Use

Data on Front Range climate is provided by two principal sources. A basically east-west transect of weather stations on the east slope of the range, west of the city of Boulder, is given in Paddock (1964:Table III). Data was compiled from stations maintained by various
federal and private organizations with each station in a particular vegetation zone characteristic of a given altitudinal range. Secondly, data collected at a station maintained by NOAA at Berthold Pass is available from that federal agency.

As in the Middle Park drainage, elevation is an important factor influencing variation in temperature, with warming occurring as one descends to lower slopes (Table 5-1). July temperatures are cool up high and warm down low. The station on the east slope of the Front Range in the alpine tundra at 12,300 ft elevation has daytime highs averaging 54°F and nighttime lows down to 39°F. A lower station at 10,000 ± ft is in the subalpine forest. Vegetation zones are discussed below, but suffice to say here that the subalpine forest is characterized by dense stands of Englemann spruce and subalpine fir. At this station, daytime highs average 66°F with nighttime lows down to 41°F. A station at 8,500 ± ft is in the upper montane zone, which is characterized by discontinuous stands of Douglas fir. Daytime highs average 77°F with nighttime lows down to 51°F. The lowest station is at 7,200 ± ft elevation and is within the lower montane zone, an ecological community which is basically a woodland of ponderosa and juniper. Here, daytime temperatures are around 83°F with nighttime lows of 55°F.

January temperatures along the transect of stations on the east slope are frigid up high, but more tolerable at lower elevations. The alpine tundra experiences daytime highs around 14°F with nighttime lows of 3°F. Temperatures in the subalpine forest vary from daytime highs averaging 27°F to nighttime lows of 11°F. The upper montane forest typically attains daytime highs around 36°F with lows down to 15°F. Mean daytime highs in the lower montane zone are up to 41°F, with lows down to 20°F.

Wind has an important effect on climate in the high Front Range year round, but of most concern here is its influence on human occupation during the height of the cold-season. The atmosphere generally experiences higher winds with increasing altitude and the Front Range rises to elevations in excess of 14,000 ft. Therefore, wind velocities are higher with
increased elevation and this holds true during both the warm and cold-seasons. For humans, wind is an especially important consideration during times in the fall and winter, particularly at higher elevations, where wind chill factors serve to make human habitation even more challenging than the cold alone. The three archaeological sites of concern in this study are located at the ecotone between the open alpine tundra and the dense forest of the subalpine forest. Frigid January temperatures coupled with average wind speeds of 25 mph on the alpine tundra make for challenging conditions where frostbite is a real concern even for modern-day people with high-tech clothing and equipment.

In the Front Range, elevation has a great effect on not only temperature, but also the amount of precipitation and of particular concern here is depth of the snowpack. Along his east slope transect, Paddock (1964:Table III) reports a low of 21 in of annual precipitation in the lower montane zone with moisture increasing correspondingly with elevation to a high of 25 in above tree line. Paddock suggests precipitation data at the alpine tundra station may be biased due to high winds causing readings to underestimate the actual amount. Instead, he suggests actual precipitation may be closer to that at the Berthold Pass station with a reading of 36 ± in. Surovell et al. (2003:5) reports that annual snowfall at the pass averages 240.6 in or 20.0 ft. During a typical year, melting and ablation of snow throughout the cold-season results in maximum snow depths of at least a few feet.

The above weather data indicates that modern-like climatic conditions in the high Front Range would have had predictable effects on land use. Extreme cold and deep snows that prevail during the height of the cold-season would force hunter-gatherers to abandon the high mountains. Unlike the Plains and intermontane basins, another factor that would encourage abandonment is the lack of animal food resources at this time of year. Today the snow depth and cold force big game animals to lower elevations. Study of a radio-collared elk herd that annual grazes in the high Front Range demonstrates that animals are normally driven to lower elevations with the snows of November and return to the alpine tundra after
sufficient melting of snow and the first appearance of new plant growth on the alpine tundra in early June (Hallock 1991, cited in Benedict 2000b). Humans could have used the tundra for some or all of this period, but returning as early as the big game animals would have required snowshoes to travel through deep and often wet snow. In light of the above, it can be stated that the high Front Range would have been abandoned by foragers for at least six months out of the year (December through May) for reasons that ultimately relate to climate. It is reasonable to theorize that throughout much of prehistory, some of the foragers that seasonally occupied the high Front Range would have wintered in lowlands to the east while others would have had land use patterns that took them down to lower elevations west of Middle Park for the winter.

Apart from assessing whether human habitation was even possible during part of the year, a consideration of modern climate also has utility for theorizing the food storage options of foragers who occupied the high Front Range on a seasonal basis. The size of the game drive systems of rock walls, alignments of cairns, and blinds implies that they were constructed by a relatively large group of people intent on cooperating in a joint economic effort. Benedict (1992) has suggested that game drives were conducted to put up stores of meat for later consumption during the cold-season. Foraging people would not have had the option of making frozen meat caches, since the deep snow and cold temperatures that would have forced the abandonment of the high Front Range would also not permit people to make multi-day trips later in the cold-season to retrieve meat. Also, since people had to make a multi-day trip out of the area to lower elevations, it would seem likely that the meat would have been made into jerky for ease of transport, since this would have reduced bulk and the weight of the meat would have been decreased by about 90 percent.
Plains Climate and Its Effects on Food Storage and Land Use

Weather stations close to the 40th parallel demonstrate trends in temperature characteristic of the Plains and allow comparison with the other two environments. July daily highs for stations along the transect are mostly in the 87 - 91° F range with nighttime lows in the 56 - 64° range (Table 5-1). January daily highs are mostly in the 34 – 42° F range with nighttime lows between 10 and 16° F. The station at Boulder, Colorado is an exception, being notably warmer with January daily highs averaging 46° F and a mean nighttime low of about 20° F. The warmer temperatures are due to its location at the eastern foot of the Front Range where it is subjected to westerly winds that travel perpendicular to the eastern slope and become less cold as they lose elevation, becoming warm “chinook” winds by the time they reach the Plains (Paddock 1964:26-28).

Precipitation along the east-west transect on the Plains portion of the study area ranges from a fairly arid 13 inches per year to a more mesic 26 inches at the eastern end. The variation is in large part due to the rain shadow effect. Moisture-laden clouds drop their precipitation upon encountering the mountains, so the atmosphere is comparatively dry in a strip of land immediately east of the Front Range. In comparison to areas further east on the Plains, the city of Boulder receives relatively high annual precipitation because its location at the base of the Front Range subjects it to precipitation from clouds dropping moisture over the mountains. Stations on the Plains with the lowest annual precipitations are found in the Colorado Piedmont at Greeley and Ft. Morgan (Table 5-2). As one moves eastward from here, evaporation gradually recharges the atmosphere and rainfall correspondingly increases to its highest levels in the eastern part of the study area.

In contrast to Middle Park and the high Front Range, climatic conditions on the Great Plains portion of the study area would not require seasonal abandonment during the height of the cold-season. Average temperatures during the fall and winter are not as cold. Influx of arctic air does result in cold snaps, but these are generally not as long-lasting as the
temperature inversions of intermontane parks where cold air becomes trapped by topography and high pressure. Unlike the intermontane basins and the high Front Range, temperatures on the Plains are amenable to year-round habitation by foragers. Being located at the base of the mountains, Boulder does get substantial snowfall with 7.1 ft of annual accumulation, but apart from this notable exception, snow totals at all Plains stations are less than the lowest total for Middle Park of 4.7 ft for the town of Kremmling located in the lowest portion of the western expanse of sagebrush grassland. Also, the snow that does fall on the Plains tends to be quickly melted by prevailing temperatures to the extent that average January snow depth at all Plains stations ranges from only 1 to 3 in. Snow depths are generally not a factor constraining the movement of game animals and people. Blizzards, of course, constitute an exception to the rule, but under the current temperature regime, they occur infrequently in the study area with several years or more between events of unusually heavy snowfall.

To better understand the affects that modern climatic conditions in the Plains portion of the study area may have had on the methods of meat storage used by foraging people, it is necessary to place the area within the context of the latitudinal variation in temperatures across the Great Plains. To do so, temperature data from the Northern, Central, and Southern Plains will be briefly considered. Daytime temperatures from the late summer and early fall in all parts of the Plains today allow for the production of jerky. Though I am not aware of experimental data on the affect of temperature on the time required to dehydrate meat, limited personal experience has shown that jerky making is most efficient in weather above 70° F. As the temperature lowers, drying raw meat into jerky is still possible, but the process requires a correspondingly longer amount of time such that its use as a viable storage method decreases with temperature down to a certain point above freezing where the time required to dry meat in the sun makes jerky manufacture no longer a viable option. Temperatures in the upper 30s on into the 50+ ° F range are definitely less than ideal for jerky manufacture. Here, however, I am specifically concerned with whether cold-season temperatures in various parts
of the Plains are low enough to permit short-term meat storage as an option to the more labor intensive method of making jerky. How well a meat cache that depends on cold weather would work depends on a number of factors relating to the degree to which the food is insulated from above-freezing daytime temperatures. As alluded to by Frison’s (1982a:363) hypothetical description of a frozen meat cache, a well insulated one would be positioned in the shade and covered with something such as hides and preferably also insulated with snow, if available. In an insulated state, daytime temperatures during the height of the cold season that rise above freezing may cause thawing of meat on the top and sides of the pile, but they would refreeze at night and meat in the center could remain frozen. With this in mind, the climatological gauge chosen to be indicative of a time of year when cold-weather storage of meat is most feasible is whether the average monthly temperature remains below freezing.

Data from single weather stations on the Northern, Central, and Southern Plains were compared to provide a cursory consideration of whether climatic conditions in the various parts of the Plains were suited to the use of frozen meat caching. Data for the Northern Plains comes from the city of Havre in north-central Montana (USDC, NOAA 2002b). Central Plains data derives from the station in Greeley, Colorado, located near the Kersey cluster of sites, as well as from the 11 other stations in the study area close to the 40th parallel. Data chosen to characterize the Southern Plains comes from Lubbock, Texas near the Lubbock Lake site which has yielded paleoclimatological data from throughout the Paleoindian period. Modern temperature data from the weather stations is compared for the four coldest months of the year (November through February) in Table 5-3.

Data from Havre, Montana indicate that cold-weather meat storage is feasible in the northern portion of the Plains under modern climatic conditions. Average monthly temperatures are below freezing for all four months and range from 15° F to 29° F. Also, in the months of December and January, average daytime highs do not rise above freezing and daily highs for the other months do not greatly exceed the freezing mark, being 41° F for
### Table 5-3. Comparison of Climatic Conditions on Northern, Central, and Southern Plains for Theorizing Regional Variation in Potential Techniques for Storing Meat from Large-Scale Bison Kills. \(^a\)

<table>
<thead>
<tr>
<th>Portion of Plains</th>
<th>Weather Station Name</th>
<th>Latitude</th>
<th>Temperature During Coolest Months for Storing Meat in Cold Weather (°F)</th>
<th>Number of Months with Mean Daily Temperature Below Freezing</th>
<th>Number of Months with Mean Daytime Highs below Freezing</th>
<th>Mean January Snow Depth</th>
<th>Mean Daily Maximum Temperatures During Summer and Early Fall for Making Jerky</th>
</tr>
</thead>
<tbody>
<tr>
<td>Southern</td>
<td>Lubbock Regional Airport, TX</td>
<td>33° 40′ N</td>
<td>November Temperatures: Mean Daily Maximum 61.6, Mean Daily Minimum 48.1, December Temperatures: Mean Daily Maximum 34.5, Mean Daily Minimum 39.7, January Temperatures: Mean Daily Maximum 36.1, Mean Daily Minimum 28.4, February Temperatures: Mean Daily Maximum 37.8, Mean Daily Minimum 28.9</td>
<td>0</td>
<td>0</td>
<td>trace</td>
<td>91.9, 90.0, 83.4, 74.4</td>
</tr>
<tr>
<td>Central</td>
<td>Greeley, UNC, CO</td>
<td>40° 24′ N</td>
<td>November Temperatures: Mean Daily Maximum 49.7, Mean Daily Minimum 36.1, December Temperatures: Mean Daily Maximum 41.3, Mean Daily Minimum 29.3, January Temperatures: Mean Daily Maximum 29.0, Mean Daily Minimum 17.2, February Temperatures: Mean Daily Maximum 33.4, Mean Daily Minimum 20.9</td>
<td>2</td>
<td>0</td>
<td>2 in</td>
<td>-</td>
</tr>
<tr>
<td>Northern</td>
<td>Havre City County Airport, MT</td>
<td>48° 33′ N</td>
<td>November Temperatures: Mean Daily Maximum 40.8, Mean Daily Minimum 29.1, December Temperatures: Mean Daily Maximum 30.1, Mean Daily Minimum 19.0, January Temperatures: Mean Daily Maximum 25.5, Mean Daily Minimum 7.8, February Temperatures: Mean Daily Maximum 23.4, Mean Daily Minimum 10.4</td>
<td>4</td>
<td>2</td>
<td>4 in</td>
<td>-</td>
</tr>
</tbody>
</table>

\(^a\) Data from USCDC, NOAA (2002b) for the years 1971-2000.
November and 33° F for February. Below-freezing temperatures in December and January would impose some difficulties on further processing meat from carcass sections because they would be frozen solid.

Weather data from the portion of the Central Plains covered by the study area suggests that the climate is marginal as to whether some method of cold-weather meat storage is possible. Of the 12 weather stations, nine have three months when average temperature remains below freezing, two stations experience two months of average temperatures below freezing, and the station at Boulder records no months of average temperatures below freezing, likely because of the chinook winds prevalent there (Table 5-1). Furthermore, months with average temperatures below freezing also have daytime highs that rise to temperatures above the freezing mark which could promote spoilage. At the 11 stations with two or three months of average temperatures below freezing, mean January daily maximum temperatures range from 34° F to 40° F (Table 5-1). Thus, temperature in the study area varies from one portion that is non-conducive to frozen meat storage to other areas where freezing may have been marginally feasible for only two or three months of the year. The above would suggest that cold-weather storage of meat may not be advisable in the Central Plains portion of the study area under climatic conditions similar to that of today. Rather, a forager group living under a climate similar to that of today may have been more likely to go through the greater effort required to preserve meat acquired in a large-scale bison kill by drying it to make jerky when the weather was still warm enough to allow this to occur (e.g. in the summer and early fall).

Data from Lubbock, Texas indicates that storage of meat via freezing is not possible in this part of the Southern Plains under the current climatic regime. It is true that during the four coldest months, average nighttime lows are cold. Most of the average nighttime temperature readings drop below freezing, ranging from 24° F to 34° F (Table 5-3). However, average monthly temperatures at Lubbock remain above freezing in the 38 to 48° F
range, suggesting that making use of cold-weather to store meat would not be advisable. This reservation is affirmed when considering that the region is subjected to daytime maximum temperatures that vary from 52° F to 62° F. At these temperatures, spoilage of meat would occur quickly. Though time consuming, sun drying meat during the height of the cold season when temperatures reach into the 50s and lower 60s may be possible. However, a more viable option for foragers living under such climatic conditions may have been to produce jerky during the summer and early fall when daytime temperatures range from the low 90s to the mid 70s (Table 5-3).

The above discussion has considered theoretical effects of differing climates in the study area on forager land use patterns, but also of concern are the ecological relationships between climate and vegetation. For example, vegetation zones may effect prehistoric subsistence and land use patterns in a very basic way by making available differing quantities and diversities of edible plants. More directly relevant to the purposes of this dissertation, however, is the observation that seasonal changes in weather effect variation in the quality of forage in grassland and alpine tundra environments. This in turn determines the predictability with which game animals may be found under natural conditions by affecting the distribution and size of herds. So with these thoughts in mind, I now turn to a consideration of the nature of flora in the study area and its possible relationship to Paleoindian diet and land use.

VEGETATION

Climatic conditions cause plant species to associate into vegetation zones. Unlike large animals, plants obviously can’t move to avoid the weather, thus they must adapt more directly to temperature and precipitation and yet they do so by the same means as animals; that being evolution through countless generations of natural selection. In this way, plants provide a better reflection of climatic conditions than do large animals. Though each plant
species is adapted to its own particular range of temperature and precipitation, similar climatic regimes occur across vast expanses of the plains, making for widespread vegetation zones.

Plains Vegetation

The Plains portion of the study area is covered by three widespread vegetation zones. Decreasing rainfall east of the mountain front plays an important role in determining the distribution of these zones. Precipitation on the Plains averages 12 inches adjacent to the Rocky Mountains and rises to 40 in at the eastern margin of the Plains (Bamforth 1988:53). This rainfall pattern serves to distribute the three vegetation zones into broad bands that are aligned north-to-south and parallel the mountains. West of the mountains, where the rain shadow effect is most pronounced, lies terrain blanketed with the short-grass prairie vegetation type. As implied by the name, dominant grass species here are referred to collectively as short grasses and grow to a height of .5 to 1.0 feet (Bamforth 1988:30-31). In the study area, blue grama, hairy grama, and buffalograss are common species in the short-grass prairie. The vegetation type extends from the Front and Laramie ranges eastward to about midway across the Central Plains portion of the study area (compare Figure 5-1 herein with Figure 5-2 in Bamforth, 1988). The eastern portion of the study area is vegetated with mixed prairie. Dominant species in the mixed prairie are referred to as midgrasses. They grow to heights of two to four feet. Common midgrass species include little bluestem, western wheatgrass, sideoats grama, blue-bunch wheatgrass, and needle-and thread.

Beginning east of the study area and extending across eastern Kansas is the true prairie. Dominant species in this zone are referred to as tall grasses, growing to heights of five to eight feet. Common species include big bluestem and switchgrass.

As one travels up the North Platte and leaves the Great Plains proper to enter the lowlands of the Wyoming Basin, the short-grass prairie gives way to sagebrush grassland.
This vegetation zone is common to dry lowlands in northwest North America, especially the Wyoming Basin, Snake River Plain, northern Great Basin, and Columbia River Plateau (Butler 1976:Figure 1). As implied by the name, sagebrush is the dominant plant in this vegetation zone with various grasses, sedges, and forbs also common. From Casper, sagebrush grassland extends southward up the North Platte drainage, occurring over much of the Shirley Basin and on into Colorado. Considering that Middle Park is more central to the present study than the Wyoming Basin, the species composition of the sagebrush grassland as described for North and Middle parks is discussed in the following section.

**Intermontane Basin Vegetation**

Sagebrush grassland extends up the North Platte drainage to cover the floor of North Park and extends over Muddy Pass to blanket Middle Park as well. The species composition of the sagebrush grassland in North and Middle parks is discussed by Lischka et al. (1983) and McPherson (1988), respectively. Common grass species include some that characterize the mixed prairie, such as western wheatgrass, blue-bunch wheatgrass, and needle-and-thread. A wide assortment of other grasses or similar plants also occur, including Indian ricegrass, various species of wheatgrass, junegrass, saltgrass, muttongrass, mountain muhly, various sedges and fescues, and others. In Middle Park, narrowleaf cottonwood is present along streams and willow is occurs along watercourses in both parks. The upper bounds of the sagebrush grassland near the lower tree line is in large part influenced by amount of precipitation (Fall 1985:40-41), with forested terrain occurring at the higher elevations above the lower tree line where more snow and rain falls. As will be seen in the following chapter, this modern ecological relationship is used as the basis for palynological studies seeking to document changes in lower tree line as a proxy for understanding the relative change in amount of precipitation throughout the Paleoindian time period. The tree species present at
lower tree line varies according to whether the forest is old-growth or successional, with Douglas fir characteristic of the former and lodgepole pine or aspen indicative of the later.

In contrast to North and Middle Park, vegetation covering the floor South Park is dominated by short grasses. The short-grass vegetation is also present in the Upper Arkansas Valley and in the open areas that occur intermittently downstream along the Arkansas River to the Central Plains.

**Front Range Vegetation**

The altitudinal changes in temperature and precipitation along an east-west transect on the east slope of the Front Range in large part explains the various vegetation zones defined by Marr (1964) for this area. The lower montane zone from 6,000 to 8,000 ft is typified by juniper and ponderosa. Extending from 8,000 to 9,000 ft, the upper montane zone is characterized by Douglas fir in old-growth areas. In areas that have recently burned, successional forests of lodgepole pine or aspen occur in the upper part of the upper montane zone as well as in the lower portion of the subalpine forest between 8,500 and 9,500 ft. The subalpine forest is composed principally of dense stands of Englemann spruce and subalpine fir in and altitudinal range extending from around 9,000 ft to upper tree line at 11,000 feet. Tree line is defined as the upper limit of dense forest. Studies suggest that the upper tree line marks the level below which average summer temperatures of 50° F promote tree growth (Fall 1985:42). This ecological relationship between temperature and upper tree line is used as the basis for various kinds of paleoenvironmental studies that aim to document the relative position of ancient tree lines in relation to the modern one to serve as a proxy measure of temperature changes throughout the Paleoindian period. Higher temperatures would serve to raise the tree line, whereas lower temperatures would cause it to drop. Above tree line, is an ecotone between the subalpine forest and the alpine tundra where some trees manage to survive, but are dwarfed and deformed by relatively low summer temperature and high winds.
The elevation to which this so-called krummholz vegetation extends is defined as tree limit. Depending upon topography and other factors, tree limit in the Front Range occurs at a maximum elevation of around 11,500 ft. Open alpine tundra is composed of various low-lying plants including species such as sedges and bunch grasses that serve as graze for big game animals.

EDIBLE PLANTS

Distribution of edible plants would have influenced movement of Paleoindians in the study area to some extent during that time of year when they were not intent on large-scale bison hunting. Making real inroads into the need to better define the role of plant foods in Paleoindian subsistence economy and land use in the study area is beyond the scope of this dissertation and probably beyond existing information, given the biased nature of the kinds of sites excavated to date. However, rather than dealing with this issue by ignoring it; the time has come to at least acknowledge it as a much needed area of research. Toward this end, I will make observations relating to the relative difficulty of doing so much as merely enumerating the main plant foods utilized. Secondly, I will provide a brief survey of ethnographic and archaeological information relating to plant food utilization by native people in and around the study area to give some conception of the kinds of plants that could very well have served as sources of food for Paleoindians and as such would have had some influence on their land use strategies.

Edible Plants of the Plains

Wedel (1986:16-21) reviews edible plants of that portion of the study area within the Republican drainage. His review suggests that tubers were an important kind of plant food on the Plains. A characteristic of grasses on the Plains is that the above-ground portions of
the plant die-off during the cold-season and the roots sprout new growth the following spring. Many forbs of the Plains have a similar adaptation in so far that they concentrate water and food resources in tubers during part of the year to survive until the following growing season. Of the 10 edible plant species Wedel lists in the Republican drainage, five are various kinds of tubers. Included are the prairie turnip, Jerusalem artichoke, Indian potato, arrowhead, and cattail.

The prairie turnip in particular is documented as a staple food of foraging people of the Central and Northern plains (Wedel 1978) and is here discussed at some length because it will later serve as a good illustration of the relative archaeological visibility of tuber harvesting and processing. The plant is best harvested when its blue-to-purple flowers allow the location of tuber patches to be identified. After flowering, the above-ground portions of the plants eventually dehydrate and form tumbleweeds to disperse their seeds. Once this has happened, the locations of tubers are virtually impossible to determine. The plant is known to have grown throughout the Plains, but is best documented from the Northern and Central plains. Native people harvested the plant in May and June on the Central Plains and during July and August on the Northern Plains (Wedel 1978:162). The likelihood that the plant was consumed by prehistoric foragers in the portion of the Plains of concern here is suggested by writings of the American explorer John Charles Fremont, who noted that in June of 1843, his group came upon five or six women of the Kansas tribe digging prairie turnips on the lower Kansas River east of the study area (Jackson and Spence 1970:1:40). The plants grow in patches that allow it be harvested in bulk. In July of 1858, the Canadian explorer Henry Youle Hind encountered a group of Plains Cree women and children on the plains of Saskatchewan gathering and processing prairie turnips for storage by cutting them into shreds and drying them in the sun. He noted that, “[m]any bushels had been harvested…” (Hind 1859:48). Most reports indicate that the prairie turnip was harvested with a wooden digging stick about three feet long (Wedel 1978:162-165). Tubers were eaten fresh by preparing in
various ways and, as noted above, also stored for later consumption. According to Hind (1859:48), “[l]arge quantities are stored in buffalo skin bags for winter use.” Wedel (1978:168) reports that dried tubers were ground into flour which was then made into a meal by mixing with water and adding other ingredients or was used to thicken soups or puddings. Finally, Wedel (1978:169,171) notes that the prairie turnip supplied mainly carbohydrates and thus, “…the tuber must have complemented the high animal protein diet of the Plains Indian bison hunters.”

Other kinds of plants of the Republican drainage were used by native people for the seeds and fruits they produced. Wedel (1986) notes that no published reports of the consumption of seeds from grasses and forbs exist for this area, but he suggests that exploitation of seeds by prehistoric foragers was likely. Sunflower, which exists throughout the Great Plains portion of the study area produces edible seeds that become available in August or September. The flesh pads and fruits of the native prickly pear cactus are edible and are known to have been eaten by foragers of the Great Basin (Steward 1938:26).

Evidence for use of weed seeds by Paleoindians of the plains of the Wyoming Basin comes from outside the study area at the Deep Hearth site, located 32 km north of Evanston, Wyoming (Rood 1993). The site is affiliation with the Late Paleoindian period, based on the presence of a Deception Creek point and radiocarbon dates from fire features at the site of 8220 ± 130 BP, 8460 ± 100 BP, and 8610 ± 90 BP, which overlap at two standard deviations and indicate a single occupation is represented. The features are steep-sided, basin-shaped hearths with charcoal-stained fill, but no rock. These characteristics suggest the features functioned as roasting pits. Seeds identifiable to the genus Chenopodium (goosefoot) were recovered during floatation of fill from the features, suggesting that processing of this plant occurred on-site. Presumably, seeds were roasted in the pits and some spilled and were not recovered by the site occupants. Species of goosefoot are annual weeds with flowering parts that produce many small seeds. That roasted seeds may have been ground into flour is
suggested by a mano and grinding slab recovered from the site. A pollen wash of the grinding slab is noted to have produced evidence for goosefoot processing, presumably in the form of a high pollen concentration. A common, though implicit, assumption in the interpretation of pollen washes from ground stone artifacts is that a high pollen concentration of a seed-producing plant may be evidence for grinding of seeds from the plant. Pollen ultimately comes from the reproductive part of a flowering plant, specifically the stamen. An implicit assumption of many palynological analyses seems to be that seeds produced by the reproductive parts of plants may come in contact with remaining pollen, even after the flowers have withered away and processing of seeds with a mano or grinding slab may thus leave a relatively high concentration of pollen on grinding surfaces. Despite this methodological uncertainty in the interpretation of ground stone washes, what is of relevance here is that evidence for the processing of goosefoot, be it in the form of charred or uncharred seeds from fire features or high pollen concentrations from ground stone artifacts, is abundant for Archaic and Late Prehistoric sites in the Wyoming Basin (e.g. Creasman and Thompson 1997, Harrell et al. 1997). Thus, goosefoot processing by Paleoindians is a trait shared with the subsistence practices of later foragers of the Wyoming Basin.

Comparing the evidence of seed processing from sites in the Wyoming Basin with a consideration of prehistoric use of tubers on the Great Plains illustrates the difficulties of researching prehistoric plant use posed by the likelihood that procurement and processing of different kinds of plants will be differentially preserved in the archaeological record. Drying goosefoot seeds so they could be ground into flour apparently required that they be roasted in a pit, thus leaving an archaeological feature. The plentiful ethnographic accounts of prairie turnip processing on the Great Plains, however, suggest that tubers were sun dried, an activity that would leave no trace in the archaeological record. Goosefoot seeds are encased in durable shells, and those lost while roasting are preserved in the archaeological record. Unlike seeds or fruits, tubers do not contain hard parts and therefore are unlikely to preserve
in the open sites of the Plains. Being reproductive parts of the plant, goosefoot seeds pulverized on a grinding slab may have left elevated levels of pollen on the tool, though as mentioned, the conclusion that pollen from a ground stone artifact may be indicative of use of the tool for the grinding of seeds is not entirely secure. In contrast, tubers are subterranean parts of plants and as such would not have been likely to have any adhering pollen. Thus, though they likely were ground with ground stone artifacts to produce flour, no evidence of this activity may remain on the grinding tools. The point to be stressed here is that when future researchers consider plant food use by Paleoindians of the study area, it is advisable that they think about the ethnographic and archaeological evidence relating to how each edible species in a region was procured and processed to weigh the likelihood that use of a particular species will be evident in the archaeological record.

Judging from the amount of documentation for the use of tubers by ethnographic people of the Plains, it is reasonable to hypothesize that this food resource was also exploited prehistorically and in particular during Paleoindian times. However, I am unaware of any direct supporting evidence. Rather than conclude that tubers were likely used, but there is essential no remaining evidence, archaeologists would do well to be cognizant of the possible ways that tuber use might be supported indirectly given what is known about their procurement and processing once non-bonebed sites are investigated in earnest. Although ethnographic examples of Plains diggings sticks used to harvest prairie turnips are wholly or predominantly made of wood, it is possible that bone or antler could have been used to produce a more durable implement that would be more likely preserved. That Paleoindians evidently used fragments of thick limb bones to dig for ochre at the Powars II site (Stafford 1990:57), located within the study area in southeastern Wyoming, at least gives some encouragement that similar bone artifacts that arguably were used to harvest tubers will eventually be identified. In this regard it is also worth noting that the Cheyenne are known to
have sometimes put elk antler tips on the working ends of root-diggers (Wedel 1978:164-165).

**Edible Plants of Middle Park**

Though a detailed consideration of edible plants in Middle Park has not been accomplished, a review of plant foods available in the sagebrush grassland of adjacent North Park by Lischka et al. (1983) provides basic information with which to begin thinking about the ways that floral resources may have played into the subsistence economy and land use of Paleoindians occupying the intermontane basins. To investigate the affect of plant distributions on the spatial patterning of archaeological sites, Lischka et al (1983) consulted Soil Conservation Service (SCS, now U.S. Department of Agriculture, Natural Resources Conservation Service) “range site” records to quantify variation in density of edible plant species. In order to assist with management of livestock grazing, the SCS mapped vegetation in North Park into 24 named “range sites” based on the kind of soil present, a major factor determining the composition of plant species found in an area. Thus, the various range sites support vegetation composed of differing species composition. To characterize forage available in various range sites, the SCS conducted surveys to inventory the particular species present. Also, for each species, the weight of above-ground vegetation was determined per hectare in order to quantify its relative abundance. Lischka et al. (1983) identified those species known to have been consumed prehistorically by native people of North America by consulting Yanovsky (1936) and Harrington (1967). With a measurement of the relative density of the edible plants found in each of 14 range sites, the correlation between the density of plant food resources and archaeological sites was investigated. For the purposes of this study, it will be sufficient to note that the North Park study documents that a wide variety of plants producing seeds and fruits are available in the sagebrush grassland of North and Middle Parks. If the Woodland Understory range site is removed from consideration, the
remaining 13 range sites are those located in the open country here subsumed under the rubric of sagebrush grassland. These 13 range sites contain a total of 59 species that provide edible greens, seeds, or fruits (Lischka et al. 1983:Appendix A).

The list of species will not be duplicated here, but a few in particular are discussed due to their abundance or because they are known from ethnographies to have been especially important plant foods. In each range site within the sagebrush grassland, by far the most common edible species are various grasses or sedges, especially various kinds of wheatgrass and fescues. Steward (1938:21-30) reviews aboriginal use of plant foods in the intermountain west and notes that seeds of wheatgrass and fescues were consumed. Two edible plants of the intermontane grasslands of Colorado are noteworthy because of their importance to people native in physiographic regions surrounding the Southern Rocky Mountains. The first is Indian rice grass, which Steward notes was gathered for storage in considerable quantities in the southern Great Basin during a period lasting a few weeks in late spring or early summer. The second is the serviceberry bush. Steward notes that in the intermountain west, berries were mashed and dried for storage.

Though the compendium of edible plants compiled by Lischka et al. (1983) is useful, it suffers from a lack of consideration of available tubers because information on vegetation from SCS range sites focuses solely on the above-ground parts of plants that can be grazed by livestock. That tubers were available in Middle Park and used by foraging peoples is seen in Fremont’s account of a group of Arapaho his expedition encountered in mid-June of 1844 near the present town of Kremmling. Fremont notes that, “[t]hey were men and women going into the hills – the men for game, the women for roots – and informed us the village was encamped a few miles above, on the main fork of the Grand [Colorado] River…” (Jackson and Spence 1970:1:713). Exactly which plant was being sought by the Arapaho is problematic, but it may be worth noting that immediately northwest of Middle Park lay the headwaters of the Yampa River, which is the namesake of the yampa plant. The Ute gathered
the plant and historic reports refer to a Yampa “band” in northwest Colorado and northeast Utah (Steward 1938:225, 228). However, details concerning use of the plant are not well known. This perennial forb grows from June to August in meadow and sagebrush grasslands of the Yampa River drainage and elsewhere between 7,500 and 7,700 ft elevation (Goodrich and Neese 1986:29).

**Edible Plants of the High Front Range**

Because there are no ethnographic records documenting use of plants of the high Front Range by native peoples in historic times, the archaeological record must serve as the sole source of information for theorizing the possible kinds of plants utilized by prehistoric groups. Excavation of Archaic and Late Prehistoric fire features at sites in the ecotone between alpine tundra and subalpine forest, as well as at lower elevations on the east slope, provide the baseline information on prehistoric plant use in this area (Benedict 1993, 2000a).

The Fourth of July Mine site is a large prehistoric camp located in the alpine-subalpine ecotone, about 2 km east of Arapaho Pass. The site was investigated during an effort to salvage fire features eroding along a hiking trail. Two of these are rock-filled fire features that appear to have functioned as roasting pits. Edible plants in the site vicinity include various berries and especially tubers; in particular the avalanche lily is common. Flotation of the feature fill did not yield evidence of tuber processing but, as noted previously, this activity is much less likely to preserve evidence of its occurrence in comparison to use of plants producing seeds or berries with shells, pits, or other hard parts. One of the roasting pits did produce evidence for the processing of berries in the form of charred strawberry and juniper seeds. Two other features produced charred macrofloral remains. A goosefoot seed was recovered from what was determined through excavation to be an area of charcoal redeposited in a depression from a nearby fire feature. A shallow basin hearth produced a goosefoot seed, bluegrass seeds, and a seed assigned to the genus
Polygonum. The goosefoot seeds are noteworthy because this species is not native to high elevations, so likely were gathered by humans at lower elevations and brought to the site as a foodstuff. The *Polygonum* seed is noteworthy because this genus contains two species of bistort that produce edible tubers that grow in the vicinity (Benedict 1993:161, 174; Goodrich and Neese 1986: 234-236). The features producing evidence for plant food use were radiocarbon dated to the Archaic and Late Prehistoric.

The above discussion of plant food use during post-Paleoindian times may seem to some to be irrelevant to the question of edible plant use during the period of concern. However, it is only through archaeological work of this kind that information is made available for theorizing which edible plants were present in the environment of the Paleoindian, how they were used, and how this use may have affected land use. No direct evidence from the site to date bears directly on the matter of whether Paleoindians did or did not use the same set of plant foods exploited by later people because fire features exposed in the trail date to later time periods. However, Cody points and what appears to be a Clovis point were recovered from the site and it is estimated that a few hundred fire features may be preserved on the site (Benedict 1993:181, Figure 5.4b). Thus, further investigation of the site may yield data on the research topic should Paleoindian fire features be present.

Bode’s Draw is another site notable for its evidence of edible plant use in the Front Range. The site is not in the high Front Range, rather is located in Estes Park, an open basin in the montane forest on the east slope. More specifically, the site is present in a clearing at 8,038 ft elevation along Bode Draw and is situated near a spring that once supported a wet meadow. Edible tubers of American bistort, known to have been used by the Cheyenne (Grinnell 1923:II, cited in Benedict 1993:36), still grow in parts of the draw that remain sufficiently wet. Two unusually large fire features eroding from a road cut were excavated at the site. They are reminiscent of ethnographically recorded pits used to roast tubers, such as those used by the Nez Perce to roast camas roots (Benedict 1993:36-37). The largest is
Feature 1, a Late Prehistoric rock-filled circular basin-shaped pit, measuring 1.4 m in diameter. Almost as large is a Late Archaic slab-lined circular pit measuring 1.2 m in diameter. As might be expected, flotation of fill from the features again revealed no evidence of tuber processing, but charred legume and kinnikinnick seeds demonstrate that some processing of plants with hard parts occurred at the roasting pits. Fairly intense use of the site for processing of edible plants over the course of many years is also supported by the high frequency of ground stone artifacts. From the 23 m² excavated at the site, fragments of an estimated 19 grinding slabs were recovered, resulting in an artifact density of about .8 grinding slabs per m². Three grinding slabs and one mano were washed for pollen and phytoliths. Again, no indication of tuber use was recovered, but possible evidence for the use of other plants was found. Grass phytoliths occur in sufficient quantities to suggest use of grinding tools for grass seed processing. Recovered pollen principally reflects the natural pollen rain with large amounts of pine and sage. The best possible evidence for plant food use is a small aggregation of pollen grains assigned to the cheno-am pollen group, which includes goosefoot. Other pollen types are mostly represented by single grains from single tools and thus constitute tenuous evidence for prehistoric use of those plants. Some of these pollen grains are only assignable to plant families that include one or more edible plants, others are assignable to particular genera. Included in the later category are cattail and skunkbush sumac. Both normally occur at lower elevation (Goodrich and Neese 1986:21, 286). Seeds of cattail and berries of skunkbush sumac where consumed by the Shoshone in the Great Basin (Steward 1938:29-30).

In light of the above discussion, archaeological evidence from the high Front Range and lower elevations on the east slope suggests that edible plants native to the mountains and surrounding regions would have played a role in the land use patterns of foragers who seasonally occupied the mountains. Though there is little direct evidence of plant food remains from Paleoindian sites in the study area, there is also no reason to believe that plants
did not play a role in the subsistence and land use of Paleoindians. Transport of edible parts of plants from lower elevations as a food resource is indicated at the Fourth of July Mine site by the presence of goosefoot seeds. Other plants native to the high Front Range may have also been harvested and roasted on-site, specifically tubers of bistort and avalanche lily. Some pollen from ground stone artifacts recovered from Bode’s Draw site in Estes Park are from species that grow at lower elevations and imply transport of plant processing tools to higher elevations in anticipation of using them at sites where a differing set of plant foods were exploited. Features interpretable as roasting pits, but especially the large examples know from lower elevations, suggest that tubers may have been an important plant food resource. Charred seeds and pollen aggregates indicate that plants producing edible seeds and berries were also eaten, including grasses, strawberries, and kinnikinnick.

FAUNAL RESOURCES

Recent review of data on Paleoindian use of faunal food resources in the Great Plains and adjacent Rocky Mountains does not support the traditional view of a subsistence economy focused on big game in all places and at all times within the Paleoindian period. Rather, data from literature and state site files demonstrate that Paleoindians in this area also made use of a much broader range of species as sources of food (Kornfeld and Larson 2008). A variety of animals may have also served as a source of bone and hide for the manufacture of bone tools, beads, etcetera, as well as other items of material culture, such as clothing, and hide covers for portable shelters. That the nature of the animal food resources available played a role in shaping Paleoindian subsistence strategies is demonstrated by the observation that the diversity of species represented in Paleoindian faunal assemblages corresponds to that present in the modern environments from which the assemblages derive. Hill (2007, 2008) has shown that sites in open grassland areas tend to produce faunal assemblages.
representing a more limited diversity of species comprised principally of big game, such as bison. In contrast, sites located along watercourses of the Plains and in montane settings commonly contain a greater diversity of species which reflects the greater variety of animals found in these kinds of environments.

Based on the knowledge that the various environments inhabited by Paleoindians would encourage the development of subsistence economies that differed in terms of the kinds of species sought and the methods and strategies involved in procurement, a brief review of the animal species commonly found in the three environments of the study area will be provided. The intent here is simply to provide the reader with an appreciation of the differing faunas of the study area and not to begin the daunting, though much needed task of providing a more sophisticated model of Paleoindian subsistence economy for the study area. Because this study does not deal with Clovis sites, fauna of the earliest Paleoindian period will not be discussed.

Given that many of the sites to be considered herein are those with bonebeds and game drive structures, the discussion will then focus on considering the topographic, climatic, and forage-related factors that arguably would have influenced the distribution and predictability of herds of big game animals in the study area. Once this is accomplished, the availability of tools tones in the three environments will be brought into the discussion. Having developed an understanding of the environmental factors affecting the availability of big game and tool stone resources, predictions will then be made regarding how the distributions of game and tool stones in the three areas would have served to shape land use patterns differently. Expectations regarding how tool stone compositions of artifact assemblages from bonebed sites should vary between the environments if indeed the theoretical differences in land use are valid can then be evaluated in a later chapter with data from existing literature.
Plains Fauna

Small animals present in the Plains portion of the study are that would have been available as potential sources of food to Paleoindians include mammals, birds, fishes and shellfish. Mammalian species would have included jack rabbits, cottontail rabbits, prairie dogs, various species of ground squirrels and other burrowing rodents, and beavers. Habitat preferences of these animals vary, but as a general statement, jack rabbits, prairie dogs, and ground squirrels commonly are found in more open country. Cottontail rabbits tend to be found in places with more cover, such as riparian and brushy areas along drainages. Beavers are found along the permanent watercourses. Available birds can be grouped into waterfowl, songbirds, and upland game birds. The prevalence of waterfowl and songbirds would vary with the season as many species migrate out the area, travelling northward in the warm-season and southward in the fall and winter. The Central Flyway is within the Plains portion of the study area. Common waterfowl that migrate along the flyway include Canadian geese, snow geese, and various kinds of ducks, especially mallards. The variety of songbirds is diverse and will not be enumerated here. Upland game birds would be available year round. On the Great Plains, the greater prairie chicken would have been found in upland settings. Wedel (1986:193) notes that an American explorer in 1849 reported turkeys and an unnamed species of grouse were common along wooded streams in the eastern portion of the study area. In the Wyoming Basin, the sage grouse would have been common. Along watercourses, a variety of warm-water fishes would be present and in the eastern portion of the study area, freshwater mussels would also be available.

Post-Clovis big game fauna of the Plains in general can be regarded as essentially modern (Walker 1982) and this generalization can be extended to the Plains portion of the study area. Bison during Paleoindian times were larger-bodied that the modern form with progressive decrease in size throughout the period. Good data relating to how common each big game species was in the Plains fauna of the time is not available. However, based on
historic accounts of large numbers of bison on the Plains and paleoenvironmental data indicating that vegetation in the Plains portion of the study area has remained essentially the same since Folsom times (Brunswig 1992), it is safe to suggest that bison were probably a common species relative to other grassland big game species. The antelope is a species adapted to the Plains and also was a common sight on open upland terrain in the Great Plains and Wyoming Basin portions of the study area in historic times (Armstrong 1972:307). Herds of elk are reported from parts of the Plains historically and were present within the study area. Wedel (1986:194) cites reports of large herds of elk along the Republican River. Mule deer today inhabit the Plains and were likely present within the study area historically. They can be found in open country, but also tend to seek cover in wooded drainages more so than antelope or bison. Some white-tailed deer are present within the study area today. Occurrence of the species on the Plains portion of the study area prior to Euroamerican settlement is suggested by historic accounts (Armstrong 1972:305). As with mule deer, they are more adapted to a forested environment and would tend to be found along wooded drainages. Modern populations occur in the Plains portion of the study area, but in Colorado, are much less common than the mule deer. Prime habitat of the species is in the Eastern Woodlands where it is the only species of deer present. A review of data on the taxonomic representation of game animals in Paleoindian faunal assemblages from the Great Plains and Rocky Mountains demonstrates that deer in general were an important component of the diet (Kornfeld and Larson 2008).

Moose do not inhabit the Plains portion of the study area today, but are deserving of some consideration because two halves of a moose mandible are reported from the Cody-age Jurgens site on the South Platte River near Greeley (Wheat 1979:31). The species is known to have definitely inhabited the more northerly latitudes of the Rocky Mountains in historic times, but there is currently debate among biologists if native populations of moose occurred in the Colorado Rocky Mountains historically. In 1978 and 1979, moose were introduced to
North Park from out-of-state populations. Abundant willow thickets along streams in this intermontane basin provide a necessary winter food source. From North Park, moose populations expanded into the Middle Park drainage. Today, moose are expanding their numbers and range. Sightings of moose are now reported from the east slope of the Front Range. The above information would tend to support those who maintain that the Rocky Mountains of north central Colorado are within the southern portion of what would be the natural range of moose were it unaffected by predation by Native and Euroamerican people in historic times. Willow occurs along the South Platte river today and likely was present in Paleoindian times, suggesting that moose conceivably may have inhabited riparian areas on the Plains in prehistoric times. Also of relevance in this matter is Wheat’s (1979:21-22) suggestion that the common occurrence of bison mandibles at the Jurgens bonebed represents a butchering strategy whereby mandibles with attached tongues were transported from the site of the actual kill to a camp. Wheat (1972:100-101) further notes that the tongue of the bison is cited in historic sources as being considered by Plains Indians as one of the more desirable cuts of meat. In light of the above, an alternative explanation of the moose jaw at Jurgens is that a moose was killed in the Front Range and its tongue was transported back to the Jurgens site. The foothills are roughly 50 km from the site, so a journey of more than one day would likely have been required. Nevertheless, the idea is not out of the realm of possibility and if true, would conform to the assertion that post-Clovis faunas in the study area are essentially modern. If so, then knowing the kinds of big game species present in the environments of the study area should provide a good start toward better understanding the food resources available to Paleoindians in post-Clovis times.

Middle Park Fauna

A differing set of small animals than that available on the Plains exists in Middle Park and includes various mammals and birds. Several of the species listed for the Plains
would be duplicated and their habitat preferences are the same. Included in this category would be jack rabbits, cottontail rabbits, various species of ground squirrel and other burrowing rodents, and beavers. Marmots can be found in rocky areas near lower tree line. Some waterfowl, including mallard ducks nest along sloughs of the Colorado River and its tributaries. Sage grouse are present in the uplands. Native species of fish in the Colorado River drainage include cutthroat trout, but no evidence exists that this species was exploited in Middle Park as a food resource.

With the possible addition of one species not reported historically, the modern and historic big game fauna of Middle Park likely provide a fair representation of the set of species available to post-Clovis Paleoindians in Middle Park. Early historic accounts of American explorers from the 1840s document the presence of bison in North, Middle, and South parks during both warm and cold-seasons (Jackson and Spence 1970:1:712-717; Sage 1887:285-289). Furthermore, bison trails leading over Muddy and Hoosier passes document that bison traveled between the mountain passes. Historic evidence also records the presence of elk, mule deer, and antelope in the parks. The explorer Rufus B. Sage traveled through the parks from late November to mid-December and mentions the big game species that were wintering in the parks. Elk and deer were specifically mentioned in North Park and were also seen in South Park, along with antelope. That antelope were also present historically in North Park is demonstrated by a report that Utes hunting there had killed a large number of antelope in the summer of 1868 (Bowles 1869, cited in Benedict 1993). Sage mentions seeing big game animals wintering in Middle Park, but does not name species. It is likely that deer, elk, and antelope wintered in Middle Park as well. In 1985, I corresponded with an elderly native of Middle Park by the name of Horace Button, who wrote back, claiming that as a boy, his father saw large herds of antelope in Middle Park during the late 1800s. The likelihood that antelope were part of the historic Middle Park fauna is also supported by geographic place names in western Middle Park, including Antelope Creek and Antelope Pass. Apparently,
antelope were hunted to extinction in the park by Euroamericans sometime around the turn of the century. The species has since reestablished itself without human intervention, probably by traveling over Muddy Pass in the 1980s. Bighorn sheep today inhabit the Never Summer Mountains in the higher elevations of the northeastern portion of the Middle Park drainage, but winter on the east slope of the Front Range. Occurrence of resident bighorn sheep within Middle Park in the area of Byers Canyon is documented in historic literature noting their presence in June or July, as well as around November of 1874 (Pritchett 1976:15, 27, 25).

Finally, as mentioned in the discussion of Plains fauna, moose are not noted by the historic literature to have inhabited Middle Park. However, their introduction to North Park in the 1970s and subsequent expansion into Middle Park suggests that the parks offer adequate moose habitat and thus may have supported native populations during prehistoric times.

Moose are more solitary than deer, elk, or antelope and are less weary of humans. These behavioral traits may have made moose more susceptible to human predation, particularly during later prehistoric and historic times when human populations had increased. Based on this reasoning, moose may have also been available to Paleoindian foragers in Middle Park.

**Fauna of the High Front Range**

Small animals of the alpine tundra that may have served as a source of food appear to be less diverse than those available in the grasslands of the plains and intermontane basins. Included are marmots and smaller burrowing rodents. Available birds would have included various songbirds as well as ptarmigan.

With the addition of bison, the variety of modern big game species that today use the alpine tundra of the study area from late spring to mid-autumn again provide a good idea of the kinds of animals available to Paleoindians in the post-Clovis period. Currently, the main herbivores that forage above tree line in the study area are elk and mule deer. Finds of bison bones provide evidence that the species foraged above tree line in the alpine tundra of the
Front Range and elsewhere in the Rocky Mountains during historic times (Fryxell 1928). Bighorn sheep would likely have been found over more of the high Front Range than at present. A remnant population of bighorns summers in the high Front Range and Never Summer Mountains in and adjacent to Rocky Mountain National Park and winters in the montane forest on the east slope in the Cache la Poudre drainage. Beginning in the late 1800s, unregulated hunting and introduction of lung worm disease from domesticated sheep decreased bighorn numbers and range (Armstrong 1972:310-311). Formerly, the winter range of the species may have extended to the lower elevations in the Front Range, including the foothills of the east slope (Armstrong 1972:310). The original range of bighorn sheep likely extended all along the high Front Range east of Middle Park.

Which of the available big game species were procured in the game drive systems remains somewhat enigmatic. Benedict (1992:6-7, 2000b:26-27) reasons that elk and bighorn are commonly found in herds above tree line and are most likely to have been the species targeted. He further suggests that bison are a large animal whose movements would be difficult to control using the Front Range drive structures and that mule deer were less likely to have been the main prey species in game driving operations because of the relatively smaller groups they form. However, it should be kept in mind that mule deer were hunted in the Sierra Nevada of California by the Owens Valley Paiute using communal drives, so there is little basis to suppose that mule deer were never killed at game drives in the Front Range. Considering characteristics of the game drive systems may be helpful when thinking about which species were hunted. The drive lines themselves are composed of alignments of rock cairns or at most are low walls of dry-laid rock (Benedict 1992, 1996, 2000b). They may have served as a psychological barrier intended to influence the movement of game animals rather than a physical impediment. Positioning of the drive lines is such that they would have taken advantage of the terrain to help direct the movement of animals. Circular or semi-circular blinds are positioned at various locations along the game drive system. Sometimes
main drive lines converge to a place where blinds are concentrated. Given this setup, it seems the game drive systems in general were intended to direct the movement of a group of animals past hunters stationed in a series of blinds. Each hunter may have had an opportunity to kill one or more animals with an atlatl dart or arrow. There seems to be no reason to suggest the drive systems were intended to constrain the movement of animals in a trap. If the game drives were intended to direct animals past hunters and not physically trap them, then ruling out bison as a possible prey species because of their large body size would not seem justified. When considering the above, along with the observation that the game drive systems were sometimes used repeatedly over the course of several millennia, it would seem reasonable to suppose that sites of this kind as a whole may have been used to procure different kinds of game animals at one time or another.

Limited archaeological evidence is available concerning which species were hunted at the game drives. Preservation of bone at the sites is poor because little soil development in the alpine tundra leaves bones exposed to weathering on the ground surface (Benedict 1992:6). Three excavated game drives dating to post-Paleoindian times have produced some bone, however. Bones identified as bighorn sheep are reported from a game drive site south of the Indian Peaks in the vicinity of Rollins Pass (Benedict 1992:6). Also remains of an antlered species (deer or elk) were found at the Murray Springs game drive. Excavation of a hunting blind at the Sawtooth game drive recovered the remains of two mule deer (Cassells 2000b:211). As was suggested earlier, the Late Paleoindian component at Caribou Lake may be associated with game driving activity in the area of Arapaho Pass. One point excavated at the site produced blood antigen attributed to elk (Pitblado 2000:144). In light of the above, it can be stated that the limited evidence available to date does support Benedict’s suggestion that elk and bighorn sheep were prey species at game drives in the Front Range, but that mule deer were taken as well. However, it should be kept in mind that bison might possibly have been procured upon occasion, considering their historic presence in the alpine tundra.
DISTRIBUTIONS OF BIG GAME SPECIES

To theorize land use patterns, it is necessary to develop expectations about how aspects of the environment would have affected the way that humans made use of the land by identifying the manner in which resources were exploited at certain times of the year. When dealing with bonebed sites, a first step would be to consider how the distribution of the hunted species would have varied throughout the year as well as from one kind of environment to another as a first step toward understanding the role of large-scale kills in the broader context of forager land use patterns. In the grasslands of the Plains and intermontane basins of the study area, the bonebeds represent bison kills known to have occurred at certain times of the year. Theorizing the distribution and predictability of bison throughout the year in grasslands of the plains and parks is needed to understand their affect on patterns of land use. In the high Front Range, theorizing the effect of prey species distribution and predictability on forager land use is more tentative because of the uncertainty with regard to which game animals were being procured. Furthermore, the general lack of faunal remains also means that the time of year that the high Front Range was used for large-scale hunting cannot be determined with precision because few teeth are available for age determination. Nevertheless, we have been able to theorize which species were sought based on knowledge of modern and historic fauna and limited archaeological evidence. Also, knowledge of seasonal variation in the modern high Front Range climate as well as the manner in which big game animal distribution responds to these changes permits the general time of year during which humans hunted on the alpine tundra to be determined. Once the distribution and predictability of relevant game animal species is theorized in the study area, this understanding can be considered in conjunction with the differential tool stone availability in the three environments to develop a fuller understanding of how the distribution of both food resources and tool stone resources affected forager land use options.
Theorizing annual changes in game animal distributions in the various environments of the study is possible with careful use of a variety of sources of information. One such source is the field of evolutionary ecology which, in the case of animal species, seeks to explain the food-getting and reproductive behavior of organisms as adaptations to the environments in which they live. Within the broader field of evolutionary ecology, that realm of foraging theory concerned with examining how changes in forage quality affect herd size and distribution is particularly relevant here. In the case of Middle Park, a second source of information for theorizing annual changes in bison distribution comes from the study of modern buffalo populations living in the analogous environment of Yellowstone National Park (Meagher 1973). A final source of information comes from recorded finds of bison bones found at high elevations in the Rocky Mountains. These records are relevant to theorizing bison distribution in the high Front Range and other areas above tree line that rim the drainage basins of the mountain parks because they indicate that bison to some extent ranged up into the alpine tundra.

**Bison Distribution on the Plains**

Historic records from the Plains portion of the study area that mention bison in passing do not allow the annual distribution of the species to be reconstructed in detail, therefore foraging theory will provide the theoretical basis for accomplishing this, following the reasoning presented in Bamforth (1988). Based on studies of African large mammals, ecologists note that a main factor affecting herd size is forage quality, with green growth being more nutritious and able to support larger herds. The season of growth for grass species varies such that some are cool-season grasses, growing in the spring and having the potential for a second peak of growth in the fall. Other grasses are warm-season species which complete a single cycle of growth in summer. Warmer regions have more warm-season grasses and vice versa. Located within the Central Plains, a mix of both warm-season
and cool-season grasses in the Plains portion of the study area may be expected to have allowed bison to form large herds at various times in the spring, summer, and fall. Forage quality in winter would be poor and consequently bison would be dispersed into small herds at this time of year. Limited support for the theoretical expectation of large herds in the spring, summer, and fall comes from the journals of U.S. army personnel exploring the Republican drainage and noting the presence of large herds of bison there from spring to fall (Wedel 1986:190-195). On June 25, Lt. John Charles Fremont noted bison were present “in great numbers, absolutely covering the face of the country.” In August of 1849, Lt. Langdon Easton noted the drainage of the North Fork of the Republican in southwest Nebraska was swarming with bison. Lastly, in reference to the Republican River, Lt. Francis Bryan noted in early October of 1856 that “the bottoms on this river afford subsistence to immense herds of buffaloes…”

Another factor that would have contributed to formation of large herds during a portion of the growing season is the annual mating season or rut. Living under natural conditions, bison in Yellowstone National Park during the years 1963 to 1968 engaged in most breeding activity from mid-July to mid-August (Meagher 1973:76). With the higher bison populations of the 1950s, McHugh earlier observed that the rut extends from mid-June to the end of September. Maximum bison population in the park during Meagher’s study was 418 (in 1968), but was over three times as high during McHugh’s study (n = 1,477 in the year 1954) (Meagher 1972:Appendix IV). Thus, the longer season of rut observed by McHugh may be due to a larger sample size that better reflects the duration of the time period in which breeding occurs. However, if actual data on the frequency of matings could be collected, presumably the data would form a normal curve with the mean centered on the first week in August. Gestation for bison is nine months with the calving season in the park peaking at the end of the first week in May.
That bison do follow the theoretical expectation of all herding animals in so far that larger groups are formed during the rut with smaller herds occurring in winter is supported by data on group size in Yellowstone. When bison population levels were high in the 1950s, McHugh (1958) found herd size ranged from 10 to 50 individuals and averaged 20 in the Lamar Valley during winter. In contrast, when the rut was occurring in Hayden Valley, he observed herds ranging from 19 to 480 individuals with a mean of 175.

In contrast to the time of year when forage quality is high and the rut is occurring, low forage quality prevailing during the months of November through March would be expected to cause bison in the Plains portion of the study area to be dispersed into relatively small herds. It is around the beginning of this period that killing frosts bring the growing season to an end. With the drying out of available forage, its nutritional content decreases and forage quality is such that relatively large herds can no longer be maintained.

The predictability of the location of bison herds in the Plains portion of the study would be expected to be generally unpredictable in comparison to the other environments. Furthermore, the degree of predictability of bison herd location in the Plains portion would be expected to vary throughout the year. Good data on the annual movements of bison on the Plains living under natural conditions is unavailable. Historic records are not detailed enough to provide an accurate reconstruction and the movement of modern Plains bison is not helpful because herds are fenced in on comparatively small wildlife refuges. Bison herds on the Plains would not have wandered in search of better forage without direction. Rather, their annual movements would have incorporated differing winter and summer ranges, although there may have been considerable variability in the actual areas used given the climatic and vegetative conditions experienced in any given year. During the growing season, there would have been fewer and larger herds. Exactly where a large herd would be within a potentially large area may be hard to predict from year to year. There are not geographic features on the Plains to hinder the movement of herds. Herd movements would have been influenced by
environmental factors prevailing at the time. Bison on the Plains would be expected to have the capability of moving to where forage is better, much in the same manner that wildebeest on the African savanna move to where rains have recently occurred. Within the Plains portion of the study area, a more uniform precipitation pattern exists in the better watered eastern portion. To the west, more arid conditions exist in the rain shadow of the Rocky Mountains and distribution of rainfall is patchy. This situation would tend to make herd location less predictable in the western portion during the growing season (see Bamforth 1988:60). Another factor that would influence bison movements at this time of year would be the distribution of surface water. Bison must water everyday, so the distribution of watercourses and playa lakes would to some degree limit the extent of terrain in which bison could be found in the growing season.

In the dormant season for grasses, bison herds would be smaller and more scattered across the landscape. Apart from the poor quality forage, a secondary factor contributing to the dispersed nature of bison herds would have been the occasional availability of snow cover. With the cooler temperatures, bison would not need to drink as much water and this in combination with the availability of snow as a potential source of water may have lessened the need for bison to remain within walking distance of a stream or body of water.

Bison Distribution in Middle Park

A source of information for theorizing the nature of bison movements in Middle Park is a study of seasonal changes in distribution of free-roaming bison herds in the analogous environment of Yellowstone National Park by Meagher (1973). When considered as a whole, the annual range of bison in Yellowstone includes winter ranges in grasslands of open valley bottoms and geyser basins as well as summer ranges consisting of higher mountain meadows within generally forested terrain. Vegetation in Yellowstone is comparable to that of Middle Park. Much of the vegetation in the winter ranges is a mix of sagebrush and grasses in the
higher ground away from the drainage bottoms where a sedge meadow predominates. The bison of Yellowstone belong to one of four named breeding populations or regional “herds.” Individual herd members tend to return to the same winter range each year and thus regional herds are named after geographic features in or near the winter ranges. Annual changes in the distribution of the three largest regional herds was studied. The Lamar herd has its winter range in the lower elevations of the Lamar River, a tributary of the Yellowstone River. The Pelican herd winters in the lower drainage area of Pelican Creek, which flows into Yellowstone Lake. Finally, the Mary Mountain herd is named for the upland area of the same name that separates two neighboring winter ranges. One winter range is the Hayden Valley, a broad open area drained by streams that feed into the Yellowstone and the other is the Firehole River drainage, where a series of geyser basins provide winter range.

The extent of areal and altitudinal movement of the herds was found to vary based on a number of factors (Meagher 1973:77-85). Factors affecting the areal extent of bison are those which tend to make the bison congregate into smaller areas and include heavy snowfall and the rut. During the cold-season, heavy snow confines herds to the lower elevations in the valleys, while in the warm-season, the rut causes bison to congregate into large herds. Factors influencing the movement of bison to higher elevations as the warm-season progresses include the availability of more nutritious green forage and the desire to avoid biting flies.

A major finding relevant to theorizing bison herd distributions in Middle Park is the observation that bison in Yellowstone that are unmolested by humans do not move tremendous distances throughout the year, although there is considerable variability in the amount of actual movement. Table 5-4 shows the variation in the areal and altitudinal movement of the named herds as they moved from winter to summer ranges. Bison of the Mary Mountain herd that wintered on one of the two neighboring winter ranges would eventually migrate to higher elevations in either of two widely separated summer ranges.
Table 5-4. Data on Annual Movements of Bison Herds in Yellowstone National Park.  

<table>
<thead>
<tr>
<th>Herd Name</th>
<th>Estimated Population During Study Years&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Winter Range Name</th>
<th>Dimensions of Winter Range (km)</th>
<th>Approximate Lowest Elevation of Winter Range (ft)</th>
<th>Summer Range Name</th>
<th>Dimensions of Summer Range (km)</th>
<th>Approximate Highest Elevation of Summer Range (ft)</th>
<th>Maximum Distance Between Winter and Summer Ranges (km)</th>
<th>Maximum Difference in Elevation Between Winter and Summer Ranges (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mary Mountain Herd</td>
<td>194 - 418</td>
<td>Hayden Valley</td>
<td>17 x 11</td>
<td>7,700</td>
<td>Beach Lake and Dryad Lake Area</td>
<td>9 x 5</td>
<td>8,500</td>
<td>17</td>
<td>800</td>
</tr>
<tr>
<td>Mary Mountain Herd</td>
<td>194 - 418</td>
<td>Hayden Valley</td>
<td>17 x 11</td>
<td>7,700</td>
<td>Madison Plateau and Pitchstone Plateau</td>
<td>33 x 12</td>
<td>8,550</td>
<td>55</td>
<td>850</td>
</tr>
<tr>
<td>Mary Mountain Herd</td>
<td>194 - 418</td>
<td>Firehole River Drainage</td>
<td>11 x 3</td>
<td>7,400</td>
<td>Beach Lake and Dryad Lake Area</td>
<td>9 x 5</td>
<td>8,500</td>
<td>33</td>
<td>1,100</td>
</tr>
<tr>
<td>Mary Mountain Herd</td>
<td>194 - 418</td>
<td>Firehole River Drainage</td>
<td>11 x 3</td>
<td>7,400</td>
<td>Madison Plateau and Pitchstone Plateau</td>
<td>33 x 12</td>
<td>8,550</td>
<td>32</td>
<td>1,150</td>
</tr>
<tr>
<td>Pelican Valley Herd</td>
<td>124 - 238</td>
<td>Pelican Valley</td>
<td>17 x 8</td>
<td>7,800</td>
<td>Upper Lamar Region</td>
<td>33 x 18</td>
<td>10,650</td>
<td>46</td>
<td>2,850</td>
</tr>
<tr>
<td>Lamar Valley Herd</td>
<td>80 - 163</td>
<td>Lamar Valley</td>
<td>17 x 6</td>
<td>6,400</td>
<td>Upper Lamar Region</td>
<td>33 x 18</td>
<td>10,650</td>
<td>49</td>
<td>4,250</td>
</tr>
</tbody>
</table>

<sup>a</sup> Data from Meagher (1973:81-86, Figure 11) and 1:500,000 topographic base map of Wyoming (United States Department of the Interior, Geological Survey 1980).

<sup>b</sup> Bison studied from 1963 to 1968.
There is a tendency for bison wintering in the Hayden Valley to spend most of the summer there before moving only a relatively short distance to forage higher meadows to the south in an adjoining summer range in the area of Beach and Dryad lakes. Based on the map of summer and winter ranges in Meagher (1973:Figure 11), this annual migration involved the shortest annual movements and the least change in elevation for all Yellowstone bison. The annual movements of these bison would have entailed moving about within an area measuring 17 km in extent and traveling within an altitudinal range of 800 ft, from the Hayden Valley at 7,700 ft to higher meadows to the south at 8,500 ft. At the other extreme are bison that wintered in the lower Lamar Valley. Movement from winter to summer range involved traveling over a maximum distance of 49 km and gaining at most 4,250 ft in elevation, as measured from the lower Lamar Valley at 6,400 ft to the highest meadows in the upper Lamar drainage at 10,650 ft. In light of the above, it can be stated that factors influencing the annual movements of unmolested bison living in an upland environment that is analogous in many ways to Middle Park produce considerable variation. Overall, however, it can be stated that bison do not migrate great distances as they make their way from winter ranges on the valley floors to summer ranges in mountain meadows. The annual movements are such that the location of bison in any given season would be predictable from one year to the next.

By applying generalizations from foraging theory to an acquired knowledge of how topographic, climatic, floral, and other factors influence the seasonal movement of bison in the analogous environment of Yellowstone, it is possible to make expectations regarding the distribution of Middle Park bison during the time they would have been on their winter ranges. One or more winter ranges would have existed in the large tract of sagebrush grassland in western Middle Park at the lower elevations drained by the Colorado River, Muddy and Troublesome creeks, and the Blue and Williams Fork rivers. The lowest elevation of this area is at 7,300 ft where the Colorado River exits the park at Gore Canyon.
At the height of the cold-season when forage quality is poor, bison would be scattered into small herds while on their winter ranges. Deep snow at higher elevations would create a situation where bison could be predictably found in the relatively small areas of suitable winter habitat. Seasonal changes in climate and vegetation that vary with elevation would have influenced the distribution of bison in Middle Park as they do in Yellowstone. Being lowest in elevation and receiving the least amount of snow, winter ranges in Middle Park would be the first to see the greening of the landscape with the appearance of nutritious new growth in April and May.

Expectations can also be made regarding the distribution of Middle Park bison when on their summer range. If the Middle Park environment is sufficiently like that of Yellowstone, it can be predicted that in June, many bison would have already left the winter ranges to graze upon the new growth that would be first appearing at higher elevations in the park proper and at higher elevations in the Middle Park drainage. At this time of year, new vegetation available in the valley bottom along the upper reaches of the Blue River and in mountain meadows in the subalpine forest above the park proper would attract bison. It is also possible that by this time of year, some bison might go over Muddy Pass to graze in North Park. However, since the behavior of bison in Middle Park would be expected to be basically comparable to that of Yellowstone, most would return to winter in Middle Park. As the warm season progressed, some bison may even have ascended above tree line to graze the alpine tundra of mountain ranges surrounding the park. The possibility that some bison from Middle Park herds would have ranged above tree line is suggested by two lines of evidence. First, limited historic records document the presence of bison above tree line. In June of 1844, explorer John Charles Fremont noted the presence of buffalo trails between Middle and South parks that would have required that bison traverse a short stretch of high mountains above tree line (Jackson and Spence 1970:1:716). Also, Fryxell (1926:102) cites a historic account of a Mr. C. E. Aiken, stating that of two herds remaining in the South Park area in
1876, one grazed the headwaters of Tarryall Creek and was frequently found above tree line in the mountains separating South and Middle parks. The second line of evidence involves early publications of zoologists that document the finding of bison bones above tree line in the Colorado mountains, including a report of skulls found at two locations in the alpine tundra on the east slope of the Front Range (Fryxell 1928:131-133). Sometime during late spring or summer, deep snows covering the passes over the high mountains separating Middle and South parks would have melted sufficiently for some bison to cross over into South Park, but most would likely return to winter in the Middle Park drainage. From June to October, bison that wintered on the floor of Middle Park may be found at various places within a larger area that encompassed the park proper, adjacent parks, mountain meadows in the subalpine forest at higher elevations in the Middle Park drainage, and areas above tree line in surrounding mountain ranges. After the first heavy snows in the fall, the bison that have traveled to areas above the park proper would be forced to descend to lower elevations such that in December, bison would usually have all returned to the smaller tracts of land encompassing their winter ranges on the floor of the park.

When comparing bison distributions at the scale of the entire study area, it is apparent that the location of herds on the Plains would have been less predictable than those in Middle Park. In contrast to Middle Park where bison were forced by topography and snowfall to follow the same pattern of ascending into higher elevations with the progression of the warm-season and returning to the same relatively small winter ranges each year, bison on the plains were not so constrained. As discussed previously, bison movements on the Plains were influenced by factors related to climate, vegetation, and available drinking water. However, in regard to topography, there is nothing to physically prevent bison from travelling great distances on the open expanse of the Plains if changing forage conditions encourage such movement. In particular, during the warm season in that broad band of the Plains situated in the rain shadow of the Rocky Mountains, sporadic rainfall characteristic of this region would
make for a patchy distribution of quality forage such that large herds would have formed
during the growing season and their location would not be very predictable from one year to
the next. Smaller herds would have formed when vegetation is dormant and forage quality is
low. Under these conditions, people searching for bison would be more likely to encounter a
herd and so the chances of finding at least some bison would be greater at this time of year.
Thus, bison may have been somewhat more predictably found at this time of year. Still, the
topography of the plains is such that at any time of year, herds that were motivated to find
better forage could physically move great distances along watercourses or over expanses of
land with playa lakes or snow cover providing adequate water.

In contrast to the Plains, the location of bison herds in Middle Park would be more
predictable at all times of year. If Middle Park bison behaved in the same basic way as those
of Yellowstone, they would have followed the same seasonal changes in distribution such
that they would move from the relatively small winter ranges upon which most bison would
spend every winter to the same summer ranges that were generally located at higher
elevations. Summer ranges in Yellowstone usually are larger than winter ranges, and this
would be expected to hold true for bison in Middle Park as well. Thus, the precise locations
of the larger herds expected at that time of year may be less predictable than in winter.
Nevertheless, the overall regularity of bison movements in Middle Park throughout the year
would mean that people seeking to find bison in the Middle Park drainage would have known
where to look for them at any time of year. Perhaps a more convincingly argument for the
greater predictability of Middle Park bison at all times of year is made by simply comparing
the areal extent of sagebrush grassland within the Middle Park drainage basin to the great
expanse of the grasslands in the Plains portion of the study area (see Figures 5-1 and 5-2).
Finally, the Middle Park environment is such that during the height of the cold-season, bison
are even more predictably found in certain areas as snowfall at higher elevations force the
bison onto comparatively smaller winter ranges.
Big Game Distributions in the High Front Range

Intense cold and heavy snows occurring during the height of the cold season in the high Front Range today dictate that big game animals abandon the area during much of the year and it is expected that this would also characterize the Paleoindian time period. The expected movement of game animals up to the grazing areas above tree line in the Front Range during the spring and back down to lower elevations in the fall is based on the fact that such is the patterned movement followed by the elk, mule deer, and bighorn sheep in the study area. Historic accounts document the presence of bison in the Front Range and it is reasonable to expect that they too would have followed an annual pattern of distribution that involved movement between higher and lower elevations. Under current climatic conditions it is normal for the high Front Range to have herds of big game first arriving in late spring, specifically in June. At this time, snow melt progresses to the point that many areas are snow-free and soon serve to attract grazing animals as nutritious green vegetation first appears. By June, the snowpack in the subalpine forest has melted sufficiently that animals are able to make it through drifts to reach the alpine tundra. Green vegetation from June through August would allow for the formation of large herds. However, killing frosts come as early as September and the resulting decrease in forage quality would serve to encourage dispersion into smaller herds from September through November. Some species are in rut during these months and may then form large herds for the purpose of mating if they are still above tree line at that time. With the coming of the first heavy snows, the alpine tundra is abandoned for grazing elevations at lower elevations which are still free of snow and easier to graze. In normal years, the alpine tundra becomes less attractive to grazing animals with the snows of November so that by December, big game have left.

One of the species killed at the game drive sites in the high Front Range is the elk, which is a large form of deer that is usually found in herds of varying size throughout the year. Most of the elk that inhabit the vicinity of Devils Thumb and Arapaho passes are part
of the Winiger Ridge herd that is named after a geographic feature in its winter range (Hallock 1991, cited in Benedict 2000b:26). Winiger Ridge is located 30 to 35 km to the east in the area of Gross Reservoir on South Boulder Creek. It is not certain if some elk that use the high Front Range belong to a population that winters in Middle Park. Benedict (2000b:26) states that elk in the vicinity of the Devils Thumb Pass are present above tree line or in the higher elevations of the subalpine forest from June into November.

Bighorn sheep were another species targeted by hunters using game drives above tree line. This species also forms herds of varying size throughout the year and formerly would have been found in high valleys of the Front Range above tree line from June into November. Bighorn sheep form comparatively large herds during the rut in November, which is also around the time of year when animals would abandon the high country for lower elevations, so it is uncertain if the presence of larger herds in the high country would have been an incentive for humans to organize game drives at this time of year.

Archaeological evidence indicates that mule deer were also procured in game drives above tree line in the Front Range. Unlike elk and bighorn sheep, mule deer in the Front Range do not tend to form large herds from June into November when they are found on the alpine tundra and in the subalpine forest (Stevens 1970, 1980, cited in Benedict 2000b:27). The rut among mule deer occurs in November and December, however, even then this species does not form especially large herds. Because of their less gregarious nature when in the high country, Benedict (2000b:27) suggests that mule deer were not as likely to have been hunted using communal techniques. As mentioned, however, evidence from the Sawtooth game drive indicates that mule deer were taken in game drive systems above tree line.

Finds of buffalo bones above tree line in the Front Range suggest the possibility that bison may conceivably have been taken in game drives, although no archaeological evidence currently exists to support this possibility. Available evidence favors the view that the game drive systems were constructed with the intention of procuring non-bison big game.
The distribution of elk, bighorn sheep, and mule deer in the high Front Range is expected to have been highly predictable from year to year. Seasonal changes in snow cover and forage availability and quality dictate that grazing animals will be present on the alpine tundra only during a certain time of year. Game animals may have returned to the same relatively small grazing areas in the alpine tundra each year.

Exactly which of dozens of drainages along both sides of the Front Range game animals would have gone up in the late spring from winter ranges east and west of the range may have varied from year to year, thereby decreasing the predictability of the exact whereabouts of big game. It is relevant to note that over 50 game drive systems are reported from along the high Front Range east of Middle Park and that in aggregate, they demonstrate use from Late Paleoindian times into the Late Prehistoric. This suggests that throughout the millennia during which game drives occurred, continued construction of new drives in advantageous locations would have resulted in there being many such sites positioned all up and down the range such that by the later centuries during which game driving occurred, there would have been many drives already set up in a number of drainages. In turn, this would serve to counter the unpredictability of not knowing in which specific drainages game animals would be found.

TOOL STONE AVAILABILITY AND ITS EFFECT ON LAND USE PATTERNS

A final step in theorizing environmental effects on land use patterns in the study area is to consider the ways in which raw material availability, in conjunction with the other environmental factors already considered, would have affected land use. To illustrate how differential raw material availability between the three environments of the study area would have influenced the formation of different land use patterns, which in turn should be reflected in varying raw material compositions of artifact assemblages, the expected tool stone
composition of sites associated with large-scale big game kills carried out by multi-band aggregations will be discussed.

Variation in the density of high-quality sources of tool stone exists between the three environments of the study area. In portions of the Plains away from the major lithic source areas, high-quality tool stone sources are widely distributed (Figure 5-1). In comparison, high-quality lithic sources in Middle Park are concentrated in a much smaller area (Figure 5-2). Tool stone availability in the high Front Range differs from that of the other areas because no high-quality sources whatsoever are present.

Under the alternative view, differences between the three environments of the study area in regard to the relative density of lithic sources and the predictability of herds of big game should have produced differing land use patterns. For example, gearing up for large-scale kills by multi-band aggregations would be expected to have differed. Predicted differences in the gearing-up activities between the areas should be reflected in the tool stone composition of assemblages. On the Plains where the locations of bison herds would have been relatively unpredictable and high-quality sources of tool stone are distributed widely, it is expected that bands with access to different lithic sources would gear up with these raw materials before aggregating for large-scale hunting. The above scenario would commonly produce assemblages composed of multiple types of tool stones that derive from different, distant sources. In western Middle Park where locations of bison herds would have been comparatively predictable and high-quality sources of tool stone occur locally, it is expected that bands aggregating for large-scale bison hunting would have the option of gearing up with the local stone prior to cooperating in a large-scale bison hunt. Assemblages produced under these circumstances would be dominated by local stone. In the high Front Range, locations of non-bison big game herds would have been relatively predictable and the exact location of planned game drives was determined beforehand by the construction of drive systems in particular locations. Communal hunts involving multiple bands in some cases would involve
cooperation between a band that wintered east of the Front Range and another that spent the winters west of Middle Park. In these cases, it would be easiest for the bands to meet in the high Front Range by following routes leading to passes over the mountains. It is therefore relevant to note that all three sites in the high Front Range cluster are at passes and two are at Arapaho Pass, which provides the easiest route over the Front Range. Tool stone used to gear up for the hunt would necessarily have been obtained from outside the high Front Range and the closest high-quality sources of stone are in Middle Park. Therefore, assemblages produced in this situation would be expected to be dominated by stone from Middle Park or else contain large amounts of stone from the park.

CHAPTER SUMMARY AND CONCLUDING REMARKS

This chapter has developed theory relating to modern environmental effects on forager land use within the study area. Land use is expected to have varied according to the differing conditions prevailing in the three basic environments that comprise the study area. These include the Plains, intermontane basins (specifically Middle Park), and the high Front Range.

Climatic variability among the three environments would be expected to have had differing effects on human occupancy. Climatic conditions on the Plains are such that foragers would have occupied this region year-round. In contrast, prolonged periods of frigid temperatures brought on by temperature inversions in Middle Park would have required that the park be abandoned during the height of the cold-season by foragers who used the park on a seasonal basis and wintered in lowlands east of the Front Range and west of the park. Abandonment of the high Front Range for the winter would similarly be required due to the strong winds, cold temperatures, deep snow, and lack of game animals.
Prevailing climate would also expect to affect the food storage techniques used to preserve meat from large-scale big game kills which in turn would influence the seasonal timing of communal hunts. If a purpose of communal hunts was to put up stores of meat to aid in surviving a lean time of year for foragers during the height of the cold-season, the easiest way to accomplish this would be to take advantage of cold weather to make frozen meat caches. Under the present climate, storing meat in frozen caches is possible on the Northern Plains, but the extra effort of drying meat to make jerky during the months prior to the height of the cold season would be required on the Southern Plains. Presently, use of frozen meat caches in the portion of the study area on the Central Plains would be a marginal proposition. Rather, preserving meat through making jerky prior to the advent of the coldest months would be a better strategy. Because Middle Park would have been abandoned during winter, large-scale bison hunts would have been held prior to the height of the cold-season and the procured meat dried into jerky to preserve it and decrease its weight for transport out of the park. Similarly, the high Front Range would have been abandoned during the height of the cold season and therefore any meat obtained in game drives to be stored for later consumption would have been dried to preserve it and lighten it for transport to lower elevations.

To begin the process of theorizing plant food use by Paleoindians, evidence for exploitation of floral resources by indigenous people of the study area was reviewed. Making real progress into further investigating this topic will required future fieldwork at the kinds of sites historically ignored due to the emphasis on sites associated with large-scale kills.

Since sites related to large-scale kills must be used to build alternative theory on land use in the study area, a good place to start is to theorize how the modern conditions in the three environments would be expected to differentially affect the predictability of big game distributions. The lack of topographic constraints on the Plains and the sporadic distribution of rainfall in the rainshadow of the mountains would bring about relatively unpredictable
distributions of bison on the Plains, particularly in the more westerly and drier portions. Annual changes in the distribution of bison in Middle Park arguably involved movements within a smaller area and entailed relocating from winter range on the park floor to summer range at higher elevations, probably in a manner analogous to the buffalo of Yellowstone National Park. In comparison to Plains bison, the distribution of herds in Middle Park would have been more predictable. Greening of the vegetation and melting of the snowpack in the spring and the coming of heavy snows in the fall would have restricted the time during which the alpine tundra could have been used by both big game and people from about June to December. The relatively small areal extent of the alpine tundra in the study area and the strong role that topography played in influencing game animal distributions caused distributions of herds to be highly predictable in this environment. Predictability of herd distributions is implied by construction of game drive structures in particular places prior to the communal hunt.

A final environmental factor affecting land use in the study area would have been tool stone availability. The distribution of high-quality sources of tool stones varies across the three environments of the study area. Quality sources are widely distributed on the Plains, concentrated in Middle Park, and nonexistent in the high Front Range. Consideration of tool stone availability in conjunction with theoretical differences in the predictability of game animal distributions in the three environments permits the raw material composition of assemblages from sites related to large-scale kills to be theorized. To illustrate this capability, the differing expected tool stone composition of assemblages produced by multi-band aggregations was discussed. On the Plains where bison herd distribution is relatively unpredictable and lithic sources are widely distributed, aggregating bands would be expected to bring stone raw material with them such that the tool stone composition of assemblages from bonebeds should contain multiple tool stones from a variety of distant sources. In western Middle Park, where lithic sources are locally available and bison distribution is
predictable, bands aggregating for a communal hunt would have the option of gearing up with local stone. The tool stone composition of assemblages from bonebeds in Middle Park may therefore be dominated by stone from the park. Bands aggregating for a big game drive in the high Front Range from lowlands situated east and west of the mountains may have taken advantage of passes that provide easy access to the alpine tundra. With this in mind, it is relevant to note that two of the three sites in the high Front Range are situated at Arapaho Pass which provides the easiest access across the range. Big game distributions in the high Front Range would have been comparatively predictable, but lithic sources are absent, so gearing up for a game drive would require procuring stone from lower elevations. Lithic sources in Middle Park are the closest to the Front Range, consequently stone from the park would be expected to dominate assemblages or at least comprise substantial amounts.

This chapter has developed expectations regarding the nature of forager land use patterns in the three environments of the study area under modern conditions. To understand how these expectations may or may not have differed throughout the roughly four millennia of radiocarbon years encompassed by the Paleoindian period, it is necessary to develop an appreciation for the manner and degree to which environmental conditions differed in Paleoindian times. Paleoenvironmental evidence from the study area will be reviewed in the following chapter to develop such an understanding.
CHAPTER 6

CHANGING PALEOENVIRONMENTAL CONDITIONS
AND THEIR EFFECT ON PALEOINDIAN LAND USE

Based on the theoretical understanding regarding the manner in which modern environmental conditions would be expected to shape forager land use patterns, this chapter will consider the extent to which the differing environmental conditions of Paleoindian times would have modified land use patterns. In particular, the effects of climatic change will be considered. As will be outlined below, paleoenvironmental investigations in the study area document that a warming and drying climate would have brought about changes in environmental conditions to which Paleoindians were subjected. Palynological studies show vegetation zones of today were in effect during Paleoindian times with short-grass and mixed-grass prairie present on the plains, sagebrush grassland in Middle Park, and forest and alpine tundra in the Front Range. Bamforth (1988) asserts that warming and drying during Paleoindian times would have modified the Plains vegetation as short-grass prairie expanded at the expense of mixed-grass prairie. Changes in vegetation would be expected to have influenced bison herd size and predictability which in turn would have brought about changes in forager land use patterns.

For the purposes of this dissertation, however, it is sufficient to note that the expected differences in the predictability of game animals in the three regions of the study area relative to one another would not likely have changed with the warming and drying trend. Bison distributions on the Plains would still be expected to have been relatively unpredictable throughout Paleoindian times in large part due to the lack of topographic constraints on the
plains. On the other hand, bison distribution in the Middle Park drainage throughout the Paleoindian period would have been comparatively predictable because it would have involved seasonal changes in elevation within a smaller area. Finally, non-bison animal distribution in the high Front Range would have been relatively predictable throughout Late Paleoindian times primarily because it entailed seasonal movement to the same set of grazing areas above tree line every year.

Consideration of how land use may have changed throughout the Paleoindian period will focus on possible effects of the warming and drying trend on the seasonal timing of communal hunts. In the previous chapter, it was argued that modern environmental conditions would force people to abandon the high Front Range and Middle Park during the height of the cold-season. Consequently, any communal hunts held in these regions to put meat into storage for a lean time of year would necessarily have been held in the months prior to abandonment. Consideration of modern climatic conditions on the Plains led to two conclusions regarding forager land use. First, hunter-gatherers could inhabit the Plains on a year-round basis. Second, a temperature regime similar to that of today would permit communal hunts to be held during the height of the cold-season on the northern portion of the Plains when freezing weather could be employed to assist in short-term storage of procured meat. Conversely, freezing temperatures on the central and southern portions of the Plains during the height of the cold-season are insufficiently long to allow storage of meat via freezing. Therefore, if communal hunts were intended to store meat for a lean time of year, such events on the central and southern sections of the Plains would have to of been held in the months prior to the height of the cold-season when temperatures were sufficiently high to have permitted preservation of meat by drying. Evidence for warming and drying will be considered in regard to how the above expectations on regional differences in the seasonal timing of communal big game hunts may or may not have changed throughout the Paleoindian period.
The paleoenvironmental reconstruction of both the high Front Range and Middle Park will be considered as a unit because insights into environmental conditions in geographic regions of the Southern Rocky Mountains largely stem from studies designed to assess temporal changes in the positions of upper and lower tree line. Upper tree line position is controlled by summer temperatures (Fall 1985:42). The position of upper tree line in ancient times is determined through study of pollen and fossil insects recovered from radiocarbon dated stratigraphic columns located near the alpine tundra-subalpine forest ecotone. Coring of high-altitude lake sediments in winter when lakes are frozen over provides a stratigraphic column that can be sampled for pollen to elucidate changes in the relative position of the uppermost vegetation zones of the Front Range and thereby assess the degree to which climatic conditions of Paleoindian times differed from those of today. The research of several palynologists working in the Front Range and at other high-altitude locations in Colorado has produced a fairly detailed record of paleoclimatic changes which has been duplicated at multiple study sites. A basically similar method has been followed by Elias (1985) who cored high-altitude bogs and other anaerobic depositional environments with the intent of producing dateable stratigraphic columns containing fossil insects adapted to the various vegetation zones of the higher elevations in the Front Range.

To add to the picture of past climates, palynological studies in the Colorado mountains have also focused on documenting the fluctuation in the position of lower tree line through time. This avenue of research is seen as a means of providing a more comprehensive assessment of paleoclimatic conditions by elucidating change in the amount of precipitation through time. Lower tree line studies are based on the basic ecological principle that concomitant increase in the amount of precipitation with rising elevation is the main factor determining the position of lower tree line (Fall 1985:40). Unlike the situation near upper tree line, verification of the history of climatic changes evident from pollen studies has not
been possible by examining fossil insects because the drier sedimentary conditions prevailing near lower tree do not favor preservation.

The nature of climates and vegetational patterns on the Plains during Paleoindian times has been determined through various paleoenvironmental methods. Study of pollen and phytoliths from dated stratigraphic columns reveals a record of changes in temperature and precipitation that is based on the understanding that plants in general, and various kinds of grasses in particular, are adapted to specific climatic conditions. Thus, relative changes in the frequencies of phytoliths from various kinds of plants throughout a stratigraphic column will document climatic changes. Studies of changes in small animal distributions through time have provided supporting evidence of climatic change, particularly in regard to temperature. Finally, changes in amount of precipitation have been revealed through pedological study of sediments deposited along watercourses.

CHANGING PALEOENVIRONMENTAL CONDITIONS ON THE PLAINS

Data from paleoenvironmental study sites in the northern, central, and southern portions of the Plains is reviewed to place the study area within the context of latitudinal variation in climate throughout the plains. This is done to assess the suggestion of Bamforth (ca. 2000) that methods of meat storage employed by Plains Paleoindians may have varied with latitude and would have affected the timing of communal hunts. Paleoclimatic data from various latitudes on the Plains will be reviewed so that a later chapter may evaluate the theoretical relationship between long-term climatic changes on the one hand, and latitudinal changes in methods of meat storage and the timing of large-scale hunts, on the other.

A major study site for the reconstruction of Paleoindian environments on the Southern Plains is the Lubbock Lake site, located in Texas on the expanses of the Llano Estacado or Staked Plains (Johnson 1987a). The site has produced stratified occupation
layers from throughout the entire Paleoindian period, as well as from Archaic and Late Prehistoric times. The site is situated near a set of springs in Yellowhouse Draw that historically formed a marshy area considered to be the headwaters of the Brazos River. In historic times, the area downstream of the springs was dredged to form a reservoir. Study of small animal remains recovered from stratified Paleoindian deposits preserved around the reservoir has permitted reconstruction of changes in climate throughout the Paleoindian period (Johnson 1987b, 1987c).

A somewhat surprising conclusion from faunal studies at Lubbock Lake is that the Clovis period experienced mild winters that lacked freezing temperatures. Today, freezing temperatures occur during the height of the cold-season. Presence of an extinct species of giant armadillo is indicative of mild winters lacking freezing temperatures. Modern armadillos live in regions of southeastern North America with mild climates and although they burrow and hibernate to escape short-term cold periods, the size of the giant armadillo, at 1.8 m long and .9 m tall, is believed to have precluded burrowing to escape the cold and is thus considered as evidence of a lack of freezing temperatures during Clovis times. Presence of an extinct tortoise in the Clovis faunal collection is also believed to be indicative of mild winters. Although the species was small enough to have been a burrowing form, contemporary relatives of the extinct species mainly occur in subtropical and tropical habitats. Finally, the presence of two species of reptile in the Clovis fauna which today are distributed in areas with frost-free winters supports the conclusion of mild winters on the Southern Plains during Clovis times. The notion of Late Pleistocene winters being warmer than those of today is counter to the generally colder temperatures attributed to this period. Some have suggested that this situation may be explained by the possibility that the thick Laurentide ice sheet may have effectively blocked cold Arctic air from descending southward during the height of the cold-season onto the Central and Southern plains, as it does today. If
so, the Southern Plains would have been dominated by warm air masses from the relatively warm Gulf of Mexico (Meltzer and Holliday 2010:9-10).

Paleoenvironmental evidence from Lubbock Lake also documents changing temperature in post-Clovis times. Mild winters persisted during Folsom and Plainview periods because southeastern species still occur in the faunal assemblages, but extinction of the giant armadillo and the Pleistocene tortoise by Folsom times indicates the onset of at least occasional periods of freezing temperatures. Summers during Folsom and Plainview times are thought to have experienced temperatures that were warming and thus becoming more modern-like because extant hibernating small mammal species that now inhabit more northerly latitudes retreated from the Southern Plains at this time. Overlying occupation layers at the site are assigned to the Firstview period, which will herein be referred to as part of the Cody period. Temperatures during Cody times are believed to have been basically comparable to those of today because the fauna represented in the archaeological collection is essentially modern in composition.

Changes in precipitation throughout the Paleoindian period are recorded in the Quaternary strata preserved at Lubbock Lake. Pedological study of sediments deposited in the drainage at the Lubbock Lake site are indicative of a general, long-term drying trend that extended throughout the Paleoindian period and extended into the Archaic (Holliday and Allen 1987). The Llano Estacado is an ideal place to study changes in precipitation on the Southern Plains throughout the Pleistocene and Holocene. The area is a section of the Plains that is elevated above the level of the surrounding terrain. Consequently, streams that cross the region do not receive meltwater from the Rocky Mountains to the west but rather arise on the Llano Estacado itself from meteoric precipitation alone. Study of sediments laid down in drainages in this region is thus an ideal way to gauge changing precipitation on the Plains. Currently, Yellowhouse Draw is an intermittent stream with the surrounding uplands vegetated with a plains-desert grassland composed of short grasses and xerophytic vegetation.
Geomorphological studies demonstrate that during Clovis times, a permanent stream that was sometimes muddy and had extensive areas of bottom sand was present in the drainage. In Folsom and Plainview times, the water had slowed such that a series of clear ponds were present in the drainage. By Cody times, the volume of water had decreased to the extent that the drainage bottom was lined with a marsh or wet meadow. The amount of water in Yellowhouse Draw immediately downstream of the springs was thus roughly comparable to that of historic times and by extension, precipitation at this time in the Paleoindian period was similar to that of today. Continuation of the drying trend into the Archaic is recorded at the Lubbock Lake site by eolian deposits produced during the Altithermal.

Paleoclimatic studies at the Agate Basin site complex on the Northwest Plains have produced a less complete picture of Paleoindian climate, but are noteworthy because they not only confirm, in part, the warming trend from Folsom to Late Paleoindian times known from the Southern Plains, but also due to the fact that they allow the difference between modern and Paleoindian temperatures to be quantified. Walker (1982) compared the modern ranges of small mammal species represented in the Folsom and Hell Gap faunal assemblages. For each time period, weather station data from within the area of overlap in the modern species distributions was assumed to provide an approximation of the prevailing temperatures in the past and allow comparison to data on the modern climate from stations near the site. This analysis demonstrated an increase in temperature between Folsom and Hell Gap times and thus demonstrates that the warming trend evident on the Southern Plains also applies here. More importantly, the method of analysis allows one to assess the degree to which temperature differed from modern times. According to Walker’s analysis, the average July temperature today is 73° F compared to 67° F in the Hell Gap period and 60° F during Folsom times. Average January temperature today is 24° F compared to 19° F in Hell Gap times and 15° F during the Folsom period. Weather station data also addresses the relative duration of the cold-season at the various points in time. Average number of frost-free days
is currently 124 compared to 74 in the Hell Gap period and 34 days during Folsom times. The above data therefore suggest that in the more northerly regions of the Plains, temperatures were appreciably colder than present during Folsom and Hell Gap times.

Paleoclimatic data from the Central Plains portion of the study area also confirms the warming and drying trend from Folsom times onward as indicated from Southern and Northwest Plains data. Study of phytoliths recovered from Paleoindian sites and paleoenvironmental study locations in the Medicine Creek drainage in Nebraska document this climatic trend in general (Scott Cummings et al. 2007). A change in the proportions of phytoliths from various kinds of grasses was the main source of paleoclimatic evidence giving support to the warming and drying thesis. For example, chloridoid-type phytoliths are from grasses adapted to dry climates and the gradual increase in chloridoid phytoliths through the Paleoindian levels at the Lime Creek and Red Smoke sites records an increase in short grasses at the expense of tall grasses. This vegetational change in turn reflects a warming climate.

The above summary of changes in post-Clovis Paleoindian climate on the Plains has generalized that the long-term warming and drying trend had progressed to the point that sometime in the early part of Late Paleoindian times when the Cody point was in use in the western Plains, the climate had become comparable to that of today. A more detailed review of paleoclimatic evidence by Muniz (2005:121-166), however, documents that more climatic variation than that suggested here prevailed during Cody times. Muniz liberally dates the Cody period from roughly 10,000 to 8000 B.P. and summarizes paleoclimatic evidence for this period.

During the first half of the Cody period as defined by Muniz, from 10,000 to 9000 B.P., evidence from the Northwestern Plains indicates that the climate was still wetter than today. At the Carter/Kerr-McGee site in Wyoming, the Cody occupation is bracketed by dates of 9390 and 8750 B.P. Pedological evidence demonstrates that Cody artifacts were
deposited in a wet meadow soil. Today, the soil is dry and the site is vegetated with short grasses adapted to more arid conditions.

The wetter conditions prevailing in early Cody times on the Northwestern Plains may have applied to the Central Plains as well, as suggested by two sites in Colorado producing evidence of wetter conditions. Absolute dates have not been produced for the Cody occupations of these sites, however. At the Lindenmeier site, the Cody component is associated with a paleosol formed in a wet meadow. The Claypool site today occurs in a dune field that is stabilized by vegetation, but subjected to a relatively arid climate. In contrast, the paleosol from which the Cody artifacts eroded is indicative of wetter conditions than at present.

In the later half of Muniz’s Cody period, from 9000 to 8000 B.P., paleoenvironmental evidence suggests that the climate perhaps had become drier that that of today. In comparison to the early half of the period, the later portion produced more paleoenvironmental study sites demonstrating evidence of active dune fields. Dune fields in the Wyoming Basin and northeast Colorado were active during late Cody times, but today are stabilized except at localized blowouts. Paleoenvironmental evidence suggests that the west-to-east gradient in precipitation that characterizes the Plains today was also in effect late in the Cody period. At this time, dune fields in the Wyoming Basin and northeast Colorado were active, but those further to the east in Nebraska and central Kansas were stabilized with vegetation.

**CHANGING PALEOENVIRONMENTAL CONDITIONS IN THE HIGH FRONT RANGE AND MIDDLE PARK**

Changes in the position of upper tree line record a warming trend in the high Front Range that prevailed throughout the Paleoindian period. Study of changes in pollen
frequencies from a stratigraphic column collected at Long Lake in the South St. Vrain drainage by Short (1985) provides the basis for reconstruction of Late Pleistocene and Holocene changes in the altitudinal position of tree line. The lake is located at modern tree line (see Elias 1985:Figure 1). The radiocarbon dated pollen column from Long Lake documents decreased levels of spruce pollen during Clovis times which in turn indicates a depressed tree line and lower summer temperatures. The reader will recall that the subalpine forest at upper tree line is dominated by Englemann spruce.

Studies of fossil insects also seek to reconstruct climatic changes by determining the relative position of tree line. Such studies are founded on the observation that beetle species adapted to climatic and vegetation conditions in the subalpine forest are predominant in that ecozone, whereas species adapted to the alpine tundra are most common above tree line. In the ecotone between these vegetation communities, the ratio of forest to tundra species is 1:1. Study of fossil beetles from a radiocarbon dated stratigraphic column elsewhere in the South St. Vrain drainage by Elias (1985) complement the pollen data. Elias analyzed beetles from sediment cores drilled near Lake Isabelle, a high altitude body of water located at tree limit, higher up in the South St. Vrain valley. The study suggests that tree line had risen from depressed elevations in terminal Wisconsin times to its present altitude by approximately 9200 B.P. (Elias 1985:Figure 9). Thereafter, summer temperatures higher than those of today prevailed in Late Paleoindian times.

Therefore, throughout most of Cody times (herein considered to date from 9400 to 8600 B.P.) upper tree line was above its current position and summer temperatures were higher than today. Review of paleoclimatological data from the Cody period by Muniz (2005) confirms that temperatures were generally higher than today throughout the Southern Rocky Mountains.

Study of pollen retrieved from a bog at La Poudre Pass demonstrates that the tree line continued to rise in the Front Range to elevations above its present position in post-
Paleoindian times (Short 1985). The bog sampled is located at tree line (see Elias 1985:Figure 2). High proportions of pine pollen relative to that of spruce in the time period dated from 6400 to 3500 B.P. indicates maximum rise of pine forest within the montane zone to elevations formerly vegetated with spruce forest of the subalpine zone. This in turn implies that upper tree line had risen to maximum elevations high above its present position during a mid-Holocene warm period in the earlier part of the Archaic.

Punctuating the overall warming and drying trend of the Paleoindian period in the high Rocky Mountains of Colorado was a period of relatively colder temperatures attributed to a global climatic episode known as the Younger Dryas. Some have characterized the Younger Dryas as a return to full glacial conditions. However, a thorough review of paleoclimatic evidence from the U.S. indicates that the period was far from having been a rerun of the extreme cold characteristic of many regions in the more northerly latitudes during the Late Glacial Maximum from 16,000 – 14,000 B.P. (Meltzer and Holliday 2010). The matter of the extent to which the climate cooled in the mountains of Colorado can be addressed with reference to a pollen column from outside the study area that is both more detailed than any from the study area and also has better chronological control for the period of concern. The pollen column derives from Black Mountain Lake, located close to tree line in the San Juan Mountains of southwest Colorado at an elevation of 11,198 ft. As an ancillary study to investigations at the Cattle Guard site in the San Luis Valley, Jodry (1999:21-55) cored the lake sediments to assess the regional climate during Folsom times. Analysis of pollen from the lake resulted in production of a pollen diagram documenting a long history of vegetational changes, dating from earlier than 14,000 B.P. to more recent than 8,500 B.P. Throughout this time period, the proportional representation of arboreal pollen generally increases, indicating a rise in upper tree line as a result of increasing summer temperatures. Within the overall trend of increasing arboreal pollen, however, the period between radiocarbon dates of roughly 10,800 and 10,100 B.P. document a minor dip in the
frequency of arboreal pollen. This indicates that rather than a return to climatic conditions characteristic of a glacial maximum, the Younger Dryas in the Colorado mountains is best thought of as a minor cooling episode in a more general warming trend that occurred throughout the Paleoindian period.

Complementing the information on changes in summer temperatures derived from study of upper tree line are a number of more recent studies of lower tree line that document the dynamics of precipitation levels throughout the late Pleistocene and Holocene. Analysis of pollen samples collected during test excavation of the Jerry Craig site (Scott Cummings and Moutoux 1998) documents changes in the position of the lower tree line in Middle Park. The site is located in the sagebrush grassland of the park near lower tree line. Stands of lodgepole pine, Douglas fir, and aspen occur not far to the west. The Late Paleoindian component of the site is situated in a topographic bowl on the north side of an east-trending ridge. Test excavations revealed a buried bison bonebed in the bowl and pollen samples collected from a stratigraphic column were analyzed (Kornfeld 1998a). Late Paleoindian points were recovered during excavations as well as from the ground surface in the bowl. As will be explained during a subsequent discussion of the site, some of the points are comparable to Cody types while others are assignable to a contemporaneous lanceolate type. Considering that prevailing winds are generally from a westerly direction, much of the pine and spruce pollen in the pollen column may derive from the relatively low segment of the Gore Range west of the park which is vegetated with extensive stands of lodgepole pine with some spruce occurring at higher elevations. Pollen samples were collected at the present ground surface and at nine deeper locations in the stratigraphic column, with the lowest sample associated with the bonebed dated at 9310 ± 50 B.P. Comparison of the relative amounts of arboreal and sage pollen from each sampled strata provides a means of measuring changes in the relative amounts of forested terrain and open sagebrush grassland in the vicinity of the site and this in turn presumably reflects changes in the elevation of lower tree
line relative to the site. The lowest three samples date to the Paleoindian period, with the highest dating to 8490 B.P. (Scott Cummings and Moutoux 1998:Figure 10.1). The proportion of arboreal pollen in all three Paleoindian samples is slightly higher than that from the present ground surface. This implies that during the Paleoindian period, the lower tree line was depressed relative to that of today because of somewhat greater precipitation.

Evidence for greater precipitation during the Cody period also comes from the fact that a soil horizon that formed in a forested environment occurs in association with the bonebed exposed in the test excavation. This indicates that a forest was present in the bowl at the bonebed during or slightly after the Paleoindian occupation (Reider 1998:64-66). Pedological evidence for expansion of forest onto the site during the Cody period bolsters the pollen evidence for greater precipitation at this time.

Returning to the pollen column, it may be noted that in post-Paleoindian times, the relative proportion of arboreal to sage pollen steadily decreases to a point sometime after 3710 B.P. This trend is here interpreted to represent a rising lower tree line and expansion of the sagebrush grassland at the expense of forest as precipitation decreased from Paleoindian times to a period of low precipitation sometime in the middle of the Holocene. From that time onward, the ratio of arboreal to sage pollen again gradually increases in the samples to that of today. This trend in the pollen data is interpreted to represent steady depression in lower tree line and expansion of forested terrain at the expense of sagebrush grassland as precipitation levels increased from the lows of the mid-Holocene to those of contemporary times.

Palynological data that is less detailed and not as well dated was collected during pollen studies completed during archaeological investigation of early Paleoindian sites in the park, including the Upper Twin Mountain site, which produced Goshen points (Kornfeld et al. 1999), and the Folsom component at the Crying Woman site (Naze 1994, Scott Cummings 1994). These data suggest that the rising elevation of the lower tree line began in early
Paleoindian times. Based on this evidence, it can be concluded that decreasing precipitation was a climatic trend that applied to the entire Paleoindian period in Middle Park and the adjacent high Front Range.

THEORETICAL EFFECTS OF CLIMATE CHANGE ON PALEOINDIAN LAND USE IN THE STUDY AREA

Having reviewed the evidence relating to climate change throughout the Paleoindian period in the environments of the study area, it is now possible to predict how this would have affected adaptations and land use through time. For each kind of environment in the study area, the following discussion will consider the affect of climate change on the ability of foragers to occupy the region year-round. Attention will also be paid to the manner in which climatic changes would or would not have affected methods of meat storage used by people engaged in communal hunts and the time of year during large-scale hunting occurred.

The Plains

The above review of paleoenvironmental data leads to the conclusion that foragers living on the Plains portion of the study area would have been subjected to a warming and drying climate. The cold-season climatic conditions to which Plains Paleoindians were exposed would have varied based upon which part of the Plains they inhabited and the particular time period during which they lived. For the Clovis period on the Southern Plains, temperatures were actually warmer during the cold-season than at present. By Folsom times on the Southern Plains, temperatures during the cold-season dropped below freezing. In this respect, Folsom climate was similar to that of today, although available evidence does not allow one to assess with precision the degree to which average cold-season temperatures differed from that of today, if at all. On the Northwest Plains, the evidence does support the
assertion that cold-season temperatures were colder that at present during Folsom times and that the cold-season temperatures had become progressively warmer by the Hell Gap period. It can be concluded, then, that during much (and perhaps all) of the early Paleoindian period on the more northerly parts of the Plains, the cold-season was appreciably colder than at present. If the evidence from the Southern Plains for elevated levels of precipitation during Folsom times was applicable for the north, the cold-season on the Northwestern and Northern Plains would have seen increase snowfall in comparison to the present. In contrast, cold-season temperatures during the Folsom and Plainview periods on the southern Plains were perhaps generally comparable to that of today with relatively small amounts of snow occurring infrequently. At the Lubbock Lake site, the similarity between the Cody period and contemporary times is evident in terms of the species composition of the small animals represented in the faunal assemblage and the amount of water in the drainage bottom. Based on this evidence, the temperature and precipitation patterns by this time in the Late Paleoindian period on the Southern Plains can be said to have been essentially comparable to those of modern times. Paleoenvironmental evidence from the Central and Northwestern Plains discussed above supports the assertion that sometime during the Cody time period, the warming and drying trend had progressed to the point where temperatures were comparable to those of today. In sum, the available evidence supports the view that temperatures across the Plains would have varied with latitude such that temperatures in northern sections were colder than in the south from at least as early as Folsom times. This temperature gradient would have progressively shifted northward as the climate became warmer.

The changing climatic conditions of the Paleoindian period would have brought about corresponding changes in the timing of communal bison hunts in parts of the Plains as well as in the methods used to store the meat. Theoretically, at any time during the post-Clovis Paleoindian period, there would have been a temperature gradient between northerly and southerly portions of the Plains. Short-term storage of meat during cold weather was
possible in the cold-season north of the boundary and drying of the procured meat would
have been required of foragers living south of the boundary. Review of the modern
latitudinal temperature gradient on the Plains in the preceding chapter demonstrated that
storage of meat by freezing is definitely possible on the Northern and Northwestern Plains, is
marginal within the Central Plains portion of the study area to the point of being ill-advised,
and is certainly not feasible on the Southern Plains. Paleoclimatic evidence reviewed in this
chapter indicates that the warming and drying trend of Paleoindian times had progressed to
the point where temperatures on the Plains were comparable to those of today sometime in
the Cody period. From this, it may be hypothesized that communal kills on the Northern and
Northwestern Plains during Cody times would have been held during the height of the cold-
season to take advantage of freezing weather to aid in preservation of meat. Communal kills
on the Central and Southern Plains would have taken place in months preceding the height of
the cold-season when temperatures were sufficiently warm to preserve meat by drying. In the
colder climate prevailing on the northern and central portions of the Plains during the early
Paleoindian period, the area within which meat could have been preserved by freezing would
have extended further south.

The expected effects of a colder climate on seasonal timing of communal hunts and
methods of meat storage employed is best justified by paleoclimatic evidence from the
Folsom period when temperatures on the northern and central portions of the Plains differed
the most from the modern-like conditions of Cody times. Paleoclimatic data reviewed above
indicates that winter conditions during Folsom times on the Northwestern Plains were much
colder than today with average January temperatures at the Agate Basin site being 24° F
today and an estimated 9° F colder, or 15° F, during Folsom times. Data permitting the
average winter temperature on the Central Plains during Folsom times to be estimated in
similarly quantified manner is currently unavailable. Information on the species composition
of the small mammal assemblage from the Folsom component at Lubbock Lake suggests that
winters during Folsom times experienced some freezing temperatures and from this evidence, climate of Folsom times is inferred to have been similar on a basic level to that of today. Because a latitudinal temperature gradient would have existed in Folsom times, one may interpolate that winter temperatures on the Central Plains would not have been as cold as on the Northwest Plains, where temperatures are estimated to have been 9° F colder, but winters would have been at least a few degrees colder. Preservation of meat via freezing is currently a marginal proposition on the Central Plains but with a drop in average winter temperatures by a few degrees, this form of food storage would have been feasible. If the above reasoning is sound, it may be hypothesized that during Folsom times, communal kills were held during the height of the cold-season and procured meat was preserved by freezing in not only on the Northern and Northwestern Plains, but also on the Central Plains. Communal kills on the Southern Plains would have been carried out in the months prior to the height of the cold-season and the meat preserved by drying.

With continued warming of the climate through Paleoindian times, the boundary north of which preservation of meat via freezing was possible would have shifted northward. Sometime in the Cody period, the boundary would have been around its modern position. As climatic warming progressed to the end of the Paleoindian period, the boundary would have shifted further to the north.

**High Front Range and Middle Park**

Paleoenvironmental data from the Colorado mountains demonstrate that foragers living in Middle Park and the high Front Range also would have experienced a warming and drying climate. Studies of fossil pollen and insects demonstrate that the upper tree line rose throughout Paleoindian times. This is indicative of a warming trend in summer temperatures from early in the period to around 9200 B.P. when continued warming produced hotter than modern warm-season weather thereafter. Pollen studies also document rise in the lower tree
line during much of the Paleoindian period, signifying that the climate became progressively
drier. Although studies of upper tree line directly reflect only changes in summer
temperatures, it may be safely assumed that summer and winter weather was correlated such
that the rising tree line evident throughout most of Paleoindian time also reflects a gradual
change from relatively cold winters early in the period to winters that were not drastically
dissimilar to those of today around 9200 B.P. and somewhat warmer thereafter.

From the above reconstruction, it may be concluded that the effect of climate on the
seasons that foragers would have been in Middle Park and the high Front Range as inferred
from modern winter conditions would have also applied to hunter-gatherers of Paleoindian
times. It was previously argued that foraging people living in Middle Park under modern
climatic conditions would have been forced to abandon the region to avoid frigid
temperatures during the height of the cold-season. Lower temperatures and greater snowfall
of early Paleoindian times would have motivated foragers even more so to leave the park at
this time of year. Temperatures that were warmer than today prevailed in the later part of the
Paleoindian period, after about 9200 B.P., but would not have brought about sufficient
warming to allow people to overwinter in the park. Foraging people occupying the high
Front Range under modern climatic conditions would have been forced by extremely cold
temperatures, heavy snowfalls, and lack of game to abandon the region from about December
through May. Colder temperatures and greater snowfall of early Paleoindian times would
have given foragers even more reason to relocate to lower elevations. The warming of the
climate after 9200 B.P. would not have warmed the climate enough to permit people to stay
at high altitude during the period from December through May. From the above, it may be
concluded that climatic determinants of land use patterns essentially remained the same
throughout the Paleoindian period in that people were forced by the climate to abandon
Middle Park and the high Front Range during certain periods of the year.
Reconstruction of climatic conditions during Paleoindian times also demonstrates that the seasonal timing of communal hunts in Middle Park and the high Front Range as inferred from a consideration of modern winter conditions would have also pertained to Paleoindians. As argued in the preceding chapter, since foragers occupying Middle Park and the high Front Range under modern climatic conditions would have to abandon these regions during the height of the cold-season, communal hunts would normally have been held in the months prior to abandonment. Any meat procured during communal hunts to be put into storage would necessarily have to be dried into jerky, making it lighter and thus more transportable. Because climatic conditions during Paleoindian times would have similarly required that foragers abandon Middle Park and the high Front Range, communal kills in these environments would necessarily have been held in the months prior to seasonal abandonment of the regions.

CHAPTER SUMMARY AND CONCLUDING REMARKS

This chapter has contemplated the effect that changing climatic conditions throughout the Paleoindian period would have had on specific elements of forager land use within the study area. A previous chapter considered the effects that the modern climate would have had on elements of forager land use in the three regions comprising the study area. The elements of land use include the seasonality of human occupation (year-round or seasonal), as well as the seasonal timing of communal hunts and the methods of meat storage used. Consideration of changing climatic conditions throughout the Paleoindian period determined that elements of land use in some regions of the study would not have changed. Elsewhere, elements of land use would have changed in response to changing climate, as detailed below.
Studies of changes in the elevation of upper and lower tree line within the study area document that a general warming and drying trend characterized Paleoindian climatic change in the Front Range and Middle Park. Changes in the elevation of upper tree line reflect changing summer temperatures with a rising tree line indicating rising temperature as forest is able to colonize alpine tundra. Study of fossil pollen and insects in the high Front Range demonstrate rising temperatures from the colder conditions prevailing in early Paleoindian times to around 9200 B.P. when the climate began to become warmer than today. Changes in the elevation of lower tree line indicate modification of levels of precipitation with a rise in tree line reflecting decreasing amounts of precipitation as sagebrush grassland expands at the expense of forest. Palynological studies in Middle Park document increased amounts of precipitation in Paleoindian times compared to today. Precipitation in early Paleoindian times was high, but decreased throughout the period. Pollen studies at the Jerry Craig site indicate that in the Cody period of Late Paleoindian times, the Middle Park climate was still experiencing greater levels of precipitation in comparison to today.

Review of evidence relating to climate in Middle Park and the high Front Range during the Paleoindian period reveals that elements of a forager land use pattern adapted to modern-like conditions would have also characterized Paleoindian land use. Under modern conditions, people would have been forced to abandon the high Front Range on a seasonal basis because of cold temperatures, heavy snowfall, and lack of game. Communal hunts in the high Front Range would have to be held during the months prior to the height of the cold-season and any meat from the kill to be stored for later consumption would have been preserved through drying. Given that climate in the high Front Range was colder and experienced greater snowfall during early Paleoindian times and subsequently approached modern conditions in the Late Paleoindian period, it is expected that Paleoindian land use would also have involved scheduling of communal hunts in the months prior to the arrival of the first heavy snows when the high country would have been abandoned. In Middle Park,
foragers living under modern-like conditions would have abandoned the park during the height of the cold-season to avoid frigid temperatures brought on by temperature inversions. Communal bison hunts in the park would therefore have been organized during the months prior to the height of the cold-season in order to preserve meat by making jerky. Considering that climate in Middle Park was colder with increased levels of snow during early Paleoindian times and thereafter trended toward more modern-like temperatures while retaining greater that modern snowfalls in the Late Paleoindian period, land use would have entailed carrying out communal hunts during the months preceding the height of the cold-season, at which time the park would have been abandoned.

Paleoenvironmental studies demonstrate that the overall warming and drying trend noted for the Southern Rocky Mountains also characterizes Paleoindian climatic changes on the Central Plains portion of the study area. Piecing together of paleoclimatic evidence from the Northwest, Central, and Southern Plains supports the case for long-term warming and drying. Evidence relating to prevailing temperatures has been garnered through study of faunal assemblages of small animals from sites in the Northwest and Southern Plains and demonstrates that a latitudinal temperature gradient was in effect for the Plains during the Paleoindian period. As is the case today, temperatures in the more northerly portion of the Plains were generally colder than regions to the south.

Evidence of the prevailing Holocene temperatures on the Plains has a number of implications for Paleoindian land use and subsistence practices. First, temperatures of the Paleoindian period would have permitted year-round occupation. Secondly, the latitudinal temperature gradient may have brought about variation in the kinds of meat preservation methods used and the seasonal timing of communal hunts. Modern weather station data presented in a previous chapter demonstrates that under the current climate, cold-season temperatures in the Northwest Plains are sufficiently low to permit meat to be preserved by freezing. In the Central Plains, this method of meat storage is marginal and ill-advised, while
in the Southern Plains, it is simply not possible. Under modern climatic conditions of the Central and Southern Plains, preservation of meat for later consumption during the height of the cold-season is best accomplished during the preceding months by drying it when the weather is sufficiently warm. Paleoclimatic evidence suggests that sometime during the Cody period in Late Paleoindian times, warming had progressed to the point that temperatures were similar to those of today. From this it may be hypothesized that during the Cody period, Paleoindians on the Northwest Plains could take advantage of freezing temperatures to aid in preserving meat and plan to hold communal bison hunts during the height of the cold-season. One the Central and Southern Plains, in contrast, communal hunts would necessarily have been held in the months prior to the coldest time of year to preserve meat through drying. Paleoclimatic evidence supports the assertion that under the colder temperatures prevailing in the Folsom period of early Paleoindian times, storage of meat by freezing was possible not only on the Northwest Plains, but also on the Central Plains. Communal bison hunts in these portions of the Plains may therefore have been held during the coldest time of the year. In contrast, paleoclimatic evidence from the Southern Plains suggests that meat preservation by freezing may not have been possible there during Folsom times. Communal hunts would thus have been planned for the months prior to the height of the cold-season so that meat could be preserved through drying.

From the above information, it may be predicted that changing climatic conditions in the Paleoindian period would have brought about corresponding changes in the seasonal timing of communal bison hunts and the methods of meat storage employed in the Central Plains portion of the study area. In early Paleoindian times, communal hunts would have been held during the height of the cold-season to preserve meat via freezing. During the Late Paleoindian period, warming of the climate would have required that communal hunts be planned for the months prior to the coldest time of year so that meat could be preserved by drying.
The preceding two chapters have developed an understanding of Paleoindian land use in the study area by considering the environmental factors that would have shaped land use patterns, as well as by using paleoenvironmental evidence to identify how changing conditions would have elicited differing land use and subsistence practices through time in the Plains portion of the study area. All of this has been done with the intent of producing a model of land use that may be tested using only the “stones and bones” that comprise the archaeological record. Toward this end, it will be necessary to properly characterize the tool stone composition of assemblages from the study area by assigning artifacts in collections to named tool stone types from sources located at varying distances form the site. In order to develop the knowledge necessary to describe the tool stone composition of an assemblage, the following chapter will discuss the tool stones used by Paleoindians of the study area and identify their source areas.
CHAPTER 7

TOOL STONES OF THE STUDY AREA AND SURROUNDING REGIONS
WITH PRELIMINARY OBSERVATIONS ON THE
TOOL STONE COMPOSITION OF ASSEMBLAGES

This chapter will describe identifying characteristics of tool stones comprising the
flaked stone artifact assemblages from the study area, map the distribution of the stone
sources, and make basic observations about the tool stone composition of the collections.
With a few exceptions that will be noted, available information indicates that the tool stones
derive from high-quality sources that would have been suitable places at which to gear up for
a communal hunt. The tool stones derive from sources both within and outside the study
area, as shown in Figure 7-1. Many of these tool stones have been adequately discussed in
the literature and therefore information on their defining characteristics, locations of their
sources, and the geological contexts in which they occur will only be summarized here.
Much of the Jurgens collection, however, is composed of varieties of tool stone that derive
from sources in northeastern Colorado and information on these tool stones has yet to be
made available in the literature. Therefore, these tool stones will be described in detail here
as will the geological context of their sources. In some cases, flaked stone raw materials
from an assemblage can not be assigned to a specific defined and named tool stone type with
one or more documented sources, but some rudimentary information on the characteristics of
the tool stone and assertions as to its source area are available in the literature. These tool
stones are discussed here to the extent that they are known. For assemblages from a few
sites, existing literature indicates that some tool stone was obtained from local river gravels
Figure 7-1. Distribution of tool stone sources within the study area and in surrounding regions.
without giving any further information. In these situations, the tool stone category will be discussed to the extent possible in a later chapter on individual site assemblages, but is not listed here.

Terms that have been applied in the archaeological literature to label tool stones in and around the study area should perhaps someday be changed to use terms that better reflect tool stone origin, but a full discussion of this is beyond the scope of the dissertation. Rather, existing terms for tool stones from specific sources that are ingrained in the literature will be used here. Since traditional theory maintains that Paleoindians preferred microcrystalline stone and avoided granular materials, the manner in which the various named kinds of stone raw material are grouped into the main categories of granularity is here reviewed.

Various kinds of microcrystalline silicate rocks form the largest category of tool stones and share the quality of being composed of a matrix of microscopic silica crystals. Many archaeologists would describe an opaque microcrystalline silica as a chert and a translucent or transparent variety as a chalcedony. However, this is not good practice for those concerned with sourcing tool stones because it is common for a source of microcrystalline silicate to produce both opaque and translucent stone. “Jasper” is a term that has been used to refer to an opaque microcrystalline silicate that is colored by iron and commonly occurs in shades of yellow, brown, or red. “Agate” is a term used to refer to a microcrystalline silicate with a variegated coloration. “Moss agate” is used to refer to an agate with dendritic inclusions. The term “flint” is used principally in Old World archaeology and is synonymous with “chert” as used in the New World literature. A final kind of microcrystalline silicate used prehistorically as raw material for tool manufacture is petrified wood, which is formed when buried wood is replaced by silica precipitated from groundwater.

Among the granular silicate rocks used as tool stones are two kinds of quartzite; a rock type produced through alteration of sandstone. Orthoquartzites are sedimentary rocks
produced through silicification of sandstone which occurs when silica is precipitated from ground water percolating through the sandstone. The resulting rock type can possess good concoidal fracturing qualities and based on this, it is reasonable to suppose that some orthoquartzites would have been desirable raw materials for stone tool manufacture. Granularity of orthoquartzites can vary based in large part on the grain size of the sand composing the original sandstone. Metaquartzites are metamorphic rocks produced when sandstones are deeply buried, melted as a result of being subjected to intense heat and pressure, then cooled. Metaquartzites have a rough texture, are difficult to flake, and possess poor concoidal fracture characteristics.

A final, minor category of tool stone based on granularity is that of amorphous silicate rocks, with obsidian being the main example. Silicate rocks possessing an amorphous structure formed through rapid cooling of molten rock and therefore do not have a crystalline structure. Consequently, amorphous silicate rocks possess excellent concoidal fracture characteristics. Obsidian, however, comprises a negligible amount of the tool stones used by Paleoindians of the study area, being represented by a miniscule number of artifacts from the Lindenmeier and Jerry Craig sites.

TOOL STONES FROM SOURCES WITHIN THE STUDY AREA

Plains Portion of the Study Area

The following section describing the tool stones of the Plains portion of the study area is by far the lengthiest, reflecting the fact that even though tool stone sources are relatively sparse in this environment, the Plains covers a much greater proportion of the study area than the other environments. Also, the section is inflated by a thorough discussion provided of those tool stones from the Jurgens site that have not been described in existing literature.
**Smoky Hill Jasper**

This opaque microcrystalline silicate rock was a major tool stone of native peoples living in the eastern portion of the study area. It is normally found in various hues of yellow to brown, but also can be red, orange, green, white, gray, or black, with purple being the rarest color. A characteristic of the stone which is sometimes present and can help distinguish it from other microcrystalline silicates is the presence of abundance small white spherical inclusions which are likely fossils of marine organisms. It derives from select outcrops of the Smoky Hill Chalk, a member of the Niobrara Formation. The Smoky Hill Chalk was laid down in the Cretaceous inland sea over much of what is now the Central Plains. Leaching of volcanic ash beds in the overlying Ogallala Formation (Miocene) and subsequent deposition of silica in the upper part of the chalk stratum by groundwater percolating downward caused silicification to take place only in select areas where the Smoky Hill Chalk is directly overlain by the Ogallala (Wedel 1986:28). Many synonyms exist for this tool stone including Alma or Graham or Republican River jasper (Wedel 1986:28), Niobrarite (Holen 1991:401), and Niobrara chert (Stanford 1978:93). The term used herein derives from the specific stratigraphic unit from which the tool stone originates. Holen (1991:Figure 23.1) maps a source area for this tool stone that covers a large expanse in northern Kansas and extends a short distance into southern Nebraska. This area is in the watersheds of the Republican, Solomon, and Smoky Hill rivers. Within this large area, Wedel (1986:Figure 2.3) plots the location of a few specific quarry sites. A second, much smaller source area is present in southwest Nebraska within drainage of Medicine Creek, a permanent tributary of the Republican River (Holen 1991:Figure 23.1).

**Ogallala Orthoquartzite**

This tool stone is described as being an olive green to greenish gray orthoquartzite that can weather to a greenish white (Wedel 1986:30-31). It normally is composed of sand in
the coarser size grades and Wedel (1986) reports that native peoples of the Republican
drainage tended to use this material to manufacture tools such as large scrapers that did not
require fine retouch to produce. Because the flaking quality of the raw material was not
conducive to manufacturing all manner of tools needed to carry out a communal bison hunt,
 sources of Ogallala orthoquartzite would not likely qualify as high-quality sources at which
prehistoric foragers would have geared-up. The stone derives from the Ogallala Formation of
Miocene age. Holen (1991:Figure 23.1) maps a large source area for Ogallala orthoquartzite
in western Kansas that encompasses the main source area for Smoky Hill jasper and also
extends some distance beyond this area (Figure 7.1). He further notes its presence in that
portion of the Republican River drainage covered by the southern tier of counties in
Nebraska. Wedel (1986:31) notes a potential source of this material east of the confluence of
Medicine Creek and the Republican River, but goes on to say that the report was not verified.

The tool stone may also be available outside the study area. Holen (1991:Figure
23.1) indicates that outcrops of Ogallala orthoquartzite also occur in northeast and north
central Nebraska along the Missouri and Niobrara Rivers. Information presented by Ahler
(1977:137) suggests that the distribution of outcrops of the green orthoquartzite continues
along the Missouri River in southeastern South Dakota, where the tool stone is referred to as
Bijou Hills orthoquartzite. Here, the stone derives from the Bijou Hills Facies of the Miocene
and Pliocene age Valentine and Ash Hollow formations which outcrop in the Bijou Hills and
other uplands.

Flat Top Chalcedony

This microcrystalline silicate was a major tool stone for indigenous people of the
Central Plains. A translucent form varies from light-to-medium gray or brown to pink or
lavender with some hand samples grading to a red or purple. White spherical inclusions,
splotches, and mottling may be present in the translucent form. Some hand samples collected
at the source and artifacts in the Jurgens assemblage of this material have a banded appearance. An opaque variety is white and will rarely contain fossils, including spherical ones that may be ostracods. Figure 7-2 presents a sample of artifacts from the Jurgens site showing the range of colors typically found. The stone is available as float and as lenses in a fine-grained, light-colored sedimentary rock which forms the caprock of Flat Top Butte, a high isolated mesa in the South Platte River drainage of northeast Colorado (Greiser 1983). The source is recorded as site 5LO34. Depressions denoting prehistoric quarrying of the tool stone are present on the butte (Figure 7-3).

A geologic study into the origin of this geographically limited, high-quality tool stone source has yet to be completed, but the nature of the rock stratum in which it is mapped and the presence of fossils in the stone suggests some possibilities. Flat Top Butte is mapped as part of the White River Group of Oligocene age (Scott 1978). More specifically, the strata of the butte are likely part of the Brule Formation, a light-colored volcanic tuff that forms the Chalk Cliffs which are situated to the north along the Colorado-Wyoming state line. Volcanic tuff is high in silica (Sanders et al. 1976:87) and groundwater percolating through this powdery sediment may have dissolved silica and later precipitated it as a bed of chert. The presence of what appear to be ostracod fossils in the stone may provide another clue to its origin. Ostracods are small, spherical shelled animals that inhabited bodies of fresh water. This would suggest that perhaps the presence of a body of water near the present location of Flat Top Butte may have somehow been involved in the formation of a high-quality source of tool stone in a relatively restricted geographic area.

Other sources of similar appearing microcrystalline silicate occur in restricted areas within the extensive area where the White River Group outcrops on the plains of Colorado, Wyoming, Nebraska, and South Dakota. The stone from all such sources has been referred to as White River Group Silica or WRGS (Knudsen 2002:115-116). Another so-called “point
Figure 7-2. Selected artifacts from the Jurgens site showing the range of colors typically seen in Flat Top chalcedony, as well as the mottling and banding characteristic of some pieces.
Figure 7-3. Quarry pit atop Flat Top Butte denoted by depression between the person on horseback and the man on foot.
source” of WRGS present within the study area to the north of Flat Top Butte is discussed below.

**Table Mountain Chert**

White River Group Silica is also present on Table Mountain, located south of the North Platte River just on the Wyoming side of the border with Nebraska. (This tool stone is not to be confused with Table Mountain jasper, a Middle Park tool stone). Hoard et al. (1993) note that stone from the Table Mountain source of WRGS is macroscopically similar to that from Flat Top Butte but can be distinguished through neutron activation analysis of trace elements. Knudson (2002:116) acknowledges the similarities existing between stone from these sources, but states that in her experience, stone from Flat Top Butte is “pinker”.

**White River Group Gravel (WRGG)**

Deposits of gravel at the base of the White River Group produce stream-rounded cobbles of orthoquartzite and chert that were an important source of tool stone for prehistoric foragers on the Central Plains of Colorado and elsewhere. Varieties of tool stone originating from exposures of the stratigraphic unit comprise a substantial portion of the Jurgens assemblage and yet are not discussed at length in existing literature. Consequently, the tool stones deriving from the White River Group will be described in detail. Exposures of the stratigraphic unit cover extensive areas of the Central, Northern, and Northwestern Plains. The White River Group is principally of Oligocene age, but the basal gravels that are the source of the tool stone may date to the late Eocene (Terry 1998). Traditionally, the White River Group is defined as being composed of the Brule Formation, which consists of thick fluvial sediments largely derived from volcanic ash, along with the underlying Chadron Formation, which is also of fluvial origin and includes the gravel deposits of concern here (Scott 1978). The gravel deposits were produced during a period of intensive erosion when
durable rocks were transported by rivers from the Rocky Mountains and related smaller uplifts out onto the Great Plains.

In his review of the lithic composition of assemblages from the Middle Missouri area of the Dakotas, Ahler (1977:134) first recognized the gravels as a source of tool stone used by Native Americans. He classified cobbles of opaque microcrystalline silica from the Chadron Formation as “Chadron chert.” Ahler noted the occurrence of chert cobbles in outcrops of the Chadron Formation in northwest Nebraska near Toadstool State Park and in the badlands of southwest South Dakota. I visited a gravel deposit near the above-mentioned state park (T 34 N, R 52 W, Sections 17 and 20) and determined that the chert and orthoquartzite cobbles present were basically the same to those present at sources in Colorado. This is likely due to the fact that chert and orthoquartzite-bearing sedimentary formations exposed along the base of the Rocky Mountain chain and related uplifts produce similar appearing tool stones. The chert and orthoquartzite cobbles present in the gravel deposits on the plains of northeast Colorado likely were transported eastward from the exposed limestones and sandstones along the eastern base of the Southern Rocky Mountain chain. Similar chert and orthoquartzite cobbles observed in the gravel deposits of northwest Nebraska probably derive from different exposures of the same limestone and sandstone formations exposed in the Hartville Uplift, located to the east, or perhaps from outcrops that encircle the Black Hills, situated to the north in South Dakota and Wyoming. In light of the above, it can be said that gravel deposits at the base of the White River Group provided similar appearing tool stones to native peoples in widely separated areas of the Great Plains.

In part due to taxonomic revisions in stratigraphy, the term White River Group gravel (WRGG) is considered a better term than Chadron chert for referring to the varieties of tool stone of concern here. Due to revision of Tertiary stratigraphy in Nebraska, the basal gravel-bearing beds of the White River Group in northwest Nebraska are now assigned to the Chamberlain Pass Formation, rather than to the Chadron (Terry 1998:27). Also, the gravel
deposits at the base of the White River Group do not solely produce chert, but much orthoquartzite is also present in cobble form and was also exploited prehistorically. Finally, rather than assigning tool stones from the gravel deposits to a particular named formation, it is preferable for archaeologists to refer to the entire group of formations because the geologic maps commonly used to assess tool stone potential of an area map the entire White River Group, rather than the individual constituent formations. Thus, subsuming the chert and quartzite cobbles under the term White River Group gravels will alert archaeologists to the potential for these tool stones to outcrop in a particular region on the Plains if this extensively occurring stratigraphic unit is present.

In relation to the Jurgens site, the closest known sources of White River Group gravel lie in an east-west aligned band situated to the northeast, between the South Platte River and the Colorado-Wyoming state line (Figure 5.1). On the eastern end of this source area lies site 5WL1445, a lithic procurement site that extends for over four km along the crest of a ridge separating intermittent tributaries of Crow Creek. Here, orthoquartzite and chert cobbles available from a linear outcrop of White River Group gravel were procured and worked by native people. In the eastern end of the source area lie two areas within the drainage of Pawnee Creek where tool stone procurement sites are clustered.

One of these tool stone procurement locations is believed to be an area by Holiday Springs. In the Jurgens site report, Wheat (1979:123) refers to the Holiday Springs quarry as a source of chalcedony used to produce a number of the artifacts in the assemblage. However, he did not elaborate on the source location of this tool stone in the site report or other publications. Thus, the source of Holiday Springs chalcedony was somewhat of a mystery to many Colorado archaeologists after the death of Wheat in 1997. From the late 1950s to his retirement in the 1990s, Wheat was on staff at the Museum of Natural History at the University of Colorado. In 2005, I examined a comparative tool stone collection amassed by Wheat from Colorado and neighboring states that is housed at the museum. A large
sample of Holiday Springs chalcedony was present. This raw material is fully describe
below, but it should be noted here that it is a distinctive stone because it commonly has black
dendritic inclusions and would therefore would be labeled as a moss agate by many
archaeologists. Furthermore, the hand samples often were in the form of stream rounded
cobbles. When going through the boxes of tool stone samples, I fortunately came upon
copies of term papers by then CU graduate students Warren Church (1983) and Robert
Nycamp (1983). Church is now an archaeology professor at Columbus State University in
Georgia and Nycamp is a federal archaeologist in Boulder. The paper by Nycamp (1983:2)
indicates that as part of a class in lithic technology, the two were part of a student group that
visited tool stone sources in northeastern Colorado shown to them by avocational
archaeologist Al Parrish of Fort Morgan. Nycamp’s report (1983:3) further indicates that
Parrish was trained in part by CU Museum archaeologists Joe Ben Wheat and Herb Dick.
Based on this information, it would seem that Parrish provided the information on the
Holiday Springs source mentioned by Wheat.

Through his association with Al Parrish, Herb Dick may have learned of a gravel tool
stone procurement site located roughly 9 km to the east of the Holiday Springs area near the
abandoned settlement of Kalouse. The site recorded by Dick as 5WL5. Parrish showed the
graduate students the Holiday Springs and Kalouse areas and the location of these lithic
sources where fortunately documented in the term papers.

I visited the sites in the Kalouse area discussed by Church and Nycamp and found
that the available varieties of microcrystalline silicates partly duplicate the raw material of
WRGG artifacts in the Jurgens collection. Tool stone procurement sites in the Kalouse area
occur as dense gravel deposits atop low hills and ridges (Figure 7-4). Site 5WL5 was
recorded in greater detail and another site discussed by Church was recorded as 5WL5181. A
landowner informed me of a third site in the general vicinity, which was recorded as
5WL5182. Mr. Conrad (“Dutch”) La Rose volunteered his time to assist in recording the
Figure 7-4. Gravel deposit containing cobbles of orthoquartzite and jasper outcropping from the White River Group at site 5WL5182 near the abandoned settlement of Kalouse. Pawnee Buttes on skyline.
According to Wheat (1979:122-123), tool stones represented in the Jurgens assemblage include orthoquartzite and jasper cobbles from river gravel deposits. The stream-rounded cortex present on some artifacts of these materials led Wheat to assume they were procured from local exposures of the Kersey Terrace, a Quaternary deposit of primarily river gravels present along the South Platte River in the vicinity of Greeley. However, cobbles of jasper and orthoquartzite do not occur in appreciable quantities in the South Platte River gravels near Greeley. Artifacts in the Jurgens collection made from stream-rounded jasper cobbles are indistinguishable from those present in the Kalouse gravel deposits. As discussed in a following section on Kalouse jasper, a number of distinctive traits help to identify artifacts of jasper as originating from deposits of WRGG.

Particular varieties of orthoquartzite available in cobble form at the Kalouse sources are also present in the Jurgens collection. One variety is known as Morrison orthoquartzite. Another variety is designated “very rough-textured orthoquartzite.” Of course, many orthoquartzites have a rough texture, but this variety is unusually so. The orthoquartzite was evidently produced through silicification of a sandstone that, upon crystallization of the introduced silica, produced an internal structure in the orthoquartzite that fractures in a manner that produces a rough textured-surface. This quality does not necessarily denote that the raw material does not flake well. A tally of artifacts present at 5WL5 according to tool stone type demonstrates the orthoquartzite is the most common kind of flaked stone artifact (see site form) and this appeared to be the case at the two other sites in the Kalouse area as well.

However, it is not possible to definitively state that the Kalouse area was the sole source of WRGG materials present at Jurgens. One of the orthoquartzites defined from artifacts in the collection (“light-to-medium red, very fine-grained orthoquartzite”) was not observed at the Kalouse sources. Also, some artifacts of very rough-textured orthoquartzite in the collection were produced from cobbles of colors not observed at Kalouse (particularly
olive green) or were produced from cobbles of a large size range that is not available at the sites. For example, the largest flaked stone artifact in the collection is made of very rough-textured orthoquartzite. The artifact is designated as SL1-57 and is classified as a flake knife by Wheat, who indicates the artifact is nearly 13 cm long (1979:Figure 56d, Table 34). A flake tool of this size would necessarily have been struck from a piece of raw material of considerable size. Cobbles of this variety of orthoquartzite presently available on the Kalouse sites rarely exceed 10 cm in maximum dimension.

I also visited the WRGG source area at Holiday Springs. Two lithic procurement sites discussed by Church (1983) were recorded as 5WL5179 and 5WL5180. Tool stone types present are duplicated in the Jurgens collection. From a local rancher by the name of Albert Kester, I learned that two springs in the channel of Igo Creek that are not marked on a 7.5' USGS topographic map are known among the local people as Holidays Springs. Legal description of the springs is: T 9 N, R 59 W, Section 3, SE ¼ of the SW ¼. The most notable pieces of raw material on the recorded sites are rounded pebbles and cobbles of the moss agate designated Holiday Springs chalcedony. Nycamp (1983:5) notes that a thin lens of the material outcrops in the vicinity of Holiday Springs, but on the sites examined, the material was only observed to occur as float in the form of subrounded stream cobbles and pebbles. Approximately equal amounts of cobbles of orthoquartzite occur along with those of Holiday Springs chalcedony. The orthoquartzite is commonly fine-grained, is usually opaque, and frequently occurs in shades of brown, red, orange, and rust. Sometimes the stone will have black dendritic inclusions, which is an unusual characteristic for orthoquartzite. Though relatively few in number, some artifacts in the Jurgens collection are made of orthoquartzites with black dendritic inclusions and may derive from stone collected in the Holiday Springs area. Opaque dendritic orthoquartzite is subsumed under the “other orthoquartzite” variety, as described below. The report of a lens of Holiday Springs chalcedony suggests that some geological process resulted in silica being precipitated out of solution to form the bed of moss
agate. Presence of float of dendritic orthoquartzite suggests the geological process also brought about the silicification of a sandstone into an orthoquartzite with black mottles or dendritic inclusions. The above would suggest that Holiday Springs chalcedony and the dendritic orthoquartzite formed in place within the White River Group in the general vicinity of Holiday Springs, rather than being types of tool stone that were transported from distant uplifts by fluvial action, as was the case with the Kalouse materials. The Holiday Springs source area is about 350 feet higher in elevation than the Kalouse source. Strata of the White River Group and other strata on the plains of northeast Colorado are basically flat-lying. These observations would in turn suggest that the Holiday Springs source is higher in the stratigraphic section than the fluvial gravel deposits at the base of the White River Group.

The following are detailed descriptions of the varieties of WRGG tool stones present in the Jurgens collections. Varieties of orthoquartzite are discussed first, followed by description of microcrystalline tool stones.

WRGG: Very Rough-Textured Orthoquartzite. As discussed above, a defining characteristic of this material is an internal structure that produces a very rough-textured surface upon being flaked. The material often exhibits a high luster. It occurs in a myriad of colors, including various shades of gray, brown, red, purple, rust, light yellow, etc. A sample of artifacts made of this material is provided in Figure 7-5 to give the reader an impression of the range of colors characteristic of the tool stone. This orthoquartzite was found to be the most common variety of WRGG at the Kalouse source area and in the Jurgens collection. Its prevalence in the collection suggests that even though it fractures in a manner that produces a very rough-texture, it apparently flaked well and was much used as a raw material in artifact manufacture.
Figure 7-5. Selected artifacts from the Jurgens site showing a range of colors of very rough-textured orthoquartzite from gravels of the White River Group.
**WRGG: Morrison Orthoquartzite.** This tool stone is most commonly a light gray, very fine-grained to fine-grained orthoquartzite with white mottling. Descriptions of clast size of particles comprising granular tool stones will follow the Wentworth system (Matthews 1974:Table 3.1). As illustrated in Figure 7-6, the range of possible colors includes medium gray and light tan. When occurring in the form of stream cobbles in White River Group gravels, stone near the cortical surface can be stained red and rust-colored. In contrast to all other varieties of WRGG, which occur in the Kalouse area in the cobble-size range, Morrison orthoquartzite is also present at sites 5WL5181 and 5WL5182 in the form of irregularly shaped, stream-rounded boulders. The material is believed to be identical to tool stone that is common in parts of Wyoming, in particular the Bighorn Mountains (Frison and Bradley 1980). Here, the tool stone is named for exposures of the Morrison Formation of the Jurassic period that outcrop along the base of the mountains. The Jurassic formation also outcrops along the eastern base of the Front Range and Laramie Mountains. Silicification of sandstone within this formation is believed to have produced a similar-appearing orthoquartzite that was the source material for the cobbles that were carried by rivers out onto the plains of northeastern Colorado and deposited at the base of the White River Group.

**WRGG: Light-to-Medium Red, Very Fine-Grained Orthoquartzite.** The name of this variety of orthoquartzite aptly describes its color and granularity. It is known from the Jurgens collection, but was not observed at the Kalouse sites. Color of the stone can vary somewhat in hue and saturation, but is usually of a uniform character through the artifact (Figure 7-6).

**WRGG: Other Orthoquartzite.** This category was created for the relatively few orthoquartzite artifacts in the Jurgens collection whose characteristics do not match those of the varieties of orthoquartzite defined above. Commonly, the material is opaque, fine-grained
Figure 7-6. Selected artifacts from the Jurgens site showing the range of colors seen in varieties of tool stone from the White River Group gravels and the South Platte River gravels. Top row: artifacts of Morrison orthoquartzite from the White River Group gravels. Bottom row, left group: artifacts of light-to-medium red, very fine-grained orthoquartzite from the White River Group gravels. Bottom row, two artifacts on the right: artifacts of white-to-light gray metaquartzite from the South Platte River gravels. Artifact on left is a bifacial core from Area 2 and artifact on right is an informal retouched flake tool (specifically a graver) from Area 1 that refits to the core.
orthoquartzite that occurs in shades of brown and red and has black speckles or dendritic inclusions. These characteristics suggest the stone derived from the Holiday Springs source or a similar place in northeastern Colorado where moss agate and dendritic orthoquartzite formed in Tertiary strata.

**WRGG: Holiday Springs Chalcedony.** One of the defining characteristics of this microcrystalline tool stone is the common occurrence of black dendritic inclusions. Some archaeologists may therefore refer to it as a moss agate. Rarely, the dendritic inclusions are so dense, the material is basically black. The color and translucency of the matrix in which the dendrites occur varies from opaque to translucent, with the more opaque portions being white and more translucent portions having a brown, gray, or whitish tint (Figure 7-7). The raw material can contain spherical inclusions and some of these that have been cut by a flake scar have exposed centers that have oxidized to an orange color. Cortical surfaces remaining on some artifacts of this material in the Jurgens collection are of two varieties. Some artifacts have an opaque white, stream-rounded cortex that is identical to that on pieces of raw material present as stream transported pebbles and cobbles on sites 5WL5179 and 5WL5180 (e.g. Figure 7-7, Specimen n). Other artifacts have a rough cortex and may derive from a lens such as the one visited by Nycamp (1983:5) (e.g. Figure 7-7, Specimens c, l, m, o). Thus, the raw material was used prehistorically in the form of angular pieces obtained from an outcropping lens and as stream-rounded cobbles available where alluvial deposits are exposed at the ground surface. Some amount of Holiday Springs chalcedony used prehistorically therefore does not derive from gravel deposits in the White River Group, but its inclusion in the WRGG category should not affect the analysis of the tool stone composition of the assemblage. Holiday Springs chalcedony shares many characteristics with a moss agate variety of Kremmling chert, making the task of differentiating between the two difficult or impossible were it not for the fact that they occur in widely separated areas situated on
Figure 7-7. Selected artifacts from the Jurgens site showing characteristics of Holiday Springs chalcedony from the White River Group. The artifacts demonstrate the typical range of colors, as well as the white spherical inclusions and black dendrites characteristic of some pieces. Specimens c, g, l, m, and o have areas of rough cortex, indicating they originate from a lens of microcrystalline silicate. Specimen n has rounded cortex, indicating it was procured from a gravel deposit. Specimen f is a notched Archaic point found on the ground surface near Area 1.
opposite sides of the Front Range. Some pieces of Holiday Springs chalcedony can be
differentiated from Kremmling chert because they contain mottling and spherical inclusions
that are red, a characteristic not found in the later raw material.

**WRGG: Kalouse Jasper.** This relatively common, opaque variety of microcrystalline
stone from the White River Group gravels often possesses a number of identifying
characteristics. The tool stone accounts for about one-fifth of the debitage at 5WL5.
However, in the Jurgens collection, it was not nearly as favored a raw material for artifact
manufacture as the orthoquartzites from White River Group gravels. The stream-rounded
cortex of the jasper is commonly covered with Hertzian cone fractures from having been
battered during stream transport. Broken nodules reveal that the cortex can be thick and
display a color distinctly different from that of the unweathered interior. If this is the case,
the cortex is often black or yellowish brown (Figure 7-8, Specimen a). Color of the
unweathered jasper commonly includes light or medium shades of gray, brown, yellow, red,
or purple, but bright orangish red and off-white also occur. The jasper can display concentric
bands that usually are subtle (Figure 7-8, Specimen a), but sometimes are visually striking.

Occasionally, the jasper will contain fossil invertebrates that help to bracket the age
of the limestone from which the cobbles likely eroded. A cobble of Kalouse jasper in the CU
museum’s tool stone collection contains what appears to be segments of crinoid stems. I
collected a hand sample from 5WL5181 containing a fusiline and another from 5WL5182
that incorporated a lacey bryozoan. Crinoids and lacey bryozoans where abundant during the
Mississippian, Pennsylvanian, and Permian periods. Fusilines are small, elongated
invertebrates with shells that taper toward each end. They existed only in Pennsylvanian and
the above information, the limestone strata in the Ingleside Formation of the Permian period,
Figure 7-8. Selected artifacts from the Jurgens site made of varieties of tool stone from the White River Group gravels. Specimens a-d: Kalouse jasper. Specimens e-l: brown-to-orange or yellow chert. Specimens m-p: dark-to-medium brown petrified wood.
which is exposed along the Front Range (Courtright and Braddock 1989), is one of the possible original sources of the Kalouse jasper found in northeast Colorado.

**WRGG: Brown-to-Orange or Yellow Chert.** As aptly described by its name, this microcrystalline silicate varies in color from brown to orange or yellow and also occurs in either light, medium, or dark shades (Figure 7-8). It also varies its degree of translucency with the more translucent pieces often possessing spherical inclusions. This raw material constitutes a very minor amount of the White River Group gravels available in the Kalouse area.

**WRGG: Dark-to-Medium Brown Petrified Wood.** Another uncommon variety of WRGG is a petrified wood that usually is dark brown, but sometimes can be medium brown or have streaks of white (Figure 7-8). At the Kalouse sites, observed pieces of the petrified wood that retain a stream-rounded cortex were small and usually tabular, apparently due to a tendency for the material to fracture along what was originally the grain of the wood.

**WRGG: Other Chert.** This relatively small category was created to accommodate miscellaneous artifacts of chert in the Jurgens collection that do not possess the defining characteristics of the other microcrystalline varieties of WRGG. Presence of a stream-rounded cortex implies the chert derives from gravel deposits of the White River Group. No detailed description of the chert in this miscellaneous category will be provided.

**South Platte River Gravels (SPRG)**

Geologically recent fluvial deposits in the floodplain of the South Platte River, as well as in exposures of terraces further from the river itself, would likely have served as sources for tool stone throughout prehistory. Gravel in these deposits produce large cobbles
and boulders of durable igneous and metamorphic rocks that may have been exploited for ground stone artifacts at the Jurgens site, such as some of the manos. The local South Platte gravels were the likely source of heavy, expedient implements, including anvil stones and hammerstones that are essentially river cobbles of appropriate shape (Wheat 1979:130-132). These artifacts may very well have been procured after the kill to extract marrow on-site from bison bone. South Platte River gravel (SPRG) was also exploited by inhabitants of the Jurgens site as a source of tool stones for informal flaked stone artifacts. South Platte River gravel was the likely source of cobbles of metaquartzite, consolidated tuff, and a small amount of Dawson petrified wood.

**SPRG: White-to-Light Gray Metaquartzite.** Because gravel from both the White River Group and the South Platte valley derive materials from erosion and transport of so-called basement rocks forming the core of the Rocky Mountains, cobbles of identical igneous and metamorphic rocks are present in gravel deposits of both geologic units. A white-to-light gray metaquartzite commonly found in sills and dikes of the basement rock in the Front Range is referred to by geologists as pegmatite. It was occasionally observed as small cobbles in the Kalouse gravel deposits. Larger cobbles of the material were used as hammerstones by people at the Jurgens site, possibly to break bison bone in order to extract marrow. Since the site is substantially closer to the Front Range than to the Kalouse deposits, it is thought that the cobbles of pegmatite metaquartzite present in the assemblage more likely were procured after the bison kill from the South Platte River gravels in the vicinity of the site, rather than from the Kalouse gravels as part of gearing up for the hunt. For this reason, the white-to-light gray metaquartzite present is classified as a variety of tool stone from the South Platte River gravels. Only four of the 2,714 flaked stone artifacts from the Jurgens site are of the white-to-light gray metaquartzite, so the somewhat arbitrary classification of the
raw material should not substantially affect analysis of the assemblage’s tool stone composition.

Cobbles of this metaquartzite also served as cores for informal retouched flake tools as illustrated by a flake tool of this material from Jurgens that was used as a graver and found to refit to the core from which it was struck (Figure 7-6). Sometimes, the cortex on cobbles of the metaquartzite is stained a rust color and this can remain on higher areas of the resulting artifacts, as is evident in Figure 7-6.

**SPRG: Other Metaquartzite.** Other varieties of metaquartzite account for a very small percentage of the Jurgens flaked stone artifacts and are classified with tool stones thought to derive from the South Platte gravels. As with the white-to-light gray metaquartzite, there is some possibility that artifacts of the miscellaneous varieties of metaquartzite actually were obtained from earlier gravel deposits, such as those in the White River Group. Other metaquartzites were most commonly used to produce flakes, utilized flakes, and retouched flake tools, rather than formal artifacts. No detailed description of the metaquartzite in this miscellaneous category will be provided.

**SPRG: Off-White-to-Light Brown Tuff.** An appreciable quantity of stream-rounded pebbles of consolidated tuff that are often tabular in shape was recovered from Jurgens. The pebbles apparently were brought into the site by people. The tuff may derive from the Brule Formation, which is largely of Oligocene age, but any number of Tertiary formations that contain sediment derived from volcanic ash falls could have produced the tuff, so the primary source of the stone remains uncertain. Many pebbles of tuff show no evidence of use and their function is enigmatic. A few items of tuff are informal flaked stone artifacts. A non-tuff flake was found *in situ* positioned between a bison skull and its still articulated axis at the Jurgens site and this was interpreted as representing use of artifacts as wedges to assist in
disarticulation of carcass segments (Wheat 1979:65, Figure 33a). One of the artifacts of tuff is here classified as a wedge and may represent use of locally available gravels as raw material for expedient tools to assist with bison disarticulation.

**SPRG: Dawson Petrified Wood with Rounded Cortex.** As fully discussed in the following section, Dawson petrified wood is a major tool stone in the Jurgens assemblage and is believed to have been principally obtained from primary sources on the Palmer Divide. The raw material derives from the Dawson Formation which was deposited in the Denver Basin primarily during the Paleocene.

Subsequent erosion of the Dawson has transported water-rounded pebbles and cobbles of this durable material northward from its primary geological context to be deposited in Quaternary and Recent alluvial deposits along streams. The tool stone is known to have been deposited in river gravels now exposed along the South Platte River and it may also be present in the watersheds of the northward trending intermittent streams that drain the southern portion of the Colorado Piedmont. Archaeologists with the University of Northern Colorado in Greeley report finding Dawson petrified wood in gravels of the South Platte River near Platteville (Robert Brunswig, personal communication 2006). The town of Platteville is 31 km southwest of the Jurgens site. Avocational archaeologist Tom Westfall confirms the prevalence of Dawson petrified wood along the South Platte River south of Greeley. Starting at Ft. Lupton, a small town on the river about 30 km north-northeast of the Denver metropolitan area, he canoed down the river in a northerly and then northeasterly direction to Greeley. Along this 37 km stretch of river, he occasionally examined gravel bars, looking for artifacts. The majority of the flakes and cores found were of Dawson petrified wood (Westfall 2005:129). Furthermore, unworked cobbles of petrified wood were noted to be abundant along this stretch (Westfall 2005:134).
Some of the stream-rounded pebbles of enigmatic function from the Jurgens site are of Dawson petrified wood and a small number of flaked stone artifacts in the assemblage were made of stream-rounded pieces of the tool stone. The types of artifacts made from the petrified wood gravel principally include utilized flakes, retouched flake tools, and an end scraper. With the possible exception of the end scraper, these artifact types likely represent use of Dawson petrified wood in gravel form to satisfy expedient tool needs. Since the closest known source of stream-rounded pieces of Dawson petrified wood occur in the South Platte gravels, these artifacts are assumed to be made of a variety of SPRG.

**Dawson Petrified Wood**

The wooded, upland region of the Plains between Denver and Colorado Springs known as the Palmer Divide contains the primary source area for a yellow-to-brown petrified wood that was used extensively in prehistory by people on the Plains of eastern Colorado. From the base of the Southern Rocky Mountains, the Palmer Divide extends to the east, separating the watersheds of the South Platte, located to the north, and the Arkansas River, situated to the south. The tool stone is herein referred to as Dawson petrified wood after the geologic formation from which it derives. Primary sources of the tool stone are found in exposures of the upper Dawson Arkose, where chunks and logs of petrified wood have weathered from the formation. The Dawson Arkose is comprised of conglomerate, sandstone, and finer grained clastic sediments deposited in the Denver Basin during the Paleocene and early Eocene, a time during which the Great Plains were covered in tropical forest. The term arkose refers to a sandstone with a high content of feldspar grains that is indicative of a relatively close granitic source, which in this case was the then newly formed Rocky Mountains of the Laramide Orogeny. The distribution of outcrops of the upper part of the Dawson Arkose is mapped as being roughly circular in shape, extending from Denver, on the north, to Colorado Springs, on the south (Tweto 1979). Outcrops of Dawson Arkose also
extend from the foothills eastward to near the town of Simla, Colorado. Anywhere within this broad area, some outcropping petrified wood may be found (Figure 7-9).

However, sources where the petrified wood is available in abundance occur within a more geographically limited area that is here referred to as the primary source area. The area was defined based on the distribution of sources of the petrified wood recorded in the Colorado state site files as well as from locations mapped in a guide book for rock hounds (Voynick 1995). The northern extent of the primary source area is marked by three adjacent lithic procurement sites located in an upland setting southeast of Cherry Creek Reservoir that were recorded as sites 5AH411, 5AH682, and 5AH684. Known sources of petrified wood are common the southern portion of the primary source area in the vicinity of the towns of Elizabeth, Kiowa, and Elbert. A large lithic procurement site east of Kiowa is recorded as 5EL257. Voynick (1995:106-107) reports that in the 1940s, petrified logs measuring 25 feet long and two feet in diameter were found west-southwest of Elbert, eroding out of gullies along Running Creek (also known as Box Elder Creek). Furthermore, Voynick indicates that in the vicinity of Elbert and in the area to the east, petrified wood is found in gullies along the upper reaches of Kiowa, Comanche, and West Bijou Creeks. Jodry visited sources of Dawson petrified wood in the primary source area near the towns of Elbert and Elizabeth and notes that the tool stone there occurs, “…in the form of large fossilized logs and as variably sized gravels in lag deposits perched on elevated landforms and in buried deposits exposed in hill slopes and drainage cuts…” (1999: 91).

Unlike other tool stones in the study area, one of the several previously applied terms in existing literature for Dawson petrified wood was not retained here simply because multiple names have been proposed without any one being subsequently used more than the others. The proposed names refer to towns or other geographic features on or near the Palmer Divide. The tool stone has been referred to as Parker petrified wood, after the city of Parker (Black 2000:134-135). Elizabethan petrified wood is another name that has been used in
Figure 7-9. Isolated piece of opaque yellow-to-brown petrified wood exposed in an outcrop of the Dawson Arkose at Castlewood Canyon State Park, located between Denver and Colorado Springs.
reference to the town of Elizabeth (Westfall 2005:45, 70, 74, 91, 129). At the Jones-Miller site within the study area, the tool stone has been called Bijou Basin petrified wood in reference to its occurrence in the drainage of the various branches of Bijou Creek (Stanford 1978:93). Finally, the stone is present in the assemblage from the Cattle Guard site in the San Luis Valley where it has been labeled Black Forest silicified wood, either for the large expanse of ponderosa pine forest on the Palmer Divide by that name or for the town of the same name (Jodry 1999:88, 91).

As mentioned, erosion and alluvial transport of sediment derived from exposures of the Dawson Arkose has created secondary sources of tool stone in alluvial deposits that contain stream-rounded pebbles and cobbles of Dawson petrified wood. Observations made by Westfall (2005:129, 134) imply that river cobbles of Dawson petrified wood occur in South Platte River gravels as far north as Greeley and Muniz (2005:206, 208) indicates that cobbles of the tool stone have been observed in the South Platte River channel downstream of Greeley, to the east.

Petrified wood from the Dawson Arkose varies in color and translucency. The most common variety is opaque and is yellowish brown or brownish yellow. On some pieces of this variety, remaining cortex or material that probably was near the weathered outer surface of the stone is white (Figure 7-10, Specimens a-c). Jodry (1999:91) visited sources of Dawson petrified wood in the primary source area and noted that besides the opaque variety noted above, transparent and translucent yellow or rust-colored petrified wood also occurs. Artifacts of a variety matching this description, but sometimes also containing brown bands, are present in the Jurgens collection (Figure 7-10, Specimens d – h), affirming the suspicion that most of the Dawson petrified wood in the collection was obtained from the primary source area. Jodry (1999:88) also describes another variety from a localized source near Elbert as butterscotch-colored with large, dark brown patches retaining macroscopically visible wood grain. A projectile point from the Jurgens site (catalog # 19570; Figure 7-10,
Figure 7-10. Selected artifacts from the Jurgens site showing the range of colors typical of Dawson petrified wood. White area on Specimen a is cortex. White areas on Specimens b and c are believed to have been near the cortex on the original unworked pieces of raw material. Specimen i matches Jodry’s (1999:88) description of a variety of Dawson petrified wood from a localized source near Elbert, Colorado. The variety is described as butterscotch-colored with large, dark brown patches that retain macroscopically visible wood grain.
Specimen i), as well as one interior flake, appear to be made of this variety, again affirming the likelihood that much of the petrified wood in the assemblage was procured from the primary source area. See Muñiz (2005:Appendix B, Image J19570 side 1) for a more detailed photograph of the point.

**Poorly Defined Tool Stones of the Boxelder Creek Drainage**

An orthoquartzite and a chalcedony are mentioned in the archaeological literature as having sources near the Lindenmeier site and being represented in the assemblage from the site. For the purpose of this dissertation, it is necessary to develop some understanding of the amount of local stone present in each assemblage to be considered. Roy Coffin (1937, 1951) was the first to recognize that important sources of orthoquartzite and chalcedony are present in the vicinity of the Lindenmeier site and comprise part of the assemblage. Mr. Coffin was a member of the family that discovered the Lindenmeier site and brought it to the attention of archaeologists. He was also a geology professor at what is now Colorado State University and his background and interest in both geology and archaeology made him uniquely qualified to investigate the origin of tool stones represented among the Lindenmeier artifacts. Coffin (1937:4, 10) noted that an orthoquartzite and a chalcedony present in his family’s collection of artifacts were similar to tool stones available locally at both primary sources in outcropping formations west of the site as well as in gravel deposits available from exposures of formations closer to the site. West of the site, uplift of the Rocky Mountains has created north-south aligned outcrops of tilted Paleozoic and Mesozoic sedimentary formations along the base of the igneous and metamorphic rocks forming the core of the Front Range. Closer to the site are exposures of flat-lying Cenozoic formations composed of sediment eroded from the mountains and foothills and transported by alluvial action eastward to the site vicinity and beyond. The sediment composing these formations includes stream transported cobbles of tool stones that eroded from the tilted formations to the west.
One of the local tool stones in the Lindenmeier collection recognized by Coffin is an orthoquartzite from the Dakota Group of Cretaceous age that has informally been referred to as Big Hole orthoquartzite. Coffin (1951:6) notes that, “[a] special variety of quartzite was extensively mined at Specimen Hill near Little Medicine, Wyoming. It was formed from a very fine grained sandstone by the addition of opalite and chalcedony as a filling-in cement giving it a smoother fracture and a more brittle structure. The upper Boxelder Creek district near the Colorado-Wyoming state line furnished this type where it was easily secured from large outcrops.” In her study of the Lindenmeier artifacts from the Roy Coffin collection at the Fort Collins Museum, Bridget Ambler (1999:101) cites Dr. Dennis Stanford of the Smithsonian Institution as referring to orthoquartzite from the foothills west of Lindenmeier as Big Hole quartzite. A topographic depression known as Big Hole is located just south of the Colorado-Wyoming state line between a north-south aligned hogback to the east, formed by the Dakota Group, and another to the west formed by the Fountain, Ingleside, and Lyons formations. I had an opportunity to speak with Dr. Stanford (personal communication 2004) and question him about the orthoquartzite. He indicated that in the 1950s, while trying to find the Lindenmeier site, he came upon a large source of the tool stone in the Big Hole area. In 2002, I viewed a large display of Lindenmeier artifacts at the Fort Collins Museum comprised of specimens owned by the museum and others belonging to Don and Eloise Coffin. Included in the display were artifacts made from an orthoquartzite believed to be from the Big Hole area that grades in color from dirty pink to maroon.

The other local material first discussed by Coffin is a chalcedony. According to Coffin (1937:10), “[a]bout 4 miles northwest of the site a semi-transparent chalcedony is in place in the Ingleside limestone and is of the type commonly represented in the artifacts.” If the bearing from the site to the source is truly northwest, this would put the source somewhere inside Wyoming. A distance of four miles would fall short of the Ingleside outcrop, but detailed geologic maps of the area were not available at the time. The Ingleside
Formation in the area is currently described as a sandstone interbedded with limestones and dolomites (Courtright and Braddock 1989). Apparently, Edwin Wilmsen also found primary sources of the chalcedony during a visit to the field in the 1960s or 1970s. In the Lindenmeier site report (Wilmsen and Roberts 1978:114) he states that, “[v]isually, the bulk of the material labeled chalcedony is indistinguishable from that presently found in four bedrock outcrops that are located 7.8 km (5 mi) west of Lindenmeier. Grainy chert is probably cortex material of this chalcedony.”

Knowledge of local tool stone sources in the Lindenmeier area was curtailed in the decades following excavation of the site in the late 1930s and early 1940s because the lands in the site vicinity were owned by a livestock company that restricted assess, but opportunity to investigate the area archaeologically began after 2005 when much of the land was purchased by the city of Ft. Collins and Larimer County as a natural area and open space land for outdoor recreation. As part of an archaeological survey of the newly acquired land by Colorado State University (CSU) under the direction of Dr. Jason LaBelle, I performed a reconnaissance of the area for several days in 2006 to look for and document any sources of orthoquartzite or chalcedony. I was assisted in this effort by Dutch La Rose as well as project archaeologists Chris Von Wedell and Casey Dukeman. Geological context of the sources discovered was determined by referring to the geologic map by Courtright and Braddock (1989).

A number of small sources of orthoquartzite from the Dakota Group were found, some of which produced a maroon stone that could be classified as Big Hole orthoquartzite. Most of these sources showed no indication of having been exploited prehistorically. A small outcrop of maroon orthoquartzite was found on a crest of the Dakota hogback 4.3 km west-southwest of the center of the Lindenmeier site (Figure 7-11). Only one piece of orthoquartzite showed evidence of having been tested by having a definite flake scar. Legal description of the source is Township 12 N, Range 69 W, Section 32, SW ¼ of NW ¼.
Figure 7-11. Looking north at small outcrop of maroon orthoquartzite on crest of Dakota hogback west-southwest of Lindenmeier site.
Universal Transverse Mercator coordinates are: zone 13; 4,535,950 m North; 487,400 m East.  

A secondary source where subangular and tabular pieces of maroon orthoquartzite from the Dakota Group were redeposited in gravels of the White River Group was found 1.5 km southeast of the site.  Locational information for this source is: T 12 N, R 69 W, Section 35, NW ¼ of NE ¼  13; 4,535,250 m N; 492,90 m E.  Sources of a light gray orthoquartzite originating from the Dakota were also encountered.  An outcrop of light gray orthoquartzite was found on a ridge formed by the Dakota 5.7 km southwest of the site.  Locational information is: T 11 N, R 69 W, Section 8, N ½ of SE ¼  13; 4,531,130 m N; 488,450 m E.  

A secondary source of angular blocks of light-to-medium gray orthoquartzite was located 3.7 km west-southwest of the site in the L.R. landslide deposit on the east slope of the Dakota hogback.  Two blocks of orthoquartzite appeared to have been flaked in the past to test quality of the stone for knapping.  Locational information is: T 12 N, R 69 W, Section 32, SW ¼ of NE ¼  13; 4,534,950 m N; 488,050 m E.  

An attempt was made to find the bedrock outcrops of chalcedony mentioned by Wilmsen by reconnoitering the outcropping Ingleside Formation 7.8 km due west of Lindenmeier.  No chalcedony outcrops were located.  However, following the crest of the hogback formed by the Ingleside Formation west of this location revealed five small outcrops of an opaque chert.  As a group, these outcrops produce chert of various colors, including red-to-brown, light red, light purple, light green, and white.  It is not known if the chert is represented in artifact collections from the Lindenmeier site.  The outcrops are located in T 12 N, R 70 W, Section 26, S ½ and Section 35, N ½.  More information is available in my field notes stored with survey project documentation at CSU.  

A chalcedony that might be the kind reported to outcrop from the Ingleside formation was found only at one secondary source.  The “chalcedony” observed varies from translucent brown or gray to opaque white.  Some pieces have mottling and spots. (Some of the artifacts seen in the 2002 display of Lindenmeier artifacts at the Fort Collins Museum that may be of
this material seemed to be of a higher grade, being almost transparent gray-to-whitish without inclusions). Pebble-sized clasts of the chalcedony with water-worn cortex were found in gravel deposits of the White River Group (Oligocene) exposed on a ridge 1.7 km southeast of the site and collected for a comparative tool stone collection housed at CSU. Locational information is: T 12 N, R 69 W, Section 35, W ½ of NE ¼ 13; 4,535,000 m N; 493,020 m E.

Though the effort to locate the bedrock sources of tool stones reported by Coffin and Wilmsen was unsuccessful, the sources that were found and documented confirm the validity of the reports and subsequent examination of one of the Lindenmeier collections by project archaeologists determined that the two tool stones are present in considerable amounts. Newton and LaBelle (2008) examined the Denver Museum of Nature and Science collection from Pit 13, a 30 ft by 30 ft excavation block, and found that, “…the local material is primarily red quartzite and gray chalcedony.”

**Hartville Uplift Chert**

This tool stone derives from a source area within a hilly region of the Plains in southeast Wyoming known as the Hartville Uplift. The region is a circular uplifted dome northeast of the Laramie Mountains and north of the North Platte River. It measures roughly 60 km in diameter. On its southern border is the town of Guernsey and just north of the uplift lies Manville, Wyoming. Chert is available from sources in the Paleozoic limestone formations that are exposed over much of the uplift and, as discussed below, Spanish Diggings orthoquartzite was procured in exposures of Mesozoic sandstone in the northwestern portion of the region. Reher (1991:Figure 16.1) maps 25 known sources of chert in outcrops of Paleozoic limestone within an irregular area of the uplift measuring 23 km north-south by 18 km east-west. Chert derives from the limestone of the Guernsey Formation (upper Devonian to Lower Mississippian), as well as from the much more
geographically extensive limestone outcrops of the Hartville Formation (Pennsylvanian and lower Permian) (Love and Christiansen 1985).

Characteristics of Hartville Uplift chert include various colors and inclusions, including fossils. Common colors include hues of yellow, orange, red, brown, and purple (Figures 7-12 through 7-14). Black dendrites are common, particularly in the brown, orange, and yellow colors, leading some archaeologists to refer to this material as dendritic jasper. Commonly, pieces of the tool stone will contain cracks that have filled with clear silica. Fossils of marine life forms are also common and include segments of crinoid stems and hard parts of other, unidentified species. Rarely, some pieces of the tool stone are mottled with bright orangish red. Cortex and some of the chert adjacent to the cortex itself is typically white, perhaps indicative of the limestone in which the tool stone originates. This white is incorporated into pieces of a highly recognizable tricolored variety that consists of the white material near the cortex, a black layer deeper into the stone, and finally a yellow-to-orange-to-brown interior. The tricolored variety is present in the Jurgens collection in the form of one end scraper and a fragmentary unifacial artifact that may be another end scraper (e.g. catalog # 30151, Figure 7-13, Specimen h). It is also seen among the color photographs of artifacts from the Cody components of Localities I and V at the Hell Gap site cluster, which is located immediately adjacent to the Hartville Uplift chert source area (Muniz 2005:Appendix B, Images hg loc 1, ES-67, hg loc 5-73, and hg loc 5-250).

**Spanish Diggings Orthoquartzite**

An orthoquartzite with high-quality flaking characteristics occurs in an area of the Hartville Uplift northwest of the main chert-bearing source area. Reher (1991:Figure 16.1) maps eight sources in this area, which measures 10 km north-south by 5 km east-west. The main quarry complex includes three named quarry sites located immediately south of Spanish Creek: the Spanish Creek Quarry, the Barbour Quarry, and the Dorsey Quarry (Figures 7-15
Figure 7-12. Selected artifacts from the Jurgens site that principally show the hues of brown and yellow characteristic of Hartville Uplift chert. Specimen j was later determined to be made from an unusual variety of Dawson petrified wood. Note bright orangish red mottling on Specimen b that is characteristic of some pieces of Hartville Uplift chert.
Figure 7-13. Selected artifacts from the Jurgens site that principally show the hues of yellow, orange, red, and brown characteristic of Hartville Uplift chert. Specimen h is of the unique tricolored variety described in the text.
Figure 7-14. Selected artifacts from the Jurgens site that principally show the hues of red and purple characteristic of Hartville Uplift chert. Specimen l is an unusual white variety. Note bright orangish red mottling on Specimen i that is characteristic of some pieces of the tool stone.
Figure 7-15. Looking north at quarry pit where Spanish Diggings orthoquartzite was procured at the Barbour Quarry.
Another stone procurement site is reported at Cedar Top, a butte located to the south.

Spanish Diggings orthoquartzite formed through the silicification of sandstone beds in the Cloverly Formation. Love and Christiansen (1985) date the formation to the lower Cretaceous period. The Cloverly correlates with the Dakota Formation to the south in Colorado.

A fairly restricted range in grain size and colors typifies Spanish Diggings orthoquartzite. Hand samples from the Barbour quarry are all very fine-grained. Colors present include mostly medium, light, and very light shades of brown, gray, and purple, but also includes medium brown and medium rust. Hand samples can be variegated or banded with alternating medium and light shades. The banding follows the bedding plane of the original sandstone. A sample of orthoquartzite from the source at Cedar Top is uniformly a medium purplish gray.

Poorly Defined Orthoquartzite from the Shirley Basin

According to Frison (1974:4, 100), a red quartzite is present in the artifact assemblage from the Casper site and a likely source of this tool stone is 80 km (50 mi) south and slightly east of the site, in the Shirley Basin. In a later publication, Frison and Reher (1980:Table 25) give the distance as 75 km. Though the above distances and direction do not plot in the area mapped on the USGS topographic map of Wyoming as the Shirley Basin, they do fall within the larger area of the Little Medicine River drainage where there are outcrops of the Cloverly Formation (Love and Christiansen 1985), which is known to produce orthoquartzite in the Spanish Diggings source area. Coffin (1951:6) affirms that the drainage of the Little Medicine Bow River produced orthoquartzite that was used prehistorically, noting that a very fine-grained variety was extensively mined in prehistory at Specimen Hill near the small settlement of Little Medicine. The large size of the
Figure 7-16. Looking north-northeast at rubble mounds where Spanish Diggings orthoquartzite was procured at the Spanish Creek Quarry. Spanish Creek is in the background.
orthoquartzite points illustrated from the Casper site (Frison 1974, 1978) indicates that the raw material was available in large pieces. In light of the above information, it can be stated that somewhere in the Shirley Basin area, there apparently is a high-quality source of red orthoquartzite that is represented in the Casper assemblage, but more information is needed to better document this poorly known tool stone.

**Summary of High-Quality Sources in the Plains Portion of the Study Area**

In general, tool stones in assemblages from sites on the Plains section of the study area were procured from high-quality sources that are widely distributed. Some tool stones were available at multiple clustered locations comprising source areas, but the areas themselves are widely separated (Figure 5-1). Source areas in the study area include those producing Smoky Hill jasper in the Kansas River drainage, Dawson petrified wood and White River Group gravels in the South Platte watershed, and Hartville Uplift chert and Spanish Diggings orthoquartzite in the North Platte drainage. High-quality sources also occur as geographically restricted “point sources,” such as the two places where White River Group Silica was procured. These include the Flat Top chalcedony quarry in the South Platte drainage and the source of Table Mountain chert along the North Platte. That some tool stone types derive from high-quality sources must be inferred by evidence from site assemblages because available information on these sources is incomplete. For example, the very rough-textured orthoquartzite variety of White River Group gravels is believed to be available in the study area from a high-quality source because the tool stone is common in the Jurgens collection and large artifacts of this material imply a high-quality source exists in northeast Colorado, but its exact whereabouts remains unknown. Furthermore, the red orthoquartzite that reportedly originates from the Shirley Basin is believed to be from a high-quality source because it is common in the assemblage of the Casper site and occurs in the form of large points.
Middle and North Park Geologic Basin

The geologic situation in North and Middle Parks is such that high-quality sources of tool stone were readily available to prehistoric peoples. The effect of raw material availability on land use may be investigated by comparing the tool stone composition of site assemblages from the park with those from the entire Plains portion of the study area, where quality sources are generally more sparsely distributed. These areas may also be compared to assemblages from the high Front Range, where no high-quality sources are available in the igneous and metamorphic rock that outcrop there and thus stone necessarily had to be imported. Silicification of outcrops of sandstone of the Dakota Group has created quality sources of orthoquartzite along the western edge of both North and Middle parks. Miocene formations present in the interior of both parks contain deposits of silica-rich volcanic ash which commonly were involved in the formation of chert beds, as was the case in western Middle Park. The Miocene was also an active time for volcanism in the Colorado Rockies. Pieces of jasper occur in association with Miocene basalt flows in eastern and central Middle Park, but the details of its origin are poorly understood. Each of these Middle Park tool stones is discussed below.

Windy Ridge Orthoquartzite

Silicification of Cretaceous sandstone belonging to the Dakota Group has created sources of orthoquartzite in Middle and North parks. Sandstones of the Dakota Group are exposed along the west and east sides of North Park. Dakota sandstone is also exposed along the west side of Middle Park and at isolated outcrops within the park. The sandstone is resistant to weathering and commonly forms hogback ridges. Silicification of Dakota sandstone in a few locations along these hogbacks has produced sources of a basically light gray orthoquartzite that served as a high-quality tool stone for prehistoric occupants of the parks.
A major high-quality source of this tool stone is located in forested terrain in the extreme northwestern portion of the Middle Park drainage. The quarry site is recorded as 5GA872. Stone from the site is named after a nearby low, unforested segment of the Dakota hogback that reportedly is prone to high winds and is known locally as Windy Ridge. Mapping of the site revealed the presence of numerous quarry pits. A total of 176 are mapped on the crest and east slope of the hogback and 182 are said to exist at the site (Bamforth 2006:512, Figure 2).

Orthoquartzite at the Windy Ridge Quarry is fairly uniform in color and composition, though some variability does exist. The orthoquartzite is very fine-grained and a large majority is light gray. A minor color variety grades from light to medium brown.

Other primary sources of orthoquartzite that are reported to be comparable or identical to that from the Windy Ridge quarry are known in Middle and North parks. Benedict (2000b:53) reports that orthoquartzite similar in color and composition to that from near Windy Ridge occurs in the tract of open country in western Middle Park, near the Williams Fork. Apparently, silicification of sandstone in the Dakota Group occurred along the hogback mapped north of Williams Fork Reservoir by Tweto (1979). Finally, Benedict (1990:20, Figure 39) describes an orthoquartzite of similar color to the Windy Ridge material from site 5JA1, located on Battle Ridge, a Dakota hogback in the extreme northwestern portion of North Park.

**Kremmling Chert**

An important microcrystalline tool stone available from outcrops in the expanse of open sagebrush grassland in western Middle Park is known as Kremmling chert (Metcalf et al. 1991; Miller 1991a; Naze 1986:26-27). Large lithic sources located southeast of the town of Kremmling and south of the Colorado River produce the tool stone in the form of outcropping lenses and as areas where broken pieces of chert occur on the ground surface as
float. The main source area occurs in the drainage of Barger Gulch where a number of large sites are recorded. The Barger Gulch site complex (5GA195) is located in dissected terrain drained by the lower segment of the gulch. Here, investigations by the University of Wyoming have discovered many chert outcrops and sites producing Paleoindian artifacts (Surovell et al. 2003; Waguespack et al. 2006). A large Folsom assemblage has been excavated at Locality B of the Barger Gulch site complex. Site 5GA1144 is a big lithic procurement site located elsewhere in the Barger Gulch drainage (Metcalf et al. 1991). At the site, pieces of Kremmling chert are available mainly as float but were also mined from two quarry pits. Elsewhere in the Barger Gulch drainage is the Crying Woman site (5GA1208), a large multicomponent camp situated around a spring (Naze 1994). Paleoindian components are present and a small outcrop of Kremmling chert is on-site. Northeast of the Barger Gulch sites lies 5GA1172, where Kremmling chert is available as float and was mined from three quarry pits (Metcalf et al. 1991). Finally, east-southeast of Barger Gulch, Kremmling chert outcrops in the drainage of the Williams Fork.

Kremmling chert varies considerably in color and degree of translucency. An opaque white variety occurs as does a translucent form that normally is light gray or light brown. The tool stone has white mottling, spots, and spherical inclusions. Sometimes black dendrites occur in the stone, especially the translucent pieces, and can be present to the extent that the stone is sometimes referred to as a moss agate. This variety can also have yellowish brown, orange, or red staining and be quite colorful.

The tool stone is also referred to as Troublesome chert (Surovell et al. 2003), after the Miocene formation from which it outcrops. The formation includes a conglomerate facies of fan and pediment gravels along the Front and Gore ranges and a siltstone facies in the interior of Middle Park that includes many volcanic ash beds. Ash is high in silica and leaching of silica by meteoric and ground water with subsequent precipitation of the mineral elsewhere in the formation was the main process involved in the formation of the chert (Miller 1991a).
Kremmling chert is similar to other tool stones from Miocene formations in northwest Colorado, perhaps because all of the tool stones derive from alteration of volcanic ash of similar composition and age. Site forms for Colorado lithic sources in river drainages neighboring Middle Park to the north, northwest, and west describe a tool stone similar to Kremmling chert (Black 2000:Appendix 9.1). Geologists suggest the ash derives from volcanic areas in the Great Basin and neighboring regions (Izett 1968; Luft 1985).

Table Mountain Jasper

Two areas in Middle Park with basalt deposits dating to the Miocene and Pliocene produce a type of jasper. The main source area is in eastern Middle Park, north of Granby, Colorado. Another source area is centrally located in the park, north of the town of Parshall.

A number of characteristics allow Table Mountain jasper to be identified. The material is opaque in hand sample and grades in color from yellow to brown to red. The later two colors are by far the most prevalent. As noted by Benedict (1990:19-20), a characteristic that can distinguish Table Mountain jasper from tool stones that appear similar in hand sample is its flocculent structure which is best seen under magnification. Opaque brown or red silica forms a floc of fine particles suspended in a clear matrix.

Recorded tool stone procurement sites in the source area in eastern Middle Park include a source on Table Mountain and others situated to the west-southwest. The flat-topped Table Mountain was formed by a basalt flow. A large lithic procurement site atop the mountain was first reported by Ives (1942:453) and later recorded as 5GA5. At this site, abundant fragments of jasper that range in size up to 15 cm in maximum dimension are available as residual detritus or “float” on the ground surface. Myers (1942:13) suggests that the jasper was originally deposited in joints and fractures in the basalt. A number of other jasper procurement sites located west-southwest of Table Mountain are recorded (5GA119 and 5GA121 through 5GA130).
Table Mountain jasper is also available in central Middle Park where it occurs in association with a series of tuffaceous beds and basalt layers known as Grouse Mountain Basalt. Recorded jasper procurement sites include 5GA176 through 5GA 178. Contrary to Myers, Miller (1991a:5) suggests the tool stone found in central Middle Park was formed when silica was deposited within the tuffaceous sediments, rather that in the basalt, but neither author explains the reasoning behind their interpretation.

Summary of High-Quality Sources in Middle Park

High-quality sources of tool stone occur in a dense distribution in Middle Park (Figure 5-1). Table Mountain jasper, Kremmling chert, and Windy Ridge orthoquartzite all are available in the Middle Park drainage from sources that can be considered high-quality. The main sources of Kremmling chert and Windy Ridge orthoquartzite are arguably better quality sources than those of Table Mountain jasper because at the former sources, much greater quantities of raw material are available and the tool stone occurs in larger pieces. Presence of thick seams of tool stone at sources of Kremmling chert and Windy Ridge orthoquartzite apparently made it worth the effort to quarry the desired raw material. In contrast, the smaller pieces of raw material available at sources of Table Mountain jasper apparently did not justify mining because no quarry pits are known at sources of this tool stone.

High Front Range

High-quality sources of tool stone are absent in the high Front Range where granite and gneiss are the predominant rock types. Low-quality sources of silicate rocks of volcanic origin that were used prehistorically for stone tool manufacture are reported from the high Front Range in Rocky Mountain National Park (Robert Wunderlich, personal communication 2003). However, tool stone from high-quality sources would necessarily have been brought
into the high Front Range from lower elevations. In relation to the high Front Range site cluster, the closest high-quality sources would be those located in Middle Park.

**Representation of Tools Stones from Within Study Area in Assemblages**

A preliminary statement concerning the prevalence of tool stones from within the study area in the artifact assemblages is made here to give the reader an idea of the relative importance of stone from high-quality sources within the study area compared to stone from more distant quality sources outside the area. A detailed analysis and interpretation of the tool stone composition of each assemblage is provided in Chapter 12. High-quality tool stone sources available within the study area were important natural resources to the Paleoindian inhabitants because they comprise the great majority of all assemblages from the area. For each site to be considered, stone from one or more of the closest high-quality sources either completely dominates the assemblage or else comprises a large majority of the collection.

**TOOL STONES FROM SOURCES OUTSIDE THE STUDY AREA**

**Southern Plains**

**Edwards Chert**

A high-quality chert that derives from a stratum of nodules in the Edwards Limestone is available from sources throughout a very large portion of the Southern Plains (Hill 1901:227-229). Edwards chert was a desired tool stone because it possesses good flaking qualities and sometimes occurs in the form of large nodules that range up to 40 cm in maximum dimension (Tunnell 1977:145). The Edwards Limestone formed in a barrier reef depositional environment off the then southern coast of North America during the Cretaceous period when the Plains were inundated by an inland sea. Hofman et al. (1991:Figure 1) map the geographic distribution of chert-producing outcrops of the Edwards Limestone in central
Texas and an adjacent part of Mexico, in an area measuring 600 km east-west by 400 km north-south. Edwards chert is primarily light gray, but can grade in color to black and include shades of brown. Artifacts of Edwards chert in the Jurgens collection are opaque and mostly light gray with one artifact being medium gray. Some artifacts of the light gray chert contain numerous minute, short, white linear inclusions that appear to be spicules. These fossils originally were calcareous structures that supported the tissue of sponges.

Alibates Agate

Supplies of a colorful tool stone that is commonly variegated or banded was obtained throughout prehistory from a primary source area in the Texas Panhandle along the Canadian River. The stone was created through silicification of dolomite in the Quartermaster Formation of the Permian period (Jodry 1999:98). Within the primary source area, the extent to which native peoples went to procure the stone is demonstrated by numerous quarry pits. Secondary sources of the tool stone were also exploited, as demonstrated by evidence that gravel deposits downstream of the primary source area to the east were visited as a source of tool stone by prehistoric peoples in Oklahoma (Jodry 1999:98). A distinctive “bacon-striped” variety of Alibates agate that appears to have been transported to distant regions more so than others includes bands that grade from brown to red to purple and that alternate with bands colored light gray to white (Shaeffer 1958). Artifacts from the Jurgens collection classified as Alibates agate are of this variety.

Central Plains

Flint Hills Chert

A gray chert available principally in eastern Kansas commonly was used as raw material for flaked stone artifacts in this part of the Central Plains. The stone is named for the Flint Hills where outcropping Permian limestones produce varieties of gray chert. Included
are the Cottonwood, Funston, Florence, Schroyer, Stovall, and Threemile limestones (Holen 1991:401). The Florence Limestone is a particularly prolific source of chert. Source areas of chert-producing limestones mapped by Holen (1991:Figure 23.1) include a small area in southeast Nebraska and northeast Kansas and a long north-south band in eastern Kansas that extends from the Kansas-Nebraska border into northeast Oklahoma (Figure 7-1). A summary description of the available tool stone is provided by Holen (1991:401): “In general the cherts range in color from light to dark gray. Some varieties are banded light and dark gray.”

**Nehawka Chert**

The term Nehawka has been applied to a group of cherts of the Pennsylvanian period whose characteristics and distributions are in need of further definition. The tool stone is named for the town of Nehawka in southeast Nebraska, located south of the confluence of the Platte River with the Missouri. Prehistoric bedrock quarries near the town were reported by Blackman (1907). Available information on Nehawka chert is summarized by Holen (1991:401) who states the stone is found in southeast Nebraska, southwest Iowa, northwest Kansas, and northeast Missouri. However, his plot of its distribution is restricted to Nebraska and Iowa (Holen 1991:Figure 23.1; this document: Figure 7-1). According to Holen (1991:401), “Nehawka” is a generic term for multiple kinds of chert that, “…have a wide color variation but generally are light to dark gray to nearly black.” He goes on to state that, “[m]ost are highly fossiliferous and many have a ‘rice-grain’ appearance from numerous foraminifera fossils.”

**Northern Plains**

**White River Group Gravel**

As noted in discussion of WRGG in the section on tool stone sources of the study area, gravel deposits containing basically the same kinds of orthoquartzites and cherts are
also present in the White River drainage of northwest Nebraska and southwest South Dakota. No artifacts assigned to these sources of WRGG are present in the assemblages. The sources are discussed merely to note the widespread natural distribution of the tool stone type. Ahler (1977:134) originally referred to tool stone from these sources as Chadron chert, but for reasons given earlier, the tool stones procured at sources in both Colorado and on the Northern Plains are here referred to as White River Group gravel. A cursory examination of a source of WRGG near Toadstool Park in northwest Nebraska (T 34 N, R 52 W, Sections 17 and 20) revealed that some of the same varieties of tool stones were present as those named and described above for the sources in Colorado. These include very rough-textured orthoquartzite, Morrison orthoquartzite, “Kalouse” jasper, brown-to-orange or yellow chert, and dark-to-medium brown petrified wood. The similarity that exists in the gravel composition of widely separated sources in Colorado and on the Northern Plains is thought to be due to the fact that the same widespread formations bearing microcrystalline tool stones and orthoquartzites were being actively eroded in all the uplifts that provided parent material for the White River Group gravels. These uplands include the foothills of the Front Range and the Laramie Mountains, the Hartville Uplift, and the Black Hills.

**Knife River Flint**

A distinctive dark brown, microcrystalline high-quality tool stone was extensively quarried in western North Dakota and transported by native peoples throughout a broad area. Qualities of Knife River Flint (KRF) that made it desirable for stone tool manufacture include its excellent flaking qualities and the fact that it can occur in large pieces ranging up to 60 cm in diameter (Ahler 1986:3). Most quarried pieces, however, occur in the 10 to 20 cm size range. KRF possesses a number of characteristics that allow it to be distinguished from similar tool stones (Clayton et al. 1970). Irregular bedding planes are often visible in the raw material. In hand sample, fossilized plant impressions are sometimes present on bedding
surfaces. The stone is normally a uniform dark brown color. It can grade into a light brown, but this variety tends to part along bedding planes and thus was less suitable for tool manufacture. Sparse white mottles may occur in the tool stone. A white or light gray patina develops on weathered surfaces.

The tool stone primarily occurs in secondary deposits within its source area with a few bedrock sources having been discovered (Miller 1991b:469-470). KRF was quarried in the form of angular clasts occurring in Pleistocene deposits that range in size from pebbles to boulders. It was originally formed through silicification of mud in channel and pond deposits of the Golden Valley Formation (Eocene).

Northwestern Plains

**Fort Union Porcellanite**

In the Powder River Basin of northeast Wyoming and southeast Montana, heating of fine clastic sedimentary strata through subterranean combustion of coal beds in the Fort Union Formation (Paleocene) fused the parent rock to the point that it now fractures conchoidally (Fredlund 1976). The resulting tool stone is opaque and usually light gray, but light purple and red varieties are also known. The material is relatively soft and artifacts of porcellanite exposed to the surface can become sandblasted. Traditionally, archaeologists on the Northwestern Plains have limited the use of the term porcellanite to tool stones produced from coal fires. Since this term is ingrained in the archaeological literature, this usage is retained here, although Miller (1991a:2, 1991b:466) suggests that the term “clinker” is the correct petrographic term.

To better define the distribution of Fort Union porcellanite, a file search was conducted of the Wyoming site records. That Paleoindians of various time periods used the porcellanite of the Powder River Basin is seen at the Carter/Kerr-McGee site, located in the basin (Frison 1984, Muniz 2005). However, a large procurement site of Ft. Union
porcellanite with Paleoindian components has yet to be recorded. A number of small lithic sources of unknown cultural affiliation have been recorded in the northern part of the Wyoming section of the Powder River Basin as a result of numerous archaeological surveys in the basin related to energy development. These sites are spread throughout a broad source area with the Wyoming portion measuring 150 km east-west by 100 km north-south (Figure 7-1). Recorded sites in Sheridan and Johnson counties include 48SH1663, 48JO207, and 48JO1473. Other sites are in Campbell County: 48CA728, 48CA866, 48CA2534, 48CA2902, and 48CA3300.

**Tongue River Silicified Sediment**

Another tool stone that derives in part from the Fort Union Formation is known as Tongue River Silicified Sediment or TRSS. The stone is named after the Tongue River Member of the Ft. Union Formation as defined in the Powder River Basin. Miller (1991b:466) reports that within the basin, TRSS was an important tool stone. He further notes that the geological processes that silicified sediment into workable stone continued in the Eocene as seen in similar appearing tool stone from sources in the overlying Wasatch Formation. TRSS also occurs farther away from the study area within a source area on the Northern Plains located northwest of the Powder River Basin. This source area is west of the Missouri River in northwest South Dakota and southwest North Dakota (Ahler 1977:137).

Tongue River silicified sediment was formed through silicification of paleosols comprised of sediments of varying clast size. Miller (1991b:466) suggests that the finer grades of TRSS in the Powder River Basin were originally clay and silt. Ahler (1977:137) notes that TRSS from the Northern Plains consists of fine and medium-grained sand cemented together with silica. As a result of the considerable size range in clast size, the tool stone has been variously described as an arenaceous chert by Clayton et al. (1970:288) (meaning a chert containing sand grains) and by others as an orthoquartzite.
Tongue River silicified sediment has a number of defining characteristics. The stone is opaque and gray, yellow, or red with fine mottling and a sugary appearance (Miller 1996b:466). Some pieces have tunnellike cavities that may be plant fossils. In reference to the TRSS source area in the Dakotas, Ahler (1977:137) reports that the material there may be divided into a coarse yellow and red variety and a smooth gray variety, with the later having been preferred for tool manufacture.

Middle Rocky Mountains

Phosphoria Chert

This poorly defined tool stone deriving from Permian formations is best known from archaeological work in the Big Horn Basin of north central Wyoming. The tool stone was first discussed by Frison and Bradley (1980:11-16), who indicate that the tool stone occurs at numerous sources that are as yet poorly documented. The best known source is said to occur in the eastern Bighorn Basin where stone is available around the edges of a low butte. More specific information on the location of this source is thought to be given by Huckell (1989:169) who cites Bradley as the source of a sample of “red jasper” from the Phosphoria Formation in the vicinity of the town of Shell. Confusion exists regarding the derivation of the name Phosphoria chert. Exposures of the Phosphoria Formation (Permian) are mapped only in the southern Big Horn Basin. Formations defined for the eastern Big Horn Basin that date to the Triassic and Permian periods and thus are partly equivalent in age to the Phosphoria are mapped as the Chugwater and Goose Egg formations (Love and Christiansen 1985).

A number of characteristics of Phosphoria chert can be identified from existing literature. The stone occurs in the form of opaque nodules and a wide range of colors is reported, with hues of red, maroon, and purple seemingly most common. In his review of largely unpublished archaeological literature on the basin, Miller (1991b:464) states that red,
maroon, purple, green, black, and white are commonly listed colors. Color photographs of Paleoindian points from sites in the Big Horn Basin suggest that stone used in point manufacture commonly is orangish red or maroon. Two of the three Clovis points from the Colby site identified having been made of Phosphoria chert appear to be an orangish red (Bostrom 1992:Artifact 168; Kaplan 1975:8). A number of the photographed points from the Horner site are maroon or an exceptionally bright orangish red (e.g. Muniz 2005:Appendix B, Images horner 1-77178 and horner 2-77156).

Yellowstone Obsidian

A major source of obsidian in Yellowstone National Park was formed during the Pleistocene by rapid cooling of a rhyolite lava flow (Davis et al. 1995). It is located north of the Yellowstone caldera. Eruptions post-dating the caldera produced four lava flows classified as the Roaring Mountain Member of the Plateau Rhyolite. One flow is known to archaeologists as the Obsidian Cliff flow, after an impressive cliff along a park highway where the obsidian is exposed and viewed by many park visitors annually. The Obsidian Cliff flow has been dated to 183,000 BP. Archaeological survey of the flow following a large fire in 1988 located a number of obsidian procurement sites, including ones with quarry pits.

Yellowstone obsidian varies in color and in the number of inclusions. As with most obsidians, the prevailing color is black and in hand sample requires trace element analysis to be assigned to a particular source. Other colors include reds, browns, and greens (Holmes 1879, cited in Davis et al. 1995:3). Some of the obsidian is spotted with spherulites, which are usually spherical, crystalline bodies of radiating crystal fibers that can be attractive, but flaw the obsidian for potential use in stone tool manufacture.
Wyoming Basin

Wamsutter Oölitic Chert

One of the varieties of chert produced in sediments of the Green River Formation laid down in and around ancient Lake Gosiute in the Wyoming Basin during the Eocene is a distinctive oölitic chert. Four named geologic basins are present in the Wyoming Basin. In the Washakie Basin, oölite deposits formed along the shores of the lake. Oöliths are white, sand-sized calcium carbonate concretions that formed in the wave-agitated waters of near-shore environments. They can be amassed by wave action into deposits that later are lithified into an oölite. Silicification of the oölite deposits in the Washakie Basin created a tool stone available from primary deposits on Delaney Rim, located west-southwest of the town of Wamsutter (Love 1997). Subsequent erosion of the Green River Formation produced secondary deposits of oölitic chert in a large tool stone procurement area recorded as 48CR8414 – 48SW15978. Freshly broken pieces of the tool stone are medium brown, but the material is highly susceptible to developing a patina and prehistoric artifacts of the tool stone are an off-white color.

Bridger Chert

Continued infilling of Lake Gosiute during the Eocene created the Bridger Formation, which is a major chert-producing stratum in the Wyoming Basin. The formation is comprised of a mix of lacustrine and terrestrial sediments and was deposited in the Green River Basin of southwest Wyoming and in the Sand Wash Basin of northwest Colorado (Love and Christiansen 1985; Tweto 1979). Several varieties of chert were formed in the Bridger Formation. Those that are represented in assemblages from the study area are discussed below.

The most visually striking variety has alternating bands of dark gray and light gray or dark brown and light brown and is known as tiger chert. Recently flaked tiger chert is dark
brown and only subtly banded. Therefore, the raw material was desired for its excellent flaking qualities, rather than aesthetic appeal. It was not until long after tools of the stone were used and discarded that differential patination brought out the contrasting banded appearance (Love 1977:230). Tiger chert commonly occurs in the form of nodules deposited in a calcareous bed. The bands in the nodules are concentric and are aligned with the rounded cortex, leading some geologists to suggest the bands represent varve-like seasonal deposits of silica formed on a gelatinous mass of silica on the lake bottom at the time the calcareous sediment was being deposited (Miller 1991b:467). Exposures of the Bridger Formation in the Sand Wash Basin offer the closest sources of tiger chert in relation to the study area. The tool stone is available at site 5MF4325 in the basin interior, where it was quarried from numerous pits. Larger sources are known to the west-northwest in the Green River Basin of Wyoming in the vicinity of Black, Pine, Cedar, and Sage Creek mountains, all located west of Flaming Gorge Reservoir (Love 1977:23; Miller 1991:467).

Another kind of Bridger chert is known as the Sevenmile Ridge variety, which is named after the upland area bordering the Sand Wash Basin on the east where is has been found at 5MF2909. The site is a prehistoric camp with a scatter of dozens of cores and thousands of flakes of the chert. The common occurrence of cores with cortex, as well as decortication flakes, suggest that the source of the stone is nearby. The Sevenmile Ridge variety is here classed as a kind of Bridger chert, but this assessment could change because exposures of the Green River Formation are present near 5MF2909 and may prove to be the source of the chert.

The Sevenmile Ridge variety of Bridger chert is defined by a number of characteristics. Some cores at 5MF2909 have a rounded rough cortex, suggesting the chert originated in a globular form in its parent bed. The stone can be medium brown, but is usually very dark brown to black. A distinctive trait is its light brown mottling. It infrequently contains various kinds of inclusions. Angular fragments of claystone,
presumably from the parent bed in which the chert formed, may be present as “rip up clasts” believed to result from near-shore wave action disturbing the sedimentary deposit prior to silicification. Small white or light blue ostracod fossils are sometimes present in the tool stone, as are red specks.

A streaked chert is the most commonly occurring variety from the Bridger Formation. It is sometimes called algal chert because the streaked appearance is due to imperfect laminae produced by a calcium carbonate-secreting blue-green algae that lived in shallow lake-bottom environments. Commonly, these calcareous deposits were later silicified. The streaked chert is normally opaque and its color varies from very light gray to black and very light brown to very dark brown. Most commonly, it is light gray or light brown. This variety of Bridger chert was quarried in the interior of the Sand Wash Basin at 5MF2677 and 5MF4325.

Southern Rocky Mountains

Trout Creek Jasper

A major tool stone of South Park and the upper Arkansas Valley is Trout Creek jasper. Factors that likely contributed to the prevalence of this material on sites in both regions are the quality of the tool stone, its occurrence in an unusually thick bedrock seam, and the position of its main source area along a natural travel route between the two regions. The lithic source, recorded as 5CF84, is situated near Trout Creek Pass, a broad saddle in the generally north-south mountain range separating South Park from the upper Arkansas Valley to the west. Long known to artifact collectors, the lithic procurement site has produced Late Paleoindian, Archaic, and post-Archaic projectile points (Chambellan et al. 1984:Table 1, Appendix E). Presence of Trout Creek jasper at the Cattle Guard site in the San Luis Valley demonstrates that the source area was exploited in early Paleoindian times as well (Jodry 1999:92). At the main prehistoric quarry area, a seam of the tool stone said to be three to four
meters thick was once exposed (Heinrich 1984:102). Unfortunately, this area was dug out with a bulldozer by rock hounds (Chambellan et al. 1984:Appendix E). An archaeological project designed to evaluate the research potential of the site noted several remaining prehistoric quarry pits (Chambellan 1984: Figure 6).

The primary source of Trout Creek jasper at 5CF84 is within a limestone outcrop exposed along the dividing range. Uplift of the range exposed bands of Paleozoic strata along its west flank in the drainage of the Arkansas River. The main quarry area with the purported three-to-four foot seam of jasper is mapped as being within an area where various Ordovician formations outcrop, including the Manitou Limestone (Scott et al. 1978). Heinrich (1984) identifies the specific formation producing the tool stone as the Manitou Limestone.

Trout Creek jasper exhibits a number of defining characteristics. The stone is basically opaque and yellowish brown with medium brown blotches and lines, some of which are branching. Some pieces are a brownish red, apparently from oxidation when exposed to fire. The material is commonly brecciated with cracks filled with silica. A petrographic analysis suggests that Trout Creek jasper may be differentiated from similar appearing tool stones because the former preserves relict structure of the dolomite or dolomitic limestone in which the jasper formed (Heinrich 1984).

**Jemez Obsidian**

Three main varieties of obsidian are available from neighboring sources in the Jemez Mountains of north central New Mexico (Shackley 2009; Wolf 1994). The obsidians were produced during a number of episodes of volcanic activity that occurred in the Pliocene and Pleistocene. The Obsidian Ridge – Rabbit Mountain variety is a brown obsidian that is the poorest of the three for tool manufacture because of the presence of spherulitic inclusions. It is available from volcanic ash flow deposits exposed in the Obsidian Ridge area and at a
possible eroded caldera known as the Toledo Embayment. The Polvadera Peak variety is the best of all three for tool manufacture. It is black with a granular texture from incorporated volcanic ash particles which make this obsidian macroscopically distinguishable from the others. The variety derives from rhyolite flows at a number of small volcanic domes.

Finally, the Cerro del Medio variety is also usually black with a granular texture. It is available from rhyolite domes that circumscribe the perimeter of the massive Valle Caldera, most notably the Cerro del Medio dome.

**Colorado Plateau**

**Washington Pass Chalcedony**

This colorful tool stone originates from a source area in the Chuska Mountains of northwestern New Mexico. Outcrops of the stone are associated with vesicular basalt flows around Washington Pass and known secondary sources are within 16 km of the flows (Cameron 1984:Figure 2; Jodry 1999:98; Maxwell 1990:3). The tool stone is also known as Chuska chert or Narbona Pass chert. At the Cattle Guard site in the San Luis Valley, the stone occurs in its distinctive colors, ranging from shades of pink to reddish orange, but also occurs in a banded variety that is gray and pink or gray and cream (Jodry 1999:98). Small irregular cavities lined with quartz crystals are a common inclusion in this generally high-quality raw material.

**Representation of Tool Stones from Outside Study Area in Assemblages**

With one exception, stone from high-quality sources outside the study area accounts for only a miniscule percentage of those assemblages in which it occurs. The exception is Alibates agate from Texas, which comprises a surprisingly high 13 percent of the Frazier assemblage, according to artifact count.
CHAPTER SUMMARY AND CONCLUDING REMARKS

A variety of tool stones from high-quality lithic sources within the study area are represented in the assemblages. For each individual collection, stone from one or more of the closest sources to the site producing the assemblage comprises a large majority of the artifacts present. Some use of stone from lower quality sources, particularly gravel deposits, is also evident.

In the Plains portion of the study area, high-quality sources of tool stone are widely distributed. Major source areas for various kinds of tool stone occur on the Plains. Included are those areas producing Smoky Hill jasper, Hartville Uplift chert and Spanish Diggings orthoquartzite, primary sources of Dawson petrified wood, and gravel deposits of the White River Group, where various kinds of tool stone are available. These major source areas are widely distributed across the Plains portion of the study area. In the intervening areas, high-quality sources of stone occur at two point sources which are also widely separated. These include the sources of Flat Top chalcedony and Table Mountain chert. The location of some high-quality sources on the Plains is not precisely known, but their existence is confirmed by the presence of ample numbers of large artifacts made of tool stone from the sources in assemblages from sites such as Jurgens and Casper.

The availability of high-quality sources of tool stone in Middle Park and the high Front Range contrasts sharply with the situation in the Plains portion of the study area. In Middle Park, high-quality sources of tool stone are clustered. These include the sources of Windy Ridge orthoquartzite, Kremmling chert, and Table Mountain jasper. Conversely, high-quality sources of tool stone are completely absent in the high Front Range. The closest available sources are in neighboring Middle Park.

With one exception, tool stones from a variety of high-quality lithic sources located outside the study area are present in particular assemblages only in very small amounts.
Stone from high-quality sources was transported to the study area from various regions within an immense surrounding area. The regions include the Northern, Central, and Southern Plains, the Wyoming Basin, the Middle and Southern Rocky Mountains, and the Colorado Plateau.

The discussion up to this point has supplied the knowledge necessary to begin to develop an understanding of the manner in which environmental variables, including tool stone availability, shaped land use patterns within the study area, according to the alternative view. Because a majority of published sites in the study area are associated with large-scale hunts, the discussion has focused on developing ideas regarding the environmental effects on land use related to communal hunting.

A final factor shaping land use that must be integrated into efforts to develop theory is consideration of what might be called the social environment. A number of lines of reasoning have been developed to bolster the thinking that Paleoindian sites attributable to communal hunting in some cases represent the work of people who aggregated into a larger group to participate in the cooperative effort. To evaluate this possibility, archaeologists must develop a method to identify aggregation in the archaeological record. It is to this and other issues that we now must turn to achieve a better understanding of Paleoindian land use.
CHAPTER 8

DEVELOPING ALTERNATIVE LAND USE THEORY AND METHODS OF ANALYSIS

This chapter will primarily develop theory on the alternative view of Paleoindian land use as well as methods through which the theoretical perspective may be tested with archaeological evidence. First and foremost is the need to develop a method of analyzing the tool stone composition of assemblages that will permit the relative validity of traditional and alternative views of land use to be assessed. Secondly, prerequisite knowledge of contemporaneous forms of points and hide scrapers in the study area will be developed to allow site specific interpretations of social interaction to be presented in Chapter 12. Finally, the framework for a model of land use in the study area constructed through consideration of modern and Paleoindian climatic conditions will be further developed with archaeological evidence.

Development of the method of evaluating the contrasting views of land use based on the tool stone composition of assemblages involved two basic steps. First, analytical units that rank tool stones according to distance to source are defined based on the size of ethnographically documented band ranges. Then, differing sets of expectations regarding what the tool stone composition of assemblages should be under the contrasting views were developed. The theoretical expectations are presented in a series of contingency tables that are intended to consider the effects of human group size and availability of a local high-quality source of tool stone. In subsequent chapters, the actual tool stone composition of assemblages from the study area will be compared to the theoretical expectations to determine the relative validity of the two views.
To accomplish this, however, it is necessary to classify study sites as having been produced via communal hunting or not, and in some cases, my site interpretation differs from that presented by the original site investigator. To explain the different interpretations, I discuss my understanding of the natural and cultural processes that would have been involved in the formation of the study area sites, as well as the presumed communal bison hunting technique normally used by Paleoindians.

The discussion of contemporaneous types of points and hide scrapers is provided to set the stage for the interpretations of individual assemblages presented in Chapter 12. The classic series of point types presented in Table 3-1 was established from work on the western Plains. Sites producing points of these types are known from the western part of the Plains portion of the study area and also from sites in the high Front Range and Middle Park. As first noted by Pitblado (e.g. 2007), by at least Late Paleoindian times, indigenous people of the Southern Rocky Mountains made a series of differing point types that includes the Angostura point. Specimens of Angostura points are present in study assemblages from Middle Park and the high Front Range. Discussion of climatic conditions in the study area has led to the suggestion that Middle Park and the high Front Range were seasonally occupied by separate populations that wintered in regions to the east and west. Study assemblages from certain sites associated with large-scale hunting in Middle Park and the high Front Range contain points conforming to both Southern Rocky Mountain and western Plains types. Contemporaneous point types of these two physiographic regions will be reviewed as background information for site-specific interpretations presented in Chapter 12 on the meaning of coeval point types at certain sites in the study area.

Other researchers have noted differences in the material culture of Paleoindians at sites in the western part of the Plains portion of the study area and that found at sites in the eastern section and made preliminary comments on what this may mean for identifying cultural groups and studying social interaction. In contrast to the classic Plains Paleoindian
point sequence of the western Plains, poorly understood concave-based lanceolate points are present in the east (e.g., Knudson 2002). Furthermore, hide scraping tools differ in that flake-based end scrapers served as hide scraping tools in the western Plains, but a bifacially flaked beveled tool was used for this purpose in the east (Bamforth and Becker 2007a). Particular study assemblages from the Plains contain both points and/or hide scrapers of types common to both western and eastern sections. Discussion of coeval types of points and hide scrapers is provided here as a prelude to subsequent individual site interpretations of the meaning that the co-occurrence of contemporaneous types may have for understanding prehistoric social interaction.

A discussion of variation in the named types of points of the Folsom period and the possible relevance of this variation to understanding the role of social aggregation in Paleoindian land use is presented to set the stage for interpretations of three sites in Middle Park that together have produced points assigned to Folsom and Goshen types. Fluting of points requires a high level of flintknapping skill and Bamforth (1991b) has argued that skilled flintknappers produced points for hunters participating in communal kills. Based on this thinking, a hypothesis will be developed asserting that bison bonebed sites producing fluted Folsom points tend to represent the work of relatively large human groups while sites yielding non-fluted points of Folsom age currently assigned to various types are indicative of relatively smaller groups.

Lastly, the model concerning the seasonal timing of communal hunts and regional abandonment within the study area will be further developed with archaeological evidence from the study area. A framework for the model was constructed during a consideration of modern and Paleoindian climatic conditions in Chapters 5 and 6. Data on the months during which Paleoindian large-scale bison kills were carried out at various latitudes on the Great Plains will be consulted to further develop the model that Paleoindians inhabited the Plains on a year-round basis and that kills in the more northerly sections were carried out during the
height of the cold-season to preserve meat by freezing, while kills planned for more southerly regions necessarily transpired during months prior to the height of the cold-season to store meat via drying. Data on the months when communal bison kills were conducted in Middle Park will be consulted to support the theoretical expectation that hunts in the high Front Range and Middle Park would have been held in the months preceding the height of the cold-season, during which time these regions would have been abandoned. Evidence said to support recent claims that Paleoindians wintered in Middle Park and other intermontane basins will be reviewed and refuted.

DEFINING UNITS OF ANALYSIS FOR STUDYING AGGREGATION THROUGH TOOL STONE SOURCING

It is important that sufficient thought be put into designing the units of analysis to be used in evaluating a research question. The units of analysis used to collect data from the archaeological record must reflect the quality of the living human society that the archaeologist is hoping to elucidate. The theoretical quality of Paleoindian society being investigated here is that bands operated within ranges comparable to ethnographically studied foragers and occasionally conducted communal hunts by themselves or in cooperation with neighboring bands. To evaluate the validity of this proposition, it is necessary to gain some understanding of the size of ethnographically documented ranges so that stone designated as being from “local” sources may be defined as that from sources close enough to the site that the indigenous band could have visited the source. In situations where sources of quality tool stone are very widely distributed, stone may have been acquired by task groups going to a source and acquiring a supply of stone for the band. In these cases, the archaeological record may not reflect the size of ranges in which bands habitually moved about in order to procure food resources from the environment. Though there may be situations where band ranges
will not be highly visible in the archaeological record, there should also times when tool stone sources are sufficiently dense that one may evaluate if Paleoindian band ranges were comparable in size to those of ethnographic peoples. Anticipating problems with the archaeological visibility of band ranges does not preclude developing the model so that its utility as an explanatory tool may be evaluated against the traditional view. That being said, “local” tool stones in an assemblage will be defined as being those from sources within an area around the site that is the size of ethnographically known band ranges. “Distant” tool stones are defined as those being from sources that are far enough from the site that they may be considered to have been within the range of a neighboring band. “Very distant” tool stone will be defined as being from sources within ranges of bands lying even more distant from the site. In assemblages from the kinds of sites considered in this study, artifacts of stone from very distant sources should be relatively few in number and be the result of one of the several previously discussed mechanisms that served to move stone long distances.

The largest known ethnographic range size will be used as the basis for defining local tool stone in this study. Existing records provide limited data on the variation in ethnographic range sizes (Table 8-1). The maximum dimension of band ranges in a sample of six foraging societies ranges from a low of 22 km to a high of 143 km. The four ethnographic groups with the smallest ranges (varying in size from 22 to 54 km in maximum dimension) live in desert, savanna, and rain forest environments of Africa and have subsistence economies that are based on a mix of plants and animals. Some big game hunting is practiced. Two examples in Table 8-1 are of Inuit groups of the North American arctic that had subsistence economies that were reliant on big game hunting. None of the ethnographic groups are especially analogous to Paleoindians of the Plains and intermontane grasslands of the study area who relied to some extent on communal bison hunting, but the Inuit groups are perhaps the most analogous because they lived in an environment somewhat similar to the grasslands of the study area (the arctic tundra). The Nunamiut band studied by Campbell
Table 8-1. Variation in Maximum Dimensions of Ranges of Ethnographically Studied, Pedestrian Hunter-Gatherer Bands.

<table>
<thead>
<tr>
<th>Cultural Group</th>
<th>Region Inhabiting</th>
<th>Band Name or Other Designation</th>
<th>Maximum Dimension of Band Range (km)</th>
<th>Reference</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bushmen (of !Kung dialect)</td>
<td>Kalahari Desert of south Africa</td>
<td>Dobe</td>
<td>22</td>
<td>Yellen (1976:Map 2.2)</td>
<td>Range size was determined by documenting movements of band members over 5 ½ month period in 1968</td>
</tr>
<tr>
<td>Efe (Pygmies)</td>
<td>Ituri Forest of west Africa</td>
<td>Andilokbe</td>
<td>22</td>
<td>Bailey (1989:669)</td>
<td>The Efe live alongside villages of the Lese for part of the year. Movements of the Andilokbe band were documented for two years in the 1980s.</td>
</tr>
<tr>
<td>Hadza</td>
<td>savanna of east Africa</td>
<td>Mangola</td>
<td>45</td>
<td>Tomita (1966:Figure 2)</td>
<td>Range size measured from west side of Morogi family group territory to east end of Yaeda family group territory. Band comprised of 80 people in the 1960s.</td>
</tr>
<tr>
<td>Bushmen (of Gwi dialect)</td>
<td>Kalahari Desert of south Africa</td>
<td>≠xade</td>
<td>54</td>
<td>Silberbauer (1981:Figure 16)</td>
<td>-</td>
</tr>
<tr>
<td>Netsilik Inuit</td>
<td>arctic of North America</td>
<td>Arviligiaarmiut</td>
<td>80</td>
<td>Balikci (1968:Figure 1)</td>
<td>Range size measurement based on reconstructed band movements in 1919</td>
</tr>
<tr>
<td>Nunamiut Inuit</td>
<td>arctic of North America</td>
<td>Tuluaqmiut</td>
<td>143</td>
<td>Campbell (1968:Figure 2)</td>
<td>Range size measurement based on reconstructed band movements during a five-year period before 1875</td>
</tr>
</tbody>
</table>
may be the most analogous to Paleoindians of the study area because the band aggregated annually for communal caribou hunting. Unlike communal bison hunts using the surround technique, the precise location of which may not have been highly predictable, the communal caribou hunting of the Tuluaqmiut band allowed these people to gather in the same place twice each year to hunt the caribou as they traveled through Anaktuvuk Pass on their spring and fall migrations. The size of the largest known ethnographic band range (that of the Tuluaqmiut band of the Nunamiut) will thus be used to provide some sense of the size of ranges used by Paleoindians in the study area (according to the alternative view) on the grounds that the environment and subsistence economy of the Nunamiut is the most analogous to that of Paleoindians in the study area.

To pick an exact number of kilometers to define the cutoff point for local stone, the maximum dimension of the Tuluaqmiut band (143 km) will be rounded up to the even number of 150 km and then divided by two (= 75 km). A site centered in a circular area with a radius of 75 km will be within an area roughly comparable in size to the largest ethnographic range. Stone available at sources within 75 km of the site can arguably be considered to be within an area comparable in size to ranges used by ethnographically documented bands. Choosing 75 km as the cutoff point to define local tool stone will have some obvious imprecision associated with it because sites will not always be positioned in the center of the range. Nevertheless, the figure should serve as a reasonable unit of analysis if indeed the size of a Paleoindian band’s range was more like that of ethnographic foragers than the huge ranges proposed by traditional thinkers. As discussed in chapter two, the work of traditional minded archaeologists that allow the size of proposed Paleoindian band ranges to be measured place the maximum dimension of the ranges envisioned somewhere between 500 and 800 km.

A diagram illustrating how the analytical units of tool stone from local, distant, and very distant sources were derived from the size of two adjacent ethnographic band ranges of
the size selected for use in this study is presented in Figure 8-1. The diagram demonstrates how distances from the site, as measured in kilometers, were chosen to define the units of analysis. Tool stones from distant sources are from sources that are located far enough away from the site to have been within the ranges of neighboring bands. Under the alternative view, some assemblages from sites associated with large-scale kills in environments where tool stone sources are widely distributed should have substantial amounts of stone from distant sources acquired by members of a participating band as part of gearing up for the hunt. As illustrated in Figure 8-1, the cutoff point for defining the upper limit of distant sources of tool stone is given by the following calculation: 75 km + 150 km = 225 km. Distant tool stone is therefore defined as originating from sources located between 75 and 225 km from the site. Tool stone from very distant sources is that which derives from sources situated beyond the ranges of adjacent bands. Very distant tool stone is defined as originating from sources over 225 km from the site.

The question arises of how stable Paleoindian band ranges were on the Plains. Dyson-Hudson and Smith (1978) discuss theoretical effects of food resource density and predictability on the territorial behavior of foragers. The relationship between food resource density and predictability may be conceptualized in a contingency table in which the rows classify food staples of an environment according to high and low resource density and the columns group the main food resources by low and high predictability (Dyson-Hudson and Smith 1978:Figure 1).

Environments with dense and predictable food resources are expected to encourage the development of geographically stable territories among foraging people. A classic example of this is seen in the Owens Valley Paiute where permanent streams flowing down through a number of ecological zones on the slopes of the Sierra Nevada Mountains in California allowed stable territories to form among the native inhabitants of the valley (Steward 1938:50-54).
Figure 8-1. Diagram illustrating how units of analysis were derived to test the alternative view that aggregation of bands with ranges comparable in size to ethnographic hunter-gatherers can best explain the tool stone composition of the Jurgens site.
Regions with dense but unpredictable food resources would favor temporary aggregation of bands at locations where the resource is plentiful as well as information sharing between bands regarding the location of food resources. An example of this situation given by Dyson-Hudson and Smith (1978) is when some groups of Northern Shoshone of the Snake River Plain and northern Great Basin would aggregate into a larger group to hunt bison herds on the Plains to the east during the warm-season.

Other environments can have low food resource density with low predictability from one year to the next. The location of food resources varies annually such that food may exist in one area during a particular year, but be scarce or non-existent in another. Under these conditions, the formation of dispersed human groups that do not have stable ranges from year to year is encouraged. As an example of this situation, Dyson-Hudson and Smith (1978) cite groups of the Northern Shoshone that foraged for seeds in the Basin and Range province where a scattered rainfall pattern made for a patchy seed distribution that varied considerable from year to year.

Finally, Dyson-Hudson and Smith (1978) discuss environments with low resource density but high predictability. Environments with these qualities tend to promote the formation of foraging groups with home ranges that were used year after year. Hill’s (2007, 2008) review of faunal remains from Paleoindian sites on the Plains demonstrates that sites on the open plains are dominated by bison, but those along gallery forests and other river valley settings produced faunal assemblages representing human use of a wide array of animal species. The data synthesized by Hill suggests that subsistence economy in river valley environments included the hunting of deer, hunting of antelope (probably in the adjacent plains), and use of a wide range of smaller mammals (especially hares and rabbits), birds, turtles, and fish. Although riverine environments on the Plains may not have offered especially dense food resources, they apparently offered a diverse array of resources. The observation that a similar suite of food animals appears in faunal assemblages from riverine
settings throughout the Plains suggest that perhaps this same basic set of resources could be predictably procured during regular, non-drought years. If so, it would follow that Plains Paleoindians would have had home ranges that remained stable year after year.

Whether or not Paleoindians of the Plains portion of the study had stable home ranges when not involved in large-scale bison hunts is somewhat irrelevant to assessing if the range size was comparable to ethnographic groups. In general, if Paleoindians operated in ranges that were comparable in size to ethnographic groups, then aggregation of individual bands for communal hunting in an area with both local and distant high-quality tool stone sources should produce an assemblage comprised of substantial amounts of local and distant stone, regardless of whether or not ranges were stable over the long-term.

EXPECTED TOOL STONE COMPOSITION OF ASSEMBLAGES UNDER THE CONTRASTING VIEWS

Now that categories of local, distant, and very distant tool stones have been defined based on the supposed organization of Paleoindian society into bands that occasionally aggregated for communal hunts, the differing expectations for the tool stone compositions of assemblages under each view may now be presented in terms of the relative proportions of local and distant tool stones to be anticipated. Variation in the tool stone composition of assemblages from sites associated with large-scale kills as expected under the alternative view is shown in Table 8-2. As demonstrated in the table, the tool stone composition of such sites is expected to vary based on the presence or absence of local high-quality sources of tool stone, whether the site was produced by a single band or a multi-band aggregation of people, and whether a visiting band would have geared before or after meeting up with the local band.

Variation in the tool stone composition of assemblages from sites related to large-scale kills under the traditional view is illustrated in Table 8-3. Assemblages are expected to
Table 8-2. Effects of Raw Material Availability, Number of Bands in Aggregated Group, and Timing of Gearing Up Activities on Tool Stone Composition of Assemblages from Sites Associated with Large-Scale Kills as Expected under the Alternative View.

<table>
<thead>
<tr>
<th>Tool Stone Availability</th>
<th>Environment with Local High-Quality Source(s) of Tool Stone</th>
<th>Environment Without Local High-Quality Source(s) of Tool Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Single-Band Aggregation</td>
<td>Multi-Band Aggregation</td>
</tr>
<tr>
<td></td>
<td>Bands Geared Up with Stone from Home Range Prior to Aggregating</td>
<td>Bands Geared Up with Local Stone After Aggregating</td>
</tr>
<tr>
<td></td>
<td>Local tool stone will dominate the assemblage.</td>
<td>Substantial amounts of both local stone, acquired by members of the local band, as well as nonlocal tool stone, acquired by members of visiting bands, will be present in assemblage.</td>
</tr>
<tr>
<td></td>
<td>Nonlocal tool stone will dominate the assemblage, having been acquired through direct procurement by task groups or through trade.</td>
<td>Nonlocal tool stone will dominate the assemblage. Multiple types of nonlocal tool stone will be present if participating bands had access to sources of different tool stone types.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Local tool stone will dominate the assemblage.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not applicable.</td>
</tr>
</tbody>
</table>
Table 8-3. Expected Tool Stone Composition of Assemblages from Sites Associated with Large-Scale Kills under the Traditional View.

<table>
<thead>
<tr>
<th>Tool Stone Availability</th>
<th>Environment with Local High-Quality Source(s) of Tool Stone</th>
<th>Environment Without Local High-Quality Source(s) of Tool Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Paleolithic Society Organized into Highly Mobile Bands that Operate Independently of One Another</td>
<td>Nonlocal tool stone will dominate the assemblage.</td>
</tr>
<tr>
<td>Nonlocal tool stone will dominate the assemblage if the band producing the site had yet to visit a local source. If the band had visited one or more local sources prior to producing the site, local tool stone may comprise substantial or large amounts of the assemblage, but artifacts of nonlocal tool stone acquired by the band at an earlier time, elsewhere in its annual range, should nevertheless comprise substantial or at least appreciable amounts of the assemblage.</td>
<td></td>
<td>Nonlocal tool stone will dominate the assemblage.</td>
</tr>
</tbody>
</table>
have less variability than under the alternative view. The lower amount of variability is due to Paleoindians always having high-quality stone on hand, even in environments without local quality stone due to their movement within huge ranges. The lesser variability is also due to a lack of variation in group size because Paleoindians are thought to have always operated as individual bands.

Differences between the two views are also evident in the following tables presenting expectations on the tool stone composition of assemblages from other kinds of sites. With few exceptions, the expectations of the traditional view are less variable than those of the alternative view because of the lesser variability thought to have existed in the quality of lithic sources that Paleoindians would use and the lack of variability in the kinds of social groups in which they operated.

Expected variation in the tool stone composition of campsite assemblages not associated with large-scale hunting under both theoretical perspectives is given in Table 8-4. Only one site in the sample from the study area (the Allen site) is definitely interpreted as a camp that is not associated with communal hunting.

The expected tool stone composition of sites located at high-quality sources also differentiates the two views. Table 8-5 gives the expected tool stone composition of such sites under the alternative view. The tool stone composition of such sites is expected to vary according to the kind of human group visiting the lithic source. In other words, depending on whether the group was a single band, a multi-band aggregation intent on gearing up, or a small task group or individual seeking to resupply the band with tool stone. The tool stone composition of assemblages from sites at sources expected under the traditional view is given in Table 8-6.

Sites producing assemblages that will be analyzed to evaluate the two views are listed in Table 8-7. A number of excavated Paleoindian sites that are within the study area and are reported in existing literature were excluded from analysis. Some are excluded because the
Table 8-4. Differing Expected Tool Stone Compositions of Assemblages from Campsites Not Associated with Large-Scale Kills under the Traditional and Alternative Views.

<table>
<thead>
<tr>
<th>Tool Stone Availability</th>
<th>Environment with Local High-Quality Source(s) of Tool Stone</th>
<th>Traditional View</th>
<th>Alternative View</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nonlocal tool stone will dominate the assemblage if the band producing the site had yet to visit a local source. If the band had visited one or more local sources prior to producing the site, local stone may comprise substantial or large amounts of the assemblage, but artifacts of nonlocal tool stone acquired by the band at an earlier time, elsewhere in its annual range, should nevertheless comprise substantial or at least appreciable amounts of the assemblage.</td>
<td>Large amounts of local stone will be present in the assemblage, having been procured by band members at one or more local sources within the home range of the band.</td>
<td>Low-quality local tool stone may comprise substantial amounts of the assemblage if it is available, but substantial amounts of high-quality nonlocal tool stone will also be present. If no local tool stone of even low quality is available, the assemblage will be comprised of large amounts of high-quality nonlocal tool stone. The nonlocal stone will have been obtained via direct procurement at the source by individuals or small task groups from the local band or through trade with members of surrounding bands.</td>
</tr>
</tbody>
</table>
Table 8-5. Variation in the Tool Stone Composition of Occupation Assemblages at Sites near High-Quality Lithic Sources Resulting from the Kind of Human Group Present, as Expected under the Alternative View.

<table>
<thead>
<tr>
<th>Tool Stone Availability</th>
<th>Environment with Local High Quality Source(s) of Tool Stone</th>
<th>Single Band</th>
<th>Multi-Band Aggregation</th>
<th>Small Task Group or Individual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment Without Local High Quality Source(s) of Tool Stone</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

Stone from the nearby source will account for a large amount ofdebitage. As tool kits are rejuvenated with stone from the nearby source, finished tools discarded on the site will be comprised of large amounts of local stone.

Stone from the nearby source will account for a large amount ofdebitage. A small amount of nonlocal stone may be represented in the debitage as some unfinished bifacial artifacts and blocky cores brought by visiting bands were flaked on-site. Tools discarded on-site may be made of a substantial amount of local stone procured by the local band along with substantial amounts of nonlocal stone procured within the home range of one or more visiting bands.

Stone from the nearby source will account for a large amount ofdebitage. A task group or individual visiting a lithic source for the sole purpose of acquiring stone in the form of unfinished artifacts would not be expected to discard a lot of finished tools. Any such tools present might suggest whether the task group or individual originated from the local band or from a more distant band.
Table 8-6. Tool Stone Composition of Occupation Assemblage at Site near High-Quality Lithic Source as Expected under the Traditional View.

<table>
<thead>
<tr>
<th>Tool Stone Availability</th>
<th>Environment with Local High-Quality Source(s) of Tool Stone</th>
<th>Band Ranging Over Anomalously Large Area and Visiting High-Quality Lithic Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stone from the nearby source will account for large amounts of debitage. As tool kits are rejuvenated with stone from the nearby source, finished tools discarded on the site will be comprised of large amounts of nonlocal tool stone.</td>
<td></td>
</tr>
<tr>
<td>Environment Without Local High-Quality Source(s) of Tool Stone</td>
<td>Not applicable</td>
<td></td>
</tr>
</tbody>
</table>
Table 8-7. Contingency Table Showing the Kinds of Sites in the Study Area by the Availability of High-Quality Lithic Source(s) in the Local Environment with Specific Sites Falling into Each Category Indicated.

<table>
<thead>
<tr>
<th>Tool Stone Availability</th>
<th>Environment with Local High-Quality Source(s) of Tool Stone</th>
<th>Site Associated with Large-Scale Big Game Kill</th>
<th>Site Near High-Quality Source of Tool Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment Without Local High-Quality Source(s) of Tool Stone</td>
<td>Jurgens ? Frazier ? Powars ? Lindenmeier ? Jones-Miller Casper</td>
<td>Hell Gap site complex, especially Cody Component at Locality V Allen Lime Creek, Zone I Red Smoke, Zone V Barger Gulch, Locality B Crying Woman</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

* Question mark next to site name indicates some uncertainty regarding whether the site is associated with large-scale big game hunting or if a high-quality source of tool stone is available locally, or both. See text for more information.
available information on the site does not allow the tool stone composition of the assemblage to be quantified, even in a rudimentary way. Assemblages from bison bonebeds can be small and those that do not include over 30 artifacts were excluded on the grounds that such a small artifact total may not constitute a representative sample.

As indicated in Table 8-7, some may question the classification of certain sites as being associated with a large-scale big game kill. Classification of four sites as being related to large kills could be questioned because a dense bonebed was not present. Included is one of the sites in the Kersey cluster (Powars) and all three sites of the high Front Range cluster. As explained below in the section on site formation processes, there is reason to believe that plentiful amounts of big game bone were present on these sites at the time they were abandoned, but natural processes destroyed most or all of the bone. A complication that may confound interpretation of the tool stone composition of the Lindenmeier site is that there are reasons to believe that part of the assemblage is related to a large-scale kill, but some is a result of camping activity unrelated to communal hunting. Further discussion of the Lindenmeier site is provided in Chapter 12.

For a number of sites listed in Table 8-7, some uncertainty exists regarding their classification as being situated in an environment without a local high-quality source of tool stone. In relation to the Kersey site cluster, the closest available tool stone that is of adequate quality and occurs in large enough pieces to make all the kinds of flaked stone artifacts present in the assemblages is believed to be found at exposures of White River Group gravel. As discussed in Chapter 10, the large size of artifacts made of one variety of WRGG that is plentiful in the Jurgens assemblage suggests that at least one variety of this raw material is of high-quality and is available in relatively large pieces. However, the specific source exploited to make the Jurgens artifacts is unknown, therefore, it is uncertain if the large pieces occur in sufficient density to constitute a high-quality source. In relation to the Kersey cluster, WRGG is available from local and distant sources, but whether the source visited to
procure stone to make the large artifacts at Jurgens is local or distant is unknown. The closest recorded source of WRGG lies at a distance of 39 km from the site cluster. Based on the available information, it can be stated that a known high-quality source of tool stone does not occur close enough to the site to suggest that visiting bands intent on participating in a communal hunt would have had the option of gearing up with local stone. Also, as discussed in Chapter 5, the relative unpredictability of bison herds in the western Plains portion of the study area would have further served to encourage any visiting bands intending to cooperate in a large-scale hunt to have already geared up with stone prior to aggregating with other people. The above suggests that the classification of the Kersey sites in Table 8-7 is reasonable and if the alternative view is valid, the tool stone composition of assemblages from these sites should conform to expectations for sites related to a large-scale kill produced in environments lacking a high-quality source of tool stone.

The availability of tool stone in the vicinity of the Lindenmeier site is thought to be similar to that of the Kersey cluster in that various tool stones are available locally, but a definite high-quality source has yet to be documented. The details of the local tool stone situation are discussed in Chapter 7 and the manner in which the presence of local tool stones may have affected Paleoindian land use and be reflected in the tool stone composition of the Lindenmeier assemblage is elaborated in Chapter 12.

OCHRE AS A POSSIBLE INDICATOR OF COMMUNAL HUNTING

To evaluate how well the tool stone composition of an assemblage fits the expectations of the contrasting theoretical perspectives, it is first necessary to assess if the site producing the assemblage is associated with communal hunting. In order to make this determination, methods such as considering the relative frequency of functional types of artifacts will be employed. Other lines of evidence will also be considered.
One possible indicator of sites associated with communal hunting is the presence of evidence for grinding of red or yellow ochre to make powdered ochre. Reasons exist to suggest that powdered ochre was used in an activity related to large-scale bison hunting. Pieces of ochre were found at five of the sites in the study area. Often the pieces are described as having striations, suggesting that they had been ground against an abrasive surface to produce a powder. Sites producing ochre include Lindenmeier, Locality B of the Barger Gulch site complex, Locality V (and others) at the Hell Gap site cluster, Jurgens, and Frazier. With exception of Frazier, all of the sites mentioned produced ground stone artifacts with adhering ochre, which suggests that the artifacts had been used to either produce powdered ochre or perhaps to apply ochre to some object. In existing literature, only Jurgens and Frazier are interpreted as definitely associated with large-scale hunting, in large part because of the presence of dense bison bonebeds. In the discussion of individual sites provided in Chapter 12, I will argue that the localities at Hell Gap and Barger Gulch are associated with communal hunting and will suggest that this may be the case for some or all of the Folsom occupations at Lindenmeier as well.

One reason that evidence for the manufacture or application of powdered ochre may be found at sites related to communal hunting is that Paleoindians may have been rubbing ochre into bison hides to inhibit their decay. Keeley (1980:170-172) has observed red ochre on the working edges of Magdalenian end scrapers. From this, it may be reasoned that red ochre had been applied to hides that were later scraped as part as part of the tanning process. In other words, ochre had been applied to a hide that had yet to be fully processed into leather. Red and yellow ochre powder is produced from the minerals hematite and limonite, respectively. Keeley (1980:170-172) notes that hide is composed of collagen and decays when attacked by bacteria producing the enzyme collagenase. Metal ions inhibit the action of collagenase and both hematite and limonite contain iron. From the above information, Keeley suggests that the application of powdered ochre to hides was intended to inhibit their decay.
decay. For sites related to large-scale bison hunting where hides were to be saved for manufacture of leather goods, evidence for the production or application of powdered ochre may indicate that ochre was being rubbed on hides that had yet to be fully processed in an effort to preserve them until they could be completed into fully tanned leather goods.

Another possible use for some of the powdered ochre produced at sites associated with large-scale bison hunting is that it may have been mixed with fat or grease to make a paint that could then be applied to objects used in rituals conducted in the context of communal bison hunts. Plains ethnography documents that rituals were performed in advance of large-scale bison kills and in some cases, the use of ritual objects, such as bison skulls painted red, is mentioned in the literature (e.g. Denig 1930:532-533). A bison skull uncovered at the Cooper site had a red zigzag painted on it (Bement 1999:176-178) and is suggestive of ritual activity conducted within the context of a communal hunt. Finally, one of two quartz crystals from the Jurgens site is coated in red ochre. Crystals were used in ceremonies conducted by some Plains tribes (Reher 1991:385-386). The ochre-covered crystal from Jurgens and the painted skull from Cooper provide evidence upon which to hypothesize that some of the powdered ochre produced at Paleoindian sites related to large-scale bison hunting may have been used to paint ceremonial objects used in the performance of rituals.

From the above information, it may be stated that there does appear to be a possible correlation between manufacture of quantities of powdered ochre and communal bison hunting and that this may be used, along with other evidence, to interpret the function of sites in the study. Possible reasons for the apparent connection were suggested, but have yet to be proven. Nevertheless, operating under the assumption that evidence for production or application of powdered ochre may be an indicator of communal bison hunting seems justified. Therefore, such evidence will be used in conjunction with other lines of evidence to
support the interpretation that some of the study sites were likely associated with large-scale bison hunting, even though they are not presented as such in existing literature.

THE RELEVANCE OF DOGS TO LAND USE STRATEGIES

An aspect of Paleoindian land use that has yet to be adequately theorized by either traditional or alternative-minded archaeologists is the potentially important role that domesticated dogs may have played in enabling the land use strategies employed in various environments. In pre-horse days, foragers on the Great Plains went about their annual movements with the aid of the dog as a beast of burden to transport material culture using pack saddles and travois (Allen 1920:454). Evidence from the archaeological record suggests prehistoric plains peoples may also have used dogs as beasts of burden. Walker and Frison (1982) compared skulls of dogs from Late Plains Archaic and Late Prehistoric sites in Wyoming to those of wolves and Inuit dogs. Ethnographies indicate that the Inuit people of arctic regions also used dogs as beasts of burden to pull dog sleds. The prehistoric Wyoming dogs were shown to be intermediate in size between Inuit dogs and wolves. The large size of the Wyoming dogs implies their use as beasts of burden. Evidence exists to suggest that large dogs were an element of the culture of even earlier Plains foragers in Wyoming where the remains of large dogs have been recovered from two Paleoindian sites (Agate Basin and Horner), an Early Plains Archaic site, and a Middle Plains Archaic site (Walker and Frison 1982:168). Complete skulls were not recovered from the early sites and so could not be included in the above-cited comparison. However, an ulna of an adult dog from the Clovis age deposits at the Agate Basin site cluster demonstrates that the animal was intermediate in size between a wolf and a coyote (Walker 1982:Figure 4.37). This provides at least some support for the idea that dogs of Plains Paleindians were relatively large and perhaps used as beasts of burden.
Information from ethnographic documents may be a source of information with which archaeologists may begin to gain some idea of the numbers of dogs that would have been possessed by prehistoric foragers of the Plains and Rocky Mountains who used dogs as beasts of burden. Limited sources exist to suggest that peoples who primarily put dogs to use as beasts of burden possessed a lot of animals. According to Ray (1974:161) the horse had been acquired by the tribes of the Canadian Plains by 1800, nevertheless, the dog continued to be an important beast of burden in that area. Alexander Henry the Younger was stationed at Fort Vermillion on the North Saskatchewan River in 1810 during which time he had trading connections with a group of Assiniboine that included 35 men. On one occasion when this group was at the fort to trade, Henry counted the number of dog travois present at 230. The above figures suggest the Assiniboine possessed a lot of dogs. Considering that the dogs were apparently being used to transport commodities for trade, the actual number of dogs needed to just transport the material possessions of the Assiniboine may have been less.

Another ethnographic reference of relevance here relates to an encounter in 1835 between trapper Osborne Russell and a band of Shoshone in the Lamar Valley of Yellowstone National Park. The reference is of importance because it suggests that foragers of the Rocky Mountains also made use of dogs and that many were required to transport their material culture. When describing his visit to the Lamar Valley, Russell (1955:26-27) found: “…a few Snake Indians comprising six men, seven women, and eight or ten children who were the only inhabitants of this lonely and secluded spot… Their personal property consisted of one old butcher knife, nearly worn to the back, two shattered fuses which had long since become useless for want of ammunition, a small stone pot and about 30 dogs on which they carried their skins, clothing, provisions, etc. on their hunting excursions. They were well armed with bows and arrows pointed with obsidian.” If the number of people in the band is taken to be 22, then for each person, there would have been 1.4 dogs to transport the band’s possessions. From the above, it can be reasoned that a lot of dogs would have
been needed by Paleoindians living in the Plains and Rocky Mountains of the study area to assist with maintaining their mobile lifestyle.

Other ethnographic sources from the Plains are especially relevant to the purposes of this dissertation because they concern the use of dogs in transporting bison meat from a kill site to a camp. Bamforth (2011) recently has argued that most Paleoindian bison bonebeds represent butchered bison remains discarded at temporary hunting camps, rather than at the actual site of the kill. Previously, Plains Paleoindian archaeologists have tended to interpret all bonebeds as having been situated at or adjacent to the actual place where bison were killed. This line of reasoning was based on ethnographic reports of bison traps and the implicit understanding that portions of bison carcasses would not have been transported far from the place where the animals were killed before being further processed. However, the Plains ethnographic record contains references indicating that dogs were used to transport sections of bison carcasses to a camp for further processing. In his study of the Hidatsa, Wilson notes that “an Indian quarter [of buffalo], cut off from the backbone” might made a load for a dog” (Wilson 1924, cited in Wedel 1963:12). Wilson’s informants also related that three or four hours were required for dogs equipped with travois to drag heavy loads of meat and hides to camp from a butchering place seven miles away. These comments strongly imply that dogs may have been instrumental in facilitating the land use strategies of Plains peoples by allowing hunters to kill bison far afield and then use travois-equipped dogs to transport the products of the hunt to a camp. An implication of these ethnographic observations is that Plains foragers during the Paleoindian period may also have been reliant on the use of dogs equipped with travois in order to successfully carry out large-scale bison hunts. The above observations also serve to illustrate the necessity for archaeologists to begin to theorize in a more encompassing way the potential roles that dogs may have played in the land use strategies of Paleoindian peoples of the Plains and Rocky Mountains.
CONSIDERING SITE FORMATION PROCESSES AND OTHER THEORETICAL MATTERS REGARDING SITE FORMATION AND INTERPRETATION

To properly interpret the role that a site played in a prehistoric system of land use, it is necessary to appreciate the manner in which various cultural and natural processes affect the formation of the archaeological record. In this way, the archaeologist can develop an accurate understanding of the ways that the scatters of artifacts and bones at sites may reflect the role that the site played in the system of land use.

A basic example of a cultural process effecting the formation of the archaeological record is the manner in which cultural material was discarded on a site. Two kinds of refuse are recognized by archaeologists. With primary refuse, the archaeologist may be able to interpret the spatial arrangement of activities on a site by studying the distribution of functionally different artifacts and other cultural remains. An example of ethnoarchaeological investigation of primary refuse deposition to understand site formation processes is Binford’s (1978) study of hearth-centered activity areas at the Mask site, a Nunamiut hunting lookout site. In secondary refuse, artifacts and other cultural material remains produced during differing activities are transported from the locus of their use to a trash deposit or midden where they all were discarded together. An example of an ethnoarchaeological investigation into the generation of secondary refuse by hunter-gatherers is O’Connell’s (1987) study of Australian aborigines. To correctly interpret the activities carried out at a site, it is important to understand if cultural material represents primary or secondary refuse.

Many natural formation processes effect the formation of the archaeological record. Simply put, development of the alternative view of land use in the study area depends on the ability to correctly assign sites produced during single episodes of use to occupation that were or were not related to large-scale hunting of big game. Sites related to large-scale kills often are recognized by presence of dense bonebeds of animals killed in a single event. However, natural processes and factors such as differing rates of sediment deposition and varying levels
of soil acidity can result in differential preservation of bone at sites where dense bonebeds were once present. Archaeologists must therefore be cognizant of the effect of differential bone preservation in order to properly interpret sites in the study area.

Apart from appreciating the importance of site formation processes, having the correct theoretical understanding of the cultural activity that is primarily represented at a site is also important to produce an accurate interpretation. Because many of the sites involved in the present study have bison bonebeds associated with communal hunting, adopting the appropriate theoretical understanding of the communal hunting technique represented is necessary to correctly interpret the sites under the alternative view. As mentioned, many of the sites with dense bison bonebeds have been interpreted by the original site investigators as the actual site of the communal kill. Commonly, bonebeds are exposed in arroyos, which is the basis for the interpretation that the hunting technique used by Paleoindians involved driving a herd into an arroyo where it was trapped and killed. Other Paleoindian bonebeds occur in relatively flat terrain where the topography could not be of assistance in trapping a herd of bison. Such sites are all close to wooded streams. Some have suggested these bonebeds represent locations where a bison pound was situated and cite ethnographic examples of circular bison pounds constructed of wooden posts set into the ground as a source of analogy. To account for the lack of post molds around the perimeter of one such bonebed, the original site investigator suggests the site “represents a pound kill in which snow was utilized as the major trapping medium” (Stanford 1978:97).

Bamforth (2011) argues that most dense Paleoindian bison bonebeds are features of temporary hunting camps where bison carcasses from a single communal kill were processed. He further asserts that most bonebeds are representative of herds killed using the surround hunting technique. Based on ethnographic information, I have suggested above that partial carcasses of bison killed in surrounds may have sometimes been transported a considerable distance from the actual location where the herd was surrounded and killed to a suitable
hunting camp. Interpreting most dense Paleoindian bison bonebeds as features of temporary hunting camps explains a number of characteristics of bonebed sites that are enigmatic when the sites are interpreted as bison traps. First, some bonebed sites occur in relatively flat terrain where the lay of the land could not have assisted in trapping the bison and there are no post molds around the perimeter of the bonebed that would provide evidence of a wooden pound analogous to ethnographic examples. Secondly, such sites commonly are in locations conducive to camping and include a source of drinking water and firewood. Also, the archaeological content of bonebed sites is often not in accord with a kill site interpretation. Such sites have produced hearths and other fire features, the presence of which is more in line with an interpretation of the site as a camp. Furthermore, some bonebeds contain discarded artifacts of types other than those expected at kill sites where the bison would have been killed, disemboweled, and quartered. For example, some bonebeds contain end scrapers used in processing hides, which is an activity expected to have been performed at camps, but not at kill sites.

If most Paleoindian bison bonebeds prove to be middens at temporary hunting camps, the original interpretations of certain bonebeds as bison traps where shamanistic rituals were performed in advance of a bison drive will have to be rethought. A number of archaeologists have noted that ethnographic accounts demonstrate that in order to ensure the success of a bison drive, shamans would perform rituals at a “shaman pole” set up in a central location in circular, wooden bison pounds. Furthermore, offerings, such as painted bison skulls, would be left at the base of the pole as offerings. From this, archaeologists have noted that some bonebeds have produced features and artifacts suggesting that similar shamanistic rituals may have been conducted in the context of Paleoindian bison kills. At the Jones-Miller site, Stanford (1978) documents a large post mold in the center of a bonebed and interprets the bonebed as representative of a bison pound where rituals were conducted at a shaman pole prior to the animals being driven into the trap. Another centrally located post mold is present
in the bonebed at the Lake Theo site and has been also suggested to have served as a
shaman’s pole (Dixon 1999:232). Under the interpretation of bison bonebeds proposed by
Bamforth, these bonebeds would represent middens at temporary hunting camps and the
environmental setting of both sites along wooded streams would support such an
interpretation. If this proves to be true, then the post molds at the sites can not be
representative of shaman’s poles because the bison may not necessarily have been killed in
pounds set up at the locations of the bonebeds.

The suggestion that shamanistic ritual was conducted in advance of a bison drive has
also been made for the Cooper site in Oklahoma where three stratified bonebeds are present
in an arroyo adjacent to the Beaver River (Bement 1999). Here, the bison bone principally
occurs in articulated units representing segments of carcasses. The site is interpreted by the
original investigator as representing a series of three kills of bison herds driven into an arroyo
trap. As suggested by the original investigator, a bison skull from the earliest bonebed had
been painted with a red zigzag on its forehead and positioned to face down the arroyo prior to
the second bison drive. This is presented as evidence of ritual conducted by a shaman prior
to the drive to ensure the success of the hunt (Bement 1999:37-38, 176-182). As discussed
below, however, geologic evidence suggests the upper two bonebeds are redeposited bone
from the lowest bonebed. If so, the site was originally a single bonebed resulting from a
single large-scale kill. Given the above information, an alternative interpretation of the site
would maintain that the original bonebed at the Cooper site represents a midden at a
temporary hunting camp. The environmental setting of the site along a wooded stream would
support an interpretation of the site as a camp. If the site is best interpreted as such, the
painted skull may still be evidence of ritual activity conducted in the context of communal
hunting, but it would not be evidence of a ritual intended to ensure the success of a hunt that
planned to drive a herd into an arroyo trap because the original bonebed may not be the
location where the bison were actually killed. Rather, carcass segments of bison killed
elsewhere may have been brought to camp where meat was removed and the articulated units then discarded into the arroyo. Along with the articulated units (which would essentially represent food processing refuse) was the painted skull which may have been purposefully placed among the bones or perhaps was also discarded when its purpose had been fulfilled.

Another example of how the theoretical outlook adopted here led to interpretations of sites that contrast with those offered by the original site investigators concerns the class of sites at high-quality tool stone sources. None of these sites has been interpreted by the original site investigators as having been associated with large-scale bison hunting. Under the alternative view, in some situations, human groups the size of individual bands or multi-band groups would have camped at high-quality lithic sources to gear up for communal hunting. Based on this theoretical perspective, many of the sites at sources will herein be interpreted as resulting from occupation by large groups of people intent on gearing up for large-scale bison hunting. The reasons that certain sites at tool stone sources are interpreted as representing occupations by large human groups involved in communal hunting with be discussed in Chapter 12. Suffice to comment here that much of the justification for inferring that some sites by sources are related to large-scale hunting is based on the presence of what are arguably midden deposits containing elevated amounts of bison bone and artifacts for killing big game and processing hides.

A difference between my assessment of the cultural transformation processes affecting site formation and that of some of the original site investigators was the root of contrasting interpretations of certain sites at sources. I interpreted dense scatters of cultural material at sites by sources as essentially middens where secondary refuse was deposited. As mentioned, the artifactual and faunal content of the middens was mainly cited to justify my site interpretations. In contrast, original site investigators apparently considered the cultural material to be primary refuse discarded at the locus where it was produced. They cite the artifactual and faunal content of the supposed primary refuse to develop a very different
interpretation of the excavated areas as basically parts of general campsites where work activities and living took place. Some even are envisioned to have included habitation structures.

Finally, my interpretations of some sites as having been associated with large-scale bison hunting is in part founded on a consideration of natural formation processes, specifically evidence that bone that once may have been present has since weathered away. A case will be made that the Powars site in the Plains portion of the study area is associated with a communal bison kill. This shallow site was excavated in a deflated dune field and the presence of bone scraps provides some evidence that bone once may have been more plentiful, but was destroyed when wind deflation of the dune exposed the bone deposit to weathering. Presence of considerable numbers of points and point manufacturing debris in the artifact assemblage bolsters the case that the site is related to large-scale bison hunting. Two sites in Middle Park near high-quality sources of Kremmling chert are here interpreted as having been occupied by relatively large human groups intent on large-scale bison hunting. One site in particular, locality B of the Barger Gulch site complex, has been extensively excavated. Considerable numbers of points, preforms, channel flakes, and end scrapers suggest that the site may be related to large-scale hunting. The possibility that bison bone may have been more common on this shallow site, but was destroyed during long periods of exposure on the ground surface is supported by evidence that relatively high proportions of artifacts and the remaining bone fragments were burned by a natural fire prior to burial. The three sites in the high Front Range are also herein interpreted as associated with communal big game hunts even though no bone of big game animals whatsoever is present on the sites. Very low rates of soil development in the high Front Range do not favor bone preservation. The interpretation that these sites are temporary hunting camps relating to large-scale hunting is therefore based on the artifactual content of the sites, their environmental setting in good places to camp, and the proximity of game drive systems.
ARCHAEOLOGICAL EVIDENCE FOR SEASONAL VARIATION IN LAND USE WITHIN THE STUDY AREA: THE TIMING OF COMMUNAL HUNTS AND REGIONAL ABANDONMENT

Ideas presented in Chapters 5 and 6 regarding the effects of climate on the seasonal timing of communal hunts and regional abandonment with the study area will now be further developed with available archaeological evidence. Most data pertaining to the season of large-scale bison hunting comes from the Plains and will be reviewed first to develop ideas on the influence of climate on the timing of communal hunts and the likelihood of year-round occupancy on the Plains. Attention will then turn to other regions where the fewer data available for the large-scale bison kills studied in Middle Park is reviewed and other archaeological evidence relating to seasonal abandonment of intermontane parks is discussed.

Great Plains

The discussion will begin with an assessment of data relating to the seasonal timing of communal bison kills on the Plains to evaluate the model of latitudinal variation in large-scale hunts. The nature of variation in the data must be reviewed and the means by which the existing data will be transformed to reflect the theoretical underpinning that Paleoindian large-scale bison kills are mostly the products of single events must first be addressed.

A certain amount of error is inherent in the seasonality data on Paleoindian bison kills and it is necessary to be assured that the error is not so great so as to cast doubt on the validity of any trends observed in the data. The technique was developed by Frison and Reher (1970) who acquired collections of mandibles from bison of various known age at the time of their death in order to describe the schedule of tooth eruption and wear on the premolars and molars. The researchers used collections of mandibles from a few places in the state of Wyoming. The most important collection for the development of the technique was obtained from the operators of a large commercial herd on the plains of northeast
Wyoming near Gillette who regularly butchered large numbers of animals of known age. Apparently, the peak of bison calving occurs around “the last of April and the first of May” because this was the time chosen as the beginning point for the tooth eruption and wear schedule developed (Frison and Reher 1970:46). By applying the schedule for tooth eruption and wear developed on the Northwest Plains to bison kills from the Southern Plains, a certain amount of error is introduced into the seasonality data because the peak of the calving season is expected to vary with latitude and elevation. For example, the peak of calving in Yellowstone National Park is in the first two weeks in May (Meagher 1973) and so is about a week later that on the plains of Gillette, which is roughly at the same latitude but about 3,000 to 3,500 feet lower in elevation. (The elevation of the calving grounds in Yellowstone range from 7,500 to 8,000 feet in elevation and Gillette is at 4,500 ft elevation). On the Southern Plains, bison are expected to calve earlier in the year because of the milder spring temperatures.

A second source of error stems from the fact that the technique for determining season of bison mortality was developed from bison living under a modern temperature regime. Application of the technique to bison that lived under a different temperature regime would also serve to introduce error into the seasonality determination. For example, bison living on the Northwest Plains during the colder climate of Folsom times would be expected to have calved later in the year in comparison to modern bison living at the same latitude.

Even though the differences in latitude and climate between modern bison and the bison represented in some Paleoindian bonebeds introduced a certain amount of error into the data, I suggest the resulting season of death estimate is not so far off from the actual time of year that the data is unusable. I suggest that the peak of calving season in modern bison living in Montana is probably not more that one and one-half months different from that in Texas and that the difference is probably less than this amount. Also, I have earlier argued
that the Paleoindian climate was not as drastically different from that of today, as has been portrayed by some archaeologists operating under the traditional view.

To use seasonality data from bison kills to more precisely define when Paleoindian groups on the Plains carried out communal hunting, it is first necessary to equate the raw data, which is expressed in terms of “dental age,” into units of time to which the non-specialist can relate. In other words, dental ages must be converted into months and seasons of the year. To quantify the schedule of tooth eruption and wear in modern bison, the system devised by Frison and Reher (1970) divides the year into 10 dental ages. To demonstrate how the system is applied to archaeological cases, consider the example of a herd of bison killed by humans one-half of a year after the peak of calving season. Teeth of a calf in the herd will ideally be assigned a dental age of .5 yr, teeth of a yearling in the herd will have a dental age of 1.5 yr, teeth of a two-year-old will be given a dental age of 2.5 yr, etcetera. A bonebed representing a large herd of bison killed by Paleoindians six months from the peak of calving season will therefore include mandibles assigned to dental ages of .5 yr, 1.5 yr, 2.5 yr, etcetera and the bonebed as a whole is said to have an associated dental age of N + .5 yr. As mentioned, the dental age scale devised by Frison and Reher and used by subsequent faunal analysts is based on the assumption that the peak of calving season is around the first of May. From the above information, the dental ages may be equated with months and seasons of the year, as indicated in Figure 8-2.

For the sake of illustration, the above example of a bonebed composed of the remains of bison killed six months after the calving season was said to have an assigned dental age of N + .5 yr, but in reality, the dental ages assigned to the Paleoindian bison bonebeds in the available literature are commonly a range of two or more individual dental ages. During 1950s, when bison population in Yellowstone National Park was high, the calving season extended over a six-week period from mid-April to the end of May (Meagher 1973:75). Considering that a single dental age unit is about five weeks in duration, assigning a bonebed
Figure 8-2. Diagram illustrating correlation of dental ages, months, seasons of the year, and division of the year into warm-season and cold-season.
to two consecutive dental ages may result simply from a faunal analyst dealing with a large sample of dentitions (mandibles and loose teeth) from a bonebed that approximates the length of the calving season. If the actual kill occurred between two dental ages, then features of some dentitions may cause the faunal analyst to classify some dentitions into a certain dental age and others into the following age category. In this case, a faunal analyst would be expected to assign the kill to two consecutive dental ages. If the timing of a bison kill (which is comprised of individuals born over at least a six-week period) precisely straddles a particular dental age (which is about 5 weeks in duration), one can easily see how a faunal analyst may assign individual dentitions from the kill to three consecutive dental ages.

Meagher (1973:75) reports that among Yellowstone bison, there are always a few late births falling outside the normal calving season that survive to adulthood. Out-of-season births and other factors may contribute to some single-event kills being assigned to four consecutive dental ages.

If a single-event bison kill may be assigned to four dental ages, this presents a problem for efforts to specify precisely when large-scale kills occurred at various latitudes on the Plains because such a time period encompasses 40 percent of a year. In rare cases, detailed raw data is presented by a faunal analyst that allows one to determine which dental age in a sequence of ages is likely the one during which a single-event bison kill occurred. For example, analysis of bison dentitions from the Mill Iron site in Montana by Todd et al. (1996) assigned specimens to a range of four dental ages that includes N + .9 yr, N + 1.0 yr, N + .1 yr, and N + .2 yr. The authors’ conclusion that the kill occurred during the N + .1 yr dental age is supported by raw data on the number of specimens of dentition falling into each dental age, with 80 percent in the N + .1 yr category (Todd et al. 1991:Tables 8.1-8.2, 8.8). In most other cases, however, only the range of dental ages is given, necessitating that the following rules be applied to narrow down the range of time assigned to the kill. For bonebeds assigned to two consecutive dental ages, both dental ages will be presented in the
tables to follow on the grounds that teeth from a single kill commonly fall into two dental ages. Kills assigned to three consecutive dental ages by faunal analysts are here considered to have occurred in the middle of the three dental ages. For kill sties originally assigned to four consecutive dental ages, the middle two will here be taken to be the time period during which the bison were killed. By applying the about rules, all the Paleoindian bison kills represented at bonebeds on the Plains proper may be assigned to time periods that are at most two dental ages in duration.

The existing literature is either controversial or vague regarding the dental ages and/or the number of kills represented by two bonebed sites located on the Plains proper, so the rationale behind how those sites are treated in the following table will be briefly explained. One such site is the Cooper site of Folsom age, located in the Oklahoma panhandle. Here, three stratified bison bonebeds were defined during excavations in an arroyo along the Beaver River. Dentitions from all three levels are assigned a dental age of $N + .3$ yr. Based on this information, the original site investigators interpret the site as an arroyo trap where three Folsom-aged bison kills took place during the same time of year, but during separate years, with an estimated one to ten years having elapsed between kills (Bement 1999; Carter and Bement 2003). In his review of the site report, LaBelle (2000) suggests that fist-sized cobbles recovered from the bonebeds many not be the hide pounding stones thought by the original investigators, but rather may be simply cobbles deposited along with the bones as water flowing in the normally dry arroyo scoured the bonebed in upper parts of the arroyo and redeposited bone and cobbles in strata overlying the original bonebed in the lower reaches of the arroyo. LaBelle called for additional information on the sediments in the arroyo to better evaluate the number of occupations represented. The original site investigators provided the information, but maintain that three kills are indicated (Carter and Bement 2003).
Upon reviewing this information and that presented in the original site report, I conclude that the geological evidence better supports the single kill interpretation. It is relevant to emphasize that the actual preserved area of the three stratified bonebeds is only a 6 m by 4 m area located at the lower end of the arroyo where it meets the floodplain of the Beaver River. At this location, bison remains from higher in the arroyo bottom could have been redeposited above the original (lowest) bonebed, which presumably once was present along the arroyo bottom for a good distance upstream of the present extent of the site (see Bement 1999:Figures 4, 21, 22, 24, 31, 36). Laminated alluvium containing fine gravel is present between the lower and middle bonebeds and extends above the upper bonebed (Carter 1999, Carter and Bement 2003). This suggests to me that the middle and upper bonebeds were deposited in a high-energy alluvial depositional episode, such as would occur during a series of gully washers produced by intense rain storms of a magnitude that would likely produce some flooding along Beaver Creek. Rapid alluvial deposition covered the lower and middle bonebeds with laminated sediments containing some relatively coarser sediments along with the cobbles mentioned previously. During the process of the cataclysmic depositional event, segments of bison carcasses from higher up in the arroyo were washed down and redeposited above the lower bonebed, forming the two overlying beds.

The flood event evidently occurred not long after the bison kill because some flesh must have been connecting the bones of the minimally processed carcass segments in all three bonebeds when they were buried. This is indicated by the articulated condition of many of the bones and the gray color of the sediment immediately underlying the bonebeds. The sedimentary unit that contains the bonebed is red alluvium (Carter 1999:45-47) that likely derives from weathering of the underlying Rush Springs sandstone, a so-called “red bed” of Permian age. The sediment containing the bones is red from iron oxides that coat all the sand, silt, and clay-sized particles. The gray color of the sediment underlying the bones is thought to result from decomposition of bison remains by soil microorganisms living in a
reducing or anaerobic environment (i.e. one lacking oxygen) (Carter 1999:50-51; Carter and Bement 2003:122-123). I suggest that rapid and deep burial of bison remains in waterlogged sediments deposited in an arroyo bottom during a flood event would be the likely manner in which such an anaerobic depositional environment was created.

In light of the above geological evidence, the Cooper site is here considered to represent only one large-scale bison kill. It is therefore assigned a single dental age of \( N + .3 \) yr in the table to follow.

The faunal analyst who examined the bison bone from the Jones-Miller site felt the data from tooth eruption and wear studies did not allow him to definitively determine the number of kills represented or to state precisely what time of year the kills occurred (Reher ca. 1984). The bonebed at the site contained Hell Gap points and is located on a terrace of the Arikaree River in northeast Colorado. Unlike most faunal analysts, Reher (ca. 1984:Table 2) did not organize his raw data by showing how many specimens of dentition fall into various dental ages measured in tenths of a year, but rather classified immature mandibles into defined classes of tooth wear, numbered 1 through 8. As noted by Reher (ca. 1984:47-51) two major clusters in the frequency of mandibles falling into the wear classes are visually evident in these data and are believed to represent two main bison kills that occurred at separate times. Reher also recognizes a possible minor cluster present between the two major ones that may represent a smaller, intervening bison kill. Examining Reher’s (ca. 1984) Table 2 reveals that the first major cluster to which he refers appears around wear class 2, the second major cluster appears around wear class 7, and the possible intervening minor cluster is near class 5. Reher (ca. 1984:48-50) indicates that his raw data occurs in a range of wear classes that equates to a range of dental ages extending from \( N + .5 \) yr to \( N + .9 \) yr. Considering that the two major clusters are not positioned at the ends of the range of dental ages, I will use dental ages \( N + .6 \) yr and \( N + .8 \) yr to graph two kills at the Jones-Miller site and ignore the possibility of an intervening kill.
Table 8-8 gives the range of dental ages assigned by faunal analysts to bonebeds associated with large-scale kills on the Great Plains proper, as well as the more restricted range to be used in the tables to follow. In an effort to have the table include only data from larger bison kills which are, according to the alternative view, more likely to be the result of communal kills, bison bonebeds containing the remains of less than 10 bison are excluded.

To investigate the relationship between latitude and seasonal timing of large-scale bison kills, data on the season of bison mortality from sites situated on the Great Plains proper will be compared among three tiers of latitude arranged north-to-south. Data on the timing of kills in the differing environments of the Wyoming Basin and intermontane basins are excluded. Each tier encompasses 5 ½° of latitude. The northern tier extends from 48° N to 42° 30′ N. To give the reader some frame of reference, the 48° N latitude line is situated one-quarter of the way from the Canadian border to the southern border of Montana. The latitude of 42° 30′ N is not far south of the northern border of Nebraska. More specifically, it is situated one-sixth of the distance from the northern border of Nebraska to the southern border of the state. The northern tier includes kill sites on the Northern and Northwestern Plains. The included sites are located in southeast Montana, northeast and central Wyoming, and extreme northwest Nebraska. One site in the northern tier is in the northernmost part of the study area (the Casper site). The central tier of latitudes extends southward to 37° N. The southern boundaries of Colorado and Kansas are situated at this latitude. Within the central tier are kill sites on the Central Plains. Most of these are within the boundaries of the study area (but are not necessarily part of the study in so far that the tool stone composition of assemblages reported from the sites will not be interpreted here). Of sites within the study area boundaries, some are in the southern portion of the Nebraska panhandle and some are in northeast Colorado. One site in southeastern Colorado is located south of the study area (the Olsen-Chubbuck site). The southern tier of latitudes extends even further south to 31° 30′ N. This latitude line runs through the middle of Texas, dividing the state into northern and
Table 8-8. Dental Ages Assigned to Paleoindian Large-Scale Bison Kill Sites on the Plains (Page 1 of 2).

<table>
<thead>
<tr>
<th>Time Period and Point Type</th>
<th>Site Name and Location</th>
<th>Minimum Number of Bison and Reference</th>
<th>Dental Age(s) Assigned to Site in this Study</th>
<th>Dental Age(s) Assigned to Site by Faunal Analyst, Reference to Publication, and Other Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Folsom-Age Sites:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mill Iron, Montana</td>
<td>35 (Todd et al. 1996:164)</td>
<td>N + .1 yr</td>
<td>N + .9 yr, N + 1.0 yr, N + .1 yr, and N + .2 yr by Todd et al. (1996:Tables 8.1 – 8.2, 8.8). A dental age of N + .1 yr is used as the season of death because 80 percent of all specimens of dentition (tooth rows and individual teeth) fall into this category.</td>
</tr>
<tr>
<td></td>
<td>Folsom, New Mexico</td>
<td>32 (Meltzer et al. 2006:236)</td>
<td>N + .4 yr to N + .5 yr</td>
<td>N + .4 yr to N + .5 yr by Todd et al (1996:169-170)</td>
</tr>
<tr>
<td></td>
<td>Cooper, Oklahoma</td>
<td>67 (see comments)</td>
<td>N + .3 yr</td>
<td>N + .3 yr by Bement (1999:Table 40). The site is interpreted as representing a single kill (see text). Minimum number of bison is based on 133 astragali from site (Bement 1999:Tables 11, 24, 35, 37). (133 astragali = 2 astragali per bison = 66.5 bison)</td>
</tr>
<tr>
<td></td>
<td>Lipscomb, Texas</td>
<td>55 Todd et al. (1990:816)</td>
<td>N + .3 yr to N + .4 yr</td>
<td>N + .2 yr to N + .5 yr by Todd et al (1990:817, 819)</td>
</tr>
<tr>
<td>Agate Basin, Hell Gap, and Plainview-Age Sites:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Agate Basin, Area 2, Wyoming</td>
<td>53 (Hill 2001:126)</td>
<td>N + .7 yr to N + .8 yr</td>
<td>range of dental ages of N + .6 yr to N + .9 yr reported by Frison (1982d:244-250) was tightened by Hill (2001:109) to N + .7 yr to N + .8 yr</td>
</tr>
<tr>
<td></td>
<td>Hell Gap, Area 3, Wyoming</td>
<td>16 (Hill 2001:146)</td>
<td>N + .6 yr to N + .7 yr</td>
<td>N + .6 yr to N + .7 yr by Frison (1982d:255-257)</td>
</tr>
<tr>
<td></td>
<td>Casper, Wyoming</td>
<td>74 (see comments)</td>
<td>N + .6 yr</td>
<td>N + .6 yr (Reher 1974:114-116). Minimum number of bison based on 62 complete left mandibles plus teeth from 12 other left mandibles (Reher 1974:64; Reher 1974:114). Later excavations (Frison et al. 1978) produced an unspecified number of additional bison bones.</td>
</tr>
</tbody>
</table>
Table 8-8. Dental Ages Assigned to Paleoindian Large-Scale Bison Kill Sites on the Plains (Page 2 of 2).

<table>
<thead>
<tr>
<th>Time Period and Point Type</th>
<th>Site Name and Location</th>
<th>Minimum Number of Bison and Reference</th>
<th>Dental Age(s) Assigned to Site in this Study</th>
<th>Dental Age(s) Assigned to Site by Faunal Analyst, Reference to Publication, and Other Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agate Basin, Hell Gap, and Plainview-Age Sites (continued):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agate Basin Frazier, Colorado</td>
<td>50 (Slessman 2004:31)</td>
<td>N + .7 yr to N + .8 yr</td>
<td>N + .6 yr to N + .9 yr (Slessman 2004:Table 33)</td>
<td></td>
</tr>
<tr>
<td>Hell Gap Jones-Miller, Colorado</td>
<td>250 ± (see comments)</td>
<td>N + .5 yr and N + .8 yr</td>
<td>See text for explanation of how dental ages used in this study were derived from data presented in Reher (ca. 1984:47-51, Table 2). Minimum number of bison based on estimated number of mandibles (Reher ca. 1984:94).</td>
<td></td>
</tr>
<tr>
<td>Plainview Plainview, Texas</td>
<td>unknown (see comments)</td>
<td>N + .3 yr</td>
<td>N + .3 yr (Fawcett 1987:Appendix D). Estimate of 100 bison is given by Wormington (1957: 108), but is not based on counting a particular bone element.</td>
<td></td>
</tr>
<tr>
<td>Cody-Age Sites:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cody Carter / Kerr-McGee, Wyoming</td>
<td>47 (Frison 1984:295)</td>
<td>N + .6 yr to N + .7 yr</td>
<td>N + .6 yr to N + .7 yr (Frison 1984:292-293)</td>
<td></td>
</tr>
<tr>
<td>Cody and concave-based points Hudson-Meng, Nebraska</td>
<td>474 (see comments)</td>
<td>N + .5 yr</td>
<td>N + .5 yr (Russell 1976). Minimum number of bison based on 948 femora recovered as of 1978. 948 femora ÷ 2 femora per bison = 474 bison.</td>
<td></td>
</tr>
<tr>
<td>Cody and concave-based points Scottsbluff, Nebraska</td>
<td>30 (Todd et al. 1990:815)</td>
<td>N + .2 yr</td>
<td>N + .1 yr to N + .3 yr (Todd et al. 1990:817)</td>
<td></td>
</tr>
<tr>
<td>concave-based and Cody points Clary Ranch, Nebraska</td>
<td>38 (Hill 2001:190-195)</td>
<td>N + .4 yr</td>
<td>N + .3 yr to N + .5 yr (Hill 2001:174-184)</td>
<td></td>
</tr>
<tr>
<td>Cody Jurgens, Colorado</td>
<td>35 to 68 (see comments)</td>
<td>N + .5 yr</td>
<td>N + .4 yr to N + .6 yr (Hill and Hill 2002). For explanation of minimum number of bison, see text.</td>
<td></td>
</tr>
<tr>
<td>Cody Frasca, Colorado</td>
<td>56 (Fulgham and Stanford 1982:5)</td>
<td>N + .5 yr to N + .6 yr</td>
<td>N + .5 yr to N + .6 yr (Hill et al. ca. 1993)</td>
<td></td>
</tr>
<tr>
<td>Cody Olsen-Chubbuck, Colorado</td>
<td>193 (see comments)</td>
<td>N + .3 yr to N + .4 yr</td>
<td>N + .3 yr to N + .4 yr (Frisman 1974:18). Minimum number of bison based on recovery of 143 skulls by archaeologists plus an estimated 50 skulls found by artifact collectors (Wheat 1972:28).</td>
<td></td>
</tr>
</tbody>
</table>
southern halves. Included in the tier are bonebeds in northeastern New Mexico as well as those sites in and near the Oklahoma and Texas panhandles.

When investigating variability in the timing of large-scale bison kills with latitude, it is advisable to first examine data from a time period with a climate most similar to that of today because we can relate to those climatic conditions and best develop an appreciation of how they may have affected the scheduling of bison hunts. The review of paleoenvironmental data indicated that temperatures during Cody times were similar to those of today. By reviewing modern temperatures on the Plains, it was earlier suggested that conditions during the cold-season on the Northern and Northwestern Plains allow for storing meat by freezing during the height of the cold-season while at the same time on the Central and Southern Plains, temperatures do not permit storage of raw meat by freezing. Paleoindian bison kills carried out in the more southerly portions of the Plains under temperatures similar to those of today would therefore have been carried out earlier in the cold-season or in the later part of the warm-season, assuming that the intent was to preserve some meat from the kill by drying it prior to the arrival of the leanest time of year. If indeed temperatures during Cody times were similar to those of today, it is expected that large-scale kills on the northernmost portions of the Plains would have occurred in the coldest months of the year, while in the central and southern portions, large-scale kills would have taken place in earlier months. Data on the timing of large-scale kills on the Northern, Northwestern and Central Plains during Cody times conforms to these expectations (Figures 8-3 and 8-4). Large-scale kill sites on the Southern Plains that date to the Cody period have not been found and excavated. If the proposed model of latitudinal variation in the seasonal timing of Paleoindian large-scale kills is valid, any Cody large-scale kills excavated on the Southern Plains in the future would be expected to produce bison dentition indicating a season of death not during the coldest months of the year, but rather during preceding months in the fall and summer when weather conditions would be best for preserving meat through drying.
Figure 8-3. Seasonal timing of Cody large-scale bison kills on the Northern and Northwest Plains.
Figure 8-4. Seasonal timing of Cody and Cody-age large-scale bison kills on the Central Plains.
With the colder temperatures that prevailed earlier in the Paleoindian period, it is expected that the imaginary line north of which short-term storage of meat via freezing was possible would have shifted southward. Figures 8-5 and 8-6 illustrate data on the timing of Agate Basin and Hell Gap bison kills which support this expectation. Large-scale bison kills during these time periods occurred during the coldest months of the year, not only on the Northwestern Plains, but also on the Central Plains. When Agate Basin and Hell Gap points were being made on the more northerly portions of the Plains, Plainview points were the predominant type in the southerly regions, at least according to the currently dominant view among Southern Plains archaeologists. The fact that the bison kill represented by the bones recovered from the Plainview type site occurred in the summer months provides further support for the model (Figure 8-7).

Data on the timing of large-scale bison kills during the Folsom period by and large supports the model. Currently available data from the Northwest Plains, however, provides mixed results. The Folsom component at the Agate Basin site provides some support for the model because the bison kill indicated by faunal remains from Area 2 occurred in the late winter (Figure 8-8). Under the substantially colder temperatures of the Folsom period, average temperatures during the late winter may have been low enough to permit short-term storage of meat. Data on season of death for the bison at the Mill Iron site in Montana is not in conformance with the model, however. As discussed below, the Goshen points recovered at the site are here considered to be possibly unfluted points that are equivalent in age to the fluted Folsom point. Bison tooth eruption and wear studies carried out for the Mill Iron site determined that the kill tool place in the spring, around the time of calving season.

If the somewhat colder temperatures of Agate Basin and Hell Gap times on the Central Plains encouraged Paleoindians to take advantage of the coldest months for short-term storage of meat via freezing, then one may predict this method to have also have been used in this portion of the Plains if temperatures during Folsom times were even colder. If
Figure 8-5. Seasonal timing of Agate Basin and Hell Gap large-scale bison kills on the Northwest Plains.
Figure 8-6. Seasonal timing of Agate Basin and Hell Gap large-scale bison kills on the Central Plains.
Figure 8-7. Seasonal timing of the large-scale bison kill at the Plainview type site on the Southern Plains.
Figure 8-8. Seasonal timing of Folsom and Goshen large-scale bison kills on the Northwest Plains.
the model is valid, then it would be expected that an excavated bonebed associated with a Folsom large-scale kill on the Central Plains would most likely prove to have been carried out during the coldest months of the year. A bonebed that represents a large-scale bison kill of the Folsom period was excavated in the late 1800s in northeast Kansas, but available information on the season of the kill is imprecise (Hill 1996; Rogers and Martin 1984; Williston 1902). Known as the Twelve Mile Creek site, the bonebed produced a fluted point and the remains of over a dozen bison. Though disagreement still exists as to whether the fluted point is best typed as a Clovis or Folsom point, the fact that the site produced three radiocarbon dates that fall in the Folsom period (Hill 1996:361) leaves little doubt in my mind that the bonebed is a Folsom site. (The site is therefore of historical importance for producing evidence of humans in the Americas fully three decades prior to the well-known excavation of the Folsom type site). Though intriguing, the site is also frustrating because dentition recovered from the site does not permit a dental age to be assigned. Bones of a bison fetus were found in direct association with the pelvis of one of the adult skeletons during excavation and I believe it very likely was a relatively large, late-term fetus, considering that it was cited as the basis for inferring that the bison were killed in winter (Williston 1902:315). Sadly, fetal bones are not among those remaining from the site in the University of Kansas Museum of Natural History. Modern cow bison normally carry fetuses from September to May. Therefore, evidence from the excavations at the Twelvemile Creek site that provides some support for the view that Paleoindians living on the Central Plains in the Folsom period held communal hunts during the height of the cold-season is, unfortunately, not definitive.

In contrast, evidence from Folsom bonebeds on the Southern Plains provides strong support for the model. The dental ages assigned to mandibles from the four bonebeds in this region of the plains indicate that large-scale bison hunting took place from about mid-July to the end of October (Figure 8-9). Paleoenvironmental evidence from Lubbock Lake reviewed
### Number of Sites Associated with Large-Scale Kills

<table>
<thead>
<tr>
<th></th>
<th>Lipscomb</th>
<th>Lipscomb</th>
<th>Lake Theo</th>
<th>Cooper</th>
<th>Folsom type site</th>
<th>Folsom type site</th>
</tr>
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<tbody>
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<td>4</td>
<td></td>
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</tbody>
</table>

| N+.1 yr | N+.2 yr | N+.3 yr | N+.4 yr | N+.5 yr | N+.6 yr | N+.7 yr | N+.8 yr | N+.9 yr | N+1.0 yr |


| mid-to-late Spring | Summer | Fall | Winter | early Spring |

**Time of Year**

Figure 8-9. Seasonal timing of Folsom large-scale bison kills on the Southern Plains.
in Chapter 6 suggests that temperatures occasionally fell below freezing on the Southern Plains. Data on the timing of large-scale bison kills presented here suggests the weather was not adequately cold for sufficiently long periods to permit short-term storage of raw meat. Rather, the data support the interpretation that large-scale hunts were carried out in the months prior to the height of the cold-season. At this time of year, daytime temperatures would likely have permitted meat to be preserved by drying it to make jerky.

The above analysis benefited from an appreciation of the effect of climate on the timing of bison hunts throughout the Plains and from the thinking that Paleoindian bison bonebeds mostly represent single kills. The analysis was consequently able to provide insight into the precise timing of the communal bison hunting season and to suggest reasons that may explain the timing of hunts. Studies of the timing of Paleoindian large-scale bison kills on the northern portion of the Plains by McCartney (1990) and Bamforth (ca. 2000) demonstrated that kills occurred during the fall and winter. This is the basis for suggesting in Chapter 3 that large-scale kills enabled Paleoindians to cope with a time of year when non-big game food resources were much less available. The analysis presented in this chapter considered seasonal data on Paleoindian large-scale kills from throughout the entire Plains that was modified to reflect the likelihood that kills were mostly single events. Results of the analysis demonstrate that kills usually occurred not only in the fall and winter, but also in the summer. Kills did not occur throughout this entire time period at all latitudes, but rather took place during the height of the cold-season in the more northerly parts of the Plains while in the more southerly portions, kills occurred prior to the height of the cold-season, either earlier in the fall or in the summer. Importantly, the analysis also suggests that within particular latitudinally defined regions of the Plains, the large-scale bison hunting season normally occurred during a time period that comprised only a minor part of the year. If one continues with the train of thought that large-scale hunts were economic events to ensure survival during the leanest time of year, the kills of the northerly latitudes that transpired during the
coldest season of year would suggest that making use of freezing temperatures was perhaps the easiest way to store meat in the short-term to survive the height of the cold-season, which would have been a lean time of year. Paleoindians living in the more southerly portions of the Plains where the climate was not sufficiently cold to store meat during the coldest months necessarily had to go through the additional effort of cutting and drying the meat to preserve it prior to the coldest time of year, which arguably was also a lean time of year for foragers living in those regions.

The results of the analysis of the timing of large-scale kills are also relevant to the more rudimentary question of whether the motivation for such events was indeed principally economic or whether a desire for social interaction was a more important factor causing Plains people to aggregate at certain times of the year. In his review of communal bison hunting, Fawcett (1987) explores the possible role that accumulation and redistribution of surplus bison products may have played in motivating politically ambitious leaders to organize bison hunts. Fawcett brings up the possibility that the primary motivation of communal hunts was for social reasons, with the production of surplus meat being of secondary concern. As previously discussed, evidence for accumulation of bison meat and hide products as commodities in a trade network is most evident for the later periods of Plains prehistory. Though Fawcett’s emphasis on the possible social motivation for communal hunts may not be especially applicable to the Paleoindian period, his highlighting of the possible social motivation for communal hunts is a valid point. One might reasonably propose that Paleoindian communal hunts were primarily motivated by a desire for periodic interaction with neighbors and the necessity of acquiring a short-term surplus of food in order to sustain a relatively large gathering of people was what ultimately motivated communal bison hunts.

Results of the analysis of the seasonal timing of bison kills do not support this view, however. If it is assumed for the sake of discussion that the prime motivation for communal
hunts was to allow for social interaction, then the timing of large kills on the more northerly portions of the Plains would still be expected to be during the height of the cold-season. Being the food storage technique that requires the least effort, short-term preservation of meat through freezing would allow the most time for social interaction. In the more southerly portions of the Plains, a greater effort would be required to amass a short-term food surplus that would allow an aggregated group to form because it would have been necessary to cut and dry the meat in order to preserve it. If the primary motivation for organizing a large-scale bison kill was to provide a food surplus to permit an aggregated group to form, then it is expected that communal hunts would have occurred in the months both prior to and after the height of the cold-season when temperatures would have been sufficiently warm to dehydrate meat. The fact that the several Paleoindian large-scale hunts known from the Southern Plains all occurred prior to the height of the cold-season (which would have been a lean time of year for foraging peoples) strongly implies that the prime motivation for such events was economic and the opportunity for social interaction with people from neighboring groups would have been a secondary benefit to participants desiring to socialize with relatives, friends, and potential mates.

Timing of communal bison hunts on the Plains speaks to the question of year-round occupation. Based on a consideration of modern and Paleoindian climatic conditions, it was reasoned that people would have inhabited the Plains portion of the study area on a year-round basis. Data on the timing of communal bison hunts on the Plains provides partial support for the expectation by demonstrating that people were on the Plains, involved in this activity during summer, fall, and winter.

High Front Range and Middle Park

In contrast to the Plains, no archaeological data currently exists to provide further support for the expectations that communal hunts in the high Front Range would have been
held in the months prior to the height of the cold season, at which time the region would have been abandoned. Much of the lack of supporting evidence is due to poor bone preservation in the alpine tundra, but some high altitude sites in the Front Range has produced bone, so there is some possibility that relevant data someday will be available.

In regard to the expectation that Middle Park would have been abandoned by Paleoindians during the height of the cold-season, it will be helpful to review pertinent information from the archaeologically better-known post-Paleoindian time periods. By the mid-1970s, federally mandated archaeological survey and excavation in Middle Park and adjacent montane regions produced good samples of mostly Late Prehistoric and Archaic sites. None of these sites had produced any evidence for permanent structures. According to Cassells (1997:100), the lack of evidence for permanent habitation supported the view among archaeologists that Archaic and later foragers were highly mobile. An implication of this perspective is that Archaic foragers would have simply left the high intermontane parks for lower country to avoid the severe cold.

This line of reasoning was drawn into question beginning in the 1970s with discoveries made in an intermontane basin in the mountains of southern Colorado known as the Gunnison Basin (Figure 5-1). Excavations at five prehistoric sites in the basin revealed evidence of above-ground structures constructed of a framework of wooden poles and branches plastered over with mud daub (Cassells 1997:107-108). At one of the sites (5GN204/205), the shape of a charcoal stain underlain by pole-impressed daub fragments suggests the structure was basically circular in planview (Cassells 1997:Figure 7-9). Radiocarbon dates obtained on charcoal believed to be associated with the structures themselves range from 8030 ± 210 B.P. to ca. 3300 B.P., indicating that they were constructed intermittently throughout a period extending from terminal Paleoindian or early Archaic times on into the middle Archaic. Evidence for similar above-ground structures was uncovered during the early 1980s in eastern Middle Park at two sites discovered along a
water pipeline (Wheeler and Martin 1982). At the Granby site, radiocarbon dates associated with two adjacent scatters of daub yielded dates of 4160 ± 110 B.P. and 3750 ± 70 B.P. Pipeline-related construction was redesigned to avoid much of the nearby Hill-Horn site, but the more limited excavations there revealed four daub scatters. The time range encompassed by eight radiocarbon dates obtained for these features range from 7960 ± 140 to 4400 ± 70 B.P.

The above information indicates that the construction methods and time range of the above-ground daub-covered structures are remarkably similar for both intermontane basins and extends from terminal Paleoindian or early Archaic times into the middle Archaic. Discovery of permanent structures that largely date to the Archaic period gave archaeologists cause to question the view of mountain foragers as highly mobile, but the crux of the matter is whether these architectural remains provide definite evidence that people inhabited the intermontane basins throughout the cold-season.

Metcalf and Black (1991) consider the question in-depth as part of reporting on the Yarmony site where two early Archaic pithouses were discovered in the Colorado River drainage only 14 km downstream (southwest) of Middle Park at an elevation of about 7,100 ft. Extended occupation of the site that likely included use during the height of the cold-season is evident at Yarmony by the presence of two semi-subterranean pithouses with ample below-ground features thought to have been used for storing food. Radiocarbon dates from the structures indicate that multiple occupations of the site took place in the early Archaic at around 6300 B.P. and again at 6000 B.P. Furthermore, test excavations of an extensive feature located elsewhere on the site that contained ash, charcoal, and artifacts determined it to be a refuse midden produced during an extended occupation later in the Archaic at 4790 ± 70 B.P. Fetal bone of bison or bighorn sheep recovered from the midden supports an interpretation of the feature as one having been produced by people who overwintered at the site. Metcalf and Black (1991:218) observe that the sites in eastern Middle Park and the
Gunnison Basin do not have substantial middens and generally lack food storage facilities in association with the structures. From this, they convincingly argue that the sites with structural remains located in the higher intermontane basins reflect shorter term occupations and do not provide definite evidence of prehistoric people overwintering in the parks.

Evidence relating to the use of Middle Park and neighboring regions by Archaic peoples is pertinent to theorizing the Paleoindian situation. To summarize, the available published information supports the view that mountain populations of Archaic foragers occupied Middle Park during part of the year, but abandoned the region during the height of the cold-season to winter in the less frigid climates found at lower elevations in the Colorado River drainage. Paleoenvironmental data from the study area indicates that during the early Archaic, temperatures during the Altithermal were warmer than those of today and warmer than at any time during the Paleoindian period. If foragers abandoned Middle Park for elevations further down the Colorado River drainage during the relatively warmer winters of the early Archaic, then one would expect that during Paleoindian times, when temperatures were colder, foragers would also move out of Middle Park during the height of the cold-season.

To the contrary, Kornfeld et al. (1999) assert that year-round occupation of Middle Park during early Paleoindian times is indicated at the Upper Twin Mountain site. Two bison long bones from the bonebed were radiocarbon dated to 10,470 ± 50 B.P. and 10,240 ± 70 B.P. and firmly place the site in the Folsom period. The authors base their claim that early Paleoindians overwintered in the park partly on the understanding that “the animals were killed in the late fall or early winter” (Kornfeld et al. 1999:666). If indeed the bison kill occurred at this time of year (i.e. around the first of January), then the argument in favor of early Paleoindians overwintering in the park would be valid because the kill would have occurred in the coldest period of the year. At the Kremmling weather station, the coldest months of the year are December, January, and February, when average daytime temperatures
do not rise above freezing (Table 5-1). This is also the time of year when temperature
inversions can occur, plunging temperatures to -40° F.

However, existing data indicate that the bison kill represented at Upper Twin
Mountain actually occurred earlier in the fall. Kornfeld et al. (1999:666) misquoted Todd et
al. (1996:169), who estimated that the bison were killed during “the fall or early winter.” A
consideration of the distribution of dental ages determined from bison mandibles indicates
that the bonebed represents a single large-scale bison kill that occurred around October or
November.

Faunal analysts specializing in bonebeds assign mandibles in the first five annual age
groups (from animals less than five years of age) to specific dental ages or to a range of
dental ages based on tooth eruption and wear schedules. After the first five years, bison teeth
are in full wear. For a group of bison that were all killed together, mandibles from bison over
five years of age can be differentiated into annual age groups based on the incremental
amounts that their teeth are worn down toward the mandible. Faunal analysts assign the
mandibles from animals over five years old to the dental age or range of dental ages
determined through analysis of the stage of tooth eruption evident on mandibles less than five
years of age.

For the Upper Twin Mountain site, the mandibles from animals less than five years
old were assigned to the following dental ages: N + .2 yr and N + .4 yr through N + . 7 yr,
inclusive. The N + .2 yr dental age was assigned to a mandible from a yearling (dental
specimen # 5GA1513-164) which Todd et al. (1996:169) assert most probably represents an
out of season birth. This assertion is unwarranted, however. A histogram of the dental ages
of a group of bison that were either killed all at once or within a short period of time (i.e.
within less than a month) will approximate a normal distribution with the mean of the
distribution providing a fairly precise estimate of the time of year when the bison were killed.
Even if a bonebed represents a herd of bison killed all at once, the spread (or “kurtosis”) of

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the normal distribution approximated by the histogram will nevertheless still cover most of the year due to the fact that the methods used in estimating the dental age introduces a lot of imprecision into the estimates produced. Since the bison died on a particular day, the dental age assigned to the time of death should ideally be only one dental age. However, faunal analysts, including those who examined the Upper Twin Mountain material, are often reluctant to assign a specimen of bison teeth to just one dental age. For example, individual specimens of dentition from the site were assigned dental ages that are one, two, or three tenths of a year in duration. This would cause the histogram produced from the dental age estimates to have a wide spread.

Another factor that introduces imprecision into estimates of dental ages and would therefore serve to increase the spread of a histogram is the fact that the method of assigning a dental age usually involves comparing the specimen to be aged not to a jaw from a modern bison of known age at the time of death, but rather to another archaeological specimen whose dental age is itself an estimate that is commonly two or more dental ages in length. To demonstrate this, it may be noted that dental ages were assigned to 14 specimens of mandibular dentition in the Upper Twin Mountain collection that are in age groups 2 through 5. Dental ages were assigned to the mandibular teeth through comparison with mandibular tooth rows from five Paleoindian bonebeds (Lipscomb, the Agate Basin component at the Agate Basin type station, Casper, Scottsbluff, and Horner), two Archaic bonebeds, (Hawken and Ayers-Frazier), and two Late Prehistoric bonebeds (Wardell and Glenrock) (Todd et al. 1996:165-168).

The dental ages or dental age ranges determined for the eight bison represented in the faunal collection that were less than five years old are presented in Table 8-9 and Figure 8-10 graphs the frequency distribution of the dental ages and dental age ranges in the form of a histogram. As suggested by Figure 8-10, the yearling bison mandible with a dental age of $N + .2$ yr may not be an outlier representing an out-of-season birth. Rather, the $N + .2$ yr dental
Table 8-9. Data on Dental Ages Assigned to Bison Mandibular Teeth from Upper Twin Mountain Site Used in Construction of Histogram Showing Frequency Distribution (Figure 8-10).\(^a\)

<table>
<thead>
<tr>
<th>Annual Age Group</th>
<th>Dentition Specimen Number</th>
<th>Side of Animal</th>
<th>Teeth Present</th>
<th>Minimum Number of Individual Bison (MNI) in Annual Age Group</th>
<th>Justification of MNI</th>
<th>Dental Age(s) Assigned to Individual Specimen(s) of Teeth Present in an Annual Age Group</th>
<th>Number of Times Dental Age(s) Plotted on Histogram</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 (yearlings)</td>
<td>5GA1513-164 R dP4 – M2</td>
<td>R</td>
<td>dP4 - M2</td>
<td>2 Based on marked difference in wear patterns displayed on the two specimens</td>
<td>N + .2 yr</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5GA1513-456 L dP4 – M1</td>
<td>L</td>
<td>dP4 - M1</td>
<td></td>
<td>N + .5 yr</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5GA1513-284 L P2 – M1</td>
<td>L</td>
<td>P2 – M1</td>
<td>1 Based on presence of one pair of mandibles</td>
<td>N, + .7 yr</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5GA1513-455 R P2 – M1</td>
<td>R</td>
<td>P2 – M1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 (animals 2 + years old)</td>
<td>5GA1513-163 R P4 – M3</td>
<td>R</td>
<td>P4 – M3</td>
<td>3 Based on presence of three right tooth rows</td>
<td>N + .4 yr through N + .6 yr, inclusive</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5GA1513-34 R P3 – M3</td>
<td>R</td>
<td>P3 – M3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5GA1513-51 L M2 – M3</td>
<td>L</td>
<td>M2 – M3</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>5GA1513-477 R P1 – M1</td>
<td>R</td>
<td>P1 – M1</td>
<td></td>
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<tr>
<td>4 (animals 3 + years old)</td>
<td>5GA1513-170 R P2 – M3</td>
<td>R</td>
<td>P2 – M3</td>
<td>2 Based on the presence of two left third molars, two right first molars, two right second molars, and two right third molars</td>
<td>N + .6 yr and N + .7 yr</td>
<td>2</td>
<td></td>
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<tr>
<td></td>
<td>5GA1513-457 R M1</td>
<td>R</td>
<td>M1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5GA1513-458 L M3</td>
<td>L</td>
<td>M3</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>5GA1513-53a R M1</td>
<td>R</td>
<td>M1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5GA1513-53b R M2</td>
<td>R</td>
<td>M2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5GA1513-54 L M2 – M3</td>
<td>L</td>
<td>M2 – M3</td>
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</tbody>
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\(^a\) Data from Todd et al. (1996:165-166, 168, Table 8.12).
\(^b\) L = Left, R = Right.
\(^c\) Example to decipher tooth codes: dP4 – M2 refers to a tooth row consisting of the fourth lower deciduous premolar through the second lower molar.
Figure 8-10. Histogram of dental ages assigned to mandibular bison teeth from the Upper Twin Mountain bonebed of unfluted Folsom or “Goshen” affiliation. Data from Todd et al. 1996:165-166, Table 8.12). See Table 8-9 and text for explanation of how data from Todd et al. (1996) were selected for inclusion in the histogram. Number of bison with assigned dental age(s) plotted on graph: eight. Minimum number of bison from excavated portion of bonebed: 15 (Todd et al. 1996:165, Table 8.13). The frequency distribution approximates a normal curve and may be interpreted in one of two ways. First, if the dashed lines accurately portray the missing parts of the histogram, then the data would suggest that a group of bison was killed during the time of year encompassed by dental ages N + .5 yr and N + .6 yr, or sometime around October or November. This is the preferred interpretation. Alternatively, if the most frequent dental age (N + .6 yr) is at the mean of the normal distribution approximated by the histogram, then the seasonal timing of the kill can be more specifically identified as having occurred sometime around the month of November.
age is more likely a datum point in the lower tail of a normal frequency distribution with missing data points at N + .3 yr, N + .8 yr, and N + .9 yr. These data points are missing simply because of the small size of the sample (n = 8 bison). The frequency distribution displayed in Figure 8-10 is normally distributed with a mean value indicating when the group of bison was killed. As explained in the caption to Figure 8-10, the mean of the frequency distribution appears to fall between N + .5 yr and N + .6 yr. This would place the time of year that the bison were killed around October or November.

Kornfeld et al. (1999) are not alone in suggesting that early Paleoindians would have wintered in the high intermontane basins of Colorado. Stiger (2006:346) argues that a Folsom group occupied a habitation structure at the Mountaineer site in the Gunnison Basin for an extended period of time, perhaps over a winter. In excavation block A, a structure is represented by a circular charcoal stain, an interior hearth, as well as a scattering of slabs of native rock and pole-and-stick-impressed daub fragments that are thought to represent a layer of mud daub and rock slabs that once covered the wooden frame of the structure. Adjacent to the structure remains are postholes and another hearth thought to represent an outside activity area where a windbreak or wooden racks were set up by a fire pit. Several radiocarbon dates ranging in the early Archaic were obtained from organic material collected from the postholes and exterior hearth (Stiger 2006:Table 1). Although charcoal and unburned wood apparently was noted in the interior hearth (Stiger 2006:Figure 3), no dates are reported for the hearth inside the former daub-covered wooden structure. In association with these features is some bone and abundant artifacts, including Folsom points, preforms, end scrapers, various other tools, and debitage. Three radiocarbon dates on bone fall within the Folsom period. The soil at the site is shallow and post-Paleoindian projectile points were found lying on the ground surface at distances of 9 and 14 m from the excavation block (Stiger 2006:Figure 1), suggesting that mingling of Folsom and features of post-Paleoindian age is a possibility.
Stiger’s claim that the archaeological remains are not mixed rests on two assertions. The first is that the dates on the exterior hearth and postholes are in error and the second is that the distribution of artifacts reflects activities performed in and around the structure. Regarding the dates, Stiger (2006:329) quotes Thomas Stafford, a radiocarbon dating specialist, who notes that the charred matter from the exterior hearth is not charcoal, but “is very vitreous and could be some variety of siliceous plant that has been heated hot enough to melt the opaline.” From this, I presume the concern is that melting of plant phytoliths (which are deposits of silica produced in the tissue of grasses and other plants) would have added an inorganic substance (silica) to the dated sample that was mistakenly thought to be composed of purely organic material (wood charcoal). The assertion that the date is bad does not seem valid because if inorganic material (silica) was not removed from the sample during the pretreatment process prior to subsequent radiocarbon dating, this would produce a date that is older that the actual age of the sample, not a date that is too young. Furthermore, the nature of the dated material from the postholes (that also produced early Archaic dates) is not discussed, but one would expect it to be charcoal if the features are indeed postholes that once contained wooden poles. In conclusion, the argument that the early Archaic dates obtained for the features are in error is not a compelling one.

More essential to Stiger’s argument is the assertion that the artifact distribution reflects activities performed by Paleoindians inside and outside of the structure. If the artifacts were discarded at or near the location where they were made and/or used, then the distribution would indeed reflect the activities performed. However, ethnoarchaeological study of Australian aborigines (O’Connell 1987) demonstrates that hunter-gatherers occupying a site long enough will clean up after themselves by removing artifactual debris from activity areas and discarding it in trash deposits. The relatively dense distribution of Folsom points and other kinds of artifacts is most probably an example of such a trash deposit. Judging from the number of points, performs, and end scrapers recovered,
inhabitants of the site apparently were involved in an activity that involved killing and processing the hides of a lot of big game animals (see Stiger 2006:Figures 10, 12, and 14).

If my observations are sound, then features and artifacts uncovered in excavation block A at the Mountaineer site do not provide evidence of a Folsom house and early Paleoindian winter occupation of a high intermontane basin in Colorado. Rather, I suggest the published information on the site better supports the interpretation that the area was used for dumping trash during an occupation of the site in the Folsom period by people who were likely involved in a large-scale big game hunt. Later, features were constructed in the area and those interpreted as postholes for a windbreak or rack were made in the early Archaic, around 7000 B.P. The daub-covered wooden structure may be tentatively assigned to a broad time range by noting that similar structures in the Gunnison Basin and Middle Park date between 8000 and 3300 B.P.

Having refuted claims that Paleoindians overwintered in Middle Park and other intermontane basins in Colorado, the expectation that mountain parks were abandoned during the height of the cold-season is affirmed. The expectation is essentially upheld by negative evidence for occupation during the coldest time of the year.

That communal bison hunts in Middle Park would have been held in the months prior to the most frigid weather of the year is supported by what little data is currently available. Data on the season during which the bison herd represented at the Upper Twin Mountain site was killed indicates that the event took place in October or November. In today’s climate, the average daytime high for October at the Kremmling weather station for October is 59° F and for November, the daily maximum temperature is 40° F (USDC, NOAA 2002b). Even though temperatures during the Folsom period were somewhat colder, the daytime highs around the time of the kill may have been sufficiently warm to preserve meat by drying it before the onset of frigid weather forced people to abandon the park. The other bison bonebed in Middle Park is at the Jerry Craig site. The bonebed is associated with Cody and
other points of a contemporaneous Late Paleoindian type. Dentition from the bonebed is assigned a dental age range of N + .3 yr to N + .5 yr, inclusive (Hill and Kornfeld 1999). If the middle dental age (N + .4 yr) is taken as the best estimate for the actual timing of the kill, the event would have taken place around September. Since climatic conditions during the Cody period approximated those of today, data from the Kremmling weather station may be used to gain insight into conditions likely prevailing around the time of the kill. The average daytime high at the Kremmling weather station for September is 70° F (USDC, NOAA 2002b), which is suitably warm for preserving meat through drying. Based on the above data, it may be concluded that available evidence supports the expectation that Paleoindian land use would have entailed communal bison hunts in Middle Park normally during the months prior to the height of the cold-season.

STUDYING SOCIAL INTERACTION THROUGH RECOGNITION OF CONTEMPORANEOUS FORMS OF ARTIFACTS: POINT TYPES, REGIONAL POINT STYLES, AND HIDE SCRAPERS

Apart from tool stone sourcing, another basic method of elucidating and use and social interaction of Paleoindians in the study area involves study of contemporaneous forms of artifact types, specifically projectile point and hide scrapers. Different types of coeval points occur across the study area in varying frequency of occurrence and their recognition and study offers one avenue of research into the ways that material culture may reflect cultural differentiation and social interaction. Archaeologists have too often uncritically equated artifact types, especially points, with prehistoric cultural groups. As mentioned in Chapter 2, however, the Desert Side-Notched point was likely used by late prehistoric forbearers of many distinct cultural groups of western North America. Similarly, the geographic distribution of the Folsom point, for example, is not likely to reflect the distribution of a “Folsom culture” in the same sense that ethnographers of the early 1900s
were able to define the traits and homelands of native cultural groups (LeTourneau 1998). Nevertheless, distribution of Paleoindian point types does vary across the study area and adjoining regions and investigation of this archaeological phenomenon has the potential to define how Paleoindian material cultural varied across the landscape and to explore the meaning of this variation. At the very least, point types with differing distributions are suggestive of people whose material culture differed to some extent. As will be elaborated below, sometimes the difference in hunting weaponry may be correlated with different forms of hide scrapers. In other situations, the differing distributions of distinct point types correlates with different environments (i.e. mountains versus western plains) that offer differing sets of food resources. In this case, the difference in material culture, specifically point types, is paralleled by demonstrable differences in subsistence economy.

Multiple sites in the study area produced points and/or hide scrapers of different types. Included are sites that arguably are associated with communal hunts, as well as one such site that produced multiple specimens of two distinct types. In particular, Late Paleoindian sites have produced possible evidence of aggregation of culturally distinct groups for large-scale hunting. These sites will be the focus of discussion. Point types sometimes found in association with contemporaneous points of a differing type include the Cody and Frederick types of the west Central Plains, poorly understood concave-based lanceolate points of the east Central Plains, and specimens of the Angostura type, which is common to the Southern Rocky Mountains. In light of the above, the co-occurrence of different point types in a number of sites may in some cases reflect some form of long-distance contact between culturally distinct groups and in other situations, actual cooperation between such groups within the context of communal hunting may be indicated.

In order to best interpret those sites producing more than one point and/or hide scraper type, the defining attributes of the types common to the study area and their differing
distributions will be outlined below with special attention paid to Late Paleoindian point types. Figure 8-11 summarizes the time span of the point types to be discussed.

Finally, if some communal hunts involved multiple bands and if point types varied across the landscape such that regional point styles may someday be defined, then identification of multiple styles of a particular type in a collection of points retrieved from a bonebed may provide support for social aggregation. The possible utility of demonstrating aggregation through the identification of regional point styles is briefly discussed at the end of this section.

**West Central Plains Point Types**

Point types of the western Great Plains were among the first to be recognized and defined in Paleoindian archaeology. Sites producing these types are principally in the western Plains portion of the study area, but are also known from the high Front Range and Middle Park.

**Points of the Folsom Period**

Three of the sites in Middle Park date to the Folsom period and some discussion of a long-standing debate in Paleoindian point typology and chronology must be addressed in order that these sites are properly interpreted in terms of their relevance to understanding social organization and land use. Fluted Folsom points have long been known to archaeology and the general public since the discovery of the Folsom site and recognition of its significance to prehistory in 1927. Haynes et al. (1992) have reviewed radiocarbon dates from sites producing fluted Folsom points and concluded that these highly recognizable artifacts range in age from 10,950 to 10,250 B.P. Two of the study sites (Barger Gulch, Locality B and the Crying Woman site) are believed to date to the Folsom period because only fluted points of the Folsom type have been recovered. One study site (Upper Twin
Figure 8-11. Chart comparing estimated time spans of post-Clovis projectile point types of three regions in and adjacent to the study area.

<table>
<thead>
<tr>
<th>Age in Uncalibrated Radiocarbon Years</th>
<th>Point Types Common in Southern Rocky Mountains</th>
<th>Point Types Common in West Central Plains</th>
<th>Point Types Common in East Central Plains</th>
</tr>
</thead>
<tbody>
<tr>
<td>11,000 B.P.</td>
<td>9000 B.P.</td>
<td>8500 B.P.</td>
<td>8000 B.P.</td>
</tr>
<tr>
<td>10,500 B.P.</td>
<td>9500 B.P.</td>
<td>9000 B.P.</td>
<td>8500 B.P.</td>
</tr>
<tr>
<td>10,000 B.P.</td>
<td>9000 B.P.</td>
<td>8500 B.P.</td>
<td>8000 B.P.</td>
</tr>
</tbody>
</table>

- **Angostura**
  - Pryor Stemmed
- **Cody**
  - Frederick & Allen
- **Agate Basin**
- **Hell Gap**
- Poorly understood concave-based lanceolate points
Mountain) is a bison bonebed that has been firmly dated to the Folsom period, but has produced only unfluted concave-based points that have been labeled as Goshen points. Beginning in the 1950s, a number of concave-based early Paleoindian point types of the western Plains have been proposed that are in some respects similar to fluted points and have sometimes been found with fluted points and sometimes not. Included are the Plainview, Midland, and Goshen types. A number of often implicitly suggested possibilities have been offered by various authors to explain the unfluted points. One suggestion is that they date either before or after the Folsom period with the later possibility prevalent among archaeologists of the Southern Plains where a number of dates attributed to the Plainview type fall broadly in the 9000 to 10,250 B.P. time range. Another possibility is that the unfluted points may be coeval with fluted Folsom points and the question of whether the people who made and used unfluted points were culturally distinct from those who made fluted points has been raised (Agogino 1969).

I will present evidence to support the hypothesis that the fluted and unfluted points were all made by Paleoindians of the western Plains during the Folsom period and that the unfluted and fluted forms, when found in sites associated with large-scale bison kills, may reflect single-band and multi-band groups, respectively. Toward this end, I will briefly review the attributes of the defined types then turn to the discussion of the possible meaning of the variation in form evident in these early points.

Folsom points are fluted lanceolate points first recognized in 1927 at the type station in New Mexico. They usually have convex lateral edges and a concave basal edge. Folsom points often have pointed basal ears. Sometimes the basal edge between the ears is straight or has a bump or “nubbin”. On some specimens, a series of small, parallel retouch flake scars is present along lateral edges. The specimens from the original Folsom site illustrate the range of variation in fluted Folsom points (Meltzer 2006).
Plainview points are unfluted, concave-based points first defined from specimens recovered at the type station, which is a bonebed excavated in Texas in 1945 (Sellards et al. 1947). Plainview points commonly display collateral flaking. Wormington (1957: defines collateral flaking as a variety of bifacial flaking pattern produced by the removal of flakes that began at the lateral edges and extend to the long axis of the point. Flake scars lie at right angles to the long axis and are parallel to one another. Plainview points from the type station are illustrated in Frison et al. (1996:Figure 11.2) alongside specimens of other Folsom-age unfluted types.

Midland points were discussed by Wormington (1957) as a result of excavation of the Scharbauer site in Texas where seven fluted Folsom points were found along with 20 unfluted points. The type is poorly described, but illustrations of 18 points from the Shifting Sands site in Texas that are classified as Midland points are basically concave-based points with convex or parallel lateral edges and collateral flaking (Hofman et al. 1990:Figure 5).

In his typological analysis of points from the Hell Gap site complex, Irwin assigned some early Paleoindian unfluted concave-based points to a new type, which he named Goshen. The term refers to projectile points that were recognized at the time to be identical to specimens of the Plainview type (Irwin-Williams 1973:46). The need for naming a new type therefore does not seem justified, but the term is currently in use among archaeologists of the northern Plains. As illustrated by the type specimen and other specimens from Locality I at Hell Gap, these points share attributes with points labeled as Plainview in being concave-based lanceolate points with collateral flaking (Kornfeld and Larson 2009:Figure 1.3, Hashizume 2009:Figure 18.2, specimens 13, 15).

The Meaning of Variation in Folsom Period Points. Attributes displayed by some specimens typed as Goshen, Plainview, and Midland points are shared with certain fluted Folsom points and support the possibility that the named varieties of points may be partly or
wholly contemporaneous. For example, two Goshen points from the Mill Iron site have basal ears with a straight basal edge between them, which is reminiscent of the base of some fluted Folsom points (Bradley and Frison 1996:Figure 4.1 c, Figure 4.3 d). Also, a point from the Shifting Sands site has basal ears with an intervening nubbin characteristic of some Folsom points (Hofman et al. 1990:Figure 5 f).

Bamforth (1991b) implied that variation in Folsom point morphology may be related to group size when he suggested that fluted points were made by skilled knappers for use by participants in communal kills and that unfluted points are more common in sites not necessarily associated with large-scale bison hunting. Subsequent fieldwork at the Mill Iron site in Montana and the Upper Twin Mountain site in the study area has demonstrated that Folsom-age sites that produce point collections exclusively or predominately consisting of unfluted points are also known to be associated with definite large-scale bison hunts (Kornfeld et al. 1999; Frison 1996). Yet this does not negate Bamforth’s idea which basically implies that the level of flintknapping skill evident on points may reflect group size. If this is true, then the skill level evident in points from bonebeds with mostly fluted points should tend to be demonstrably better than in points from bonebeds with mostly unfluted points and these should in turn tend to display a higher level of skill than points from sites not associated with large-scale bison hunting. These theoretical differences in flintknapping skill level may therefore potentially serve as archaeological indicators of differences in group size.

To begin to develop theory on how variation in the level of knapping skill may reflect group size, one might characterize the general skill level represented by points from the three categories of sites and then relate the skill levels to the hypothetically different sized groups that produced the sites and the points recovered from them. Fluted points from bonebeds arguably are demonstrative of excellent flintknapping skill because fluting is an inherently difficult process to successfully complete. The rate of success for completion of fluted points is best calculated from a large sample of fluted points and preforms obtained from a number
of sites in a region in order to minimize sampling error that may occur if, for example, an assemblage from only one site is examined and the site either did or did not emphasize point production. A large regional sample was obtained during a survey of the Central Rio Grande Valley in New Mexico where 130 fluted Folsom preforms and 116 fluted Folsom points were collected from 15 sites (Judge 1973:Table 3). Data on the frequency of fluted preforms broken in manufacture and the frequency of fluted points suggests a 47 percent success rate for manufacture of fluted Folsom points from the unfluted preform stage (116 fluted points ÷ 246 fluted points and preforms = 47 percent success rate). In other words, of all unfluted preforms that were originally intended to be fluted and then retouched into a completed point, only 47 percent actually were.

Unfluted points of possible Folsom age from bonebeds and other sites that may be associated with large-scale bison hunting arguably exhibit an above average level of flint knapping skill. Included are points labeled as Goshen, Plainview, and Midland. Points that have been labeled as Goshen and Plainview have a collateral flaking pattern produced by removing pressure flakes that extend from the lateral edges to the long axis of the point. An above average level of skill is evident in the collateral flaking on unfluted points from bison bonebeds as seen in the sample of Goshen points from the Mill Iron site and Plainview points from the type site (Frison et al. 1996:Figure 11.2). Though less well defined and illustrated, many Midland points from the Scharbauer and Shifting Sands sites also have collateral flaking (Frison et al. 1996:Figure 11.2; Hofman et al. 1990:Figure 4). The sites have not produced reliable radiocarbon dates. Both sites are in dune fields and might possibly be associated with large-scale bison hunting. The Shifting Sands site is known from surface remains that include an eroding deposit of extremely fragmentary bison bone, 92 points, and lumps of red ochre. The Scharbauer site produced 20 unfluted points and seven fluted ones (Wormington 1957:241-246). In sum, the well controlled, uniform pressure flaking evident
on unfluted points termed Midland, Plainview, and Goshen are arguably evidence of an above average level of flint knapping skill.

Unfluted points from Folsom occupation levels are not well represented in the literature, perhaps due to the emphasis on excavation of sites associated with large-scale bison hunting, but some unfluted points arguably produced by knappers of average workmanship are illustrated. As will be elaborated in the discussion of the Lindenmeier site in Chapter 12, a high proportion of points reported from the site are unfluted and possibly result from occupations of the site unrelated to large-scale bison hunting. Illustrated unfluted points from the site generally have concave basal edges, convex lateral edges, and non-patterned flaking (Wilmsen and Roberts 1978:Figure 111). The lack of patterned flaking suggests that the artifacts were made by persons of average flintknapping ability. Other unfluted points from the site are so-called pseudo-fluted points made on a flake with retouch flaking confined to lateral edges in order to give the appearance of a fluted point. Four illustrated pseudo-fluted points from the site are not very symmetrical and have undulating edges (Wilmsen and Roberts 1978:Figure 110). These attributes are suggestive of manufacture by persons of average flintknapping skill. A pseudo-fluted point from the Folsom component of the Agate Basin site exhibits a concave basal edge, convex lateral edges, and non-patterned flaking (Frison 1982e:Figure 2.26 g). A photographic illustration of two unfluted Folsom points from the Cooper site shows points with concave basal edges, convex lateral edges, and obscured flaking patterns (Bement 1999:Figure 38 t, bb).

Sites produced during a time of year when Folsom people would theoretically have been dispersed into small groups living by means of a more generalized foraging strategy may be expected to produce a relatively greater proportion of points demonstrative of average knapping skill. All hunters would be expected to be able to manufacture their own points and they would even produce points displaying below average skill during their teens when learning the craft. Certainly some number of points produced during site occupations by
small groups would be expected to demonstrate above average or event excellent knapping skill because knappers of above average skill or better would also be dispersed into small groups during much of the year. Also, some points of better than average workmanship may be present in sites produced by small dispersed groups because they were obtained by participation in communal bison kills and through exchange. On the whole, however, one would expect that points from sites not associated with large-scale bison hunting would tend to demonstrate average workmanship.

If indeed the ability to consistently flute points was an uncommon ability requiring excellent flintknapping skill, then one might further theorize that bison bonebeds representing the work of an aggregation of a single band may tend to contain mostly points with collateral flaking made by the best flintknapper or flintknappers in the band who would usually be of only above-average skill. Aggregation of members of a single band for communal hunting may be expected to have sometimes produced bonebeds with fluted points if one or more expert flint knappers were members of the band.

Finally, if a bonebed was produced by two or more bands, the possibility would be greater that the aggregated group would contain one or more knappers with the excellent skill level necessary to consistently produce fluted points. For this and other reasons to be discussed below, one might reasonably theorize that a bison bonebed produced by an aggregation of multiple bands would more likely contain a preponderance of fluted points than a smaller aggregated group composed only of members of the local band.

Support for the theoretical construct comes from sites related to large bison kills carried out in the warm-season when slain animals would have to of been field dressed within a day because such sites allow the relative number of bands involved in the communal hunt to be estimated. Many Folsom sites associated with large-scale bison kills have bee completely excavated or else enough excavation has taken place that one may state that most of the bone present has been collected. Included are several sites on the Southern Plains and one in the
San Luis Valley, an intermontane basin in Colorado. All of these represent kills that took place in summer. An excavated possible Folsom-age bonebed located on the Northwest Plains in Montana is the Mill Iron site. Here, the bison represented in the faunal assemblage were killed in the spring of the year (around May) when the average temperature would likely have been warm enough to also require that field dressing of the bison killed be conducted within a day or less.

As discussed in Chapter 4, archaeological remains of large-scale kills conducted during a time of year when warm weather would have required rapid field dressing permit an assessment to be made as to whether the amount of work involved in field dressing the number of bison carcasses present could have been accomplished by members of one band of average ethnographic size or would have required the labor of people from multiple bands. The assessment is based on estimates of the time required for a person to field dress a bison and the number of people capable of assisting in the task that would be available in a band of average size.

The fact that the Mill Iron site bonebed was completely excavated permitted the site to be used to illustrate that the smaller bison bonebeds may represent large-scale bison kills conducted by a single band (see Chapter 4). The Goshen level at the site has yet to be unequivocally radiocarbon dated. Presence of what is arguably a fluted Clovis preform (Bradley and Frison 1996:51, Figure 4.7 c), a hearth dated at 11,340 ± 120 B.P., and a possible artifact of mammoth ivory provide evidence for a Clovis component at the site. Eight other radiocarbon dates were obtained on flecks of charcoal from various proveniences. Six dates range in the Clovis period and two fall in the Folsom period as defined by Haynes (Frison 1996:7-11, Table 1.1). The above information supports the possibility that the Goshen level could be of Folsom age, but a firm date for the occupation has yet to be determined. Table 8-10 presents data useful for estimating whether the number of bison represented at the Mill Iron site and five other sites of definite or possible Folsom age could
Table 8-10. Estimates of Relative Size of Human Group Present at Bonebeds Containing Fluted and/or Unfluted Folsom-Age Points.

<table>
<thead>
<tr>
<th>Site Name and Location</th>
<th>Number of Fluted Points</th>
<th>Number of Unfluted Points</th>
<th>Minimum Number of Bison Represented</th>
<th>Dental Age of Bison and Estimated Seasonal Timing of Bison Kill (See Chapter 8)</th>
<th>Number of Hours for Band of Average Ethnographic Size to Field Dress Bison</th>
<th>Could Bison Be Field Dressed by a Single Band In Daylight Hours of a Single Day?</th>
<th>Comments</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonfire Shelter, Texas</td>
<td>1</td>
<td>4</td>
<td>24</td>
<td>$N + .2 \text{ yr to } N + .4 \text{ yr}$ around July or August</td>
<td>6.75</td>
<td>Yes</td>
<td>-</td>
<td>Byerly et al. (2005), Dibble and Lorrain (1967)</td>
</tr>
<tr>
<td>Mill Iron, Montana</td>
<td>1</td>
<td>20</td>
<td>35</td>
<td>$N + .1 \text{ yr}$ around May</td>
<td>8.75</td>
<td>Yes</td>
<td>Only points from excavated contexts were counted. One point (Bradley and Frison 1996:Figure 4.5 f) appears fluted.</td>
<td>Frison (1996)</td>
</tr>
<tr>
<td>Folsom Type Site, New Mexico</td>
<td>21</td>
<td>0</td>
<td>32</td>
<td>$N + .4 \text{ yr to } N + .5 \text{ yr}$ around late September</td>
<td>7.75</td>
<td>Yes</td>
<td>See text for further discussion. Only illustrated points are counted.</td>
<td>Meltzer (2006)</td>
</tr>
<tr>
<td>Cattle Guard, Colorado</td>
<td>37</td>
<td>3</td>
<td>49</td>
<td>$N + .3 \text{ yr to } N + .4 \text{ yr}$ around August</td>
<td>12.25</td>
<td>No</td>
<td>Number of fluted and unfluted points based on complete points and complete bases.</td>
<td>Jodry (1999)</td>
</tr>
<tr>
<td>Lipscomb Bison Quarry, Texas</td>
<td>22</td>
<td>1</td>
<td>51 (See Comments)</td>
<td>$N + .3 \text{ yr to } N + .4 \text{ yr}$ around August</td>
<td>13.75</td>
<td>No</td>
<td>A minimum of 55 bison were present, but four bison are complete and likely represent spoiled carcasses that were not field dressed.</td>
<td>Bamforth (1991b), Todd et al. (1990)</td>
</tr>
<tr>
<td>Cooper, Oklahoma</td>
<td>29</td>
<td>2</td>
<td>67a</td>
<td>$N + .3 \text{ yr}$ around July or August</td>
<td>16.75</td>
<td>No</td>
<td>Whether three point fragments were fluted or not could not be determined.</td>
<td>Bement (1999)</td>
</tr>
</tbody>
</table>

a  See text for determination of minimum number of bison.
have been field dressed within a day by members of a single band of average ethnographic size. The table also indicates whether points from the sites are primarily fluted or unfluted. One point from the Mill Iron site that may be a reworked distal fragment appears to retain the distal portion of a flute (Bradley and Frison 1996:Figure 4.3 f), but most specimens from the site are unfluted. As elaborated in Chapter 4, the number of bison butchered at Mill Iron could have been field dressed by a single band of ethnographic size because, as demonstrated in Table 8-10, the work involved is estimated to have taken a band about 8¾ hours to complete.

Bonfire Shelter in south Texas is another site that produced mostly unfluted points from a deposit of bison bone that arguably was produced by a single band, based on currently available information. The bonebed, which is argued by Byerly et al. (2005) to represent a single large-scale bison kill, was partially excavated in the 1960s and produced the remains of an estimated 27 bison, based on a count of proximal femur fragments by the original site investigators (Dibble and Lorrain 1967). The site is located within a rockshelter where the archaeological deposit is separated into three bonebeds in some places that merge into a single layer elsewhere. A fluted Folsom point was found in the lowest bonebed and a Plainview point was recovered from the uppermost. Two other Plainview points were associated with the bone deposits, but not with a specific bonebed. Three radiocarbon dates were obtained on charcoal from a hearth associated with the bone deposit. One date of 10,230 ± 160 B.P. is just after the Folsom period as defined by Haynes and two other dates are younger at 10,100 ± 300 and 9920 ± 150 B.P. (Dibble 1970; Dibble and Lorrain 1967:72). The recent analysis of the faunal sample indicates that a single kill is represented and suggests that the separation of the deposit into three bonebeds is the result of periods of exposure of part of the bone deposit followed by redeposition (Byerly et al. 2005).

The re-examination of the faunal collection produced an estimate of 24 individuals based on a count of astragali present (Byerly et al. 2005). The excavation units were
scattered over the area encompassed by the bonebed and in total exhumed approximately half of the bonebed. The recent site investigators assert that the estimate of 24 to 27 bison, although based on only partial excavation of the bonebed, does not drastically underestimate the number of bison represented. If so, then Bonfire Shelter would constitute another potentially Folsom-age bison bonebed that produced mostly unfluted points and could represent the work of a single band. Should future excavations at Bonfire Shelter substantially increase the estimated number of bison killed, the conclusion that the work of a single band could be represented would have to be reconsidered.

The calculations and reasoning used to estimate whether a group of slain bison could be field dressed in one day by a band of average ethnographic size will be reviewed here for the relevant data from Bonfire Shelter. The total number of hours to field dress the Bonfire Shelter bison may be calculated by multiplying 27 bison by 5.25 hr per bison (see Chapter 4 for justification of this figure) to arrive at 141.75 hr. Dividing the 141.75 hours required to field dress the bison by the 21 people in a band of average ethnographic size able to assist in field dressing (see Chapter 4 for justification of this figure) produces an estimate of 6.75 hr to field dress the bison. Dental ages of the bison were determined to be N + .2 yr to N + .4 yr. Operating on the assumption that a single kill is represented, the middle dental age of N + .3 yr can be taken as the time of year in which the kill occurred. A group of slain bison with dental ages averaging N + .3 yr would have been killed around July or August. Though there is not direct evidence relating to summer temperatures on the Southern Plains during Folsom times, it is reasonable to assert that during this time period in what is now south Texas, the normal temperatures during July or August would have required that bison be field dressed within a day or less to prevent meat spoilage. If the bison herd was killed in the morning, there would have been ample daylight during July or August for a single band to field dress the carcasses before the meat spoiled, based on the currently available data from the site.
The Folsom type site in New Mexico provides a record of a large-scale bison hunt, produced only fluted points according to site investigators, but could represent the work of a single band, based on currently available data. Six radiocarbon dates on amino acid extracted from bison bones average 10,490 ± 20 B.P. (Meltzer and Holliday 2006:147). Excavated in the 1920s, the site consists of a deposit of bison bone and artifacts preserved in the valley of Wild Horse Arroyo, a tributary of the Dry Cimarron River (Meltzer 2006). A minimum of 32 bison are represented in the faunal assemblage, based on counts of astragali (Meltzer et al. 2006:236). All of the 21 points from the site illustrated by line drawings are classified as fluted points by the site investigators. One fragment consisting of the midsection and tip is not obviously fluted, but is said to retain the remnant of a flute (Meltzer 2006:Figure 8.4 specimen 18, Table 8.2). The original excavations were centered in an ancient northward draining, broad swale that was a tributary of the drainage now known as Wild Horse Arroyo, the main stem of which currently traverses the northern part of the site as it flows southeastward toward the Dry Cimarron River. Recent reinvestigation of the site has referred to the swale as the “paleotributary.” I will simply refer to it as the swale. Widely separated clusters of bison bones described as individual skeletons by the original site investigators are scattered throughout the swale, suggesting to me that individual bison were butchered were they fell. An elongated, north-south aligned area in the western part of the swale described by original excavators as consisting of skeletons that were “more or less mixed” (Meltzer et al. 2006:209-211, Figure 7.1) suggests to me that articulated and disarticulated bone was discarded in this part of the swale and formed a bonebed. Recent excavations on the edge of this feature found both articulated and disarticulated bone (Meltzer et al. 2006:Figure 7.2). Isolated bone north of the present channel of Wild Horse Arroyo is 2.5 m below the level of the bonebed on the south side of the arroyo, some 15 m away (Meltzer et al. 2006:211). The map of the 1920s block excavations showing the distribution of the skeletons, artifacts, and possible bonebed (Meltzer et al. 2006:Figure 7.1) gives me the impression that cultural
deposits containing more bison skeletons likely extend beyond the limits of excavation, particularly to the north where they would be buried under many meters of overburden. In light of the above, it seems the current faunal sample may likely underestimate the number of bison actually killed. Nevertheless, based on current information, it is estimated that the number of bison represented could have been field dressed within one day to avoid meat spoilage by a single band of average ethnographic size. Should future excavation increase the minimum number of bison, this tentative determination may have to be reconsidered.

At the Cattle Guard site in Colorado, a recently excavated deposit of bone and artifacts represents a locality were a large-scale bison kill was processed by a group of people equipped primarily with fluted Folsom points (Jodry 1999). Judging from the bone distribution map, it appears that much, though not all, of the archaeological deposit has been excavated. Based on the excavation completed to date, carcasses of at least 49 bison were processed at the site. Dental ages of the bison range from N + .3 yr to N + .4 yr, indicating the kill occurred around August. The site is not radiocarbon dated, but occupation during the Folsom period is inferred by the predominance of fluted Folsom points. Based on refitting and raw material variation, Jodry (1999:157-158, 177) determined that of the 211 Folsom points and fragments, a minimum of 104 points are represented. Of these, 40 were sufficiently complete to determine if they were fluted or not. A total of 3 complete points were unfluted compared to 37 fluted points that include 8 complete points and 29 complete bases.

It is estimated that a band of average ethnographic size would have required 12.25 hr to field dress 49 bison. Since it is estimated that there are 15 hr of daylight in August, and that the people would have needed about three hours throughout the day to eat and rest, it appears doubtful that the required field dressing could have been conducted in one day or less by just one band, even if it is assume that the animals were killed at daybreak.
The Lipscomb bison quarry in Texas also represents a large-scale bison kill, produced principally fluted points, and is not likely the work of just one band. Based on the preponderance of fluted points in the collection (22 of 23 points), the site is inferred to date to the Folsom period (Bamforth 1991b:Table 1). The site was excavated along Sand Creek, a drainage within the watershed of the North Canadian River. A bonebed at the site contained the remains of 55 bison, based on the number of astragali present (Todd et al. 1990:816). Dental ages of the bison at the time of death are here considered to be either N + .3 yr or N + .4 yr (Table 8-8), which would indicate that the kill occurred around August (Figure 8-2). A map of the bonebed showing partially and fully articulated skeletons demonstrates that four complete animals are present in the bonebed. The presence of whole adult bison suggests the bonebed is at the location where the bison were killed. The complete bison skeletons also strongly suggest that four carcasses spoiled in the hot weather before they could be butchered and may not have been field dressed. Subtracting the four possibly unbutchered bison from the total of 55 produces an estimate of 51 bison having been field dressed at Lipscomb.

It is estimated that a band of average ethnographic size would have taken 12¾ hr to field dress 51 bison. As reasoned in the discussion of the Cattle Guard site, there is not enough time during daylight hours to permit a band of average ethnographic size to complete the required field dressing and have time to eat and rest, even if the herd was killed at dawn. Therefore, it is likely that the Lipscomb bison herd was killed and processed by an aggregated group composed of multiple bands.

Finally, the Cooper site in Oklahoma is related to large-scale bison hunting, yielded primarily fluted points, and is more definitely the work of multiple bands. The site was located in an ancient arroyo bottom exposed in a bluff adjacent to the modern floodplain of the Beaver River (which in its lower reaches is known as the North Canadian River). As explained previously, the three stratified bonebeds present at the site are most likely indicative of erosion and redeposition of a single bonebed that is associated with a single
bison kill. Examination of mandibular teeth from all three bonebeds determined that the
dental age of the bison at the time of death was N + .3 yr, which means that the herd was
killed around July or August. The faunal assemblage from the site has not been analyzed
from the perspective of the three bonebeds being the product of but one bison kill, however,
the minimum number of animals represented may be estimated from data given in the report.
A total of 133 astragali were recovered from the three bonebeds and the slump area. The
later part of the site is where sediment and bone from the arroyo fell from the steeply sloping
side of the bluff onto the floodplain of the Beaver River as a result of lateral cutting of the
river channel sometime in post-Folsom times. The numbers of left and right astragali are not
specified, but since there are two astragali per bison, a minimum of 67 bison is indicated (133
astragali ÷ 2 astragali per bison = 66.5 bison). This estimate is indeed a minimum number
because unknown amounts of the bone bearing deposits were lost through erosion of the
bluff. A band of average ethnographic size would have taken an estimated 16¾ hours to
perform the evisceration of 67 bison necessary to prevent meat spoilage in warm weather.
Since it is estimated that there are 15 hr of daylight at the time of year when the bison were
killed, the minimum number of 67 bison could not have been field dressed in one day or less
by a single band of average ethnographic size. From this, it is concluded that the group of
people who participated in the slaughter and processing of the bison herd represented at the
Cooper site would more likely have come from multiple bands.

The above data support the hypothesis that fluted and unfluted Folsom-age sites are
contemporaneous. Furthermore, the data uphold the idea that single-band communal hunts
mostly made use of unfluted points while multi-band communal hunts were equipped
principally with fluted points.

The tool stone composition of assemblages from Folsom-age sites associated with
large-scale bison hunting could provide another line of evidence to support the hypothesis.
Support would be garnered if, for example, sources of tool stone represented in an
assemblage with unfluted points are within an area the size of an ethnographic band range and sources of stone represented in a collection with fluted points are located throughout a larger area that arguably would encompass multiple band ranges. The possibility that the tool stone composition of assemblages may further support the hypothesis will therefore be kept in mind when interpreting the three collections from Folsom-age sites in Middle Park. It will be argued that all three such sites are associated with large-scale bison hunting. Two of the sites produce only fluted points and one yielded only unfluted points.

The possible contemporaneity of Plainview and Folsom on the Southern Plains has yet to be firmly established, so the model developed previously on the seasonal timing of large-scale bison hunting equates the Plainview bonebed with the Agate Basin and Hell Gap time periods on the more northerly portions of the Plains. Should future dating efforts confirm the suspected contemporaneity of Folsom and Plainview points, then the model will need to be revised as follows. For the Agate Basin and Hell Gap period on the Southern Plains, there will be no data on the seasonal timing of large-scale bison hunts. The dental ages assigned to the bonebed at the Plainview site (N + .3 yr) and Bonfire Shelter (median of N + .3 yr) should be added to the other data for Folsom sites to affirm that the seasonal timing of large-scale kills on the Southern Plains during Folsom times was during the time represented by N + .3 yr to N + .5 yr, or from around July through the end of October (see Figures 8-7 and 8-9).

**Agate Basin Type**

Agate Basin points were first described from work at the type station in Wyoming. Original, complete specimens are elongated with slightly convex lateral edges and convex or straight basal edges. Flaking is commonly non-patterned. Photographs and drawings of dozens of specimens recovered from the type station illustrate the range of morphological variation in the type (Frison and Stanford 1982). At Locality I of the Hell Gap site cluster,
Agate Basin points occur stratigraphically above Folsom and below Hell Gap. Due to sources of imprecision associated with radiocarbon dating, the time span of Agate Basin points expressed in calendar years is poorly understood. The type is here estimated to date from ca. 10,250 to 9900 B.P. Agate Basin points are best known from excavations of sites in the Northern, Northwestern, and Central Plains.

**Hell Gap Type**

Excavation of stratified deposits at Hell Gap in Wyoming helped to define the Hell Gap type and establish relative chronological relationships. The type shares attributes with Agate Basin, but is stemmed and shouldered. From a straight or convex basal edge, lateral edges of the stem expand toward the relatively broad blade with convex lateral edges. Drawings of a large sample of specimens conforming to the type are found in the Casper site report (Frison 1974). At Locality I of Hell Gap, the type occurs stratigraphically above Agate Basin and below Cody points. As with the Agate Basin type, radiocarbon dates associated with Hell Gap points vary widely, but the type is here estimated to have been in use on the more northerly portions of the Plains from 9900 to 9500 B.P.

**Cody Type**

Based primarily on specimens recovered from sites related to large-scale bison kills, numerous kinds of square-based points dating to the Cody period have been defined and named. Common attributes include a squared base formed by parallel lateral edges that meet with a straight or slightly concave basal edge to form pointed, nearly right-angle corners. Shoulders may or may not be present. Blades on original, complete points are usually parallel-sided, at least in their proximal portion, but can vary to basically triangular. Flaking varies considerably with some kinds characterized by a dominance of percussion flaking and others characterized by fine, parallel pressure flaking. Wormington (1957) first recognized
the basic morphological variability in square-based points when she defined the Eden type (basically a narrow variety with parallel flaking), the Scottsbluff type (a wider variety), and the Alberta type (a less finely flaked variety). Later typological studies by archaeologists working in various parts of the Plains defined a total of 11 different kinds of square-based points. Bamforth (1991b) argues that the numerous kinds are best thought of as sharing the same mental template, but varying according to factors such as individual flintknapping skill and regional stylistic variations. Following Bamforth, the various named types of square-based points are here subsumed under the more inclusive concept of a “Cody type.”

Due in large part to the interest in large bison bonebeds and the often exquisitely made points common to these kinds of sites, the distinctively shaped points of the Cody type are associated with many radiocarbon dates. Frison (1991:Tables 2.2, 2.4-2.5) lists dates from eight Cody sites or cultural levels at multicomponent sites in Colorado, Wyoming, and Nebraska. Some of the dates are here excluded from those used to define the Cody period for reasons given below. Dates of 9380 ± 100 and 8990 ± 190 B.P. on bone from the Hudson-Meng site are considered acceptable, but the date of 9820 ± 160 B.P. on scattered charcoal is too old. The original site investigator states that the charcoal was from the bonebed (Agenbroad 1989:116). That the sample was widely scattered is indicated that the date was run on charcoal accumulated over four field seasons of excavation. Some charcoal could be from a natural fire that pre-dates site occupation. Of the several dates reported for the Horner site in Wyoming (Frison 1987:Table 4.1), some were run in the early days of radiocarbon dating and were reported by none other than Willard Libby, the inventor of the dating technique. The dates were obtained on samples of bison bone and charcoal collected from a hearth, but are in the range of 6000 + and 7000 + B.P. and thus are simply too recent. Dates of 9875 ± 85 B.P. on charcoal and 10,060 ± 220 B.P. on a charred log are too old and the imprecision of the later date is seen in the unusually large standard deviation. Only the dates of 8750 ± 120 and 8840 ± 140 from the Horner site are acceptable as Cody dates. To the
above list of good Cody dates may be added those from the Jerry Craig site (9310 ± 50 B.P.) and one acceptable date on bison bone of 8870 ± 350 from the Lamb Spring site near Denver (Kornfeld 1998:53-54; Rancier et al. 1982). Based on the above information and assessment, the Cody point type can be said to date from about 9400 to 8600 B.P. Knudson (ca. 2012:Table 2) lists other dates associated with Cody points from sites in the study area that fall into the above time span. Included are dates from Localities I and V at Hell Gap, the Scottsbluff site, and the Lime Creek and Red Smoke sites.

**Frederick and Allen Types**

Compared to Cody points, subsequent Late Paleoindian concave-based lanceolate points of the western Plains in southeast Wyoming and northeast Colorado are not nearly as well known. The uncertainty applies to both the morphological variation inherent in the types and the time range during which they were in use. Pitblado (2003) has recently synthesized radiocarbon dates reported for Late Paleoindian points throughout Colorado and Utah as part of a sustained effort to better understand point typology and its implications for cultural dynamics. Her work demonstrates that the dates reported in the literature for the various types span long periods of time that overlap one another to a large extent. In large part the great overlap is due to imprecision inherent in the dating technique when dealing with materials from the Paleoindian period, but some of the imprecision is due to careless application of the technique by archaeologists trying to date a site and lack of caution in reporting that an acquired date actually pertains to the site occupation. If archaeologist are to successfully define when the point types were present and how much their use overlapped, it is necessary to exercise care both in using the radiocarbon technique to date sites, as well as in evaluating the reliability of dates already reported in the literature. With this in mind, I will evaluate, rather that merely repeat, relevant dates given in the literature.
Basic rules for evaluating the reliability of a radiocarbon date will be followed. Prior to the 1990s, methods to pretreat organic material from bone to ensure that all inorganic material was removed met with mixed results. Needless to say, with the emphasis on bonebed excavation, many of the Paleoindian dates were obtained on samples of bone. If charcoal is to be dated, it is best to run a sample from a cultural feature, such as a hearth. Lacking this, archaeologists turn to collecting scattered bits of charcoal found in a cultural level producing artifacts. If most bonebeds are indeed refuse from temporary hunting camps, a date on pieces of charcoal from the bonebed itself may be reliable. If this technique is applied to non-bonebed sites, it is best to be able to demonstrate a tight vertical association between charcoal and the cultural level being dated. Unfortunately, needed information to evaluate a date’s reliability is often not given in site reports. When sufficient information is available, however, the above rules will be used to assess the reliability of applicable dates reported for the study area.

Apart from problems with the reliability of dates attributed to the point types, another basic typological concern is that the types recognized and used by archaeologists should encompass morphological differences that allow (or potentially will allow) Paleoindian peoples to be differentiated geographically and temporally. In her study of Late Paleoindian points, Pitblado (2003, 2007) combined the Frederick and Allen types into a Jimmy Allen/Frederick category which she later refers to as simply Jimmy Allen. Based on my admittedly more geographically limited understanding of Late Paleoindian point types in southeast Wyoming and northeast Colorado, I believe Frederick and Allen to be currently valid point types that appear to be morphologically and possibly temporally distinguishable. Therefore, both types are retained in the discussion to follow. If future work demonstrates beyond doubt that the two types are best conceived of as one and the same, they should be combined as suggested by Pitblado. Also, instead of the more commonly used term “Jimmy
Allen,” I will use the term “Allen point” to refer to the type, following the name originally proposed by Mulloy (1959:113).

Based on excavations in the 1960s at Locality I of the Hell Gap site complex, the Frederick type was defined. Only recently, however, have photographs of many of the recovered points been published (Bradley 2009a:Figure 17.12). Unfortunately, the points are short basal fragments. Two fragments glued together have irregular edges and appear to be a preform that was nearly completed into a point (Bradley 2009a:Figure 17.12 m). In sum, specimens from Hell Gap suggest that lateral edges on an original complete point would be basically parallel in the proximal portion and midsection of the point, and then taper gradually toward the tip. Basal edges are slightly or moderately concave. The juncture of basal and lateral edges forms distinct corners or ears that are relatively pointed, rather than rounded. A parallel diagonal flaking pattern is the norm. At Locality I of Hell Gap, the Frederick cultural level occurs in stratum F, above an erosional surface separating it and the Cody level at the top of stratum E. A date of 8690 ± 380 B.P. was obtained on charcoal and charcoal-stained sediment from above the erosional contact. The date has a large associated standard deviation. Although the date it is less than ideal, collection of the sample from a stratigraphically known position that is well correlated with the Frederick level makes the date minimally acceptable.

The Caribou Lake site in the study area has produced points that conform to the Frederick type and radiocarbon dates are assigned to the specimens, but it is best to consider the Paleoindian component as undated. One complete point, two basal fragments, and a tip from the Caribou Lake site may be subsumed under the Frederick type. According to Pitbado (2000), the points are associated with a series of radiocarbon dates on charcoal from two hearths. However, as explained in the discussion of the site in Chapter 12, reasons exist to question whether the purported hearths are definitely cultural in origin, so the more conservative conclusion taken here is that the points from the site remain undated.
One point that is here classified as a Frederick point (Benedict 1981:Figure 67a) was recovered during excavation of the Fourth of July Valley site, but this site also is best considered to be undated. Repeated attempts have been made to secure radiocarbon dates for the site, but scattered charcoal recovered during excavation is not firmly associated with the cultural material. The site was initially dated to the Archaic, based on a radiocarbon assay of 5880 ± 120 B.P. on charcoal from a basin that was believed to be a hearth (Benedict 1981:75). Upon reconsideration by the original site investigator, the charcoal-filled basin is now believed to have been produced by a forest fire because excavation records document thermal oxidation beneath charcoal concentrations as much as 4 m from the purported hearth (Benedict 2005:799). In another effort to date the site occupation, Benedict re-opened the site and dated a total of 15 radiocarbon samples. A date of 8920 ± 50 B.P. was obtained on six small charcoal particles found in association with five microflakes, some of which were discolored from exposure to fire. The charcoal and flakes were collected from a stratum designated Unit 2. Benedict concluded that the site occupation predates a forest fire that occurred around 8900 B.P. and discolored some of the flakes left at the site. It is important to note that nowhere is it demonstrated that most of the artifacts are buried in Unit 2. Flakes were also found at a higher stratigraphic position in association with a date of 6280 ± 50 B.P. (Benedict 2005:Table III). Artifacts from the occupation are mixed between various strata. Furthermore, charcoal buried at the site has moved vertically by soil mixing processes as seen in the fact that two charcoal particles from the contact between Unit 2 and the overlying Unit 3 produced a data of 9170 ± 40 B.P. This date does not overlap at three standard deviations with the date of 8920 ± 50 B.P. from Unit 2, so it is highly probable (99 percent) that older charcoal was moved to a stratigraphically higher position by soil mixing processes. In light of the fact that both artifacts and charcoal particles (that are not definitely cultural in origin) have been moved among the various soil strata, we must conclude that the site cannot be reliably dated.
The James Allen site in the Laramie Basin of Wyoming was a bonebed associated with a large-scale bison kill from which 30 points were collected and used by Mulloy (1959) to define the Allen type. Lateral edges of the point type are slightly convex and basal edges are deeply concave. Ears are usually rounded. Slight constrictions of one or both lateral edges are sometimes present above the ears, causing the ears to appear to flare outward slightly. Flaking is often parallel and may be aligned either perpendicular or diagonal to the lateral edges. An imprecise radiocarbon date with a large standard deviation was obtained on bison bone by the original site investigator, but a better date of 8405 ± 25 B.P. was recently assayed from a sample of bone (Knudson and Kornfeld 2007). Drawings of six original, complete Allen points from three Colorado counties in the northeastern part of the state suggest that examples of the type on the Plains may have lateral edges that gradually converge from the base to the tip, creating a vaguely triangular blade (Perino 1971:2, Plate 1).

From the above review, the very limited information available on the post-Cody point types of the western Plains in southeast Wyoming and northeast Colorado only permits a basic, preliminary chronological ordering of point types which are themselves only tentatively established. Frederick points apparently pre-date the use of Allen points in the study area based on an imprecise date from Locality I at Hell Gap (8690 ± 380 B.P.), coupled with a better date from the James Allen site (8405 ± 25 B.P.).

**Southern Rocky Mountain Point Types**

**Angostura Type**

Recent work by Pitblado (2007) demonstrates that the Angostura point was an important point type of Late Paleoindian groups in the Southern Rocky Mountains. Angostura points have slightly or moderately convex lateral edges that taper toward the tip and base. Basal edges can be straight or concave. Ears formed at the juncture of the lateral and basal edges are usually rounded but can be somewhat pointed. Reworking of Angostura
points with a tip broken off can produce strongly shouldered specimens, especially on ones with moderately convex lateral edges. The flaking pattern is sometimes parallel diagonal and sometimes unpatterned. In support of the thinking that Angostura points were made by people native to the Southern Rocky Mountains, and that finds of Frederick and Allen points represent points left by visitors from the Plains, Pitblado (1999, 2007:329) presents evidence suggesting that the Angostura type is the most common Late Paleoindian point found in the physiographic province. She examined a sample of 130 Late Paleoindian points from the Southern Rocky Mountains housed in various museums and private collections and found the Angostura point was by far the most common (37 percent) and that points belonging to her Jimmy Allen/Frederick type were the next most common (17 percent). Apart from common surface finds, Angostura occupation of the Southern Rocky Mountains has recently been documented at the Chance Gulch site, a campsite in the Gunnison basin where excavations by Pitblado revealed an Angostura component (Nijhuis 2002).

Within the Southern Rocky Mountain portion of the study area, Angostura points have been associated with radiocarbon dates at two sites. At the Jerry Craig site in Middle Park, the point type is dated to 9310 ± 40 B.P. (Kornfeld 1998). In the high Front Range, at the Devils Thumb game drive, dates of 9410 ± 90, 9310 ± 60, and 9270 ± 40 were secured on grains of charcoal that were closely associated with a buried cultural level that likely produced a surface point that is possibly of the Angostura type. The fragmentary point has parallel diagonal flaking and is missing the base, but the proximal portion of one lateral edge has begun to converge toward the missing basal edge in a manner highly reminiscent of Angostura points (Benedict 2000b:Figure 2.28 c). Although the point cannot be definitely classified as belonging to the type, another point found elsewhere on the Devils Thumb game drive (in Lithic Scatter J) is indisputably the base of an Angostura point (Benedict 2000b:Figure 2.19).
The point type is also known from lower elevations to the west and northwest of the Southern Rocky Mountains. A sample of Late Paleoindian points (n = 49) from various locales on that portion of the Colorado Plateau in the states of Colorado and Utah was examined by Pitblado. The Great Basin Stemmed type was the most common (46 percent), but the Angostura type was the next most prevalent (23%). Northwest of the Southern Rocky Mountains, occupation of the Wyoming Basin by people who used the Angostura point is indicated at the Cathedral Butte Site in Colorado, where 13 points were found at the base of an eroded butte that has two sink holes containing deposits of bison bone (Stucky 1977:33-38, Figures 7-8). However, the presence of 14 Late Prehistoric points and three Archaic points at the site precludes definitely attributing the bison remains to the Angostura occupation. An Angostura occupation is also represented at the Pine Spring site in Wyoming. Ten of the illustrated points from the site belong to the Angostura type (Sharrock 1966:52-55, Figure 35 a-d, i, k-n, Figure 36 a).

Angostura sites are also known from the Middle Rocky Mountains in Wyoming. The most important of these for establishing the time span of the type is Mummy Cave in the Absaroka Range where Angostura points were found in five evenly-spaced cultural levels denoted by ash-stained layers that contained hearths. The cultural levels are designated culture layers 27 through 31. The 24 projectile points recovered from these cultural levels are illustrated and described (Husted 1978:79-82, Plate 61) and all conform to the Angostura type. A radiocarbon date of 8100 ± 130 B.P. is reported from the top culture layer (# 27) and a date of 8740 ± 140 B.P. was obtained from the middle layer (# 29). Hearths are reported from both layers. It is presumed that the excavators dated charcoal collected from features because they report excavating 11 fire pits in the lowest culture layer (# 31), but lament that, “[n]one, however, produced sufficient quantity of charcoal for a satisfactory C-14 dating” (Husted 1978:82). Even if the dated charcoal was not collected from hearths, its recovery from well-defined occupation layers in a rockshelter would indicate that the dates are reliably
associated with human activity. Due to the fact that the culture layers are evenly distributed throughout a vertical distance (McCracken 1978:Plate 19), the age of the lowest layer may be established from the dates obtained from the top and middle layers, if constant deposition is assumed. Seeing as though the date for the middle layer is 640 years older than that for the top, the date of the lowest layer may be estimated at 640 years older than the date for the middle layer, or 9380 B.P. If the above reasoning is sound, data from Mummy Cave suggests a time span of about 9400 to 8100 B.P. for Angostura points in the Middle Rocky Mountains. This time range will be used to estimate the duration of the type in the Southern Rocky Mountains where it is not well dated.

**Pryor Stemmed Type**

Limited evidence exists to support the notion that the type of point used by mountain people who made use of Middle Park in terminal Paleoindian times was a point comparable to the Pryor Stemmed type. The type was originally defined by Husted (1969) for specimens found in the area of the Bighorn Mountains of Wyoming and Montana. As implied by the name, Pryor Stemmed points are a stemmed type with shoulders present at the juncture of the stem and blade. On the stem, basal edges are concave and lateral edges are straight or slightly concave. Ears can be pointed or rounded. Original blade edges are parallel or convex. Frison and Grey (1980:Table 1) report dates from sites in and around the Bighorn Mountains that produced Pryor Stemmed points. Dates from Medicine Lodge Creek, Schiffer Cave, and 48JO303 are here disregarded because they are from cultural levels that also produced points that are best subsumed under the Angostura type, which is partly older than the Pryor Stemmed type (Frison and Grey 1980:Figure 3 g-i, Figure 7 f-g, j, l, Figure 9 g). The radiocarbon dates from levels at these sites that are attributed to the Pryor Stemmed type may actually pertain to archaeological deposits that pre-date the type. Only Pryor Stemmed points are reported from Bottleneck Cave and the Paint Rock V rockshelter and are here
considered reliable dates for the type. Occupation III at Bottleneck Cave contained 14 Pryor Stemmed points and produced two dates: 8160 ± 180 and 8140 ± 150 B.P. At the Paint Rock V rockshelter, charcoal from two hearths in a cultural level that produced five Pryor Stemmed points provided dates of 8340 ± 160 and 8140 ± 150 B.P. From the above, it can be estimated that the Pryor Stemmed type was in use from ca. 8300 to 8100 B.P. The above date range in conjunction with that from Mummy Cave for the Angostura types suggests that use of the Angostura type might have been partly contemporaneous with early use of the Pryor Stemmed type. Occupation of Middle Park by makers of the Pryor Stemmed type is indicated at site 5GA2247, located in the open tract of sagebrush grassland in western Middle Park. At the site, three definite Pryor Stemmed points and possibly two more basal fragments were collected from the ground surface.

East Central Plains Points and Hide Scrapers

Concave-Based Lanceolate Points

Recent work has helped to establish the time span of concave-based lanceolate points that are common on the east Central Plains but as yet poorly understood. Concave-based lanceolate points are of interest because they are in part contemporaneous with other Late Paleoindian point types. Based on radiocarbon dating and the co-occurrence of point types, the concave-based lanceolate points are in part contemporaneous with Cody, Frederick, and Allen types common to the western Plains, as well as the Angostura type found most often in the Rocky Mountains. Some of the concave-based lanceolate points appear to be comparable to the Dalton type, but most are as yet poorly defined and in need of typological study. A descriptive, generic term is used here to refer to the points. Commonly, the points have parallel diagonal flaking and a bi-beveled blade.

The temporal span of concave-based lanceolate points is best documented at the Allen site in the Medicine Creek drainage of Nebraska (Bamforth 2007). Here, a one-meter
thick sequence of radiocarbon dated deposits record repeated occupations of the site as a residential hub by relatively small groups of people throughout much of the Paleoindian period. Occupation Layer 1 (OL 1) at the bottom of the deposit is coincident with a paleosol. This is followed by an Intermediate Zone (IZ) representing a less stable ground surface. At the top of the sequence is another paleosol referred to as Occupation Level 2 (OL 2). One concave-based point was recovered from OL 1. Radiocarbon dates on organic material recovered from fire features in OL 1 are 10,600 ± 620 B.P. (Feature 21) and 10,270 ± 360 B.P. (Feature 10). Another concave-based lanceolate point was recovered from the IZ. A third specimen is unprovenienced, but believed to have come from OL 2. The occupation level dates to 8670 ± 90 B.P. based on scattered charcoal from the general level.

Concave-based lanceolate points are also common at the nearby Red Smoke site. At least two specimens were recovered from Zone III (a.k.a. Zone 80) (Davis 1953:Figure 134 c; Knudson 2002:Figure 7.11 e). The level is undated, but bracketed by dates of 9870 ± 80 and 9210 ± 60 B.P. (May 2007:Table 3.8, Figure 3.7). Several points of the variety were recovered from Zone IV (a.k.a. 83), one of which is illustrated (Davis 1953:Figure 134 b). The zone is dated to 9210 ± 60, based on scattered charcoal (May 2007:Table 3.8, Figure 3.7). Finally, a large sample of 17 concave-based lanceolate points from Zone V (a.k.a. 88) is illustrated by Knudson (2002:Figures 7.7 - 7.11). The zone has been dated to 8910 ± 130 and 8830 ± 130, based on a split sample of charcoal with some burned bone fragments from a hearth designated Feature 1593 (Knudson 2007:Table 7.2, May 2007:36, Table 3.8, Figure 3.7).

Concave-based lanceolate points are also known from dated bison bonebed sites situated west of Medicine Creek where they occur in association with definite or possible Cody points. The Norton site in northeastern Kansas produced an unillustrated point described as a concave-based lanceolate point with parallel diagonal flaking and a reworked blade that gives the point a stemmed appearance (Hofman et al. 1995:20-21). A radiocarbon
assay on bison bone produced a date of 9080 ± 60. Two sites along the North Platte River in western Nebraska produced concave-based lanceolate points. One is known as Clary Ranch, which produced three specimens dated to 9040 ± 45 based on a sample of bison bone (Knudson 2002:Figure 7.14 left; ca. 2012:Table 2). The other bonebed is the Scottsbluff site. Here, a concave-based lanceolate point is associated with dates of 8938 ± 85 and 8680 ± 85 on bison bone (Knudson ca. 2012:Table 2, Figure 4 c).

**Beveled Tools**

Bamforth and Becker discuss a sample of 23 beveled tools from the Allen site (2007a:152-153, 155, 161-162, 170-173, Figure 10.1). They apply the term beveled tool to the artifacts in reference to the beveled character of the presumed working edge. Use wear analysis of the specimens determined that beveled tools functioned as hide scraping tools. In this regard, beveled tools are functionally equivalent to many end scrapers, the hide scraping tool common on the western Central Plains and in the Southern Rocky Mountains. Morphologically, beveled tools are comparable to Dalton adzes and Clear Fork gouges found in the more wooded environments east of the Plains where they functioned as wood-working tools. The sample of beveled tools was recovered from throughout the meter-thick cultural deposit at the Allen site and therefore the artifact type can be said to date from ca. 10,600 to 8700 B.P. Importantly, no end scrapers were recovered from Allen. The above observations are the basis for hypothesizing that beveled tools may prove to be an artifact class diagnostic of a cultural group of the east Central Plains that also made concave-based lanceolate points. Though a strong possibility, the possible association between the point and hide scraper types is clouded by the fact that point types common to the west Central Plains also occurred at the Allen site, including single specimens of Agate Basin and Hell Gap points.

The possible utility of beveled tools as an artifact type diagnostic of peoples native to the east central Plains is partly bolstered and in part confounded by evidence from the Red
Smoke and Lime Creek sites. At Red Smoke, two beveled tools are noted from Zone IV (a.k.a. 83) with concave-based lanceolate points and an associated date of 9210 ± 60 (Bamforth 2002b:69-70; May 2007:Table 3.8, Figure 3.7). Two beveled tools from Red Smoke are illustrated by Knudson (2002:Figure 7.8 a-b), but specific provenience in not given. Further clarification of the possible utility of the beveled tool as a hide scraper type diagnostic of peoples of the east Central Plains must await further analysis and write-up of the Red Smoke collection. As will be elaborated in the discussion of the Lime Creek site in Chapter 12, Level I produced 15 Cody point preforms and three of the five points are here classified as Cody points. Hicks (2002:Appendix C) classifies one artifact from the level as a beveled tool (catalog number 8266), but because the artifact is not illustrated, the specimen is not counted among the definite beveled tools from Medicine Creek.

**Distribution of Coeval Late Paleoindian Point and Hide Scraper Types**

Co-occurrence of point types at sites related to large-scale hunting is most evident during the Late Paleoindian period, therefore relevant information is reviewed here to develop theory on interaction between culturally distinct groups in the study area to aid in interpreting individual sites in Chapter 12. The discussion will focus on sites in and around the study area that may reflect cooperation of culturally distinct groups in communal hunts. The time period of concern is 9400 to 8400 B.P. During this time, Cody points were in use on the western Plains and later, the Frederick type was in use with perhaps some period of overlap (Figure 8-11). That makers of Cody points also occupied the Wyoming Basin is seen at sites such as Finley (Frison 1991). The period of interest also covers the later portion of the time when concave-based lanceolate points were in use on the east Central Plains as well as all but the end of the time span of Angostura points in the Rocky Mountains and Wyoming Basin. The discussion will begin by reviewing information relevant to understanding interaction between peoples of the eastern and western portions of the Central Plains.
Toward this end, sites producing concave-based lanceolate points, beveled tools, and Cody points will be reviewed. Next, the discussion will turn to information concerning interaction between peoples based in the Rocky Mountains and populations on the western Plains. Primarily, sites producing Angostura and Cody points in the Middle and Southern Rocky Mountains and Wyoming Basin will be reviewed. Finally, a site that may provide evidence of the contemporaneity of Angostura and Frederick points will be discussed.

**Evidence for Interaction Between Peoples of the East and West Central Plains**

To discuss evidence for interaction between makers of Cody points and concave-based lanceolate points, published sites will be reviewed moving from east to west up various river drainages. The review will begin in eastern Nebraska where sites with only concave-based points are reported, then move to western Nebraska, western Kansas, and eastern Colorado where sites with a mix of point types are located, and continue west on the plains of eastern Colorado and Wyoming where sites with only Cody points predominate. The Medicine Creek drainage is important to this discussion because of its high-quality source of tool stone and therefore the relationship of the drainage to the areas within which the two point types occur will be given special attention.

Located in the Platte River drainage of southeast Nebraska, a deposit of bison bone known as the Meserve site produced two concave-based lanceolate points. Excavated in the 1930s, not much is known about the site beyond the fact that the points were recovered from among the bones of an unspecified number of bison that included two skulls (Wormington 1957). Both points were made of Nehawka chert from a source in southeast Nebraska (Knudson 2002).

Evidence from sites in the Medicine Creek drainage produced relevant evidence. Medicine Creek is about half way across Nebraska in an east-west direction. Though the creek is a tributary of the Republican River, which is in turn part of the Kansas River...
watershed, Medicine Creek is fairly close to the Platte drainage, lying only 53 km south of the river itself. One attraction of Medicine Creek would have been its high-quality sources of tool stone. The Allen site produced evidence of repeated occupation from ca. 10,600 to 8700 B.P. Recovery of 23 beveled tools, no end scrapers, and three concave-based lanceolate points throughout the cultural deposits is the basis for attributing most occupations to groups with cultural affiliations to populations of the east Central Plains. At the Red Smoke site, evidence for occupation by makers of concave-based lanceolate points is found in Zones III through V and two beveled tools are reported from Zone IV. A large sample of points was recovered from Zone V that includes 36 concave-based lanceolate points and two Cody points (Knudson 2002). Zone I at the Lime Creek site produced evidence for Cody occupation of Medicine Creek for the purpose of mass producing hunting weaponry. A total of 15 Cody point preforms were discarded at the site (Hicks 2002) and three of the points from Zone I are here classified as Cody points.

Continuing up the watershed of the Platte River, two bison bonebeds along the lower reaches of the North Platte are germane to the discussion. One is the Clary Ranch site, located 185 km northwest of the Medicine Creek sites. Analysis of faunal remains from the bonebed indicates that a large-scale kill is represented because the remains of at least 41 bison were present (Hill 2001:165). Of the 13 points recovered from the site, four are illustrated in Knudson (2002:Figure 7.14). Three of the points are concave-based lanceolate points, but the specimen depicted on the far right is a short point with a reworked tip that has a straight basal edge, parallel lateral edges, and appears to be possibly classifiable as a Cody point. The second bonebed is the Scottsbluff site, which is located 150 km further upstream (Knudson ca. 2012). Examination of the faunal collection indicates that the bonebed represents a large-scale bison kill of a minimum of 30 individuals (Todd et al. 1990). Of the four points from the site, two are here typed as Cody points, one is considered a concave-based lanceolate point, and one can not be classified with certainty.
By continuing up the North Platte into southeastern Wyoming, one arrives at the Hartville Uplift where evidence from the Hell Gap site cluster indicates that the area was home to makers of the Cody point. Occupation by Cody groups is evident at Localities I and V. One point from an unspecified provenience that is not illustrated is labeled as a possible Dalton point (Bradley 2009b:Table K.1), but no evidence currently exists to indicate that large groups of people equipped with concave-based points comparable to those of the east Central Plains actually visited the Hartville Uplift.

The relationship between lands used by makers of Cody points versus people equipped with concave-based lanceolate points is less clear in the South Platte drainage in Colorado, but some information is available. The portion of the South Platte drainage from the Colorado-Nebraska state line to Fort Morgan, Colorado lies roughly the same distance to the west as the stretch of the North Platte in western Nebraska where the Clary Ranch and Scottsbluff sites are found. One bonebed in this section of the South Platte drainage is the Frasca, site which produced seven points of the Cody type (Fulgham and Stanford 1982).

Further up the South Platte River drainage, a strong Cody occupation is evident at the bison bonebeds of the Jurgens site where 76 Cody points and 92 end scrapers were found. Recovery of one beveled tool from the site provides some evidence for contact between makers of Cody points and people native to the east Central Plains.

Upon returning to the Kansas River drainage, examination of artifacts from bison bonebeds in the upper reaches of that watershed helps to define the vague cultural boundary between makers of the two kinds of points. As one moves eastward up the watershed from a north-south line through Medicine Creek, sites producing only concave-based points seem to be replaced by sites dominated by Cody points and sites producing both kinds of points are found along the way. Such is the case with the first site encountered in west central Kansas. Known as the Norton site, the bonebed has yielded a Cody point and another described as a concave-based point with parallel diagonal flaking (Hofman et al. 1995). The Laird site is a
small bison bonebed in northwest Kansas that has been test excavated (Hofman and Blackmar 1997). A scatter of bone measuring only six by three meters on the ground surface prior to excavation proved to be a bone deposit in an ancient gully that contains the bones of a minimum of two bison. The site evidently represents a small-scale bison kill. A concave-based lanceolate point with a resharpened triangular blade and beveled edges was recovered in association with the bone deposit. Just across the Kansas-Colorado border to the west, a now largely destroyed Cody site known as Wetzel is reported by Cassells (1997:85).

The Claypool site is located further west on the plains of northeast Colorado. The site is within the watershed of the Republican River, but here the land is more arid and rather than finding permanent streams such as Medicine Creek, the generally eastward flowing streams are intermittent and peter out as water seeps underground in extensive dune fields. Wind erosion at the site caused a blowout to form which exposed artifacts of various ages, but by far the most points were of the Cody type. Bradley and Stanford (1987) illustrate close to 100 Cody points from the site. From this, one may be justified in suggesting that the Cody occupants of the site were likely involved in large-scale bison hunting. Fragmentary bison bones were reportedly exposed in the blowout (Cassells 1997:83). Of the 80 Cody points from the site examined by Muniz (2005:Table 5.14), 10 were made of Smoky Hill jasper from sources to the east in the Kansas River drainage. Knudson (2002:115) also examined artifacts from Claypool and noted a point of Smoky Hill jasper that she compares to concave-based lanceolate points from Medicine Creek. Finally, a photograph of artifacts from the site shows mostly Cody points, but also two concave-based lanceolate points (Wormington 1957:Figure 42, third row, second and third from right).

Because much of the interaction between peoples of the eastern and western portions of the Central Plains will herein be examined from the perspective of assemblages from Medicine Creek, the position of this drainage within the broad land use patterns outlined above will be reviewed. West of Medicine Creek lies the broad north-to-south aligned band
of terrain within which are bison bonebeds that have produced both Cody and concave-based lanceolate points. Possible explanations for this co-occurrence of points of different types include: 1) acquisition of points of a different type through trade during preparations for a communal hunt, 2) participation in large-scale hunts by individuals or small groups from a neighboring cultural group, or 3) aggregation of bands from neighboring bands to cooperate in communal hunting. Currently, small sample sizes of points form many of the sites frustrates attempts to substantiate one alternative over the others. Further west of the band containing bonebeds with two point types are lands producing evidence of occupation by only bands using Cody points. The distribution of bonebeds with two point types suggests that Medicine Creek may have been well within the western part of the area that might be considered the homeland of people who made concave-based lanceolate points. This possibility is bolstered by the assertion that small groups of people who used a type of hide scraper (the beveled tool) possibly diagnostic of the eastern cultural group repeatedly occupied the Allen site during a time of year when they were not engaged in communal bison hunting. At Medicine Creek, people who made concave-based lanceolate points could gear up at a local high-quality tool stone source prior to going on a communal bison hunt by themselves or perhaps in cooperation with Cody people in lands to the west. Though information is limited, no published bison kills producing Cody points are known east of Medicine Creek. From the perspective of people making Cody points, Medicine Creek may have been on the eastern edge of the terrain within which bands operated. Medicine Creek may not have been within the homeland of the makers of Cody points in the sense that they evidently did not inhabit the area for most of the year when dispersed into small groups involved in generalized foraging. Rather, makers of Cody points may have visited Medicine Creek only around the time of the large-scale bison hunting season in order to gear up with stone needed for communal hunts.
Evidence for Interaction Between Peoples of the Mountains and the Western Plains

Discussion of interaction between mountain and plains peoples will begin in the Middle Rocky Mountains where most work has been conducted to identify so-called mountain-orientated Late Paleoindian peoples. Work by Frison and colleagues in and around the Bighorn Basin of northern Wyoming has established that Late Paleoindian populations of the mountains were culturally distinct from Plains groups in that they were based in separate physiographic regions, had differing subsistence economies, and produced different point types (Frison and Grey 1980; Frison 1992).

Earlier work in and around the Bighorn Basin first recognized the contemporaneity of Cody and Angostura points. Based on their work at Mummy Cave in the Absaroka Range of Wyoming, Wedel et al. (1968) were the first to point out the importance of evidence supporting the idea that the Cody type was contemporaneous with specimens of a widespread type that is here identified as Angostura. Faunal remains from the rockshelter indicate that from Late Paleoindian to Late Prehistoric times, the occupants of Mummy Cave possessed a subsistence economy dependent on food resources of the montane environment, including a heavy reliance on bighorn sheep with few deer and almost no bison represented. A large net found in a niche in a rockshelter elsewhere in the Absaroka Range was radiocarbon dated to 8860 ± 170 B.P. and provides further evidence for exploitation of bighorn sheep or mule deer by Late Paleoindian inhabitants of the area (Frison et al. 1986). At Mummy Cave, 24 Angostura points were the only type of point recovered from five sequential cultural levels estimated to date from ca. 9400 to 8100 B.P. (see above). Of particular interest to Wedel and others on the Mummy Cave project was the absence of evidence for a Cody occupation.

Wedel (1987) had earlier supervised the 1952 Smithsonian Institution excavations at the Horner site, a Cody large-scale bison kill in the Bighorn Basin, located only 60 km east of the rockshelter. Dates from the site that fall within the range of acceptable dates for Cody sites elsewhere are ca. 8800 and 8700 B.P., and thus fall within the temporal range of
Angostura points. A large sample of 83 points from Horner may be assigned to the Cody type. Apparently, Wedel was unaware that an Angostura point had also been recovered from the Horner bonebed during the 1950s. The point was later brought to light when the site was further investigated in the 1970s and 1980s and all existing museum collections were examined (Bradley and Frison 1987:226, Figure 6.14 b). Two other museums had excavated at Horner and the point may not have been in the Smithsonian collections. In total, the above information suggests that people making Cody points were engaged in large-scale bison hunting in the Bighorn Basin at the same time that contemporary people were using Angostura points to primarily hunt bighorn sheep in mountains adjacent to the basin. The presence of the Angostura point at Horner suggests some form of social interaction between the two groups.

The Larson Cache from the Wyoming Basin should also be discussed as providing direct evidence of the contemporaneity of Cody and Angostura points (Ingbar and Frison 1987). Artifacts comprising the cache were found eroding out of a dune field by an artifact collector during multiple visits to an active blow-out. Though discovered in an eroded context, it is important to note that artifacts considered to be part of the cache were all likely to have been deposited in the archaeological record at the same time. Along with several tools and large flakes, there were more than 30 Cody points and a straight-based lanceolate point that is best classified as an unusually long Angostura point (Ingbar and Frison 1987:Figure A6.1 i). One specimen from the Larson Cache is best classified as a Dalton point with a resharpened blade (Ingbar and Frison 1987:Figure A6.1 h). The Dalton type is one of the kinds herein included in the general category of concave-based lanceolate points. The Dalton type was originally defined from surface finds of specimens with resharpened, triangular blades found in woodlands east of the Plains in Missouri and Arkansas (Bell 1958:18, Plate 9). Specimens of original Dalton points, whose shape is unaffected by resharpening are lanceolate points with convex lateral edges. Based on the number of
specimens of each of the three point types represented, the Larson Cache was likely deposited by a person or persons affiliated with people who made Cody points. The cache included one well made and particularly long example of each of two contemporaneous point types, one common to regions west of the Central Plains proper (Angostura) and one most prevalent in the more easterly portions of the Central Plains and woodlands farther east (Dalton).

Large-scale bison hunting in Middle Park by an aggregation of people who made Angostura points and others who made Cody points is strongly suggested at the Jerry Craig site. Limited test excavations exposed 4.5 m² of the bonebed and recovered 16 points or fragments from the bonebed (Logan et al. 1998:Figure 3.13). Although only five bison are represented in the faunal assemblage, the limited extent of excavations, coupled with the fact that a total of 64 points have been recovered in the bonebed area strongly implies that large-scale bison hunting is represented. A date of 9310 ± 50 B.P. obtained on charcoal in direct association with the depositional unit containing the bonebed and associated artifacts falls into the time range of both Cody and Angostura types. Analysis of bison dentitions produced a dental age range of N + .3 yr to N + .5 yr, which is consistent with a single-event bison kill (Hill and Kornfeld 1999).

As part of a typological study of points from the site, Richings (1998) discusses and illustrates 11 complete points from the site and concludes the specimens are a variety of Cody point. However, of the four complete points from the excavations, two conform to the Cody type and two do not. Of the non-Cody points, one specimen was apparently excavated in association with the bonebed (Richings 1998:29-30, Figure 4.1, first page, first row, left specimen). The point has convex lateral edges, is widest about midway between the basal edge and the tip, and has a straight basal edge. Based on the specimen’s similarity to straight-based points from cultural layers 27 to 31 at Mummy Cave, it is here classified as an Angostura point. The second non-Cody point is from the excavations, but was not recovered in situ from the bonebed (Richings 1998:Figure 4.1, first page, second row, right specimen).
Attributes of the point include a concave base and convex lateral edges which are furthest apart about midway between the basal edge and the tip. The specimen conforms to the Angostura type. All of the remaining seven complete points are from the ground surface and are in a private collection. Six are Cody points, but one is not (Richings 1998:Figure 4.1, second page, second row, middle specimen). The non-Cody point has a concave basal edge, convex lateral edges that are furthest apart about midway between the basal edge and the tip, and is here classified as an Angostura point. To summarized, of the 11 complete points from the site, eight are of the Cody type and three are Angostura points.

Presence of multiple specimens of both Angostura and Cody points is grounds to hypothesize that the site is representative of a large-scale bison hunt that involved the cooperation of two culturally distinct peoples; one from the mountains and one from the plains. If the relative frequency of points of each type reflects the proportion of plains people participating in the hunt relative to mountain people, it would appear that there may have been a larger group of plains people present.

That mountain people may have participated in a bison hunt is not necessarily at odds with evidence from the Middle Rocky Mountains indicating a broader based subsistence economy for mountain peoples. Given that historical and archaeological evidence demonstrate that bison have long been and important food resource for native peoples in Middle Park, it is not surprising that mountain people sometimes hunted bison. Four points from the Jerry Craig site were tested for blood protein residues (Puseman 1995). One point tested positive to bison antiserum. Another tested positive to antiserum of both bison and deer, implying that the artifact was used to hunt mule deer before it was used on bison and then deposited on the site. The blood protein residue study was carried out before the presence of two point types was recognized at the site, so the current literature does not specify the point type for the two specimens with blood protein residue.
The possibility that makers of the Angostura point may have interacted with people on the Plains in supported by evidence from the Hell Gap site cluster in the Hartville Uplift of Wyoming. Hell Gap is only 50 km east of the Laramie Mountains, so it is not beyond the realm of possibility that mountain people traveled out onto the western Plains to participate in communal bison hunting with plains groups. Excavation of Locality V at Hell Gap revealed a deposit of bison bone and primarily Cody diagnostic artifacts. That makers of the Cody point engaged in hunting of bison and processing of hides while camped at Hell Gap and involved in gearing up with stone from local high-quality sources is supported by the recovery of the remains of a minimum of seven bison, 21 Cody points, 19 Cody point preforms, and 19 end scrapers (Knell et al. 2009; Muniz 2009). The buried component of Locality V was discovered in the 1960s during excavation of a backhoe trench. An Agate Basin point was said to have been recovered from the trench, causing the archaeologists to initially think that the buried level was of Agate Basin affiliation (Knell 1999:10). Among the Cody points illustrated from Locality V is a non-Cody point base with a straight basal edge and lateral edges that expand outward from the basal edge (Knell et al. 2009:Figure 11.2 w). The basal fragment has ground lateral and basal edges, indicating it is a finished artifact. The outline of the point is reminiscent of the Agate Basin type, but the basal width of the point is 2.6 cm, which is much wider than any of the over 90 Agate Basin points from the type station with basal portions sufficiently intact to measure basal width (Frison and Stanford 1982:Figures 2.48-2.59). Considering the Cody points are contemporaneous with the Angostura type and that some Angostura points have broad, straight basal edges (e.g. Stucky 1977:Figure 7 k), the possibility that the non-Cody point is representative of some form of interaction between peoples who made different point types should be seriously considered.

The possibility that mountain people interacted with plains groups is supported by finds of definite Angostura points elsewhere at Hell Gap. A backhoe trench dug north of the
excavation block that revealed the Cody level in Locality V produced the base of an
Angostura point (Kornfeld et al. 2002:68-71, Figure 6 f). Furthermore, the original site
investigators proposed the Lusk projectile point type based on specimens from Locality II,
which they acknowledge are similar to what has been termed the Angostura type, but which
had yet to be adequately described (Irwin-Williams et al. 1973:51; Knudson 2009:Figure 2.8
c). Renewed field investigations at Hell Gap in recent years unearthed another Angostura
point in a backhoe trench west of Locality II (Kornfeld 2002:62-68, Figure 6 c). Finally, an
Angostura point found somewhere in the Hell Gap site cluster is in the collection of the site
discoverer (Duguid 2009:Figure A.1, bottom row, right).

Finally, consideration of the types of points present at the Fourth of July Valley site
in the high Front Range suggests that some form of social interaction within the context of
preparing for or operating a big game drive took place between a mountain group equipped
with Angostura points and people of the west Central Plains who made Frederick points.
Located between one and two km southeast of Arapaho Pass, the site is a camp situated in the
forest-tundra ecotone. Recovery of 18 fragmentary projectile points, most of which are basal
fragments, indicates that hunting weapons damaged during use in the surrounding area were
discarded on-site. Game drive structures in the vicinity of Arapaho Pass were arguably used
by site occupants to carry out a communal kill involving what was likely a non-bison big
game species. Thirteen points from the site retain their basal portions and are classifiable as
to type. Twelve points are here classified as Angostura (Benedict 1981:Figure 67 b-g, h-m).
Of these, two are stemmed (Benedict 1981:Figure 67 l, m). Rather than being Pryor
Stemmed points (which have original blades with convex or parallel edges), the triangular
blade remaining on one of the stemmed specimens compares well to a distal fragment from
the site (Benedict 1981:Figure 67 r), suggesting that sufficiently long proximal fragments
were rejuvenated for re-use as points by flaking an Angostura-like base onto the fragments,
thereby creating stemmed points. One point from the site is here assigned to the Frederick type (Benedict 1981:Figure 67 a).

Regional Point Styles

For bonebeds that produced points of only one type, morphological variation among those points may prove to be the basis for a method of analysis through which aggregation of Paleoindians for communal hunting may be demonstrated. Bamforth (1991b) has argued that expert Paleoindian flintknappers produced points for hunters participating in a communal hunt and as a result, points from sites associated with large-scale kills tend to be more nicely made and demonstrate a high level of skill in craftsmanship when compared to points from other kinds of sites. To support this proposition, the proportion of Folsom points from bison bonebeds that were fluted (an operation requiring a high level of skill) was shown to be significantly higher than Folsom points from sites not associated with large kills. If Bamforth’s argument is sound and if some instances of aggregation for communal hunting involved multiple bands coalescing from neighboring ranges after gearing up at sources of stone within their own ranges, then it follows that points in an assemblage made from a local tool stone, for example, might have a different appearance from points made of a distant tool stone. Possible stylistic differences in the morphology of points made of different tool stones could be due to phenomena such as the existence of regional styles of the point type or idiosyncratic differences in the work of knappers from different bands. Defining these differences in a sample of points of a particular type from a large-scale kill and assessing if they tend to be associated with particular lithic sources is thus another method of potentially demonstrating aggregation in the archaeological record. Fully developing such a method of investigation is beyond the scope of this project, but the potential utility of the method will be explored in a rudimentary way using the sample of Cody points from the Jurgens site.
CHAPTER SUMMARY AND CONCLUDING REMARKS

This chapter was devoted to theorizing Paleoindian land use in the study area under the alternative view and developing methods by which the theoretical perspective may be evaluated. Assessing whether the tool stone composition of an assemblage is representative of a single band or multiple bands requires that one develop an understanding of the size of ranges exploited by ethnographically studied hunter-gatherers. Such an understanding forms the basis for differentiating the tool stones of assemblages into analytical categories of local versus nonlocal stones. Some conception of the size of forager ranges is also necessary for separating nonlocal raw material into distant and very distant tool stones. Distant stone is that from sources that lie at such a distance that they arguably could have been used by neighboring bands intent on gearing up for a communal hunt. Very distant stone is from sources so distant that it likely arrived at the site not by the aggregation of bands, but by one of the other mechanisms of social interaction that involved the travel of individuals or groups smaller than a band. In developing the analytical categories of local, distant, and very distant tool stone, the question of how stable band ranges would have been over time was addressed and found to not be a fatal flaw in the rationale that the categories may allow social aggregation to be identified in the tool stone composition of study area assemblages. The categories will serve to evaluate if data on the tool stone composition of the Jurgens assemblage supports the alternative view’s expectation that the site represents an aggregation of multiple bands. The categories also served as the basis for stating the differing expectations of the two views regarding how the tool stone composition of assemblages reported in existing literature should vary based on whether or not the site is associated with communal bison hunting and the availability of raw material in the local environment.

To conduct the above analyses, it is first necessary to classify the study sites as having been either associated with communal hunting or not, and in some cases, my
interpretation differs from that of the original site investigator. To explain the reasoning behind the difference in classification, a discussion of my understanding of the natural and cultural processes that may affect the formation of the sites was presented along with a discussion of the hunting technique that likely was normally used by Paleoindians to carry out communal bison hunts.

The bulk of analyses to be performed will deal with the tool stone composition of assemblages, but some analyses and interpretations to be presented will focus on typological and possible regional stylistic differences between projectile points in the assemblages. Therefore, some discussion was directed toward developing the theoretical framework necessary to evaluate alternative ideas about Paleoindian land use and social organization based on variation in point morphology. Specifically, a need was identified for exploratory analyses directed toward assessing if possible regional stylistic differences between points from the Jurgens collection support the alternative view’s expectation that the assemblage in large part was produced though aggregation of bands. A hypothesis that morphological variation in the fluted Folsom point and coeval unfluted points may reflect differences in the size of groups participating in communal hunts was developed. Furthermore, a number of the Late Paleoindian assemblages in the study area contain two types of points, so a theoretical framework was developed to support the thinking that some of these assemblages may have been produced by the aggregation of culturally distinct peoples.

Evidence that Paleoindians of the Plains had large dogs was reviewed to simply emphasize the need for future theory development to better integrate the possible role of dogs in shaping land use patterns. If most Paleoindian bison bonebeds represent temporary hunting camps, the role that the dog would have played in enabling a land use strategy that involved killing bison herds in open country and transporting carcass segments back to a camp for further processing needs to be better understood.
The framework for a basic model of land use in the study area constructed through consideration of modern and Paleoindian climatic conditions in Chapters 4 and 5 was further developed with relevant archaeological data and found to be a sound basis for interpreting sites in the study area from the alternative perspective. Data on the seasonal timing of communal bison hunts on the Plains suggests this physiographic province was inhabited year-round. Latitudinal variation in the seasonal timing of communal kills on the Plains was demonstrated. People living in the more northerly section of the Plains carried out communal kills during the height of the cold-season when cold weather could assist in short-term storage of meat through freezing. To the south, inadequately cold conditions during the height of the cold-season forced people to hold communal hunts during the preceding months in order to store meat for the lean time of year by drying it in warm weather. Data on the seasonal timing of large bison kills demonstrates that with the warming of the climate throughout the Paleoindian times, the imaginary line north of which preservation of meat via freezing was possible shifted northward. The ramification of the above climatic changes for the timing of communal hunts in the Plains portion of the study area is that large-scale kills were conducted during the height of the cold-season during Folsom, Agate Basin, and Hell Gap times, but were carried out in the preceding months during Cody and terminal Paleoindian times.

Ideas on the timing of communal bison hunts and regional abandonment of Middle Park were also further developed by available archaeological evidence. The expectation that Paleoindians would have seasonally abandoned Middle Park during the height of the cold-season was indirectly evaluated with archaeological evidence from the post-Paleoindian period and substantiated. Recent claims that archaeological evidence supports the view that early Paleoindians overwintered in Middle Park and other intermontane basins were refuted. Limited data on the seasonal timing of communal bison kills in Middle Park is consistent with the theoretical expectation that hunts were planned for the months prior to the height of the cold-season, at which time the park was abandoned. A consideration of Late Paleoindian
point types present at the Jerry Craig site supports the expectation that Middle Park was used by both mountain people, who wintered west of the park, as well as by plains groups who wintered east of the Front Range on the west Central Plains.

No archaeological evidence from the high Front Range is currently available to test ideas on the timing of game drives and regional abandonment developed through a consideration of climatic conditions, but some evidence exists to support the thinking that the high Front Range was used peoples who wintered both to the east and west of the mountains. No archaeological data on the season during which game drives were conducted in the high Front Range is as yet available due in part to poor bone preservation. The expectation that drives for non-bison big game animals were held in the months prior to the height of the cold-season at which time the high Front Range was abandoned is considered valid, but as yet unsupported archaeologically. A consideration of Late Paleoindian point types recovered from the high Front Range sites affirms the expectation that the region was used for communal hunting by both mountain and plains people.

The above discussion has developed the methods necessary to evaluate contrasting views on Paleoindian land use in the study area, most notably by demonstrating that the distinct theoretical approaches lead to differing expectations on how the tool stone composition of sites from the study area should, or should not, vary based on raw material availability and social considerations, particularly aggregation. The issue of whether Paleoindian land use involved group aggregation is central to the debate and must be better demonstrated if proponents of the alternative view are to further develop their way of thinking. With these thoughts in mind, I will now use the methods of analysis developed in this chapter to state how data collected from the Jurgens assemblage and existing literature will be used to further test both the traditional concept of a frugal Paleoindian lithic technology and the alternative view’s thinking that aggregation was an important feature of Paleoindian social organization.
CHAPTER 9
RESEARCH DESIGN

This chapter will lay out the basic plan for judging the validity of the contrasting views on Paleoindian land use in the study area. The research design called for data from the Jurgens site to be used to evaluate the traditional view’s position that occupants of the site possessed a frugal lithic technology that permitted a highly mobile way of life. Data from the site was also collected with the intent of assessing the alternative view’s position that Paleoindian bands operated within ranges not wholly unlike those of ethnographically documented peoples and that bands occasionally aggregated for communal bison hunting. Finally, the research design called for the compilation of more general data on the tool stone composition of 16 other assemblages from sites in the study area and comparing these data to theoretical expectations developed under both views to aid in determining which school of thought best explains the observed variability.

BASIC DATA COLLECTION PROCEDURES FOR THE JURGENS ASSEMBLAGE

Artifacts were examined to collect data relevant to evaluating the contrasting views using fairly standard procedures. Data on the artifact collection was encoded into databases using the Microsoft Windows-based program of Predictive Analytic Software (PASW), formerly known as the Statistical Package for the Social Sciences (SPSS). Two computer databases were constructed: a main database and a smaller one for just projectile points that was designed for collecting data on possible stylistic attributes. Each of the 2,814 artifacts in
the collection was examined. The main database includes data on several variables collected from all the formal flaked stone tools, as well as from informal flaked stone tools and debitage (waste flakes, blocky cores, and unfinished bifaces) from the ground surface of all four areas and from excavated contexts in Areas 2 and 3. Data was collected on the variables of artifact class, parent object type, tool stone type, cortex type, type of raw material flaws present, as well as other variables. To expedite data collection, part of the main database consists of a more limited data set that basically includes only the variables of artifact class and tool stone type. This more limited data set was collected from the 1,548 items excavated from Area 1 that are not formal tools. The vast majority of these items are waste flakes or utilized flakes (n = 1,521).

Artifacts were assigned to tool stone types principally through comparison with hand samples collected from known sources. Prior to examining the collection, I familiarized myself with the main tool stones that were likely to be encountered in the collection by examining comparative tool stone collections and by visiting lithic sources to collect hand samples. Comparative collections examined include one amassed by Dr. Joe Ben Wheat of the CU Museum and another housed at the Archaeology and Paleoenvironment Research Laboratory of the University of Northern Colorado that was collected by Dr. Robert Brunswig and his students. I also examined the comparative collection of Dr. Douglas Bamforth and made my own comparative collection of tool stones from sources in the study area. Tool stone identification of artifacts in the Jurgens collection was made by essentially comparing characteristics of the raw material to the qualities of hand samples from known sources in and around the study area. Characteristics taken into consideration included color, translucency, texture, cortex, and the nature of inclusions. Hand samples and artifacts were examined macroscopically and with the aid of a 10-power hand lens.

To aid in assigning the artifacts to specific tool stones with known sources, the fluorescent color response of an artifact under long-wave and short-wave ultraviolet (UV)
light was recorded and taken into consideration when assigning the artifact to a tool stone type. The color response of hand samples in comparative collections was first recorded to collect data on the kind and frequency of color combinations obtained under both long and short-wave UV light. These data were then recorded for the Jurgens artifacts. UV color response data was found to be primarily a useful way of verifying tool stone type determinations made based on examination of artifacts in normal light. For example, the most common UV color response for Flat Top chalcedony is a bright orange under long-wave UV light and bright green under short-wave radiation. For certain artifacts classified as Flat Top chalcedony under normal light, some doubt existed as to the correctness of the classification due to unusual color or small size, but by obtaining the characteristic UV color responses, the tool stone classification of the artifacts was verified.

EVALUATING THE FRUGAL TECHNOLOGY CONCEPT WITH THE JURGENS ASSEMBLAGE

The traditional view that Paleoindians preferentially used high-quality microcrystalline stone as part of a lithic technology designed to use tool stone in an especially frugal manner will be evaluated with data from the Jurgens site. The methods to be used are straightforward and simply involve examination of raw data and percentages. The amount of orthoquartzite in the assemblage will be considered in light of the traditional view that granular tool stones were very much avoided by Paleoindians. The understanding that all kinds of microcrystalline tool stones were preferentially used by Paleoindians over orthoquartzites because the former varieties have better flaking qualities which ultimately permitted a more frugal consumption of tool stone will be further evaluated using data on the incidence of flaws of various kinds in artifacts of the main tool stones. Apart from raw material granularity, the presence of flaws in the raw material is another factor that would be
expected to affect flaking quality. For artifacts of the major kinds of microcrystalline and granular tool stones, the presence or absence of a variety of flaws was recorded. The kinds of raw material flaws noted include irregular material, inclusions, cavities, internal structural planes, cracks, and other flaws.

The relative frequencies of flakes and flake-based artifacts in the Jurgens assemblage that demonstrably derive from bifaces, as opposed to blocky cores, differs under the two views and comparing the actual frequencies to expected amounts served to assess the validity of the biface argument. Under the traditional view, the assemblages should contain a large proportion of flakes and flake-based artifacts that derive from bifaces if indeed most unworked raw material being transported by Paleoindians was in the form of bifacial cores. Under the alternative view, assemblages produced in part during gearing up for a bison kill and in part through processing meat and hides from the kill would be expected to contain quantities of not only bifacial tools, such as points and knives, but also unifacial tools, including those that are best made by retouching thick flakes produced during the reduction of blocky cores, particularly end scrapers. Debitage from stone tool manufacture in assemblages related to large-scale kills should therefore contain substantial amounts of not only flakes derived from bifaces, but also those that were struck from blocky cores. Under the alternative view, assemblages produced as a result of gearing up for large-scale bison hunting and processing the acquired meat and hides should be composed of quantities of both unifacial and bifacial tools as a consequence of the tasks that needed to be performed. Therefore, assemblages from the Jurgens site should contain quantities of both unifacial and bifacial tools.

A method of assessing how much of the Jurgens collection derived from the reduction of bifaces and how much originated from blocky cores was needed so that this information could then be compared with the differing amounts of biface-derived artifacts and blocky core-derived artifacts expected under the competing views. Formal flaked
artifacts often do not retain evidence of the kind of flake from which the artifact was produced, but waste flakes often do retain attributes that allow a determination to be made as to whether the parent object for the flake was a biface or a blocky core. For flakes that came from bifaces, it is commonly not possible to determine specifically if the parent object was a possible bifacial core, an unfinished bifacial tool from which biface shaping or thinning flakes were struck, or a finished bifacial tool that was being resharpened. Nevertheless, the method does allow flakes produced from bifaces in general to be quantified and as such should serve as a measure by which the Jurgens collection may be compared to the theoretical expectations. Utilized flakes, informal retouched flake tools, and formal unifacial tools, such as end scrapers, also commonly retain some or all of the same attributes that permit the parent object to be determined. Because these classes of artifacts comprise a large portion of the Jurgens collection, it is possible to get a good idea of how much of the collection derives from bifaces versus blocky cores.

Qualities of several attributes differ between flakes struck from blocky cores and those that derive from bifaces, as shown in Table 9-1. The more attributes that can be considered for each flake, the greater the confidence with which the flake may be classified with regard to the parent object that produced it. The method is not 100 percent accurate, as it does involve a certain amount of judgment to be exercised on the part of the analyst, especially for artifacts that exhibit relatively few of the distinguishing attributes. Nonetheless, the method was development with the intent of achieving some level of objectivity in assessing the relative amount of biface-derived artifacts versus blocky core-derived artifacts in the Jurgens assemblage. The distinguishing qualities of the attributes are compared in Table 9-1 in an attempt to give the reader some sense of the means by which waste flakes, utilized flakes, informal retouched tools, and end scrapers were classed according to parent object when it was possible to do so.
Table 9-1. Attributes of Flakes Removed from Blocky Cores and Bifacial Cores.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Flakes Removed from Bifacial Cores</th>
<th>Flakes Removed from Blocky Cores</th>
</tr>
</thead>
<tbody>
<tr>
<td>flake angle = angle formed by striking platform and longitudinal axis of flake</td>
<td>relatively low flake angles are common (e.g. 30 to 40°), demonstrating the flakes were struck off of a parent object with a comparatively sharp edge.</td>
<td>relatively high flake angles are common (e.g. 70 to 80°), demonstrating the flakes were struck off of a parent object with a comparatively blunt edge</td>
</tr>
<tr>
<td>curvature of flake when viewed from a lateral perspective</td>
<td>flakes commonly are gradually curving, as a result of being removed from the curved face of a biface with a biconvex cross section</td>
<td>the flakes are not curving in the manner of biface thinning flakes</td>
</tr>
<tr>
<td>flatness</td>
<td>flakes are characteristically flat as a result of having been removed from the flat surface of a biface</td>
<td>flakes are commonly not flat as a result of having been struck from a blocky core with an irregular surface</td>
</tr>
<tr>
<td>striking platform attributes</td>
<td>striking platforms commonly are isolated and ground</td>
<td>striking platforms commonly are plain</td>
</tr>
<tr>
<td>orientation of flake scars on dorsal face</td>
<td>The alignment of ripple marks commonly indicate that flake scars on the dorsal face were produced by flakes that were orientated basically parallel with the longitudinal axis of the flake itself as a result of a series of flakes having been removed from the biface edge toward the midline of the biface. Often a ridge between flake scars on the dorsal face is at the midline of the flake itself and extends to the striking platform as a result of the flake having been removed from a high area along the biface edge.</td>
<td>there is a greater tendency for ripple marks on flake scars on the dorsal face to indicate a more random orientation to the flakes</td>
</tr>
</tbody>
</table>
Some discussion is in order regarding the thinking that underlies the method to be used in evaluating the traditional view that Paleoindian tools were frequently resharpened as part of frugal use of tool stone. If it may be assumed that a band visited tool stone sources when it needed to resupply with raw material to replace a depleted tool kit and that approximately the same amount of stone was acquired by the band during each visit, then the traditional view implies that the most prevalent tool stone in a site assemblage would have been the one that had been acquired by the band most recently before occupying the site and that the tool stone which is second most common in the assemblage would have been procured at an earlier time, etcetera. If Paleoindian tools were constantly being resharpened as part of a highly mobile lifestyle, then tools made of stone from the most recently visited source should demonstrate a certain amount of resharpening, tools of stone from the second most recently visited source will have been resharpened more, tools of stone from the third most recently visited source will have been subjected to even more resharpening, etcetera.

Projectile points are a class of artifact that may be resharpened if they are broken in use and a sufficiently long fragment is retrieved to rework into a shorter point. Traditional thinkers may point to the fact that Paleoindian point types are commonly long to bolster their view that points were one of the kinds of tools that was subjected to a lot of resharpening. The long-standing belief that Paleoindian points were resharpened frequently is demonstrated in the Jurgens site report. Though not expressly a proponent of the traditional view, Wheat (1979:Table 20) classified 21 of the 24 complete points from the site as secondary complete points, meaning that he believes that were resharpened.

End scrapers used on hides comprise another class of artifact that would have been frequently resharpened when in use by peoples of all time periods because dulling of the distal edge required that it be resharpened frequently (Schultz 1992, cited in Bamforth and Becker 2009). Repeated resharpening of the distal edge of hafted and non-hafted end scrapers would cause them to become increasingly shorter.
Under the traditional view, then, both points and end scrapers should have tended to become shorter in length the longer the amount of time they remained in the tool kit due to on-going resharpening as part of tool maintenance. Furthermore, the traditional view maintains that Paleoindians were focused on hunting big game animals throughout the year. Therefore, points were continually being broken and in need of resharpening. Also, if hides were being procured and processed from the animals being killed, then end scrapers would have been continuously resharpened.

From the above, it may be reasoned that if the concept of frugal tool stone consumption is valid, then points and end scrapers made from the most common tool stone should be, on average, the longest; those from the second most common stone should be the next longest, etcetera. This expectation may be expressed in terms of the analytical units of distance to tool stone used in this study. Under the traditional view, tools in an assemblage that are made of raw materials from local and distant sources would likely have been made and put to use more recently in comparison to tools made of raw materials from very distant sources. If the traditional view is valid, samples of complete points and end scrapers made of tool stones from local and distant sources should be significantly longer than the relatively few complete points and end scrapers made of raw materials from very distant sources that were still present in the tool kit. According to the traditional view, reworked points and used end scrapers of tool stones from very distant sources would have been generally shorter prior to a hunt than points and end scrapers of raw materials from local and distant sources. During a hunt, points would have been broken by breaks that traverse the blade, producing fragments of varying length. While processing hides obtained in a hunt, end scrapers can break in use by fractures that traverse the longitudinal axis of the tool. Under the traditional view, fragmentary points and end scrapers made of tool stones from local and distant sources should also be significantly longer than points and end scrapers of raw materials from very distant sources.
On the other hand, the alternative view maintains that points and end scrapers made from various tool stones in an assemblage from a site associated with a large-scale bison kill should not be significantly different in length. Just prior to the hunt, points made in order to gear up for the event would all be within a certain range of lengths and the points of the various tool stones would all be prone to break into fragments that fall within a similar range of lengths. Likewise, end scrapers made to gear up for processing a lot of hides would be within a certain range of lengths when new. Presumably, end scrapers of the various tool stones would all be susceptible to comparable rates of dulling and resharpening such that end scrapers of the different tool stones that were discarded because they are no longer sufficiently long will also be within a certain range of lengths. End scrapers of the various tool stones that were broken in use should not be of significantly different lengths. If the bison kill was to be conducted by a multi-band group, all participating bands would have produced, or acquired through exchange, newly made points prior to killing a large number of bison. Members of all participating bands would also be expected to make or otherwise acquire new end scrapers in advance of working on hides. Some variation in the original size of artifacts would be expected if one or more of the tool stones used was available in pieces that were, on average, smaller than pieces of the other kinds of stone. In general, however, it would be expected that if people in the participating bands all used the same type of projectile point and the same types of end scrapers, then the “mental templates” of what would be thought of as a sufficiently long, new projectile point or end scraper would have been shared among all participating bands. After a sufficient number of animals were killed and processed, points and end scrapers broken beyond repair and end scrapers that were no longer sufficiently long would have been discarded at the camp. Specimens of points and end scrapers that were still functional may also have been discarded if the recent bison kill was the last one to be carried out that hunting season.
From the above discussion, it may be stated that the contrasting views on land use have differing expectations regarding the lengths of points and end scrapers of tool stones from local and distant sources, on the one hand, and the lengths of points and end scrapers of raw materials from very distant sources, on the other. Under the traditional view, the relatively few points and end scrapers of tool stones from very distant sources should be shorter and this will ultimately be a reflection of the mobility of Paleoindian bands within huge ranges. According to the alternative view, the points and end scrapers of raw materials from very distant sources should be the same length as those made from tool stones from local and distant sources. This is because most points and end scrapers used in a communal kill would have been assembled in new or like-new condition to gear up for a large-scale kill, regardless of the distance to the source of raw material used in tool manufacture. Based on the above reasoning, the lengths of points and end scrapers from the Jurgens site will be compared based on the distance to the source of raw material in order to evaluate the relative validity of the two views on land use.

METHODS OF ASSESSING THE ALTERNATIVE VIEW USING THE COLLECTIONS FROM JURGENS

Before data from the Jurgens site could be used to develop an alternative view of land use, it was first necessary to direct some research effort toward determining the kind and relative number of occupations represented. Up to this point in the discussion, the Jurgens site has been referenced during discussion of sites associated with large-scale bison kills. There is good reason for this, because information available in the site report (Wheat 1979) and an article reporting on a study of bison tooth eruption and wear patterns (Hill and Hill 2002) strongly suggests that much of the faunal material at the site is indicative of a large-scale bison kill. The dental ages of the specimens of bison dentition range from N + .4 yr to
N + .6 yr (Hill and Hill 2002). For reasons given in Chapter 8, this relatively tight cluster of
dental ages implies that a single kill is represented. The time period associated with the
middle dental age (N + .5 yr) suggests the kill took place sometime in the period extending
from late September to the end of October. I earlier suggested the minimum number of
individual bison (MNI) represented at the site ranges from 35 to 68 bison. Based on the
understanding that a single kill is represented, the higher MNI estimate derives from the sum
of all MNI estimates for all three areas of the site (31 bison for Area 1, two bison for Area 2,
and 35 bison for Area 3). The higher estimate assumes there is no mixing of bison bone
between areas. The lower estimate of 35 is the highest MNI of all three areas and assumes
bison bones from individual animals may have been deposited in multiple areas. The MNI
estimates for the site are indeed minimum estimates because excavations did not uncover all
areas where bison bone is distributed. In particular, the dense bison bonebed uncovered in
Area 3 extends for unknown distances to the east and west of the excavated area. From the
above information, it is evident that much of the faunal material uncovered from the site
relates to large-scale bison hunting. Two lines of evidence casted some doubt on the idea that
the site is basically associated with a single large-scale bison kill, however.

The fact that the bison bones occurred in three widely separated areas was cause to
question the tentative interpretation of the site as the product of a single bison kill. The three
site areas were discovered in the 1960s when heavy earth moving equipment leveled terrain
on a portion of the Kersey terrace to prepare the area for use as a corn field. The Kersey river
terrace formed along the South Platte River sometime in late Pleistocene or early Holocene
times. The Jurgens site is located along the edge of a segment of the Kersey terrace south of
the river, with the current floodplain situated at a lower elevation north of the site. The
Frazier site, of Agate Basin age, is also situated along the edge of the Kersey Terrace about
one to two km west of Jurgens. This implies that the episode of downcutting by the South
Platte River that formed the Kersey Terrace began sometime before Agate Basin times.
Therefore, the edge of the segment of Kersey terrace overlooking the South Platte Valley would have been a geomorphic setting that would have attracted occupation by people throughout the Late Paleoindian period and perhaps earlier as well. Since the formation of the terrace, sediments and soils have accumulated on the top of the terrace. At the Jurgens site, the sloping edge of the Kersey terrace is aligned northwest to southeast. Prior to land leveling operations, a low ridge that may have been a remnant of an ancient gravel bar was present along the northwest-southeast aligned edge of the terrace (Wheat 1979:8, 11). Back from the edge of the terrace, on the top of the terrace, a northwest-southeast aligned swale paralleled the base of the ridge along the terrace edge. Land leveling operations effectively decapitated the ridge, leaving a strip of gravel that formerly formed the core of the ridge along the terrace edge. Much of the gravel and dirt from leveling the ridge was pushed over the terrace edge to the northeast to fill in a lower area on the slope of the terrace. Artifacts collected from the surface of this disturbed area are designated as having come from the Fill Area. Land leveling also exposed three areas along the swale where bone and artifacts were concentrated. From southeast to northwest, these areas are designated Areas 1, 2, and 3. Block excavations that evidently were of much more limited areal extent than the surface scatters of archaeological material were positioned in each area and determined that intact archaeological deposits were preserved in the swale at the three areas.

The relatively high density of bone and artifacts strongly suggests that the areas are not places where gearing up and bison processing activities were actually performed, but rather are middens where trash generated by the activities was discarded (see Wheat 1979:Figures 10, 23). Although the location where the activities were actually performed may never be known for certain due to the extent of ground disturbance, Wheat (1979:11) quite reasonably speculates that the adjacent ridge overlooking the South Platte Valley was a likely area where much of the activity occurred.
The areal extent and relative position of the surface scatter of bone and artifacts that define the three areas is suggested by a scaled sketch map in the site report (Wheat 1979:Figure 4a). From the center of Area 1, the center of Area 2 lies 93 m to the northwest. From the center of Area 2, the center of Area 3 lies another 134 m further northwest. Thus, the site occurs sporadically along the edge of the Kersey Terrace for a distance of 227 m.

If the site represents a single large-scale kill, then the size of the site implies that a large group of people had aggregated for the event, but other interpretations were possible. Alternatively, the site could have been formed through multiple bison kills that occurred in one year within a particular season during which large-scale bison hunting took place. Yet another possibility was that multiple kills occurred during the large-scale bison hunting season, but during different years. This is the interpretation preferred by the original site investigator (Wheat 1978, 1979). In any case, sorting out the number of occupations represented at Jurgens was identified as the first item to be addressed by the research agenda.

Information on the stratigraphic position of the bone deposit in the three areas of the site further suggested that addressing the number of occupations was a necessary first step. In Areas 1 and 2, the stratigraphic position of the bone deposit is described as being in the upper part of a clay stratum (Wheat 1979:15-16, 32-33). In contrast, the bonebed in Area 3 was located at the contact between the clay stratum and an underlying stratum of sand (Wheat 1979:39-42). In reference to the clay stratum in Area 2, Wheat (1979:32) states that, “[a]fter the bone bed was emplaced, the clay layer continued to form, gradually sealing in the cultural material. From this statement, it is apparent that Wheat believed the clay stratum slowly accumulated on an ancient ground surface. However, clay strata commonly form through eluviation whereby clay-sized particles are transported in suspension by groundwater to a lower stratigraphic position where a clay stratum forms in a pre-existing sedimentary deposit. Groundwater conditions across the site may have varied such that the clay stratum could have varied in the depth at which it formed. If so, then the cultural level (i.e. the bone layer) may
occur at varying depths in the clay stratum. This would give the appearance of the bonebeds in separate areas being of different ages if the clay stratum is interpreted as having formed through slow accumulation on a former ground surface. The varying stratigraphic position of the bonebeds in a clay stratum was another reason to investigate the number of occupations that occurred at Jurgens.

Important to the issue of the number and kind of occupations represented at the site was the occurrence in all three areas of a diversity of non-bison faunal remains. One might suggest the variety of fauna represented among the non-bison bones demonstrates that other species of animals were procured during the time that the site was occupied to gear up for a large bison kill and process the meat and hides obtained after a successful hunt. An alternative explanation is that the variety of large, medium, and small mammals, as well as birds, fish, and a species of reptile were procured during one or more separate occupations of the site during a time of year when Plains Paleoindians were not aggregated for large-scale bison hunting, but were dispersed into individual bands or smaller groups that subsisted on a variety of plant and animal food resources. Examination of the non-bison assemblage is needed to determine if the collection of bones and teeth contains indications of the season during which the animals died. If seasons other than that of the bison kill are indicated, then the case for multiple and differing kinds of occupations of the site would be supported. This task was beyond the scope of the project, but the diversity of animals indicated in the non-bison faunal assemblage is summarized here to bolster the possibility that occupations not focused on large-scale bison hunting may have occurred at the site.

A variety of non-bison mammals, birds, and even one species of fish and a species of reptile were recovered from Area 1 (Wheat 1979:30-32). Big game animals represented in the faunal assemblage from Area 1 included a moose, two elk, one deer, and two antelope. Remains of medium-to-small sized mammals include one of each of the following: cottontail rabbit, beaver, muskrat, marmot, skunk, and a member of the dog family. Wheat states that
the species to which the member of the dog family belongs is undetermined, but then states the pelvis and incisors recovered are probably of a wolf. It should be kept in mind that dogs used for beasts of burden by prehistoric people on the Plains were large. Also, ethnographic evidence indicates Plains peoples also made use of the dog as a food supply. Therefore, the possibility exists that the fragmentary canid pelvis and three incisors recovered from Area 1 are of a domesticated dog. The remains of marmot are also of interest. In the discussion of environmental conditions during Paleoindian times, I noted that if the setting in which Cody peoples lived was not much different from that of modern times, the occurrence of moose mandibles at the Jurgens site was somewhat surprising. It was suggested that if the environment indeed was comparable to that of today, then the mandibles may represent transportation of moose tongue to the site during a multi-day trip from the Front Range. The presence of marmot remains would support such an interpretation because, like the moose, the marmot is not known to inhabit the Great Plains of Colorado today. Rather, marmot habitat occurs throughout all elevations of the Southern Rocky Mountains in places where areas of broken rock provide shelter (Armstrong 1972:113-117). Wheat also mentions that bones from six species of rodents occurred in Area 1. It is uncertain if they represent food remains or bones of burrowing animals that died underground after site formation. Bones of three kinds of birds were also present at Area 1. These are described as a turkey-sized bird, a bird the size of a prairie chicken, and another the size of a songbird. A minimum of one fish is represented in the collection and is said to be of medium size compared to species native to the South Platte River. Finally, the remains of one turtle are present. They are possibly from an ornate box turtle which is the most common species of turtle on the Plains of Colorado.

Though less diverse, multiple species of non-bison animals were recovered from Areas 2 and 3 (Wheat 1979:38, 59-60). The faunal collection from Area 2 included bones from three antelope along with one individual of each of the following kinds of animals: elk, deer, unidentified small mammal, gopher (possibly intrusive), and a medium-sized bird. Big
game remains excavated from Area 3 include those from one elk, one deer, and two antelope. Smaller mammals were represented by one of each of the following: jack rabbit, cottontail rabbit, and an unidentified species. Miscellaneous bones of various kinds of rodents were recovered, including two partial skeletons that may be intrusive.

The presence of manos and metates at all three areas further suggested the possibility that occupation unrelated to large-scale bison procurement may have occurred at Jurgens because these kinds of artifacts are not typically found at sites associated with bison kills. Most ground stone artifacts were found on the ground surface. However, two grinding slab fragments were recovered from excavated contexts in Area 2 and were apparently associated with the buried Cody cultural level. The numbers of grinding slab fragments and manos from the three areas present in the collection were found to vary somewhat from the figures reported by Wheat (1979:129-130). Furthermore, I assessed if particular grinding slab fragments likely derive from the same original, complete artifact and if so, those fragments were only counted once in my tally of the ground stone. The ground stone artifacts will be discussed in detail in the following chapter, but will be summarized here to convey the idea that ground stone artifacts are indeed common in the Jurgens collection. Fragments of four grinding slabs were found in Area 1, including one specimen that also had fragments in Area 2. Not counting these grinding slab fragments, three other grinding slabs were represented in Area 2 by fragments and also, three manos were present there. A grinding slab fragment was recovered from Area 3. Two grinding slabs and two manos were present in the Fill Area.

Two basic methods were employed to assess the number of occupations represented at the site. A method known as refitting has the potential to establish that separate trash disposal areas of the site were in use contemporaneously by demonstrating that numbers of artifacts that now occur in the separate areas were once part of the same tool or core through the process of physically conjoining broken tool fragments back together or by refitting flakes to one another or onto the core from which they derive. If no tool fragments conjoin between...
areas, or if no debitage from one area refits to that of another, then it is most likely that the
areas represent different occupations. The other method to be used to investigate the number
occupations represented at Jurgens was first developed by Larson (1990) and is known as
minimum analytical nodule analysis or MANA. Using this method, connections between
artifacts are made by identifying artifacts made of the same nodule or batch of tool stone that
possesses unique characteristics of color, texture, inclusions, etcetera. Relationships between
artifacts suggested through the use of this method of analysis are perhaps less secure that
those identified through refitting which actually establishes a physical connection between
broken fragments or flakes that came from the same parent object. However, the method has
the advantage of being able to establish relationships among a larger number of artifacts in an
assemblage than refitting studies and was found to be useful for understanding the spatial and
temporal relationship of activities performed at the Jurgens site.

Following an assessment of whether one or more occupations are indicated, the
analysis of the Jurgens assemblage turned toward testing the assertion that much or all of the
collection is associated with large-scale bison hunting by a multi-band aggregation, but in
order to do this, it was first advisable to determine if the collection came from the actual site
of the kill or an associated hunting camp. Most Paleoindian bison bonebeds were produced at
a temporary camp associated with a large kill (Bamforth 2011), but a small number are
located at or very near the actual site of the kill. An assemblage from a bonebed at or very
near the kill site should have points and perhaps other kinds of artifacts related to field
dressing and initial butchering, such as bifacial knives, resharpener flakes, and informal
retouched flake tools. In addition to these kinds of artifacts, a collection of artifacts from a
temporary hunting camp associated with a large kill may also have artifacts for processing
hides (such as end scrapers), as well as plentiful debitage from knapping blocky cores and
bifaces to gear up with the necessary number of bifacial and unifacial artifacts. The presence
of large numbers of end scrapers and a lot of debitage at the Jurgens site suggested that the
part of the assemblage related to the bonebed is essentially trash from a temporary camp, rather than cultural debris that was discarded at the kill site itself.

The interpretation that the site is not at the location where the actual bison kill took place is also supported by the kinds of bones that dominate the faunal assemblage. Based partly on historic documentation of Native American bison butchering practices, Wheat (1972:102) suggests that certain skeletal parts that contain relatively little meat, particularly the skulls and pelvises, were the kinds of bones that would most likely have been left at the actual kill site. Enthoarchaeological study of caribou bone assemblages from modern Inuit sites also supports the thinking that bones from the less meaty portions of the animal were more prone to being left at the kill site (Binford 1978a). Bonebeds that are located at the actual site of a Paleoindian large-scale bison kill as demonstrated by relatively high proportions of skulls and pelvises include the Olsen-Chubbuck and Casper sites (Frison 1974; Wheat 1972). The former bonebed is interpreted to have resulted from a bison herd having been stampeded into an arroyo and the later is suggested to represent a herd that was trapped and killed in a parabolic sand dune. Most bison bone at the Jurgens site occurred in Areas 1 and 3. In comparison to the minimum number of individual bison represented by the bones from Areas 1 (MNI = 31) and 3 (MNI = 35), these areas contained low numbers of skulls and pelvises (Wheat 1979:Figures 16, 30). This suggests that the bonebeds are not located at the location where the bison were actually killed.

The composition of the faunal assemblage from Jurgens does support an interpretation of the site as a hunting camp. The faunal collections from Areas 1 and 3 contain comparatively high numbers of most long bones from the forelimbs and hindlimbs, as well as large numbers of ribs (Wheat 1979:Figures 16, 30). This supports an interpretation of the Jurgens site as a camp associated with a large-scale kill. Limbs and portions of rib cages evidently were transported from the actual kill site to a camp at Jurgens where the carcass segments were further processed. Very possibly, this was accomplished with the aid of dogs.
pulling loads of meat on travois. The presence of relatively large numbers of most limb bones in the middens may be explained by stripping of meat from the bones and discarding them in the trash. The limb bones that are relatively uncommon are the femora and humeri. These upper limb bones may represent roasts consisting of the upper portions of hindquarters and forequarters that apparently were not consumed on-site. A detailed analysis of the faunal assemblage from the Jurgens site is beyond the scope of the project, but the above discussion does provide another line of evidence to support the conclusion that much of the cultural material at the site is essentially comprised of bones and artifacts from a large-scale bison hunt that were discarded at a temporary hunting camp, rather than at the location of the actual kill.

Assessing the alternative view of the Jurgens artifact assemblage as largely the result of occupation of a hunting camp by a multi-band group that had geared up for large-scale bison hunting basically proceeded by testing the validity of a series of expectations regarding what the artifact and tool stone composition of the assemblage should be if this interpretation is accurate. The assemblage should be composed of large amounts of tools used to kill and process meat and hides from a large number of bison. Much of the assemblage should be in the form of debitage demonstrating that raw material in unfinished form was present on-site and worked to produce a good number of tools. Debitage and unifacial artifacts retaining evidence of the kind of parent object from which they derive should demonstrate that both blocky cores and bifaces were flaked. Artifacts of distant tool stones should reflect the combined size of the participant group’s ranges within which they geared up with tool stone. Furthermore, the artifact composition of distant tool stones should be composed of roughly similar proportions of the kinds of tools needed for a large bison kill.

If the alternative view is viable, that portion of the assemblage comprised of tool stones from very distance sources will differ from the assemblage of distant tool stones in amount and perhaps in the proportions of artifact types present. Very distant tool stones will
comprise less of the assemblage than distant raw materials, since they were not procured by entire bands or members of participating bands intent on gearing up. Rather, artifacts of very distant stone may represent the participation of individual hunters or small groups of visiting hunters, as suggested by MacDonald (1998, 1999). Alternatively, smaller amounts of stone from very distant sources may result from raw materials coming into the tool kits of participant bands through exchange networks that served to move artifacts, particularly points, across long distances (Bamforth 2009b). In either case, the amount of stone from very distant sources relative to that from distant sources should be comparatively small.

Finally, the possibility that aggregation of bands at the Jurgens site is indicated by point styles that correlate with particular distant tool stone sources was explored. Wheat (1979) suggests that points from Jurgens demonstrate a high degree of resharpening. He maintains that Cody points from the site (which he refers to as Kersey points) were originally parallel flaked artifacts with straight basal edges. After breakage, fragments of suitable size were reworked into “secondary points” that have non-patterned flaking on the reworked part of the point. According to Wheat (1979:88), “[i]n making a new base from the broken piece, it was necessary to remove a considerable mass of material from the thick center portion of the blade, while the thinner edges required a minimum of reflaking. The result was that, in trying to achieve a thin basal edge, the knapper continued to remove flakes from the central mass after the basal corners were established. This very frequently resulted in a concave, base, in contrast to the original square base form.” To support his way of thinking, photographs of both faces of each point are provided in the site report (Wheat 1979:Figures 35-40). On one of the faces illustrated, Wheat indicates which flake scars he believes to be original and which are from reworking the point. Having examined these points, I believe that in many cases, the suggested reworking of the points is not definite, particularly on those points that Wheat indicates were refurbished by flaking a new basal portion onto a midsection or tip. On the above-cited figures, Wheat also provides a cut-out image of the profile of
many of the points as seen from a lateral perspective in order to illustrate that the suspected reworked portions of the points truncate the point in a manner that might occur if a point fragment that ended with a break facet had been retouched. Upon examining these points, I found the cut-out images sometimes exaggerate the amount of truncation present or even go so far as to suggest that truncation is present when it is not. Certainly, some of the points and artifacts that Wheat terms “stemmed knives” definitely appear to have been reworked to provide the artifact with a new tip (e.g. Wheat 1979:Figures 39 a, 41 a). My intent in disagreeing with Wheat on the extent to which points were reworked is not to provide a more accurate assessment of the degree of reworking. Rather, I am merely suggesting that the attributes that Wheat believed to be a result of reworking may actually be alternative ways of making Cody points that could reflect regional stylistic differences. Specifically, some points have a parallel flaking pattern and some have non-patterned flaking only, which to me appears to be original flaking. Also, some points that do not appear to have definite indications of having been reworked have a straight basal edge while others have a slightly concave edge.

A final point of disagreement concerning the classification of projectile points must be mentioned. The artifact classification used by Wheat (1979:84-85) includes a “stemmed knife” type. Most specimens in this category are square-based bifaces that are very similar in outline to the points in the collection, but are wider. Stem widths range from about 2.5 to 3.0 cm (Wheat 1979:Figure 41, Table 23). For this and other reasons, Wheat believes the artifacts functioned as knives, rather than projectile points. I retained the stemmed knife type during artifact analysis, but upon further thought, I believe that the evidence supporting their classification as knives is weak and that they are best considered to have functioned as projectile points. Consequently, the 16 artifacts I classified as stemmed knives are included along with the artifacts classed as projectile points in the analyses to follow.
While examining the collection, I developed the impression that points made of the main tool stones from the South Platte drainage (WRGG, Flat Top chalcedony, and Dawson petrified wood) tend to have a different flaking pattern, basal edge shape, and cross section than points made of the main tool stone source from the North Platte drainage (Hartville Uplift chert). In short, points made from materials from the South Platte drainage seemed to more often have non-patterned flaking, a slightly concave basal edge, and a lenticular cross section. Points made from the chert obtained in the North Platte drainage appeared to primarily exhibit parallel flaking, have a diamond-shaped cross section, and have a straight basal edge. As discussed in the previous chapter on theory, a situation that could result in minor morphological differences between points of a single type that are made of tool stones from widely separated sources is the former existence of regional points styles or idiosyncratic variation in the work of skilled flintknappers from different bands. To test the value of the attributes for identifying regional or idiosyncratic differences in Cody points from Jurgens, each point made of the above raw materials was classified according to type of flaking pattern, basal edge, and cross section and the strength of association between tool stones of the two river drainages and point attributes believed to be predominant in each drainage was tested with appropriate statistical tests. Figure 9-1 illustrates the differing qualities of flaking pattern, basal edge, and cross section seen in the points from Jurgens.

Though much of the assemblage is related to large-scale bison hunting, it is reasonable to suppose that some portion of the collection is not and therefore developing expectations about the kinds of artifacts that would have been deposited in the archaeological record during occupations of this kind was necessary. I earlier theorized that Plains Paleoindians not engaged in large-scale bison hunting would have had a more broad-based subsistence economy. Ground stone artifacts in the Jurgens collection suggest that processing of plant food resources occurred on-site and this is in conformance with a more mixed subsistence economy. If subsistence was not focused on large-scale bison hunting, the tool
Figure 9-1. Projectile points from the Jurgens site illustrating the hypothetical stylistic attributes to be analyzed. Specimen a [no catalog #, designated “Test C-2” in Wheat 1979:Table 21)] displays parallel flaking, a diamond-shaped cross section, and a straight basal edge. Specimen b (catalog # 19570) exhibits non-patterned flaking, a lenticular cross section, and a slightly concave basal edge.
kit would contain less bifacial artifacts, such as the quantities of points and knives needed for killing and butchering a herd of bison. Small-scale hunting would still have occurred and point bases that would be principally of local stone would have been deposited at the site. When making a living by means of a more mixed subsistence economy, Paleoindians and other foragers may have satisfied the need for tools suitable for cutting and scraping tasks related to food resource processing and activities involving the manufacture and maintenance of material culture by relying less on the manufacture and use of formal tools and more on the production and use of informal retouched flake tools struck from blocky cores. For ease of discussion, this later kind of lithic technology is here referred to as simply “core-and-flake technology” to distinguish it from tool production intended to produce formal bifacial tools. If the Jurgens site was in part the result of one or more occupations by the local band or subunits thereof, then much of the assemblage that was made from the local White River Group gravels should reflect use of this raw material in a core-and-flake technology intended to produce expedient flake tools. The part of the assemblage produced by local people making tools with a core-and-flake technology will not necessarily have a lot of cores of the local stone. The work of Bamforth and Becker (2000) suggests that blocky cores may have comprised a highly curated class of artifacts that was transported from site to site and used to produce flakes for informal retouched flake tools as needed. If so, then assemblages resulting from one or more occupations by members of a local band would be expected to be comprised of substantial amounts of informal retouched flake tools, but relatively few, if any, blocky cores.

**Statistical Techniques for Analyzing the Jurgens Assemblage**

Having developed theoretical expectations regarding the Jurgens assemblage from the perspective of both views, I will now summarize the basic manner in which the expectations will be evaluated through analysis of data collected from the artifact assemblage.
Assessment of the traditional concept of fugal technology will be accomplished by simply considering data from the assemblage presented in the form of tables and graphs. To evaluate the alternative school of thought, potential causal relationships apparent in the data will be investigated with the use of contingency tables, standardized residuals, and statistical tests designed for categorical data.

Contingency tables array categories of a hypothetical independent variable with categories of a dependent variable so that possible trends in the data may be examined. In the tables to follow, hypothetical independent variables are expressed by data organized into columns representing the categories that together comprise the variable. The independent variable may be thought of as consisting of categories of behavior that hypothetically varied between categories of tool stone. For example, under the alternative view, the behavior of gearing up for large-scale bison hunting with local tool stone should have focused on the selective use of the rough-textured orthoquartzite variety of WRGG, if indeed this common tool stone in the assemblage was suitable for use in gearing up as has been hypothesized. On the other hand, the behavior of producing flakes from a blocky core to make informal retouched flake tools as part of a core-and-flake technology should be reflected not only in the artifacts of rough-textured orthoquartzite, but should be disproportionately represented in the other varieties of WRGG if indeed these stones were not suitable for gearing up. In this example, and in most of the contingency tables to follow, categories of behavior thought to be associated with different categories of tool stone should have produced differing proportions of the kinds of artifacts that comprise the tool stone categories. Therefore, in most of the tables to follow, dependent variables are comprised of various categories of artifacts that are listed in table rows. If the independent variable of behavior varied according to tool stone category in the manner hypothesized, then the dependent variable of the relative frequencies of artifacts that fall into various artifact categories should vary in some predictable way. For example, if use of stream cobbles of the local WRGG varieties, exclusive of the very rough-
textured orthoquartzite, were primarily knapped to make informal retouched flake tools, then
this should have caused a significantly higher proportion of flake tools of these tool stones to
retain areas of stream-rounded cortex in comparison to artifacts of the very rough-textured
orthoquartzite which was in large part used to make bifacial artifacts of the kind needed to
gear up for bison hunting (i.e. points and knives). Use of generally larger clasts of the very
rough-textured orthoquartzite variety (which may have range up to boulder-sized pieces) for
gearing up would also have contributed to a greater proportion of decortication flakes among
the other varieties of WRGG simply because bigger pieces of raw material will produce
fewer decortication flakes relative to interior flakes. The above example serves to illustrate
the basic way that contingency tables were used to explore the data for relationships between
variables in an effort to assess the explanatory value of the alternative view.

A standardized residual is a statistic that can assist in evaluating possible
relationships apparent in contingency tables. If there is no relationship between a
hypothetical independent variable and a dependent one, data in a particular cell of a
contingency table should largely be the product of the number of artifacts of the particular
tool stone grouped in the cell’s column and the number of artifacts of the particular artifact
class or classes in the cell’s row. For each cell in a contingency table of categorical data, a
standardized residual may be calculated that measures the degree to which the observed
number of artifacts in the cell deviates from the expected number under a null hypothesis of
no relationship between the variables. The statistic is standardized in the sense that the
obtained figure is scaled in the same way that z-scores are distributed about the mean in a
normal distribution. (A z-score of 1.0 is one standard deviation above the mean, a z-score of
-2.0 is two standard deviations below the mean, etcetera). Therefore, a z-score table can be
used to determine the probability that particular standardized residuals could have occurred
by chance alone in order to assess the degree to which data in the cells deviate from what
would be predicted under the null hypothesis. Standardized residuals with a low associated
probability might reflect a causal relationship between independent and dependent variables. For a situation where a hypothetical causal relationship predicts that the number of cases in a cell should be higher than expected under the null hypothesis, standardized residuals of 1.64 or higher have less than a five percent probability of occurring by chance alone. In the behavioral sciences, a statistic with an associated probability of less than five percent (.05) is considered to be a significant result that denotes a situation where a causal relationship between variables may be indicated. Similarly, in a situation where a hypothetical causal relationship predicts that the number of cases in a cell should be lower than expected under the null hypothesis, standardized residuals of less than -1.64 have associated probabilities of less than five percent and indicate situations that might denote a causal relationship. A series of contingency tables were made in order to draw out the hypothetical relationships between variables that are logical implications of the theoretical understanding that the Jurgens assemblage is the product of gearing up for large-scale hunting as well as possibly the result of a core-and-flake technology employed in a more mixed subsistence economy. The PASW program calculates standard residuals in contingency tables to one decimal place. Cells with standardized residuals $\geq 1.7$ (probability = .0446) or $\leq -1.7$ were taken to indicate possible causal relationships between variables.

When possible causal relationships were identified in the contingency tables, appropriate statistical tests were performed to determine if the strength of the relationship is significant at the .05 significance level. In other words, statistical tests were run to determine if the probability of the observed relationship occurring by chance alone is equal to or less than five percent. Because the data occurred in categories, the chi-square test and the Fisher exact probability test were used to gage the strength of possible causal relationships suggested by standardized residuals.

The PASW program allowed for easy manipulation of data in two important ways. First, the original artifacts categories and tool stone types could be combined or separated to
meet the requirements of particular analyses. For example, original artifact categories of blocky cores, tested cobbles or pebbles, pieces of shatter, primary flakes, and secondary flakes could be combined into a category intended to include all artifacts characteristic of the early stages of flintknapping to examine if this category of artifact tends to be more prevalent among varieties of WRGG thought to have been selected as raw material for a core-and-flake technology. Secondly, the PASW program allowed ideas about the nature of the assemblage to be tested with multiple lines of evidence through examination of different attributes of the artifacts. For example, the hypothesis that local cobbles of certain varieties of WRGG were used in a core-and-flake technology could be evaluated by testing the expectation that this category of tool stone should include not only a comparatively large amount of artifacts with remaining cortex, but also should have a relatively high proportion of flakes and flake tools that demonstrate evidence of having been struck from a blocky core as opposed to having been detached from a biface.

EVALUATING TRADITIONAL AND ALTERNATIVE VIEWS USING EXISTING LITERATURE

Data derived from existing site reports was used to judge the relative validity of the competing views on the geographic extent of land use in a less rigorous manner than analyses of the Jurgens collection. For each site, the tool stone types present in the assemblage were classified into local or nonlocal (distant and very distant) categories. The local to nonlocal composition of an assemblage was then compared to the expected amounts under both views, given the kind of site from which the assemblage was collected and the availability of tool stone in the local environment. As seen in the tables presented in Chapter 8, the expected tool stone composition of assemblages under each view is expressed only in relative terms, such as is seen in expressions like “local stone will dominate in the assemblage,” or “will
occur in substantial amounts” or “appreciable amounts.” Therefore, assessing the two views using existing literature was not as rigorous and did not always allow one view to be readily favored over the other in a definitive way. In other cases, expectations for the tool stone composition of assemblages from certain kinds of sites in particular circumstances of local tool stone availability differ greatly between the two views and so making a definitive statement as to which view better accommodates the data was easier in these cases.

Data from existing literature on the tool stone composition of assemblages from clustered sites was used to assess the relative validity of the contrasting views on the degree of regularity inherent in Paleoindian land use. If bands moved about the landscape in an irregular fashion within huge ranges of the size envisioned by traditional minded archaeologists, then the tool stones present in assemblages from clustered sites could very greatly. For example, in the case where a high-quality source of tool stone is not available locally, bands coming into a specific area from different directions and making large-scale bison kills in that location could very well bring different sets of tool stones from distant and very distant sources to the sites they produce. According to the alternative view, if bands operated within ranges comparable in size to ethnographic people and maintained some form of interaction with neighboring bands that occurred at sufficiently frequent intervals and resulted in transfer of tool stone or artifacts, then the same set of tool stones could be present in assemblages from clustered sites. In the case where communal hunts are planned in an area lacking a high-quality source of tool stone, the proportional representation of various kinds of raw materials from low-quality local sources and high-quality distant sources may vary greatly depending on the particular circumstances of the communal hunt. A local band might have geared up by sending a task group to go and get stone from a particular high-quality distant source to augment the supply of local stone. On another occasion, multiple visiting bands could have geared up with stone in their home ranges and brought tool stones from distant sources with them to a rendezvous with the local band. The proportional
representation of stone from local and distant sources in the assemblage produced in the two above situations would be expected to vary greatly. Nevertheless, the same set of local and distant tool stones should be present in both collections, if indeed Paleoindian bands operated in ranges comparable in size to ethnographic foragers and maintained on-going interactions with neighboring bands. Data on the tool stone composition of assemblages from clustered sites will therefore be considered along with other evidence to evaluate the competing views on the regularity of land use practices.

CHAPTER SUMMARY AND CONCLUDING REMARKS

Traditional and alternative views on Paleoindian land use were assessed with data from the Jurgens site. Tables and graphs were constructed to simply present data relevant to judging the traditional view’s concept of a frugal lithic technology. Specifically, the data will be used to address the thinking that Paleoindian lithic technology focused on selective use of microcrystalline tool stones, emphasized use of bifacial cores, and included tools that were continuously resharpened. To test expectations for the assemblage developed under the alternative perspective, data from the Jurgens collection was analyzed by means of contingency tables, standardized residuals, and statistical tests of association for categorical data. If the alternative view is valid, the assemblage may provide evidence in support of the assertion that distant tool stones were brought to the site in quantity to gear up for large-scale bison hunting. Local stone will also have been used for this purpose, but could also have been put to use during one or more separate episodes of site occupation when Paleoindians subsisted on a more mixed subsistence economy and made more use of a core-and-flake technology to meet tool needs. Finally, evidence should exist to support the idea that artifacts of very distant tool stone came to the assemblage through long-distance exchange or movement of individuals or small groups from very distant bands.
Both traditional and alternative views on land use will be evaluated in a less rigorous way using data from existing site reports. Data on the amounts of local and nonlocal tool stones in the assemblages will be compared to expectations developed under the opposing views to determine which theoretical perspective offers a more empirically supportable model of the geographic extent of land use. The degree to which assemblages from clustered sites contain the similar sets of tool stone will be considered along with other evidence to assess the relative validity of the differing views on the amount of regularity inherent in land use practices.

The following three chapters will present the results of the above-described analyses. Data from existing literature is discussed in Chapter 12. An evaluation of the traditional view using data from the Jurgens site is the topic of Chapter 11. The following chapter analyzes data from Jurgens to develop the alternative view of land use.
CHAPTER 10

SOCIAL AGGREGATION AND LAND USE AS SEEN FROM THE JURGENS SITE

The purpose of this chapter is to develop an interpretation of the Jurgens assemblage from the alternative view and evaluate how well data and other evidence from the site supports the theoretical perspective. Specifically, the analysis to follow will evaluate the supposition that the site was formed through occupation by an aggregation of multiple bands involved in large-scale bison hunting. Support for the above interpretation will come primarily from a thorough analysis of the artifact assemblage and its tool stone composition, but some support will be garnered through a more general consideration of the faunal assemblage and other sources of evidence.

Results will be presented in six sections. The first section will present data on the basic characteristics of the flaked stone artifact assemblage. This will include a discussion of the types of artifacts in the assemblage and their relative frequencies, as well as an assessment of the amounts of various tool stone types in the collection and the distances to their sources. The first section will also review possible evidence for the site being the product of multiple occupations and a case will be made that the cultural material in all three areas was deposited during a single occupation related to large-scale bison hunting. This contention will be affirmed in the second section which will present the results of a refitting study and minimum analytical nodule analysis to demonstrate that the areas were used contemporaneously. The third section analyzes the main tool stones in the assemblage, which include varieties of orthoquartzite and microcrystalline stone from locally available White River Group gravel, as well as stone from high-quality distant sources on the Plains to the
north, east, and south. The section will develop the argument that the assemblage was largely produced by bands native to local and distant areas gearing up for a communal hunt by using stone accessible to them in order to make needed points, end scrapers, etcetera. Certain varieties of local stone were used for other purposes. A fourth section further analyzes the main tool stones of the assemblage by considering the nature of the parent object of end scrapers, other flake-based tools, and waste flakes. This analysis explores how tool stones exploited to gear up for bison hunting were differentially used to produce both bifacial and unifacial tools needed to kill and process a large group of bison. The fifth section examines the artifacts of very distant tool stones in relation to artifacts of distant tool stone to investigate hypothetical cultural processes thought to be responsible for moving comparatively small amounts of tool stone great distances. The final section explores possible stylistic attributes observable on points of local and distant tool stone in order to assess the utility of using point style analysis as a means of further substantiating band aggregation.

GENERAL REVIEW OF ASSEMBLAGE AND PRELIMINARY ASSESSMENT OF THE NUMBER OF OCCUPATIONS REPRESENTED AND THE IDEA OF SOCIAL AGGREGATION

The purpose of this section is threefold. First, the general nature of the assemblage as a whole will be examined to gain some understanding of the types and relative frequencies of artifacts comprising the assemblage. Also, the types, amounts, and sources of tool stones present in the assemblage will be presented. Secondly, information will be presented to provide initial support for the idea that the assemblage relates to bison hunting by a large group of people that possibly was formed through aggregation of multiple bands. Finally, a preliminary assessment of the number of occupations represented at the Jurgens site will be developed.
The discussion will begin by reviewing the basic layout of the site. This topic was discussed in the previous chapter on the research design to justify directing initial research to the goal of determining just how many occupations are indicated by the three widely separated areas of the site. The essential points to recall are that the three areas defined by Wheat as Areas 1, 2, and 3 were present in a swale situated back from the edge of the river terrace on which the undisturbed site was located and that the areas are here interpreted as middens where bone and artifacts were discarded. It was suggested that a camping area was situated somewhere in the vicinity of the middens. Modern-day land leveling designed to create an agricultural field uncovered the middens and decapitated a ridge along the edge of the river terrace, leaving a strip of gravel where the ridge once stood. The land leveling operation also pushed disturbed earth containing gravel, soil, artifacts, and bones over the edge of the terrace to a low lying area northeast of the former ridge. This portion of the site is referred to as the Fill Area. The spatial relationships between the four areas of the site and the distances between them are shown in Figure 10-1.

Given the information available to him, Wheat (1978, 1979) interpreted the three areas as separate kinds of occupation that took place during the Cody period. Area 1, with its remains of 31 bison and assorted non-bison bones, was reasoned to have functioned as a long-term camp. Area 2 contained the remains of two bison as well as bones from assorted other species and was classified as a short-term camp. Finally, Area 3 produced bones of 35 bison and assorted non-bison faunal remains. The bison remains included partial skeletons. Area 3 was interpreted as a bison processing site. Concentrations of debitage in Areas 1 and 2 were seen as chipping stations which was a view congruent with the interpretation of these areas as campsites.

Information from more recent studies supports the thinking that cultural material in the three areas is at least partially, if not wholly contemporaneous. This possibility was supported through study of both the faunal and artifacts assemblages.
Figure 10-1. Map of Jurgens site showing position of Areas 1, 2, and 3, along with the Fill Area. Redrawn from Wheat (1979:Figure 4a).
Study of specimens of bison dentition from Areas 1 and 3 by Hill and Hill (2002) assigned teeth in both areas to the same dental age range of $N + .4$ yr to $N + .6$ yr. As elaborated previously, this strongly suggests the bison represented in both areas were killed at the same time of year (around October), which in turn implies that bison remains in both areas were deposited during the same occupation.

The assorted non-bison faunal remains in the three areas might still be the result of food remains discarded in the middens during occupations of the site by small groups of people subsisting by means of more generalized hunting and gathering. However, this interpretation would seem to require that small groups of people would have camped out along the river terrace edge on at least three occasions during which time food remains were discarded in the middens that also happen to contain bison bones from a single large-scale kill and are spread over a distance totaling 227 meters. This possibility seems less likely than an alternative explanation maintaining that a variety of non-bison animals were taken during occupation of the site by a large group of people that was amassed at the site primarily to engage in communal bison hunting. Future analysis of the non-bison faunal remains is needed to determine if the animals taken were also killed around October. Study of the cementum growth rings of the teeth of several species of ungulate present (including moose, elk, and antelope) may someday prove to be a way of determining if the non-bison faunal remains were deposited contemporaneously with the bison bones.

Recent study of the Jurgens artifact assemblage also produced evidence suggesting that some or all of the cultural material in the three areas may be contemporaneous. As explained further below, artifacts found in separate areas of a site may be shown to have been deposited during the same occupation of the site if they are made from a nodule or batch of tool stone with unique, recognizable characteristics (referred to as a minimum analytical nodule).
Muniz (2005) examined the Jurgens collection primarily to conduct an in-depth use wear analysis, but also completed a preliminary examination of the assemblage to ascertain if artifacts belonging to the same minimum analytical nodule were present in the separate areas. A total of six analytical nodules were identified, which together suggest that at least some, and perhaps all, of the cultural material in the three areas was deposited during one occupation of the site (Muniz 2005:203-206).

Muniz’s identification of several minimum analytical nodules in the Jurgens assemblage had important implications for how the site could be interpreted in this study. As elaborated below, stone from high-quality distant sources and a kind of orthoquartzite from a possibly local source of White River Group gravel was arguably exploited to gear up with points, scrapers, etc. for a communal hunt by a large group of people. Other varieties of WRGG less suited for gearing up tended to have been used to produce informal tools using a core-and-flake technology. These artifacts might have been deposited by small groups during occupations of the site that were unrelated to communal hunting. Alternatively, the artifacts made of lower quality local stone using a core-and-flake technology may have been used during a single occupation of the site by a large group involved in communal hunting. Daily camp activities and certain gearing up activities not requiring the use of stone from high-quality sources may have been accomplished using informal tools of lower quality local stone. To give but one example, an instance of gearing up may entail manufacturing spears and drying racks from wood, which could be accomplished with informal tools of lower quality stone in order that pieces of high-quality stone could be used for production of points and tools related to bison processing.

The presence of lots of grinding slab fragments and manos in the Jurgens assemblage was initially seen as not in conformity with the possibility that cultural material in all three areas could have been deposited during a single occupation related to communal bison hunting. Grinding slabs and manos are not typically found at sites related to large-scale bison
hunting. These are multipurpose tools, but were commonly used to process plant foods, a function that would not be in keeping with the idea that all cultural material at the Jurgens site was deposited during an occupation related to communal bison hunting. A use wear study of ground stone artifacts from Walpi pueblo by Adams (1988) demonstrated that a number of the handstones originally thought to have functioned as manos to grind corn were actually used as hide-processing stones. Similar use wear analysis of the ground stone artifacts from the Jurgens site is recommended to address the question of the kind of occupation represented, but was not performed as part of this project.

However, an in-depth examination of the ground stone artifacts for evidence of use in production of powdered ochre does provide an explanation for the grinding slab fragments and manos that conforms to the view that the site was produced during an occupation associated with communal hunting. Many grinding slabs and manos were used to process hematite and limonite into powdered red and yellow ochre, respectively. Five manos are present in the collection and four have traces of ochre adhering. A total of 17 grinding slab fragments are in the assemblage. Similarities in the thickness and raw material of some of the fragments suggest that they represent a total of 10 grinding slabs. Of these 10 tools, two display evidence of having been used to produce powdered ochre. As discussed in Chapter 8, pulverized ochre may have been used as a hide preservative and if so, evidence that grinding tools at the Jurgens site were used to pulverize hematite and limonite into a powder would constitute strong evidence in support of the interpretation of the site as a camp associated with a communal bison kill. If indeed powdered ochre acts as an antibacterial that serves to preserve hides, it would have been used on fresh hides that had to be set aside so that they could be tanned at a later time. Fresh hides are still moist and are subject to attack by bacteria, but completely dried rawhide is relatively impervious to bacteria. With this in mind, it is relevant to note that a thorough examination of use wear on end scrapers from the
Jurgens site determined that a large majority was used on hide that was fresh, rather than dry (Muniz 2005:359-380).

Of the four manos with adhering ochre, evidence exists to suggest that they were used to break up pieces of hematite. Red ochre is present in pock marks on the edge of two of the manos, suggesting that they may have been used to reduce hematite into smaller pieces (Table 10-1, Manos 1 and 2). Three of the manos display evidence, such as battered edges, indicative of having been used as a hammerstone. It is uncertain if the battered edges resulted from use of the manos as hammerstones along with the anvil stones in the collection to break up bison bones in order to extract marrow, or to reduce pieces of hematite, but red ochre is no longer adhering to the manos. Two of the manos are fragments of granite river cobbles, which presumably would have to of been used with considerable force in order to break. Of these, one has red staining which may have been produced by ochre.

Evidence that the ground stone artifacts were used to grind the smaller fragments of hematite into powdered ochre also is present. Of the four manos with evidence of having been used to process ochre, two have red staining on their grinding surfaces, presumably as a result of having been used to pulverize hematite (Table 10-1, Manos 2 and 3). Of the two grinding slabs that evidently were used to process ochre, one is represented by a fragment composed of an orangish tabular piece of Lyons sandstone with grinding surfaces on both faces (Table 10-1, Grinding Slab 8). Orange is not a normal, natural color of this sandstone and the fact that both grinding surfaces on the fragment have a more intense orangish tint than the broken surfaces of the sides suggests that the original, complete artifact was used to pulverize hematite into powdered ochre. A second grinding slab that evidently was used to produce ochre powder is represented by four fragments, one of which appears to have microscopic pieces of red ochre on one face. Another fragment has possible microscopic pieces of red and yellow ochre on one face (Table 10-1, Grinding Slab 5).
Table 10-1. Grinding Slab Fragments and Manos from the Jurgens Site (Page 1 of 2).

<table>
<thead>
<tr>
<th>Designation of Artifact in this Document</th>
<th>Tool Stone Description</th>
<th>Catalog Number</th>
<th>Provenience</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grinding Slab 1</td>
<td>Lyons Sandstone. light brown.</td>
<td>30201i</td>
<td>Area 1, ground surface</td>
<td>These four fragments are thought to derive from the same grinding slab of Lyons Sandstone that originally was light brown with sparse, rust-colored or medium brown circular spots (iron concretions?). Fragments 30201i and 30201g are conjoining fragments from Area 1. A large scratch runs across one of the faces of both fragments, suggesting recent breakage by farm equipment. Fragment 30201e was found in Area 2, but is believed to be from the same grinding slab. The fragment has the same unusual spots as the conjoining fragments, but the spots are maroon because it has been oxidized from exposure to fire. The fragment had been used on both faces. Another fragment from Area 2 is assigned to the same grinding slab fragment as the others, but this determination is tentative because the fragment has been darkened to a medium gray by exposure to fire and so lacks the distinctive spots. This fragment, like the other one from Area 2, had been used on both sides and was exposed to fire. The possibility that all fragments are from the same grinding slab is bolstered by similar thicknesses. The fragments from Area 2 are 2.0 and 2.6 cm thick and the thickness of the conjoining fragments from Area 1 is 2.8 cm.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30201g</td>
<td>Area 1, ground surface</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>30201e</td>
<td>Area 2, ground surface</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>30201n</td>
<td>Area 2, ground surface</td>
<td></td>
</tr>
<tr>
<td>Grinding Slab 2</td>
<td>Lyons Sandstone. discolored by fire</td>
<td>30201f</td>
<td>Area 1, ground surface</td>
<td>The artifact has been exposed to fire. Part of the outer surface has reddened from oxidation. A fresh break facet reveals a darkened interior.</td>
</tr>
<tr>
<td>Grinding Slab 3</td>
<td>limey sandstone</td>
<td>30201b</td>
<td>Area 1, ground surface</td>
<td></td>
</tr>
<tr>
<td>Grinding Slab 4</td>
<td>arkosic sandstone. light brown.</td>
<td>30201j</td>
<td>Area 1, ground surface</td>
<td></td>
</tr>
<tr>
<td>Grinding Slab 5</td>
<td>Lyons Sandstone. light reddish brown.</td>
<td>23130</td>
<td>Area 2, Excavation Unit 11F53</td>
<td>All four fragments are thought to derive from the same grinding slab. Mineral composition, size grain, and angularity of the sand grains is identical in all fragments. Thicknesses of the fragments are similar, ranging from 1.1 to 1.7 cm. Fragment 30201m possibly has microscopic pieces of red and yellow ochre on one face. Fragment 30205b possibly has microscopic pieces of red ochre on one face.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>23139 (one of two items with same catalog #)</td>
<td>Area 2, Excavation Unit 11F53</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>30201m</td>
<td>Area 2, ground surface</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>30205b</td>
<td>Area 2, ground surface</td>
<td></td>
</tr>
</tbody>
</table>
Table 10-1. Grinding Slab Fragments and Manos from the Jurgens Site (Page 2 of 2).

<table>
<thead>
<tr>
<th>Designation of Artifact in this Document</th>
<th>Tool Stone Description</th>
<th>Catalog Number</th>
<th>Provenience</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grinding Slab 6</td>
<td>Lyons Sandstone. light brown.</td>
<td>30201h Area 2, ground surface</td>
<td>Based on similarities in sandstone color and on the fact that the sandstone of both fragments is prone to break along bedding planes, these two fragments are thought to belong to the same grinding slab. The fragments are also similar in thickness, with one measuring 1.9 cm and the other being 2.3 cm.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>30201L Area 2, ground surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grinding Slab 7</td>
<td>arkosic sandstone. light brown and rust.</td>
<td>30201k Area 2, ground surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mano 1</td>
<td>granite. medium gray, probably from South Platte River gravels.</td>
<td>30202b Area 2, ground surface</td>
<td>The mano was also used as a hammerstone. Red ochre is present in pock marks in one portion of the edge of the stream cobble that was used as a mano, suggesting that the artifact was used to break up pieces of hematite.</td>
<td></td>
</tr>
<tr>
<td>Mano 2</td>
<td>granite. light brown, probably from South Platte River gravels.</td>
<td>30202d Area 2, ground surface</td>
<td>The mano was also used as a hammerstone. Red ochre has stained both grinding surfaces and is present in pock marks on the battered cobble edge. The mano evidently was used to break up hematite and grind it into a powder.</td>
<td></td>
</tr>
<tr>
<td>Mano 3</td>
<td>granite. medium gray, probably from South Platte River gravels.</td>
<td>30202e Area 2, ground surface</td>
<td>The artifact is a mano fragment. There is red staining on the artifact that may be from grinding ochre.</td>
<td></td>
</tr>
<tr>
<td>Grinding Slab 8</td>
<td>Lyons Sandstone. The orangish color of this fragment may be the result of staining by red ochre.</td>
<td>30201d Area 3, ground surface</td>
<td>Both faces of this grinding slab fragment have a more noticeable orangish tint than the sides, suggesting that the artifact may have been used to grind red ochre.</td>
<td></td>
</tr>
<tr>
<td>Grinding Slab 9</td>
<td>Lyons Sandstone. pink.</td>
<td>30201c Fill Area, ground surface</td>
<td>A fresh break on the artifact reveals that part of the artifact has been darkened to medium gray from exposure to fire.</td>
<td></td>
</tr>
<tr>
<td>Grinding Slab 10</td>
<td>sandstone. grayish white.</td>
<td>30201a Fill Area, ground surface</td>
<td>The outer surface of the artifact was oxidized to a reddish color from contact with fire.</td>
<td></td>
</tr>
<tr>
<td>Mano 4</td>
<td>sandstone. light brown.</td>
<td>30202a Fill Area, ground surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mano 5</td>
<td>granite. light brown, probably from South Platte River gravels.</td>
<td>30202c Fill Area, ground surface</td>
<td>The artifact is a mano that was broken and appears to have been secondarily used as a hammerstone and an abrading stone. Both grinding surfaces are reddened from having been used to grind ochre.</td>
<td></td>
</tr>
</tbody>
</table>
The above consideration of evidence related to the number of occupations represented at the Jurgens site supports a preliminary assessment of the site as the product of a single occupation by a large group of people involved in large-scale bison hunting. An artifact refitting study and a thorough minimum analytical nodule analysis were carried out and found to bolster this conclusion, as is discussed in the following section.

A preliminary consideration of the types of flaked stone artifacts in the Jurgens assemblage and their relative frequency in the collection gives further support to the interpretation of the site as primarily the product of large-scale bison hunting. The numbers of specimens of each of the types of artifacts comprising the assemblage are presented in Table 10-2, along with the relative frequency of each type as expressed as a percentage of the entire collection. Examination of the table reveals that many projectile points or preforms and a lot of end scrapers are present. Projectile points total 76 specimens when the 16 stemmed knives are included. Points therefore total 2.7 percent of the collection. Another 16 artifacts were classified as projectile point preforms and comprise .6 percent of the assemblage. Projectile points and relative artifacts thus total 3.3 percent of the assemblage. A total of 92 end scrapers are in the assemblage, which also accounts for 3.3 percent of the collection. The large numbers of points or preforms and end scrapers conforms to the supposition that the site served as a hunting camp associated with large-scale bison hunting where hides were processed. Although the formal tools are dominated by points and end scrapers, an appreciable amount of the assemblage is comprised of simple tools resulting from using an interior flake of appropriate size (utilized flakes = 13 percent) or retouching a flake prior to use (informal retouched flake tools = three percent).

Most of the assemblage is composed of debris from artifact manufacture. Interior waste flakes comprise a large majority of the assemblage (70 percent). An appreciable amount of the collection is comprised of artifacts with some remaining cortex. Tested cobbles or pebbles, primary flakes (defined as having cortex over 80 percent of their dorsal...
Table 10-2. Artifact Type Composition of the Jurgens Assemblage (Page 1 of 2).

<table>
<thead>
<tr>
<th>Artifact Type</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tested Cobble or Pebble</td>
<td>5</td>
<td>.2</td>
</tr>
<tr>
<td>Blocky Core</td>
<td>12</td>
<td>.4</td>
</tr>
<tr>
<td>Bifacial Core</td>
<td>2</td>
<td>.1</td>
</tr>
<tr>
<td>Piece of Shatter</td>
<td>8</td>
<td>.3</td>
</tr>
<tr>
<td>Primary Flake</td>
<td>4</td>
<td>.1</td>
</tr>
<tr>
<td>Secondary Flake</td>
<td>28</td>
<td>1.0</td>
</tr>
<tr>
<td>Decortication Flake</td>
<td>1</td>
<td>.0</td>
</tr>
<tr>
<td>Interior Flake</td>
<td>1,962</td>
<td>69.7</td>
</tr>
<tr>
<td>Pot Lid</td>
<td>9</td>
<td>.3</td>
</tr>
<tr>
<td>Unfinished (Stage 2) Biface</td>
<td>4</td>
<td>.1</td>
</tr>
<tr>
<td>Unfinished (Stage 3) Biface</td>
<td>2</td>
<td>.1</td>
</tr>
<tr>
<td>Unfinished Biface (Unknown Stage)</td>
<td>1</td>
<td>.0</td>
</tr>
<tr>
<td>Projectile Point Preform</td>
<td>16</td>
<td>.6</td>
</tr>
<tr>
<td>Tool Flaked from Naturally Shaped Tool Stone</td>
<td>2</td>
<td>.1</td>
</tr>
<tr>
<td>Utilized Piece of Shatter</td>
<td>3</td>
<td>.1</td>
</tr>
<tr>
<td>Utilized Primary Flake</td>
<td>8</td>
<td>.3</td>
</tr>
<tr>
<td>Utilized Secondary Flake</td>
<td>52</td>
<td>1.8</td>
</tr>
<tr>
<td>Utilized Interior Flake</td>
<td>305</td>
<td>10.8</td>
</tr>
<tr>
<td>Utilized Pot Lid</td>
<td>4</td>
<td>.1</td>
</tr>
<tr>
<td>Retouched Pot Lid</td>
<td>1</td>
<td>.0</td>
</tr>
<tr>
<td>Informal Retouched Flake Tool</td>
<td>81</td>
<td>2.9</td>
</tr>
<tr>
<td>Informal Retouched Core Tool</td>
<td>1</td>
<td>.0</td>
</tr>
<tr>
<td>End Scraper</td>
<td>92</td>
<td>3.3</td>
</tr>
</tbody>
</table>
Table 10-2. Artifact Type Composition of the Jurgens Assemblage (Page 2 of 2).

<table>
<thead>
<tr>
<th>Artifact Type</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beveled Tool</td>
<td>1</td>
<td>.0</td>
</tr>
<tr>
<td>Finished (Stage 4) Biface</td>
<td>4</td>
<td>.1</td>
</tr>
<tr>
<td>Stemless Knife</td>
<td>14</td>
<td>.5</td>
</tr>
<tr>
<td>Stemmed Knife (^a)</td>
<td>16</td>
<td>.6</td>
</tr>
<tr>
<td>Drill</td>
<td>2</td>
<td>.1</td>
</tr>
<tr>
<td>Projectile Point</td>
<td>60</td>
<td>2.1</td>
</tr>
<tr>
<td>Wedge</td>
<td>2</td>
<td>.1</td>
</tr>
<tr>
<td>Unidentifiable Flaked Stone Artifact</td>
<td>13</td>
<td>.5</td>
</tr>
<tr>
<td>Thermally Fractured Piece of Tool Stone – Possibly Part of Flaked Stone Artifact</td>
<td>1</td>
<td>.0</td>
</tr>
<tr>
<td>Grinding Slab Fragment</td>
<td>17</td>
<td>.6</td>
</tr>
<tr>
<td>Mano</td>
<td>5</td>
<td>.2</td>
</tr>
<tr>
<td>Shaft Abrader</td>
<td>3</td>
<td>.1</td>
</tr>
<tr>
<td>Abrading Stone</td>
<td>1</td>
<td>.0</td>
</tr>
<tr>
<td>Hammerstone</td>
<td>8</td>
<td>.3</td>
</tr>
<tr>
<td>Anvil Stone</td>
<td>2</td>
<td>.1</td>
</tr>
<tr>
<td>Non-Flaked, Modified Stream Cobble or Pebble</td>
<td>11</td>
<td>.4</td>
</tr>
<tr>
<td>Unmodified Stream Cobble or Pebble</td>
<td>27</td>
<td>1.0</td>
</tr>
<tr>
<td>Piece of Ochre</td>
<td>18</td>
<td>.6</td>
</tr>
<tr>
<td>Possible Ochre Applicator</td>
<td>3</td>
<td>.1</td>
</tr>
<tr>
<td>Crystal</td>
<td>2</td>
<td>.1</td>
</tr>
<tr>
<td>Pipe</td>
<td>1</td>
<td>.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2,814</td>
<td>100.0</td>
</tr>
</tbody>
</table>

\(^a\) The “stemmed knife” type of Wheat’s (1979:83-85) classification was retained in this table, but the type is considered to be equivalent to the projectile point type in the analyses to follow.
faces), utilized primary flakes, secondary flakes, and utilized secondary flakes together total nearly four percent of the assemblage. In regard to the tool stone from local and distant high-quality sources brought to the site to gear up with needed formal tools, it would seem reasonable to suppose that the raw material would not likely have been in the form of unworked raw material. Rather, cortex on tool stone would, for the most part, have been removed and raw material would have at the very least have been reduced to the form of blocky cores and unfinished bifaces. The presence of an appreciable amount of artifacts with remaining cortex suggests that lower quality tool stones from local sources may have been brought to the site as raw material for a core-and-flake technology to be used in production of useable flakes and other informal tools needed for daily camp life and gearing up activities that do not require the use of formal tools. Support for this thinking would come through demonstrating that the raw material of the decortication flakes was principally obtained from the local gravel deposits while tool stone from distant high-quality sources was used to produce formal tools. So it is with this thought in mind that we now turn to the task of classifying the Jurgens assemblage into various tool stone types and determining if sources of the tool stone are best categorized as local, distant, or very distant.

No great effort was made to source the raw materials of the ground stone, but many can be said to have potential sources in the local environment. Six of the 10 grinding slabs are of Lyons Sandstone. The primary source of this raw material is along a north-south aligned outcrop at the eastern base of the Front Range. This outcrop is 49 km from Jurgens at its closest point. The sandstone was formed through silicification of Permian sand dune deposits. The material has a tendency to cleave along bedding planes, a quality which is ideal for grinding slabs. Lyons Sandstone is composed of pink or light brown fine-grained quartz sand. Sides of sandstone slabs show the laminated structure of the ancient sand deposit. Future study of the Jurgens collection may profit by enlisting the aid of a stratigrapher familiar with the lithology of the named sedimentary rock formations exposed along the Front
Range in order to identify more potential raw material sources of the grinding slabs.

Research into the procurement of raw material for ground stone artifacts remains a neglected research domain. However, the likelihood that such sites are indeed recognizable is demonstrated by Kvamme’s (1977) report on a possible Late Prehistoric grinding slab quarry situated on an outcrop of the Ingleside Formation along the base of the Front Range in Larimer County, Colorado. Of the five manos from the Jurgens site, four are granite river cobbles with the South Platte River gravels being the likely source. Granite cobbles are available in the channel of the South Platte which presently is as close as .5 km to the site. One mano is of light brown sandstone and its sides appear to have been purposefully rounded by pecking. It is uncertain if the mano originally was a cobble obtained from stream gravels or an angular piece of sandstone obtained from an outcrop.

Table 10-3 summarizes the tool stone composition of the Jurgens flaked stone assemblage and lists the kilometer measurements used in the analysis to quantify the distances from the site to lithic raw material sources. For each tool stone type, the table lists the percentage of the assemblage composed of the raw material, both in terms of artifact counts and the percentage of the total weight of the collection that is composed of the raw material. Many of the tool stones in the assemblage are available from multiple sources spread over a large area, so the reasoning behind each distance measurement assigned to a tool stone type is justified below in detail. The distances to tool stone sources used in the analysis are listed in Table 10-3 to aid in preliminary discussion of the tool stone composition of the assemblage by characterizing the various raw materials present as originating from local, distant, or very distant sources. Four main tool stones from local or distant sources comprise the bulk of the collection. A small amount of tool stone came from gravel deposits of the South Platte River. Several very distant sources are also represented by small amounts of artifacts. Finally, several tool stones with unknown sources are represented by a single artifact each.
Table 10-3. Amounts of Various Tool Stone Types in Jurgens Flaked Stone Assemblage by Artifact Count and Tool Stone Weight.

<table>
<thead>
<tr>
<th>Tool Stone Type</th>
<th>Artifact Count</th>
<th>Percentage of Assemblage by Count</th>
<th>Number of Artifacts Weighed</th>
<th>Weight of Tool Stone (gm)</th>
<th>Percentage of Assemblage by Weight</th>
<th>Distance to Tool Stone Source Used in Analysis (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>White River Group Gravel</td>
<td>469</td>
<td>17.3</td>
<td>467</td>
<td>2235.73</td>
<td>36.7</td>
<td>68</td>
</tr>
<tr>
<td>Flat Top Chalcedony</td>
<td>1634</td>
<td>60.2</td>
<td>1631</td>
<td>1755.72</td>
<td>28.8</td>
<td>114</td>
</tr>
<tr>
<td>Dawson Petrified Wood</td>
<td>169</td>
<td>6.2</td>
<td>167</td>
<td>593.35</td>
<td>9.7</td>
<td>90</td>
</tr>
<tr>
<td>Hartville Uplift Chert</td>
<td>386</td>
<td>14.2</td>
<td>385</td>
<td>897.76</td>
<td>14.7</td>
<td>220</td>
</tr>
<tr>
<td>Knife River Flint</td>
<td>16</td>
<td>.6</td>
<td>16</td>
<td>57.66</td>
<td>.9</td>
<td>760</td>
</tr>
<tr>
<td>Smoky Hill Jasper</td>
<td>1</td>
<td>.0</td>
<td>1</td>
<td>2.71</td>
<td>.0</td>
<td>362</td>
</tr>
<tr>
<td>Aliabates Agate</td>
<td>8</td>
<td>.3</td>
<td>8</td>
<td>46.40</td>
<td>.8</td>
<td>572</td>
</tr>
<tr>
<td>Edwards Chert</td>
<td>12</td>
<td>.4</td>
<td>12</td>
<td>32.58</td>
<td>.5</td>
<td>905</td>
</tr>
<tr>
<td>Wamsutter Oölitic Chert</td>
<td>1</td>
<td>.0</td>
<td>1</td>
<td>3.06</td>
<td>.1</td>
<td>328</td>
</tr>
<tr>
<td>Ft. Union Porcellanite</td>
<td>1</td>
<td>.0</td>
<td>1</td>
<td>10.62</td>
<td>.2</td>
<td>490</td>
</tr>
<tr>
<td>South Platte River Gravel</td>
<td>11</td>
<td>.4</td>
<td>11</td>
<td>387.31</td>
<td>6.4</td>
<td>.5</td>
</tr>
<tr>
<td>Unsourced Tool Stone A</td>
<td>1</td>
<td>.0</td>
<td>1</td>
<td>5.66</td>
<td>.1</td>
<td>-</td>
</tr>
<tr>
<td>Unsourced Tool Stone B</td>
<td>1</td>
<td>.0</td>
<td>1</td>
<td>68.75</td>
<td>1.1</td>
<td>-</td>
</tr>
<tr>
<td>Unsourced Tool Stone C</td>
<td>1</td>
<td>.0</td>
<td>1</td>
<td>1.00</td>
<td>.0</td>
<td>-</td>
</tr>
<tr>
<td>Unsourced Tool Stone D</td>
<td>1</td>
<td>.0</td>
<td>1</td>
<td>.03</td>
<td>.0</td>
<td>-</td>
</tr>
<tr>
<td>Unsourced Tool Stone E</td>
<td>1</td>
<td>.0</td>
<td>1</td>
<td>.10</td>
<td>.0</td>
<td>-</td>
</tr>
<tr>
<td>Unsourced Tool Stone F</td>
<td>1</td>
<td>.0</td>
<td>1</td>
<td>.11</td>
<td>.0</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2714</strong></td>
<td><strong>100.0</strong></td>
<td><strong>2706</strong></td>
<td><strong>6098.55</strong></td>
<td><strong>100.0</strong></td>
<td></td>
</tr>
</tbody>
</table>
Of the four main tool stone types in the assemblage, White River Group gravel (WRGG) is the only one thought to derive principally from local sources, based on the current knowledge of sources. The wide disparity between the amount of WRGG in the assemblage as determined by artifact count compared to the amount of the tool stone based on weight illustrates the potential utility of using both techniques of quantifying amount. Commonly, archaeological studies of prehistoric land use compare the relative abundance of tool stones in a collection by artifact count alone. WRGG accounts for 17 percent of the assemblage, according to artifact count, but its prevalence in the collection jumps to over twice that amount (37 percent) when its relative amount is measured by weight. The disparity results from the fact that the WRGG sample tends to include the largest, and therefore the heaviest, flaked stone artifacts. Included among the large and relatively heavy artifacts are cores or informal tools made on large decortication flakes struck from cobbles. An appreciation of the size of some of the artifacts of WRGG may be acquired by noting the relatively large sizes of an informal retouched flake tool and a utilized secondary flake, both of which retain cortex indicating that they were struck from stream cobbles procured from exposures of White River Group gravel (Figure 7-8 a, k). In contrast, some cores of WRGG are small, having been reduced to a size where it would appear to be difficult to safely strike more flakes from them while they were being held in one hand (Figure 7-8 b - d). The relatively large size of some utilized flakes and informal retouched flake tools of WRGG, along with the comparatively small size of exhausted cores of this raw material, serve to bolster the thinking that a certain amount of WRGG artifacts represent the production of informal tools.

The tendency for local tool stones to include some large and therefore heavy artifacts is also seen in the sample of flaked stone from the locally available South Platte River gravels (SPRG). The raw material accounts for only .4 percent of flaked stone assemblage by weight, but its frequency in the collection rises to 6.4 percent when the total weights of the
various tool stones are compared (Table 10-3). The relatively large and heavy nature of SPRG artifacts as a whole is illustrated by the bifacial core of white-to-light gray metaquartzite pictured in Figure 7-6. As discussed in Chapter 7, stream cobbles of this material occur not only in gravels along the South Platte River, but also in exposures of WRGG. Many of the hammerstones in the collection are large stream cobbles of this kind of metaquartzite that were used without modification. They probably were not transported to the site from very far away. For this reason, flaked stone artifacts made of white-to-light gray metaquartzite were considered for the purpose of analysis to be a variety of SPRG, rather than WRGG.

Of the three remaining tool stones that comprise the bulk of the Jurgens collection, two are considered to be from distant sources (Flat Top chalcedony and Hartville Uplift chert) and one is believed to be composed of artifacts that primarily were procured from distant primary sources (Dawson petrified wood). Flat Top chalcedony was obtained from a source of restricted geographic extent on a butte of the same name. In relation to the site, the source is situated further down the South Platte drainage basin at a distance of 114 km in an east-northeast direction (Figure 5-1). Artifacts of Flat Top chalcedony comprise 60 percent of the collection by artifact count, but only 29 percent when based on total tool stone weight (Table 10-3). As demonstrated below, the greater representation of Flat Top chalcedony in the assemblage when based on artifact count might be explained by the fact that a high proportion of artifacts of this material are interior flakes which are generally lighter than other types of flaked stone artifacts. Dawson petrified wood comprises six percent of the assemblage by artifact count and 10 percent according to total weight of the tool stone. Most of the artifacts of Dawson petrified wood were believed to have been acquired from the primary source area in the Palmer Divide area. The distance to the tool stone sources used in analysis was obtained by measuring to the closest primary sources, which are 90 km south of the site (Figure 5-1). The most distant primary sources are estimated to lie about 52 km
further south at a distance of 142 km from Jurgens. As mentioned in the description of the tool stone in Chapter 7, an unusual variety of the petrified wood that is said to derive from a source near Elbert, Colorado may be represented in the Jurgens collection. This suggests that sources further away from Jurgens than the closest ones may have been visited to gear up. However, this would not change the results of the analysis, as the closest and farthest distances to the primary source area both fall within the distant source category. As will be discussed further below, some of the artifacts of Dawson petrified wood retain stream-rounded cortex which suggests the tool stone was obtained from deposits of South Platte River gravel. However, the amount of Dawson petrified wood from local SPRG deposits is believed to be minor and should not cause a serious problem for analysis. Hartville Uplift chert accounts for 14 percent of the collection according to artifact count and 15 percent by weight. The raw material is considered to originate from distant sources because the closest known sources of the stone in the southern Hartville Uplift lie north of the site at a distance of 220 km, which is within the upper defining limit of 225 km for distant sources of stone (Figure 5-1). Known chert procurement sites are distributed throughout much of the Hartville Uplift and extend into the northern part of this region where they lie at a distance of 257 km from Jurgens. Some of the northern chert procurement sites in the Hartville Uplift therefore fall into the category of very distant sources.

Six tool stones represented in the Jurgens collection are classified as having originated from very distant sources. The sources of all these tool stones lie at distances of well over 225 km from Jurgens (Table 10-3). The amount of stone from very distant sources is small with each tool stone type comprising less than one percent of the assemblage when measured by both artifact count and tool stone weight. All parts of the Great Plains and Wyoming Basin are represented in the artifacts from very distant sources. A point of Wamsutter oölitic chert was made of stone procured in the Wyoming Basin. The closest source of the stone is situated west-northwest of Jurgens at a straight-line distance of 328 km.
(Figure 7-1). Another point was made of Fort Union porcellanite from the Northwest Plains. The center of the large area where sources of this tool stone are distributed lies 490 km from the site in a north-northwest direction. A variety of artifacts are of Knife River flint from a source area on the Northern Plains. The closest part of the source area lies north-northeast of Jurgens at a distance of 760 km. A utilized interior flake of Smoky Hill jasper from the site derives from one of many potential sources situated far to the east on the Central Plains. The closest source of this stone mapped in the archaeological literature is east of the site in the Medicine Creek drainage at a distance of 362 km. Various kinds of artifacts were made of Alibates agate from the Southern Plains. The closest part of the source area of this tool stone is 572 km from Jurgens in a south-southeast direction. Finally, a variety of artifacts were made of Edwards chert from a source area situated even farther from Jurgens on the Southern Plains. The nearest part of the huge source area for Edwards chert is south-southeast of the site at a distance of 905 km.

Finally, six tool stones in the collection could not be assigned to a known raw material that derives from a particular point source or source area. The tool stones are each represented by a single artifact, so the inability to source six tool stones present in the collection will not affect the results of the analysis. In light of the fact that artifacts from local and distant tool stone sources comprise at least appreciable amounts of the assemblage while artifacts of stone from very distant sources are represented by anywhere from one to at most 16 artifacts (Table 10-3), it is reasonable to speculate that the sources of the unsourced tool stones may lie in very distant regions. Because the unsourced tool stones may assist in understanding Paleoindian land use if they are someday identified, they are described in Table A-23 in Appendix A.

One artifact of an unsourced tool stone is especially noteworthy. It is made from a translucent, rough-textured, light bluish gray chert with smoky splotches, sparse white mottling, and sparse blue-to-black specks. The artifact is here classified as a beveled tool.
Wheat 1979:98-99, Figure 50 b) refers to the artifact as a combination tool and states that it is made of Holiday Springs chalcedony. However, the bluish tint and blue specks, along with the rough texture of the stone, are not characteristic of Holiday Springs chalcedony.

Bamforth (2002b:70-71) notes that beveled tools are comparable to a tool type variously known as a Dalton adze or Clear Fork Gouge. The tool type is known from Dalton and later assemblages in Texas, Oklahoma, and Arkansas and is bifacially flaked. Bamforth and Becker (2007:152-153, 155, 161-162, 170-173, Figure 10.1) discuss a sample of 23 beveled tools from the Allen site in Nebraska. They apply the term beveled tool to the artifact type in reference to the beveled character of the presumed working edge. Use wear analysis of the specimens from the Allen site determined that beveled tools functioned as hide scraping tools. Like some of the beveled tools from the Allen site, the specimen from Jurgens had been made by reworking the break facet of an unfinished biface that traversed the longitudinal axis of the artifact. The presence of the beveled tool in the Jurgens collection is noteworthy because its raw material is possibly from a very distant source. If someday the source of the tool stone is identified far to the east of the Jurgens site, this would bolster the possibility that the artifact is of a type used by makers of concave-based lanceolate points and therefore provide further evidence of social interaction between people of the eastern and western plains within the context of large-scale bison hunts.

Artifacts in the Jurgens collection were primarily assigned to one of the tool stone types through familiarity with the color, texture, luster, and other characteristics of the raw materials gained through examination of comparative tool stone collections and visits to tool stone sources. Photographs of artifacts assigned to the main tool stone types were presented in Chapter 7 to demonstrate the range of colors peculiar to each type and are here referred to again to instill in the reader a sense that the assemblage has been accurately classified to raw material type (Figures 7-2, 7-5 through 7-8, 7-10, 7-12 through 7-14). Select artifacts of tool stones from very distant sources are illustrated in Figure 10-2.
Figure 10-2. Selected artifacts from the Jurgens site made from tool stones originating from very distant sources. a) projectile point tip of Wamsutter oölitic chert. b) projectile point of Ft. Union porcellanite. c) – m) artifacts of Knife River flint. n) utilized interior flake of Smoky Hill jasper. o) – s) artifacts of Alibates agate. t) – z) artifacts of Edwards chert.
Tool stone type identification was facilitated by recording the fluorescent color response of artifacts in the Jurgens collection to long and shortwave ultraviolet (UV) light. The color responses of hand samples collected from lithic sources were observed and recorded as were the responses of artifacts in the Jurgens collection. In those cases when the tool stone assignment of an artifact was in question after examining its color and other characteristics in normal light, greater confidence in classifying the artifact into the suspected raw material type could be achieved if the UV color response of the artifact was one of the color combinations common to the stone type. When hand samples were collected from lithic sources by myself and others intent on producing a comparative tool stone collection, there was no attempt to collect in a systematic manner that would produce a representative sample to characterize the UV color responses of tool stone types. Also, the samples collected by me and others were often not large enough to comprise a representative sample in a statistical sense. For these reasons, the data collected on UV color responses is less than ideal. Nevertheless, these data may be useful for future researchers seeking to source artifacts from sites in northeast Colorado and are therefore summarized in a narrative in Appendix A. Furthermore, Tables A-1 through A-23 present the data on the UV color responses of the various tool stone types based on hand samples collected from sources and from artifacts in the Jurgens collection.

Table 10-4 presents data on the varieties of tool stone from the White River Group gravels present in the assemblage and their relative amounts based on artifact counts and total weight. Some varieties are the same as those commonly found at lithic procurement sites in the Kalouse area which may derive from gravels at the base of the White River Group. These varieties include very rough-textured orthoquartzite, Morrison orthoquartzite, Kalouse jasper, brown-to-orange or yellow chert, and dark-to-medium brown petrified wood. Other varieties in the Jurgens collection are the same as those found at lithic procurement sites in the nearby Holiday Springs area which are topographically higher and may occur at a stratigraphically
Table 10-4. Amount of Various Tool Stones from White River Group Gravels in Jurgens Flaked Stone Assemblage by Artifact Count and Weight.

<table>
<thead>
<tr>
<th>Variety of Tool Stone from White River Group Gravels</th>
<th>Artifact Count</th>
<th>Percentage of Assemblage by Count</th>
<th>Number of Artifacts Weighed</th>
<th>Weight of Tool Stone (gm)</th>
<th>Percentage of Assemblage by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very Rough-Textured Orthoquartzite</td>
<td>346</td>
<td>12.7</td>
<td>344</td>
<td>1306.37</td>
<td>21.4</td>
</tr>
<tr>
<td>Morrison Orthoquartzite</td>
<td>28</td>
<td>1.0</td>
<td>28</td>
<td>92.19</td>
<td>1.5</td>
</tr>
<tr>
<td>Light-to-Medium Red, Very Fine-Grained Orthoquartzite</td>
<td>9</td>
<td>.3</td>
<td>9</td>
<td>38.27</td>
<td>.6</td>
</tr>
<tr>
<td>Other Orthoquartzite</td>
<td>4</td>
<td>.1</td>
<td>4</td>
<td>1.34</td>
<td>.0</td>
</tr>
<tr>
<td>Holiday Springs Chalcedony</td>
<td>44</td>
<td>1.6</td>
<td>44</td>
<td>212.46</td>
<td>3.5</td>
</tr>
<tr>
<td>Kalouse Jasper</td>
<td>6</td>
<td>.2</td>
<td>6</td>
<td>196.80</td>
<td>3.2</td>
</tr>
<tr>
<td>Brown-to-Orange or Yellow Chert</td>
<td>15</td>
<td>.6</td>
<td>15</td>
<td>230.39</td>
<td>3.8</td>
</tr>
<tr>
<td>Dark-to-Medium Brown Petrified Wood</td>
<td>9</td>
<td>.3</td>
<td>9</td>
<td>65.40</td>
<td>1.1</td>
</tr>
<tr>
<td>Other Chert</td>
<td>8</td>
<td>.3</td>
<td>8</td>
<td>92.51</td>
<td>1.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>469</strong></td>
<td><strong>17.3</strong></td>
<td><strong>467</strong></td>
<td><strong>2235.73</strong></td>
<td><strong>36.7</strong></td>
</tr>
<tr>
<td>Non-WRGG Tool Stones</td>
<td>2245</td>
<td>82.7</td>
<td>2239</td>
<td>3862.82</td>
<td>63.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2714</strong></td>
<td><strong>100.0</strong></td>
<td><strong>2706</strong></td>
<td><strong>6098.55</strong></td>
<td><strong>100.0</strong></td>
</tr>
</tbody>
</table>
higher position in the generally flat-lying formations comprising the White River Group. These varieties include Holiday Springs chalcedony and “other” orthoquartzite.

By far the most prevalent of any variety of WRGG is rough-textured orthoquartzite and its abundance in the assemblage is cause to suspect that it may have been selected for use in gearing up. This suspicion will be supported below when it is demonstrated that many points were made from this variety of WRGG. Rough-textured orthoquartzite comprises 74 percent of all WRGG artifacts in the assemblage, according to artifact count (Table 10-4) (346 artifacts of very rough-textured orthoquartzite ÷ 469 artifacts of WRGG = .74). Some data is available to support the contention that the frequency of cobbles of rough-textured orthoquartzite among the cobbles of other varieties in exposures of WRGG is not nearly as high as 74 percent. If so, then the possibility that very rough-textured orthoquartzite was a variety of WRGG that was preferred for use in gearing up over other varieties would be supported. I classified a sample of 99 artifacts present on one of the lithic procurement sites in the Kalouse area (5WL5) into varieties of WRGG. The sample was comprised mostly of cores or tested cobbles, waste flakes, pieces of shatter, and retouched flake tools. A total of only 38.4 percent of the sample was composed of orthoquartzite that includes both the very rough-textured variety and the “other orthoquartzite” as defined herein. More information on the relative frequencies of varieties of WRGG at site 5WL5 is provided on the site form. If the above percentage accurately reflects the natural frequency of very rough-textured orthoquartzite, then the much higher percentage of this tool stone among the other varieties of WRGG in the Jurgens assemblage suggest that it was intentionally being selected for over other varieties of WRGG.

The relatively large size of some artifacts of very rough-textured orthoquartzite in comparison to artifacts of other varieties of WRGG also supports the thinking that this particular variety was especially favored for use in gearing up. Large pieces of tool stone would be helpful in gearing up because all types of artifacts could be produced from the raw
material. The particular source or sources of WRGG visited by people at Jurgens evidently had some large pieces of the orthoquartzite available. This is suggested by the great size of the largest informal retouched flake tool from the site, which is made of the very rough-textured orthoquartzite variety of WRGG and is 13 cm long (catalog # 30155, field number SL1-57; see photograph in Wheat 1979:Figure 56 d). Another informal retouched flake tool of the same tool stone with similar colors (catalog # 30166) is not as long (8.6 cm), but appears to have cortex of a stream cobble remaining on its striking platform. This suggests that some large pieces of orthoquartzite had been obtained from a gravel deposit. According to the Wentworth scale of clast size, cobbles are defined as ranging in size from 6.4 to 25.6 cm in maximum diameter, with all larger clasts being classified as boulders (Matthews 1974:23). The above information suggests that the pieces of orthoquartzite used to manufacture the large retouched flake tools at Jurgens were obtained in the form of large river cobbles or possibly even pieces the size of small boulders.

Data presented in Table 10-4 that pertain to the relative weight of artifacts made of varieties of WRGG also support the notion that certain varieties were favored for use in gearing up while other varieties were more suitable for use in a core-and-flake technology. If very rough-textured orthoquartzite was used in gearing up, many waste flakes would result from reduction of unfinished bifaces and blocky cores. The average artifacts would therefore not be especially large or heavy. Dividing the percentage of the assemblage composed of very rough-textured orthoquartzite according to weight (21.4) by the percentage of the collection comprised of this raw material based on artifact count (12.7) produces a ratio of 1.7. This means that the percentage representation of the tool stone in the assemblage is only .7 times greater when measured by weight compared to being measured by artifact count. In contrast, varieties of WRGG suspected of having been used to make relatively few large and heavy expedient tools by way of a core-and-flake technology should not be as common in the assemblage. Also, the ratio of percentage representation by tool stone weight to percentage
representation by artifact count should demonstrate a much greater representation when measured by weight due to the large and heavy artifacts produced. These expected trends are seen in Kalouse jasper which accounts for only .2 percent of the assemblage by count (n = 6 artifacts) but 3.2 percent by weight. The percentage representation of Kalouse jasper in the assemblage is 16 times greater when measured by weight in comparison to being measured by artifact count (3.2 ÷ .2 = 16). This indicates that the relatively few artifacts of this tool stone are generally large and heavy. These trends are also evident for brown-to-orange or yellow chert which accounts for only .6 percent of the assemblage by count and 3.8 percent by weight. The percentage representation of this variety of WRGG in the assemblage is 6.3 times greater when measured by weight in comparison to being measured by count (3.8 ÷ .6 = 6.3). This demonstrates that the comparatively few artifacts of this raw material are also large and heavy.

Consideration of whether cortex present on artifacts is rough or stream-rounded can assist in confirming the classification of artifacts into the various tool stone types and thus the correctness of their assignment to differing raw material sources. Artifacts with rough cortex derive from a primary source (i.e. from an outcrop of tool stone). Conversely, artifacts with stream-rounded cortex originate from a secondary source, specifically from a deposit of alluvial gravel. One hundred percent of artifacts with cortex that were assigned to Flat Top chalcedony and Hartville Uplift chert based on examination in normal and UV light were also determined to originate from primary sources of these raw materials based on the presence of rough cortex (Table 10-5). Some gravel of these raw materials likely occurs in nature, but evidently was not exploited by occupants of the Jurgens site.

In contrast, tool stones from exposures of the White River Group are available from secondary gravel deposits of stream-rounded pebbles, cobbles, and boulders. A large majority (96 percent) of artifacts with cortex classified as WRGG have stream-rounded cortex, thus affirming their identification of having originated from alluvial deposits of the
<table>
<thead>
<tr>
<th>White River Group Gravel</th>
<th>Count</th>
<th>Stream-Rounded and / or Polished</th>
<th>Rough or Not Stream-Rounded and / or Polished</th>
<th>Indeterminate</th>
<th>None</th>
<th>Total</th>
<th>Only Artifacts with Either Stream-Rounded or Rough Cortex</th>
<th>Stream-Rounded and / or Polished</th>
<th>Rough or Not Stream-Rounded and / or Polished</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>81</td>
<td>3</td>
<td>3</td>
<td>305</td>
<td></td>
<td>392</td>
<td>81</td>
<td>3</td>
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<tr>
<td></td>
<td>20.7%</td>
<td>.8%</td>
<td>.8%</td>
<td>77.8%</td>
<td></td>
<td>100.0%</td>
<td>96.4%</td>
<td>3.6%</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>Flat Top Chalcedony</td>
<td>Count</td>
<td>-</td>
<td>17</td>
<td>-</td>
<td>272</td>
<td>289</td>
<td>-</td>
<td>17</td>
<td>17</td>
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<tr>
<td></td>
<td>5.9%</td>
<td>-</td>
<td>94.1%</td>
<td>100.0%</td>
<td></td>
<td></td>
<td>-</td>
<td>100.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dawson Petrified Wood</td>
<td>Count</td>
<td>5</td>
<td>18</td>
<td>112</td>
<td></td>
<td>136</td>
<td>5</td>
<td>18</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.7%</td>
<td>13.2%</td>
<td>.7%</td>
<td>82.4%</td>
<td></td>
<td>100.0%</td>
<td>21.7%</td>
<td>78.3%</td>
<td>100.0%</td>
<td></td>
</tr>
<tr>
<td>Hartville Uplift Chert</td>
<td>Count</td>
<td>-</td>
<td>16</td>
<td>-</td>
<td>293</td>
<td>309</td>
<td>-</td>
<td>16</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.2%</td>
<td>-</td>
<td>94.8%</td>
<td>100.0%</td>
<td></td>
<td></td>
<td>-</td>
<td>100.0%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 10-5. Types of Cortex Present on Jurgens Artifacts Made from Main Tool Stone Types.
White River Group. A small amount (four percent) of artifacts with cortex that were classified as WRGG have rough cortex, indicating they originate from a primary source. These artifacts are of Holiday Springs chalcedony. As mentioned in discussion of this tool stone in Chapter 7, lithic procurement sites containing this tool stone that I recorded in the Holiday Springs area are secondary sources containing stream-rounded pebbles and cobbles, but a primary source of this material is also reported in the vicinity of Holiday Springs. The primary source apparently was deposited in a localized area in northeast Colorado where an Oligocene formation of the White River Group was accumulating. Furthermore, the primary source apparently provided the parent material of the gravel of Holiday Springs chalcedony found in secondary sources deposited elsewhere in the White River Group. Thus, the fact that a small amount of artifacts with cortex classified as WRGG have a rough cortex does not suggest a problem with the identification of White River Group exposures as the geologic source of the artifacts.

The collection of artifacts of Dawson petrified wood contain some flake stone specimens with a rounded cortex, suggesting that a certain amount of tool stone from the South Platte River gravels is mixed in with the petrified wood obtained from primary sources in the Palmer Divide area. Among Dawson petrified wood artifacts with cortex, those with stream-rounded cortex account for a relatively large amount of the artifacts, based on artifact count (Table 10-5). The large amount of stream-rounded cortex may not directly reflect the amount of artifacts of SPRG mixed in with those made from Dawson petrified wood from primary sources because using small stream-rounded pieces of the tool stone as part of a core-and-flake technology to make flakes for expedient tools would tend to produce proportionally more decortication flakes than gearing up using large pieces of tool stone procured from the primary source. Five unmodified stream-rounded pieces of the petrified wood in the collection suggest that this tool stone was available locally from exposures of South Platte River gravel where it probably occurs in relatively small pieces. The five items are here
classified as unmodified stream cobbles or pebbles of the Dawson petrified wood variety of SRRG. The items were out of place geologically in the site and are believed by Wheat (1979:134) to be manuports that were transported to the site by people. Their maximum dimensions (in cm) are: 2.6, 4.4, 5.2, 5.8, and 6.9. All are relatively small and knapping them would produce a high proportion of decortication flakes. Their small size suggests they were unlikely to have been transported far as pieces of raw material suitable for knapping, only to be discarded unused at the site. That some stream-rounded pieces of petrified wood were in fact knapped to produce artifacts in the Jurgens collection is demonstrated by the five artifacts classified as being made of Dawson petrified wood with a stream rounded cortex. Included are one tested cobble or pebble, three utilized flakes, and one end scraper. There presence in the collection implies that some of the artifacts of Dawson petrified wood that lack any cortex probably also derive from stream-rounded pebbles or cobbles from local SPRG. After the analyses were completed, it was realized that the artifacts of Dawson petrified wood with stream-rounded cortex are best classified as a variety of SPRG. However, their inclusion in the Dawson petrified wood category along with some other artifacts lacking cortex that probably derive from the local river gravels is not thought to have seriously affected the results of the analysis.

Having provided a thorough discussion aimed at justifying the accuracy of the tool stone identifications, further discussion is in order to finalize the distances to sources that will be used in the analysis. Most tool stones in the assemblage occur at multiple sources spread over broad areas. For example, multiple local sources of WRGG have been discussed and since exposures of the White River Group occur in areas distant from the Jurgens site, distant sources probably exist as well. Also, one very distant source of WRGG was discussed and others likely exist. Rather than adopt a nihilistic attitude and conclude that the widespread distribution of many tool stone types does not allow one to judge between the competing views in an objective manner, a specific point on the landscape was selected for providing a
measurement from the site to the source of a particular tool stone. In general, the closest recorded lithic procurement site where the tool stone is available was measured to, or else the closest point of a general source area mapped in the archaeological literature was used. The specific rationale for the distance measurements to be used in the analysis is given in Table 10-6. Distances to the closest and furthest sources of each tool stone in the assemblage are given in Table 10-7 to give the reader an appreciation of the variability inherent in distance measurements to tool stone sources and hopefully instill a sense that the distances to local and distant sources used in analysis are reasonable estimates of the distances to the sources actually visited by occupants of the Jurgens site.

In light of the fact that artifacts from the Jurgens collection classified as White River Group gravel compare well with tool stones observed at the Kalouse and Holiday Springs areas, the distance from the site to a point between these sources will be used to quantify the distance to exposures of WRGG for the purpose of analysis. As discussed in Chapter 7, some of the artifacts of orthoquartzite present in the assemblage were not duplicated in the gravel sources visited, so it is possible that a certain amount of the tool stone in the collection classified as WRGG was obtained elsewhere, but it is thought that measuring to the Holiday Springs and Kalouse area will not seriously bias the analysis of the tool stone composition of the Jurgens assemblage.

By plotting the locations of potential sources of the main tool stones present in the Jurgens assemblage in relation to the site itself, it is possible to gain an appreciation of the general area encompassed by the ranges of neighboring bands that hypothetically cooperated in a large bison hunt. Figure 10-3 provides such a map depicting the site in relation to the potential sources or source areas of the main tool stones. Also indicated on the map is the nearest outcrop of Lyons Sandstone and the directions to the sources of tool stones from very distant sources.
Table 10-6: Distance Measurements to Tool Stone Sources and Source Areas Used to Interpret Paleoindian Land Use with Data from the Jurgens Assemblage.

<table>
<thead>
<tr>
<th>Tool Stone Name</th>
<th>Distance to Source (km)</th>
<th>Direction from Site to Source</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Platte River gravel</td>
<td>.5</td>
<td>northeast</td>
<td>Average of measurements from Areas 1, 2, and 3 to the closest point on the current South Platte River bed.</td>
</tr>
<tr>
<td>Lyons Sandstone</td>
<td>49</td>
<td>west</td>
<td>Measured to closest outcrop of Lyons Sandstone.</td>
</tr>
<tr>
<td>White River Group gravel</td>
<td>68</td>
<td>northeast</td>
<td>Measured to point between Holiday Springs source and Kalouse source.</td>
</tr>
<tr>
<td>Dawson petrified wood</td>
<td>90</td>
<td>south</td>
<td>Measured to the closest set of three adjacent tool stone procurement sites (5AH411, 5AH462, and 5AH464) in the primary source area of the Palmer Divide area which is here defined by the location of these three procurement sites, a fourth procurement site (5EL257), and 12 rockhounding locations plotted by Voynick (1995:106-107). The source area extends for 52 km farther away from the Jurgens site.</td>
</tr>
<tr>
<td>Flat Top chalcedony</td>
<td>114</td>
<td>east-northeast</td>
<td>Measured to Flat Top Butte.</td>
</tr>
<tr>
<td>Hartville Uplift chert</td>
<td>220</td>
<td>north</td>
<td>Measured to the closest lithic procurement site in a cluster of 25 likely chert procurement sites plotted by Reher (1991:Figure 16.2) on exposures of Paleozoic limestone in the Hartville Uplift. The cluster of sites extends for 37 km farther north, away from the Jurgens site.</td>
</tr>
<tr>
<td>Wamsutter oölitic chert</td>
<td>328</td>
<td>west-northwest</td>
<td>Of the two source areas of this material in the Wyoming Basin mentioned by Coffin (1951:5), the one located about 90 km closer to the Jurgens site was used in the analysis by measuring to Delaney Rim, located near Wamsutter, Wyoming.</td>
</tr>
<tr>
<td>Smoky Hill jasper</td>
<td>362</td>
<td>east</td>
<td>Measured to center of source area in Medicine Creek drainage as mapped by Holen (1991:Figure 23.1). Because the source area is relatively small (measuring roughly 12 km west-southwest by east-northeast and 25 km north-northwest by south-southeast), distance was measured to the center of source area.</td>
</tr>
<tr>
<td>Fort Union porcellanite</td>
<td>490</td>
<td>north-northwest</td>
<td>Measured to the center of the source area in northeastern Wyoming defined by tool stone procurement sites 48CA728, 48CA866, 48CA2534, 48CA2902, 48CA3300, 48JO207, and 48SH1663.</td>
</tr>
<tr>
<td>Alibates agate</td>
<td>572</td>
<td>south-southeast</td>
<td>Measured to closest part of source area as mapped by Hofman, Todd, and Collins (1991:Figure 1).</td>
</tr>
<tr>
<td>Knife River flint</td>
<td>760</td>
<td>north-northeast</td>
<td>Measured to closest part of source area as drawn by Ahler (1986:Figure 2).</td>
</tr>
<tr>
<td>Edwards chert</td>
<td>905</td>
<td>south-southeast</td>
<td>Measured to closest part of source area as mapped by Hofman, Todd, and Collins (1991:Figure 1).</td>
</tr>
</tbody>
</table>
Table 10-7. Distance Measurements from Jurgens Site to Tool Stone Sources Not Used in Analysis, but Presented to Demonstrate the Variability in Distances to Sources (Page 1 of 2).

<table>
<thead>
<tr>
<th>Tool Stone Name</th>
<th>Source Name / Lithic Procurement Site Number</th>
<th>Distance to Source (km)</th>
<th>Direction from Site to Source</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>White River Group Gravel</td>
<td>5WL1445</td>
<td>39</td>
<td>north</td>
<td>Distance from Jurgens site measured to point between the two lithic procurement sites.</td>
</tr>
<tr>
<td></td>
<td>Holiday Springs source area. 5WL5170, 5WL5180</td>
<td>64</td>
<td>northeast</td>
<td>Distance from Jurgens site measured to point between the two lithic procurement sites.</td>
</tr>
<tr>
<td></td>
<td>Kalouse source area. 5WL5, 5WL5181, 5WL5182</td>
<td>73</td>
<td>northeast</td>
<td>Distance from site measured to point between the three lithic procurement sites.</td>
</tr>
<tr>
<td>Dawson petrified wood</td>
<td>5DA411, 5DA462, 5DA464</td>
<td>90</td>
<td>south</td>
<td>Distance from Jurgens site to these three sites clustered at the north end of the primary source area was measured to a point between the three lithic procurement sites.</td>
</tr>
<tr>
<td></td>
<td>5EL257</td>
<td>119</td>
<td>south</td>
<td></td>
</tr>
<tr>
<td>Hartville Uplift chert</td>
<td>southern edge of source area</td>
<td>220</td>
<td>north</td>
<td>Distance to the southernmost chert procurement site in the cluster of sites plotted by Reher (1991:Figure 16.2)</td>
</tr>
<tr>
<td></td>
<td>northern edge of source area</td>
<td>257</td>
<td>north</td>
<td>Distance to the northernmost chert procurement site in the cluster of sites mapped by Reher (1991:Figure 16.2)</td>
</tr>
<tr>
<td>Wamsutter oölitic chert</td>
<td>Delaney Rim source area</td>
<td>328</td>
<td>west-northwest</td>
<td>Approximate distance to closest of the two source areas discussed by Coffin (1951:5). Measurement taken to Delaney Rim, near Wamsutter, Wyoming.</td>
</tr>
<tr>
<td></td>
<td>Boars Tusk source area</td>
<td>418</td>
<td>west-northwest</td>
<td>Approximate distance to farthest of the two source areas discussed by Coffin (1951:5). The source area caps a mesa near the Boars Tusk. Measurement taken to the Boars Tusk, southeast of Farson, Wyoming.</td>
</tr>
<tr>
<td>Smoky Hill jasper</td>
<td>Medicine Creek source area</td>
<td>352</td>
<td>east</td>
<td>Measured to that part of the relatively small source area in the Medicine Creek drainage located closest to the Jurgens site (Holen 1991:Figure 23.1).</td>
</tr>
<tr>
<td></td>
<td>main source area</td>
<td>501</td>
<td>east</td>
<td>Measured to that part of the comparatively large source area in Nebraska and Kansas located farthest from the Jurgens sites (Holen 1991:Figure 23.1).</td>
</tr>
<tr>
<td>Ft. Union porcellanite</td>
<td>southern edge of source area</td>
<td>412</td>
<td>north-northwest</td>
<td>Measured to the part of the source area that is closest to the Jurgens site. See Chapter 7 for discussion of how source area was defined.</td>
</tr>
<tr>
<td></td>
<td>northern edge of source area</td>
<td>at least 555</td>
<td>north-northwest</td>
<td>Measured to the part of the source area that is farthest from the Jurgens site. See Chapter 7 for discussion of how source area was defined.</td>
</tr>
</tbody>
</table>
Table 10-7. Distance Measurements from Jurgens Site to Tool Stone Sources
Not Used in Analysis, but Presented to Demonstrate the Variability
in Distances to Sources (Page 2 of 2).

<table>
<thead>
<tr>
<th>Tool Stone Name</th>
<th>Source Name / Lithic Procurement Site Number</th>
<th>Distance to Source (km)</th>
<th>Direction from Site to Source</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alibates agate</td>
<td>northern edge of source area</td>
<td>572</td>
<td>south-southeast</td>
<td>Measured to the part of the source area in the Texas panhandle as drawn by Shelley (1984:Map 1) that is closest to the Jurgens site.</td>
</tr>
<tr>
<td></td>
<td>southern edge of source area</td>
<td>602</td>
<td>south-southeast</td>
<td>Measured to the part of the source area in the Texas panhandle as mapped by Shelley (1984:Map 1) that is farthest from the Jurgens site.</td>
</tr>
<tr>
<td>Knife River flint</td>
<td>southern edge of source area</td>
<td>760</td>
<td>north-northeast</td>
<td>Measured to closest part of source area as drawn by Ahler (1986:Figure 2).</td>
</tr>
<tr>
<td></td>
<td>northern edge of source area</td>
<td>795</td>
<td>north-northeast</td>
<td>Measured to farthest part of source area as mapped by Ahler (1986:Figure 2).</td>
</tr>
<tr>
<td>Edwards chert</td>
<td>northern edge of source area</td>
<td>905</td>
<td>south-southeast</td>
<td>Measured to closest part of source area as drawn by Hofman, Todd, and Collins (1991:Figure 1).</td>
</tr>
<tr>
<td></td>
<td>southern edge of source area</td>
<td>1,349</td>
<td>south-southeast</td>
<td>Measured to farthest part of source area as mapped by Hofman, Todd, and Collins (1991:Figure 1).</td>
</tr>
</tbody>
</table>
Figure 10-3. Rose diagram showing Jurgens site and sources of tool stones represented in the flaked stone assemblage.
To gain some understanding of how the area indicated by the main tool stone sources may have been partitioned into band ranges of comparable size to ethnographic groups, the dimensions of the size of the largest known ethnographic band range may be used as an aid (Table 8-1). The Tuluaqmiut band of the Nunamiut operated within an area measuring 143 km by 104 km (Campbell 1968:Figure 2). Previously, it was noted that most ground stone artifacts in the Jurgens collection were made from Lyons Sandstone which outcrops along the eastern base of the Front Range. If one were to define an area of the plains in the vicinity of the Jurgens site that is the size of the largest ethnographic band range, one might begin due west of the Jurgens site at the base of the Front Range where Lyons Sandstone outcrops and measure 143 km in an east-northeast direction down the South Platte River drainage to establish the east-west dimension of the hypothetical band range. This would begin to define an area that would encompass several known sources of WRGG north of the South Platte River, but the area would not extend to the source of Flat Top chalcedony. To establish the north-south dimension of the hypothetical band range, one might measure out 104 km along a line positioned through the Jurgens site and perpendicular to the first line. If the north-south dimension line is positioned such that the known sources of WRGG are in the northern part of the area defined, then the area would include terrain south and east of the South Platte, but the area would fall short of the primary sources of Dawson petrified wood in the Palmer Divide area.

The point to made here is that if Paleoindian bands operated within ranges that were comparable in size to those of ethnographic foragers, then the habitual range of the local band might reasonably be expected to cover an area that included sources of Lyons Sandstone along the mountain front and several sources of WRGG off to the east on the plains, but not the sources of Flat Top chalcedony or Dawson petrified wood. If a large part of the Jurgens assemblage is the result of a large-scale bison kill carried out by multiple bands, the local participating band may have geared up using tool stone from a local source of WRGG. One
might further hypothesize, given the above information alone, that quantities of Flat Top chalcedony and Dawson petrified wood in the Jurgens collection were carried to the site by participating bands that had geared up at tool stone sources in their own habitual ranges situated elsewhere in the South Platte drainage.

If the ranges of Paleoindians were comparable in size to ethnographic peoples, then the presence of a quantity of Hartville Uplift chert in the Jurgens collection may be interpreted as resulting from participation in the large-scale kill by a band whose habitual range was situated to the north of that of the local band. An alternative interpretation of Paleoindian land use would assert that the area of the plains located north of the Jurgens site and east of the Laramie Range would also be populated by Paleoindians. If the range of a neighboring band inhabiting this area was comparable in size to that of the largest ethnographically documented band, the range might have encompassed the upper reaches of Lodgepole Creek, all of the Horse Creek drainage, and the lower reaches of the Laramie River drainage (Figure 10-3). The closest source of tool stone suitable for gearing up would be the sources of chert in the southern part of the Hartville Uplift. The artifacts of Hartville Uplift chert in the Jurgens assemblage might reasonably be interpreted as evidence for this hypothetical northern band participating in the bison kill. The absence of Spanish Diggings orthoquartzite in the Jurgens collection also may be cited as supporting the above interpretation. Sources of this orthoquartzite are located in the northwestern portion of the Hartville Uplift. If a Paleoindian band whose habitual range was situated south of the Hartville Uplift intended to procure stone to gear up for a bison kill in the South Platte drainage, the band or some members of the band would visit the closest suitable chert sources in the southern part of the uplift, rather than travel the extra distance to reach the orthoquartzite quarries in the northwestern portion of the uplift.

It should be noted that Figure 10-3 somewhat artificially suggests those areas actually inhabited by participating bands by using thick solid lines to local and distant sources
producing stone accounting for over 10 percent of the assemblage while dotted lines were used to indicate the direction of sources that each produced less than one percent. It is reasonable to expect that if the local band geared up with local stone and one or more neighboring bands geared up with stone from distant sources, then lots of stone from local and distant sources should be present in the assemblage and the decrease in the amount of stone from very distant sources should be abrupt and quite apparent. To best evaluate if the Jurgens assemblage meets these expectations, actual data on the tool stone composition of the collection needs to be examined.

Figure 10-4 graphs the amount of each sourced tool stone in the Jurgens collection according to artifact count on the y-axis and the corresponding straight-line distance to each source on the x-axis. As expected, the amounts of stone from very distant sources show an abrupt decrease in comparison to the quantities of stone from local and distant sources. The graph suggests that on-site production of artifacts to kill and process many bison did not occur equally among the main tool stone types. Rather, the number of artifacts of Flat Top chalcedony (most of which are flakes) far exceeds the frequency of artifacts made of the other three main tool stones.

Figure 10-5 displays the amount of each sourced tool stone in the Jurgens assemblage based on total weight of the raw material on the y-axis and the straight-line distance to each source on the x-axis. Again, the amounts of stone from very distant sources show a dramatic decline when compared to the weight of stone from local and distant sources. The graph serves to reiterate the suggestion that Flat Top chalcedony was used in the on-site production of artifacts related to hunting and processing many bison more so than Dawson petrified wood or Hartville Uplift chert. The tool stone category with the greatest representation by weight is WRGG, which includes many of the heavier artifacts.

The above general review of the Jurgens assemblage provides preliminary support for the interpretation that the collection was produced by a large, aggregated group of people.
Figure 10-4. Amounts of tool stone types (according to artifact count) in Jurgens assemblage by distance to tool stone source.
Figure 10-5. Amounts of tool stone types (according to weight) in Jurgens assemblage by distance to tool stone source.
composed of neighboring bands that had gathered together for the purpose of communal bison hunting. However, the interpretation may be further supported by demonstrating that a large group of people were present on-site and that they discarded the kinds of artifacts related to killing and processing a lot of bison in all three widely separated middens at the site during a single occupation. Efforts at refitting and conjoining artifacts, along with minimum analytical nodule analysis, have the potential to provide such evidence.

EVIDENCE FOR NUMBER AND KIND OF OCCUPATIONS FROM REFITTING AND RELATED STUDIES

Refitting of flakes and conjoining of artifact fragments, as well as minimum analytical nodule analysis, were methods of analysis carried out on the Jurgens collection for a number of reasons. First, if ample connections between artifacts in all three widely separated areas of the site can be demonstrated, this would support the notion that a very large group of people was present on the site. This in turn would support the possibility that the group had formed through the aggregation of multiple bands. Conversely, the above kinds of analyses would suggest that the three areas instead result from multiple occupations of the site if no connections between areas are established. Furthermore, such studies also have the capability of suggesting functionally different portions of the site. If indeed the Jurgens site was a hunting camp where people geared up for a large bison hunt and processed the meat and hides, it is expected that the camp would have been laid out such that the kinds of tasks that needed to be preformed would have taken place in different parts of the site. Given that the site may be considered a hunting camp with bonebeds, it is reasonable to suppose that activities performed in or near the actual living area of the camp would have taken place separately from the area or areas where carcass segments were stripped of meat and bones discarded.
Differences in the condition of bison bones from the three areas of the site do suggest functional differentiation across the site in regard to the main kinds of activities emphasized near each area. Bones in Area 3 form a dense cluster and commonly are part of articulated units (Wheat 1979:Figure 23). This suggests that bison carcass segments were transported from wherever the kill site was to this portion of the Jurgens site for continued butchering. For the purpose of discussing site structure, Area 3 will be referred to as the butchering midden. Masses of muscle would have been stripped from the carcass segments and butchering waste, which included some bone in articulated condition along with disarticulated bones, were all discarded in Area 3. That meat had been stripped from carcass segments is seen in an articulated unit composed of the cervical vertebral column and part of the rib cage. The cervical vertebrae are aligned in a sinuous shape that can only have resulted from neck muscles having been stripped from the bones (Wheat 1979:Figure 27 i).

In contrast, bones in Area 1 form a less dense scatter comprised primarily of disarticulated bones (Wheat 1979:16-18, Figure 10). The vast majority of bones had been broken. Of the 2,448 bison bones in Area 1, a total of 467 were long bone fragments (Wheat 1979:16, 27). Considering that study of dentition from Areas 1 and 3 indicates that bison remains in both areas were killed at the same time of year (Hill and Hill 2002), it is reasonable to suppose that some bones from the meat-stripping area were transported to a work area near Area 1 where they were broken open to retrieve the marrow. Subsequently, the fragments were discarded in Area 1.

The bison bones in Area 2 differed from those in the other two areas, comprising a diffuse scatter of bones of a minimum of only two bison (Wheat 1979:33-34, Figure 19). Most of these had been broken, probably to extract marrow. Bison mandibles and teeth were recovered from excavations in Area 2 (Wheat 1979:Figure 17) and should be examined to determine if the season during which the bison were killed was the same as that for bison remains in Areas 1 and 3. Assuming that the bison bones in Area 2 also relate to the large
bison kill indicated in Areas 1 and 3, it is reasonable to suggest that some marrow extracting activity also took place in the vicinity of Area 2 and resulting bone fragments were discarded in the midden.

The kind and number of artifacts in Areas 1 and 2 suggest these portions of the site may have been situated closer to the location of a former camp than was Area 3. For the purpose of discussing site structure, Areas 1 and 2 will be referred to as the camp middens. Artifacts from activities that would have occurred in or near camp occur most commonly in Areas 1 and 2. As discussed, one such activity was cracking open bones to extract marrow. Another camp-related activity was stone tool manufacture. Artifact concentrations composed primarily of flakes were present in Areas 1 and 2, but not in Area 3. Two concentrations (numbered 1 and 2) were present in Area 1 and another was in Area 2. Wheat (1979:Table 36) refers to the concentrations as chipping floors, implying that flintknapping actually took place at the concentrations. The context of the concentrations of lithic artifacts within the scatters of bone in Areas 1 and 2 argues against the possibility that they are indicative of chipping floors, but instead suggests that they are trash dumps composed of flakes and tools collected from in and around a nearby camping area and dumped in Areas 1 and 2. This is especially true for the concentrations in Area 1 which occur among a fairly dense scatter of bone. Some flakes were found scattered in Area 3 (n = 108), but greater quantities of flakes in Area 2 (n = 553) and Area 1 (n = 1,610) (Wheat 1979:Table 35), along with the occurrence of flakes in concentrations here interpreted as trash dumps, all suggest that the camping area at Jurgens was closer to Areas 1 and 2.

If the artifact concentrations can be shown to have been places where tools and debitage related to gearing up for killing and processing many bison were dumped within the general scatter of the camp middens, this would fortify the case that a large group of people had amassed at the site to engage in bison hunting. For this reason, it is necessary to define how artifacts from concentrations may be differentiated from those originating from the
Because artifacts in the collection were labeled as having come from a particular 2 m by 2 m excavation unit, a map of the concentrations plotted on the excavation grid, along with Wheat's verbal description of the portions of the excavation units covered by the concentrations, allows one to determine which excavation units were completely within a concentration and which units were only partially within a concentration (see Wheat 1979:119, 121, Figures 7, 17a, 63).

Which excavation units were positioned within the two artifact concentrations in Area 1 may be determined from information in the site report. In Area 1, artifacts from Excavation Unit 14H90 were definitely in concentration 1. The densest part of the concentration measures about two meters by one meter and is located in the southern half of the excavation unit. In the periphery of the concentration, a diffuse scatter of artifacts extends into adjacent excavation units, so artifacts from units 14H87, 14H99, and 14H100 are possibly from concentration 1. Adjacent excavation unit 15H91 is in between concentrations 1 and 2 and so the diffuse artifact scatter found there cannot be assigned to either concentration. The densest part of concentration 2 measures about three and one-half meters by two meters and is centered over excavation units 15I2 and 15I12. Artifacts from these excavation units are definitely in concentration 2. A diffuse scatter of artifacts in the periphery of the concentration extends into adjacent excavation units, such that artifacts from units 15H92, 15I1, 15I13, 15I11, and 15I13 can be said to be possibly from concentration 2. Wheat (1979:121, Figure 63) defines a concentration 3 for Area 1, but the map of plotted artifacts in Area 1 shows that the excavation units said to contain the concentration only have a diffuse scatter. For this reason, concentration 3 is not considered to be valid and will not be used in this analysis.

In Area 2, Wheat defines a concentration centered in excavation units 10F60 and 11F51. The densest parts of the concentration occur in two adjacent areas, with one centered in excavation unit 10F60 and the other located to the east in 11F51 (see Wheat 1979:Figure
As will be elaborated below, artifacts from the concentration assigned to particular minimum analytical nodules were mostly or exclusively found in one or the other of the densest areas of the concentration. Based on this observation, the concentration is thought to be comprised of separate dumping areas that may represent discrete episodes of trash disposal. Therefore, the different parts of the concentration will here be referred to as the eastern cluster or half and the western cluster or half. Artifacts from excavation unit 10F60 will be considered to have definitely come from the western half of the concentration. If artifacts were found in the adjacent excavation units of 10F50, 10F59, and 10F70, they will be considered to possibly be from the cluster. Artifacts from excavation unit 11F51 will be considered to have definitely come from the eastern half of the concentration. If artifacts were found in the adjacent excavation units of 11F41, 11F52, 11F61, and 11F62, they are considered to possibly be from the cluster.

Activities related to processing hides are also likely to have occurred in or near camp. This expectation is based on ethnographic photographs of Plains Indians working on hides stretched out on the ground in the vicinity of tipis (e.g. Wedel 1987:Plate 10.2). End scrapers that were broken in use or were either worn out or no longer needed would have been discarded in the trash. Area 1 produced 33 end scrapers and Area 2 had 31, but only 11 were recovered from Area 3 (Wheat 1979:Tables 29-30). These figures further suggest that the trash middens in Areas 1 and 2 were closer to camp than Area 3. As discussed, pulverizing hematite and limonite into powdered ochre with the use of grinding slabs and manos was an activity carried out at Jurgens and this activity may be related to preservation of fresh hides for further processing at a later time. Broken grinding slabs and manos no longer needed would be deposited in the trash and the predominance of these ground stone artifacts in Areas 1 and 2 again supports the thinking that these areas were closer to the encampment than Area 3 (Table 10-1). Fragments of three grinding slabs were recovered from Area 1. Three additional grinding slabs are represented by fragments from Area 2 and fragments of an
additional grinding slab were found in both Areas 1 and 2. Finally, three manos were present in Area 2. In contrast, only one grinding slab fragment was present in Area 3. Wheat (1979:Table 40, Figure 67 c, d) reports two manos from Area 3, but these are river cobbles that do not have definite indications of having been used in a grinding fashion.

The Jurgens collection was examined to identify any connections that may be evident between artifacts within areas and between areas. This was done for two reasons, the first being to test the idea that the site was produced during a single occupation by a large group. Secondly, establishing connections between artifacts found in different parts of the site may serve to further the thinking that the occupants were involved in communal hunting as seen in a structured use of the site for gearing up and processing of bison products. Two techniques of establishing connections among artifacts were employed. The first involves identifying conjoining tool fragments and refitting flakes or other artifacts to their parent object. This technique has the advantage of establishing definite connections between parts of a site through identifying physically matching artifacts. Another technique entails identifying sets of artifacts made from the same nodule, piece, or batch of stone through recognition of unique identifying characteristics of the raw material in order to define those parts of a site that are connected by artifacts made from the same “minimum analytical nodule” or MAN. Though establishing less definitive connections between artifacts and between parts of a site, the technique has the advantage of identifying more spatial connections between areas than typically achieved through identification of conjoining or refitting artifacts. Minimum analytical nodules and sets of conjoining or refitting artifacts that highlight use of the site in a structured manner by people involved in communal hunting are summarized in Table 10-8. This table focuses on particular MANs and conjoining or refitting artifacts to provide a listing of the kinds of behavior represented by the artifact sets as well as to indicate the parts of the site where those behaviors took place. A more detailed accounting of the artifact sets is given in Appendix B. Table B-1 presents data on sets of conjoining or refitting artifacts. Data
Table 10-8. Summary of the Kinds of Connections Within and Between Areas of the Jurgens Site as Indicated by Noteworthy Refitting or Conjoining Artifacts and Minimum Analytical Nodules.

<table>
<thead>
<tr>
<th>Primary Behaviors(s) Represented by Minimum Analytical Nodule or Set of Refitting or Conjoining Artifacts</th>
<th>Designation of Relevant Minimum Analytical Nodule (MAN) or Set of Refitting or Conjoining Artifacts Discussed More Fully in Appendix B, Tables B-1 and B-2.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacture of projectile points near a camp midden (Area 2) and discard of rejected preforms in Area 2</td>
<td>MAN # 6 and 37</td>
</tr>
<tr>
<td>Manufacture of points mostly near Area 2, but possibly also by Area 1, use of points somewhere afield, loss or discard of points in butchering midden (Area 3)</td>
<td>MAN # 2 through 5 and 9</td>
</tr>
<tr>
<td>Loss or discard of fragments of the same point in the butchering midden (Area 3)</td>
<td>Sets of conjoining artifacts # 11 and 12</td>
</tr>
<tr>
<td>Manufacture of points near the camp middens (mostly by Area 2, but possibly also by Area 3), use of the points somewhere afield, discard of points in Area 2 during repair of hunting weaponry</td>
<td>MAN # 1, 7, and 8</td>
</tr>
<tr>
<td>Possible manufacture of knife in camp, discard of utilized flake from knife manufacture in a camp midden (Area 2), and discard of Knife fragment in butchering midden (Area 3)</td>
<td>MAN # 10</td>
</tr>
<tr>
<td>Manufacture of 11 bifacial artifacts to gear up for large-scale bison hunting and discarding resulting debitage in two trash dumps (concentrations 1 and 2) of a camp midden (Area 1)</td>
<td>MAN # 21 through 31</td>
</tr>
<tr>
<td>Manufacture of 17 bifacial artifacts to gear up for large-scale bison hunting and discarding resulting debitage in two adjacent trash dumps comprising artifact concentration at the other camp midden (Area 2)</td>
<td>MAN # 39 through 51, 53 and 54, 56 and 57</td>
</tr>
<tr>
<td>Production of end scrapers from blocky cores in camp, use of scrapers on fresh hide, discard of scrapers in camp midden</td>
<td>MAN # 19, set of refitting artifacts # 1</td>
</tr>
<tr>
<td>Reduction of blocky core near a camp midden (Area 2) in order to produce informal flaked stone tools (gravers and utilized flakes) that were subsequently discarded in both camp middens (Areas 1 and 2)</td>
<td>MAN # 14 / set of refitting artifacts # 2. Also MAN # 15</td>
</tr>
<tr>
<td>Use of a grinding slab in camp resulting in breakage and subsequent discard of a fragment in a camp midden (Area 1). Reuse of another fragment in an activity producing wear on both faces, breakage of the fragment, and discard of the resulting fragments in the other camp midden (Area 2)</td>
<td>MAN # 17 / set of conjoining artifacts # 4</td>
</tr>
<tr>
<td>Reduction of locally available stream cobbles in camp area, use of some of the flakes produced as informal tools, and discard in camp midden</td>
<td>MAN # 32 and 33, 58 and 59</td>
</tr>
</tbody>
</table>
relating to minimum analytical nodules are given in Table B-2 with MANs demonstrating connections between areas listed first, followed by MANs providing evidence of connections among artifacts within areas.

The number of connections between areas of the site identified during analysis of the Jurgens collection provides strong support for the assertion that the site is the product of a single occupation by a large group. Most of the connections between areas are established by minimum analytical nodules composed of artifacts found in multiple areas. Table B-2 documents connections between areas and the number designation of MANs that provide evidence of behavioral connections between the contemporaneous areas. The numbers of MANs demonstrating connections between areas of the site are as follows: between Areas 1 and 2 = five MANs, between Areas 2 and 3 = seven MANs, between Areas 1 and 3 = three MANs, and between Areas 1, 2, and 3 = one MAN. Connections between Areas 1 and 2 are further demonstrated by two sets of refitting artifacts. The kinds of artifacts composing the MANs and sets of refitting artifacts demonstrating connections between areas and the behaviors they represent are discussed below.

Certain MANs and sets of conjoining or refitting artifacts together support the thinking that gearing up and processing of hides tended to occur in the vicinity of Areas 1 and 2 and that butchering of carcass segments transpired closer to Area 3. The MANs and refitting artifacts are listed in Table 10-8 and will be discussed in the order given.

The first four listings in the table basically concern gearing up with projectile points, use of those points in a large-scale bison hunt somewhere afield, and discard of broken or unwanted points back at the site. MAN # 37 consists of two preforms found in Area 2 and MAN # 6 consists of two other preforms from Area 2 and related bifacial thinning flakes, most of which came from Area 2. The two MANs suggest that point production principally took place near the centrally located camp midden where manufacturing rejects were discarded. This is affirmed by five MANs (# 2 – 5, 9) that are composed of a point discarded
or lost in the butchering midden (Area 3) and flakes from one of the camp middens. In
combination, the five MANs suggest points were made in or near camp, used somewhere
afield, and discarded or lost during butchering operations at the northwestern end of the site.
One of the five MANs consists of a point from Area 3 and a utilized flake that ended up in
Area 1. Four of the five MANs are comprised of a point from Area 3 and one or more waste
flakes from Area 2 and affirm that point production took place near Area 2. Of these four
MANs, two have flakes from one or both clusters of the artifact concentration in Area 2,
indicating that they were discarded along with lots of other debitage during instances when
debris in camp was cleaned up and dumped in a nearby midden. Two sets of conjoining
artifacts (#11 and 12) are fragments of points from the butchering midden.

Three MANs suggest that other points manufactured mostly or entirely near Area 2
were used in the field and then returned to the camp area where hunting weaponry was
repaired and unwanted points were discarded in Area 2. The first MAN (#1) is composed of
a point tip and several flakes (Figure 10-6). Though not visible in the photograph, the raw
material of all of the artifacts is composed of areas of clear matrix that are embedded with
yellowish brown branching structures suggestive of fossils. The internal structure of the tool
stone therefore further allowed the artifacts to be assigned to the same MAN. The bifacial
artifact is a tip from an artifact with a triangular blade that has lateral edges that converge
toward the tip (catalog #23046). Wheat (1979:Table 23) considers the artifact to be the
fragment of a stemmed knife. However, Cody points with triangular blades are known from
the Central Points and the Wyoming Basin (Ingbar and Frison 1987:Figures A6.1-A6.4;
Knudson 2002:Figure 7.16), although no complete specimens were recovered from the
Jurgens site. The biface tip is here considered to be more likely a point than a stemmed knife.
The point and four flakes (two of which were utilized) were found in Area 2. The fact that
the point tip and two of the flakes were found in the western cluster of the artifact
concentration in Area 2 demonstrates that they were discarded during the same episode of
Figure 10-6. Six of eight artifacts comprising Minimum Analytical Nodule 1. The artifacts came from different areas of the Jurgens site and all derive from manufacture of one point of Hartville Uplift chert. a) utilized interior flake from ground surface of Area 1 (catalog # 30196, item 34). b) – d) artifacts from Area 2: b) biface thinning flake from ground surface (catalog # 30197, item 109), c) utilized biface thinning flake from ground surface (catalog # 30197, item 108), d) tip of point (a.k.a. “stemmed knife,” according to Wheat’s (1979) classification) (excavation unit 10F60, catalog #23046). e) utilized biface thinning flake from Area 3 (excavation unit 5D21, catalog # 19594). f) utilized biface thinning flake from ground surface of Fill Area (catalog # 30199, item 16). Two artifacts not illustrated are a biface thinning flake (catalog # 23095, field specimen F86) and a utilized biface thinning flake (catalog # 23095, field specimen F82), both from Excavation Unit 10F60 in Area 2.
camp cleaning. One utilized flake belonging to the MAN was discarded in Area 1 and another ended up in Area 3. The second MAN (# 7) consists of a point from the ground surface of Area 2 and two flakes that had been discarded in the eastern cluster of the artifact concentration of Area 2 during camp clean up. Finally, MAN # 8 consists of a short point, two point bases, and 12 waste flakes. The points and three of the flakes had been dumped in the eastern cluster of the artifact concentration and seven flakes were tossed onto the western cluster. Two of the flakes had somehow ended up in the other camp midden (Area 1).

Some commentary on points recovered from the butchering midden is in order because characteristics of the artifacts are not congruent with the concept of a frugal Paleoindian lithic technology. Point fragments embedded in flesh, either by themselves or still attached to foreshafts, may have been found by people when stripping meat from carcass segments. Points encountered during meat stripping were apparently discarded in Area 3 along with the bison remains. Broken points were present along with complete points. Of a total of 33 points and “stemmed knives” recovered from Area 3, two are long, complete points (Wheat 1979:Figure 37 a, length = 8.7 cm, Figure 41 a, length = 7.2 cm) and one is a long point with all but the very tip missing (Wheat 1979:Figure 35 a, no catalog number, designated “Test C-2,” length = 9.2 cm). Presence of points that are either functional or can be refurbished with a little effort in what is thought to be a trash deposit may at first be surprising. Articulated carcass segments in Area 3 suggests that long points at Jurgens may simply have not been retrieved by Paleoindians from the less than fully processed carcass segments. The presence of a number of short, complete and fully functional points as well as large fragments that could have been reworked into smaller points is of interest. Of the 33 points and stemmed knives from Area 3, three are the long, complete or nearly complete points mentioned above, seven are shorter, complete points less than 5½ cm in length (Wheat 1979:Figures 37 b, d, e, 38 a, d, e, 39 a) and eight are fragments over 5 cm in length that could have been reworked into complete points, if so desired (Wheat 1979:Figure 34 a top, 34
a bottom, 34 b, 35 b, 39 f, 39 g, 40 a, 42 b). (Figure 36 a appears to be a fragment over 5½ cm in length, but was found in two fragments). The presence of a number of complete functional points is noteworthy because this is not in conformity with the traditional view of Paleoindians needing to conserve tool stone to enable a highly mobile way of life.

A single MAN is noteworthy because it provides some support for the reconstruction of Area 3 as principally a butchering midden. The MAN (# 10) is comprised of the tip of a stemless knife from Area 3 and a utilized flake from Area 2. Together, the artifacts suggest a knife was manufactured in the camp area and later broken during the process of butchering near Area 3 where the fragment was discarded. The knife fragment had a graver retouched into the extreme tip and therefore evidently was reused for another purpose prior to discard. Unfortunately, the knife was not among the tools from Area 3 examined for use wear by Muniz (2005), so the suggestion that the biface was used to cut meat during bison butchering can not be confirmed.

Eleven minimum analytical nodules are comprised of artifacts that were mostly or wholly within the concentrations in Area 1 and are interpreted as evidence that gearing up for a large-scale bison hunt involved production of a lot of bifacial artifacts. Manufacturing debris from this activity was cleaned up and discarded in the concentrations in Area 1 that are thought to represent trash dumps. The MANs are comprised of anywhere from two to 13 items, with most being classified as biface thinning flakes or interior flakes. Evidently, some of these flakes were subsequently utilized before being discarded. Flint knapping experiments demonstrate that potentially hundreds of flakes are produced when a single bifacial artifact is manufactured from start to finished. For example, during the production of three Clovis points, Henry et al. (1976:Table 2) report that a total of 538 flakes larger than one cm in maximum dimension are produced. This equates to about 179 flakes for each point made. One might expect that fewer flakes per bifacial artifact would be produced at Jurgens if partially finished bifaces and point preforms were being completed into points and knives.
Also, the excavation technique employed at Jurgens is described as involving excavating with trowels and sometimes screening the fill through coarser-meshed screen (Wheat 1979:118). This would result in recovery of fewer flakes from each biface in comparison to screening all fill from the cultural level through 1/4 in or 1/8 in hardware mesh, as is commonly done today. Nevertheless, the above factors are not likely to have been the main cause of the generally low number of flakes that can be associated with a particular biface. Rather, it is suggested that the process of cleaning up a part of the living space in a camp and dumping the debris in the midden in Area 1 resulted in there being relatively few biface thinning flakes from each biface in comparison to the number of thinning flakes actually removed on the site from each biface. Nodule 21 is composed of by far the largest number of flakes or utilized flakes from a biface in Area 1 (n = 13) and includes twelve biface thinning flakes and one uniface resharpening flake, indicating that the batch of stone represented by this MAN was not only used to make a bifacial artifact, but also a unifacial tool.

Of the eleven bifaces represented by the MANs from the concentrations in Area 1, two have thinning flakes definitely or possibly in concentration 1 (nodules 28 and 29), three have thinning flakes definitely or possibly in concentration 2 (nodules 27, 30, and 31), and six have thinning flakes in both concentrations (nodules 21 – 26) (Table B-2). This situation strongly suggests that the two concentrations both relate to gearing up activities conducted in advance of a large bison hunt and that they represent trash dumps that were used during the same occupation of the site.

Of the eleven nodules from Area 1 discussed above, six are made of Hartville Uplift chert, three are of the very rough-textured orthoquartzite variety of WRGG, and two are of Flat Top chalcedony. The relative lack of Flat Top chalcedony does not necessarily by itself reflect a low frequency of biface thinning flakes of this material in Area 1 concentrations. Rather, this phenomenon could be due to the lack of memorable color distinctions between
artifacts of this material. To some extent, this may also account for the complete lack of bifaces of Dawson petrified wood among the nodules identified for Area 1.

An extensive analysis of the distribution of bison remains at Jurgens is beyond the scope of this project, however, it should be noted that artifact concentration 2 in Area 1 appears to coincide well with the distribution of long bone fragments and metapodials. The apparent correlation is seen by comparing Figures 15 h and 63 in the site report (Wheat 1979). The correlation implies that an episode of cleaning up involved gathering together debris from both stone tool manufacture and bone breaking operations to extract marrow and then dumping both in the same trash scatter in Area 1.

The minimum analytical nodules identified in the concentration of artifacts in Area 2 also provide evidence that the process of gearing up at the Jurgens site involved manufacturing a lot of bifacial artifacts. As mentioned previously, the concentration in Area 2 has a cluster of debitage in the western half and a cluster in the eastern portion. This suggests two discrete trash dumps are represented. The minimum analytical nodule analysis confirmed this suspicion. Of the 17 nodules defined during analysis, 16 represent bifaces from which thinning flakes were detached (nodules 40 – 51, 53 – 54, 56 – 57) and one is a batch of stone from which both bifacial artifacts and blocky cores were produced (nodule 39) (Table 8-2). Flakes from all nodules were either all or mostly in one of the two halves of the concentration, thus affirming that two discrete trash dumps are present.

Seven minimum analytical nodules representing bifaces were identified in the debitage from the western half of the Area 2 concentration. MAN # 40 is comprised of by far the most flakes. Twenty-three flakes from the western half of the concentration and four from the eastern half derive from the MAN # 40 biface (Table B-2). Six other nodules (# 45 – 46, 53 – 54, and 56 – 57) represent bifaces and consist of two to four flakes recovered from the western half.
Ten minimum analytical nodules were identified in the debitage from the eastern half of the concentration in Area 2. MAN # 39 represents a batch of stone from which bifacial and unifacial artifacts were produced. Nodule 39 is comprised of by far the most items (n = 67), including flakes (and utilized flakes) and a piece of scatter. Included in the collection of artifacts are 17 biface thinning flakes and 20 blocky core reduction flakes. Of the 67 total flakes, 63 were found in the eastern half of the concentration and only four were found in the western half. MAN # 41 consists of 23 interior flakes or biface thinning flakes. A total of 19 flakes of this MAN were recovered from the eastern half of the concentration with only four coming from the western half. The remaining eight nodules identified from the eastern half of the concentration (nodules 42 – 44 and 47 – 51) are comprised of between three to 10 flakes, all of which were found in the eastern half of the concentration.

Of the 17 nodules from Area 2 discussed above, nine are made of the very-rough textured orthoquartzite variety of WRGG, two are of the Morrison orthoquartzite variety of WRGG, five are of Hartville Uplift chert, and one is of Dawson petrified wood. As previously suggested for the Area 1 concentrations, the lack of nodules of Flat Top chalcedony recognized for the concentration in Area 2 does not reflect a relative absence of biface thinning flakes of this raw material from Area 2. Rather, this phenomenon likely results from a lack of memorable color distinctions between artifacts of the tool stone. A lack of color distinction between flakes of Dawson petrified wood may also explain the relative lack of nodules of this material identified in the above minimum analytical nodule analysis.

The camp middens produced a set of refitting artifacts and a minimum analytical nodule which together support the scenario that end scrapers were manufactured in or near camp from flakes struck from blocky cores and then used on fresh bison hides obtained in a large-scale hunt. Set of refitting artifacts # 1 consists of an end scraper from artifact concentration 1 in Area 1 and an unutilized flake that refits to the dorsal face of the scraper. The waste flake was struck from the dorsal face of the scraper during manufacture and was
found in the excavation unit immediately west of the artifact concentration in Area 2. The flake blank from which the scraper was retouched can not be said to have definitely been a blocky core reduction flake. Use wear analysis of the end scraper revealed that it was used on fresh hide (Muniz 2005:362). The set of refitting artifacts supports the view that end scrapers were manufactured in or near camp and later used on bison hides obtained in a large-scale hunt. Later still, the end scraper and matching waste flake were discarded in trash dumps in the camp middens along with other artifacts when the camp or adjacent work areas were cleaned up.

Minimum analytic nodule # 19 consists of an end scraper from the ground surface in Area 1 and an unutilized blocky core reduction flake possibly from concentration 1 in Area 1. The core reduction flake is 3.2 cm long. The shape of the end scraper indicates it was made by retouching a core reduction flake measuring at least 4.3 cm long. Use wear on the scraper indicates it was used on fresh hide (Muniz 2005:362). MAN # 19 strongly suggests that both the waste flake and end scraper were struck from a blocky core and that only one of two flakes produced was deemed to be of suitable size and shape to be retouched into an end scraper. The waste flake was possibly discarded in a trash dump in Area 1 along with other artifacts when the camp or adjacent work areas were cleaned up.

Other MANs demonstrative of manufacture and use of end scrapers in or near camp may have been missed when the assemblage was examined. End scrapers are a common artifact class in the collection and, as elaborated below, most were made from Flat Top chalcedony. The relatively non-distinctive coloration of many of the artifacts of Flat Top chalcedony may have contributed to the low number of MANs identified that are indicative of end scraper production at the Jurgens site.

That Areas 1 and 2 may be interpreted as middens adjacent to a camp where people performed a similar set of activities is supported by two MANs that are demonstrative of reduction of blocky cores near Area 2 to produce informal flaked stone tools (gravers and
utilized flakes) that were subsequently discarded in both camp middens. Flakes were apparently struck off of a thick bifacial core made from a river cobble of metaquartzite in the vicinity of Area 2 and one of the flakes was modified into a graver. The core and two secondary flakes were found in Area 2. One secondary flake was excavated from the western cluster of the artifact concentration representing a trash dump. The graver apparently was taken to the portion of the camp or an adjacent work area near Area 3 where the informal tool was put to use and later discarded in Area 3. The graver and one secondary flake refit to the core (set of refitting artifacts # 2 / MAN # 14) (Figure 7-6). All together, the artifacts represent knapping of a core near Area 2 to produce a number of flakes, selection of one with an appropriately shaped projection to serve as a graver, and use of the informal tool elsewhere in or near the camp portion of the site, after which it was finally discarded in Area 3.

Minimum analytical nodule # 15 is comprised of a graver (Figure 7-12 j) and six utilized flakes from Area 2, as well as three utilized flakes from Area 1. The graver and seven of the nine utilized flakes were struck from a blocky core. All of the artifacts are from the ground surface, except for three excavated from Area 2. Of the three flakes with specific provenience information, one came from the western cluster of the concentration in Area 2, one possibly did, and one possibly originated from the eastern cluster. From the above information, it may be surmised that flakes were struck from a blocky core to produce informal tools (a graver and utilized flakes) which were subsequently used in the camp or adjacent work areas located in both the central and southeastern portion of the site. The tools from Area 2 were discarded in the adjacent trash dump along with other artifacts when the camp or adjacent work areas were cleaned up.

A final MAN demonstrating a connection between the activities performed in the camp or adjacent work areas near Area 1 and those carried out in or near Area 2 is composed of four fragments of what was originally a relatively large grinding slab (Table 10-1).
Though the fragments are obviously not part of a nodule of siliceous tool stone, the practice of identifying fragments from the same piece of stone that were found in different parts of a site is a useful method of investigating site formation processes that can be applied to ground stone artifacts as readily as it can to flaked stone. Two conjoining fragments from the ground surface of Area 1 form a large fragment of a grinding slab of light brown Lyons Sandstone that has unusual markings for the raw material in the form of sparse, circular rust-colored or brown spots. A large scratch running across one face of both fragments suggests recent breakage by farm equipment. Two other fragments from the ground surface of Area 2 are discolored from exposure to fire but also are thought to derive from the same grinding slab. Of these two fragments, one has the same unusual spots, but they are now maroon from having been oxidized when the fragment was subjected to fire. The other fragment was darkened to a medium gray by fire and, as a result, may now lack the distinctive spots. Unlike the fragments from Area 1, which demonstrate grinding use on only one face, those from Area 2 were used on both faces. All fragments are of similar thickness. The above suggests that the original grinding slab fragment, which had been used on one face, was broken in camp or an adjacent work area and a large fragment was discarded in Area 1. A piece of the grinding slab was taken to near Area 2 where it was reused in such a manner that both faces were ground. This piece was then broken, the resulting fragments were differentially subjected to fire, and they then were discarded in Area 2.

Four minimum analytical nodules identified in the collection of artifacts from Areas 1 and 2 support the idea that stream cobbles were knapped on-site as part of a core-and-flake technology in order to make use of available lower-quality local stone to produce informal tools. Such tools could be used in daily camp activities or tasks related to communal hunting that did not require formal tools and thus served to conserve supplies of stone from high-quality sources. Four MANs, numbered 32 to 33 and 58 to 59 are composed of flakes that include one or more decortication flakes struck from cobbles obtained from the locally
available White River Group gravels. Two of the three artifacts comprising Nodule 59 are utilized flakes, suggesting that a cobbled may have been knapped to produce expedient flake tools. As mentioned above, the very rough-textured orthoquartzite variety of WRGG may have been used especially for making bifacial artifacts to gear up for bison hunting. The blocky cores represented by the four analytical nodules, to the contrary, are of other varieties of WRGG. Two of the minimum analytical nodules each included two or three flakes collected from the ground surface of Area 2 (Nodules 58 and 59). The remaining two MANs were each composed of two or three flakes from Area 1. Two of the three flakes comprising Nodule 32 were recovered from excavation unit 15I24. The third flake also came from an excavated context, but was found in back dirt and the area in which it was found was not specified. One of the two flakes comprising Nodule 33 was exhumed from excavation unit 15I23 and the other was collected from the ground surface. The excavation units that produced flakes of Nodules 32 and 33 are in the general midden deposit of Area 1, not either of the concentrations of artifacts thought to be associated with large-scale hunting. Although by no means definitive, the context of the flakes of nodules 32 and 33 tends to support the thinking that they were discarded in the Area 1 midden during one or more episodes of trash disposal separate from the times when debitage and tools related to gearing up and hide scraping were dumped to make the artifact concentrations in Area 1.

In summary, it may be stated that minimum analytical nodule analysis and artifact refitting and conjoining have proven helpful in developing the idea that the Jurgens site is a result of occupation by a large group of people involved in communal hunting. The analysis demonstrated multiple connections between all areas of the site. Furthermore, the analytical techniques elucidated the manner in which gearing up activities and processing of bison products took place in various parts of the site.
THE ARTIFACT COMPOSITION OF THE MAIN TOOL STONES

The artifact composition of the main tool stones was analyzed to test the thinking that the main tool stones from local and distant sources would have been those exploited by local and neighboring bands to gear up with formal tools and that locally available stream cobbles would have been used in a core-and-flake technology to make informal tools to conserve stone for gearing up. Table 10-9 presents a chi-square table comparing the main tool stones by various categories of debitage and tools. A chi-square value of 454.82 was calculated from data in the table and has a probability of .000 of occurring by chance alone. This indicates that artifact frequencies in particular cells are not simply a reflection of the frequency of a particular tool stone type and the frequency of a certain artifact category. The table provides basic data on the differences between raw materials in terms of the kinds of artifacts made of the main tool stones.

Because most artifacts of each of the main tool stones are debitage, the table is primarily of value for noting basic differences between the raw materials in regard to the relative proportion of the debitage present and specifically the relative proportion of what might be termed early-stage debitage, which characteristically has varying amounts of cortex remaining, and generally later-stage debitage, which is comprised of flakes without cortex. The sample of Flat Top chalcedony is comprised of the most amount of debitage according to artifact count (94.3 percent), followed in order of decreasing frequency by WRGG (85.4 percent), Hartville Uplift chert (82.6 percent), and Dawson petrified wood (72.1 percent). To characterize differences between the main tool stones in regard to the relative frequency of various kinds of debitage they contain, the reader is referred to the top two rows of Table 10-9. To create an artifact category comprised of debitage from early stages of stone tool manufacture that generally has cortex remaining, the following artifact types were combined: blocky cores, bifacial cores, tested cobbles or pebbles, pieces of shatter, primary flakes, and...
Table 10-9. Chi-Square Table Showing Main Tool Stone Types by Artifact Category.

<table>
<thead>
<tr>
<th>Artifact Category</th>
<th>Main Tool Stone Types</th>
<th>White River Group Gravel</th>
<th>Flat Top Chalcedony</th>
<th>Dawson Petrified Wood</th>
<th>Hartville Uplift Chert</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Count</td>
<td></td>
<td>82</td>
<td>12</td>
<td>12</td>
<td>10</td>
<td>116</td>
</tr>
<tr>
<td>Expected Count</td>
<td></td>
<td>20.6</td>
<td>71.2</td>
<td>7.3</td>
<td>16.9</td>
<td>116.0</td>
</tr>
<tr>
<td>Std. Residual</td>
<td></td>
<td>13.5</td>
<td>-7.0</td>
<td>1.7</td>
<td>-1.7</td>
<td></td>
</tr>
<tr>
<td>Interior Flakes (Including Utilized Specimens)</td>
<td>Count</td>
<td>316</td>
<td>1510</td>
<td>107</td>
<td>307</td>
<td>2240</td>
</tr>
<tr>
<td>Expected Count</td>
<td></td>
<td>397.0</td>
<td>1375.2</td>
<td>140.6</td>
<td>327.2</td>
<td>2240.0</td>
</tr>
<tr>
<td>Std. Residual</td>
<td></td>
<td>-4.1</td>
<td>3.6</td>
<td>-2.8</td>
<td>-1.1</td>
<td></td>
</tr>
<tr>
<td>Informal Retouched Flake Tools</td>
<td>Count</td>
<td>20</td>
<td>25</td>
<td>15</td>
<td>16</td>
<td>76</td>
</tr>
<tr>
<td>Expected Count</td>
<td></td>
<td>13.5</td>
<td>46.7</td>
<td>4.8</td>
<td>11.1</td>
<td>76.0</td>
</tr>
<tr>
<td>Std. Residual</td>
<td></td>
<td>1.8</td>
<td>-3.2</td>
<td>4.7</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>End Scrapers</td>
<td>Count</td>
<td>1</td>
<td>41</td>
<td>18</td>
<td>27</td>
<td>87</td>
</tr>
<tr>
<td>Expected Count</td>
<td></td>
<td>15.4</td>
<td>53.4</td>
<td>5.5</td>
<td>12.7</td>
<td>87.0</td>
</tr>
<tr>
<td>Std. Residual</td>
<td></td>
<td>-3.7</td>
<td>-1.7</td>
<td>5.4</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>Unfinished Bifaces (Stages 2 and 3), Finished (Stage 4) Bifaces, Stemless Knives, and Drills</td>
<td>Count</td>
<td>7</td>
<td>9</td>
<td>3</td>
<td>6</td>
<td>25</td>
</tr>
<tr>
<td>Expected Count</td>
<td></td>
<td>4.4</td>
<td>15.3</td>
<td>1.6</td>
<td>3.7</td>
<td>25.0</td>
</tr>
<tr>
<td>Std. Residual</td>
<td></td>
<td>1.2</td>
<td>-1.6</td>
<td>1.1</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>Projectile Points, Preforms, and &quot;Stemmed Knives&quot;</td>
<td>Count</td>
<td>40</td>
<td>17</td>
<td>10</td>
<td>18</td>
<td>85</td>
</tr>
<tr>
<td>Expected Count</td>
<td></td>
<td>15.1</td>
<td>52.2</td>
<td>5.3</td>
<td>12.4</td>
<td>85.0</td>
</tr>
<tr>
<td>Std. Residual</td>
<td></td>
<td>6.4</td>
<td>-4.9</td>
<td>2.0</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>466</td>
<td>1614</td>
<td>165</td>
<td>384</td>
<td>2629</td>
</tr>
<tr>
<td>Expected Count</td>
<td></td>
<td>466.0</td>
<td>1614.0</td>
<td>165.0</td>
<td>384.0</td>
<td>2629.0</td>
</tr>
</tbody>
</table>
secondary flakes. Even though utilized primary and secondary flakes are technically tools, they were added to this category because they exhibit cortex indicative of early stages of stone tool production. (Blocky cores, bifacial cores, and pieces of shatter do not necessarily have cortex, nor do they always represent the early stages of stone tool manufacture. Examples of these artifact types are few in number and were added to the category comprised mostly of decortication flakes to set this category of debitage apart from interior flakes).

Interior flakes in large part form a category of debitage that is more commonly produced in subsequent stages of manufacture. Though technically tools, utilized interior flakes are included in this category. The reader will recall that standardized residuals in the cells of the first two rows that are greater than 1.64 or less than -1.64 are noteworthy because they may denote cells with observed frequencies that vary greatly from expected frequencies under a random distribution and therefore account for much of the variation making for a significant chi-square result.

Raw data and statistical measures presented in the top two rows of Table 10-9 demonstrate meaningful differences in the artifactual composition of the main tool stones. In the sample of artifacts of WRGG, a standardized residual of 13.5 indicates that artifacts signifying the earlier stages of manufacture are much more common than would be expected if early-stage artifacts were randomly distributed across tool stone types. A standardized residual of -4.1 indicates that interior flakes and utilized interior flakes of WRGG are less common than expected. These two observations on the frequency of artifacts from earlier stages of manufacture relative to the frequency of artifacts common to later stages affirms the hypothesis that the sample of locally available cobbles of WRGG includes a high proportion of earlier stage artifacts in comparison to the other main tool stones. This in turn provides some support for the thinking that a certain amount of the WRGG sample is composed of flakes struck from cobbles as part of a core-and-flake technology to make expedient stone tools.
Trends evident in the frequency data for Flat Top chalcedony are opposite to those for WRGG (Table 10-9). There are far fewer pieces of early-stage debitage of this raw material than would be expected under a null hypothesis. The artifacts of early-stage debitage of Flat Top chalcedony include only 10 secondary flakes and two pieces of shatter. Interior flakes and utilized interior flakes of Flat Top chalcedony are more frequent than expected under the null hypothesis. The above information suggests that the pieces of Flat Top chalcedony were brought to the Jurgens site primarily in the form of prepared blocky cores that had all or most cortex removed and as unfinished bifaces that likely had no cortex. Flat Top chalcedony was the raw material used in most of the flintknapping that occurred on-site. This raw material accounts for 1,510 interior flakes and utilized interior flakes from the site. The next most common raw material in the sample of interior flakes and utilized interior flakes is WRGG with 316 artifacts, followed closely by Hartville Uplift chert with 307 specimens.

Trends in the relative frequencies of early and late-stage Dawson petrified wood debitage are also noteworthy. There are more pieces of early-stage debitage of this raw material than expected. Early-stage debitage of Dawson petrified wood includes a tested pebble, a blocky core, two primary flakes, and eight secondary flakes. As discussed previously, a certain amount of stream-rounded pieces of Dawson petrified wood from local South Platte River gravels are likely included in the sample of this raw material which is principally believed to be comprised of tool stone obtained from primary sources in the Palmer Divide area. Knapping of locally obtained stream-rounded cobbles of Dawson petrified wood should have produced a proportionately high amount of debitage with cortex. This likely would have contributed to the unexpectedly high observed frequency of early-stage debitage of Dawson petrified wood. The observed frequency of late-stage debitage of Dawson petrified wood is correspondingly less than expected.
The less-than-expected observed frequencies of late-stage debitage of Dawson petrified wood, WRGG, and Hartville Uplift chert is in part simply due to the much greater amounts of late-stage debitage of Flat Top chalcedony. However, the less-than-expected observed frequencies do point out the fact that the frequencies of interior flakes and utilized interior flakes are low relative to the number of formal tools. Counts of finished and unfinished formal tools are given in the bottom three rows in Table 10-9. The ratio of interior flakes and utilized interior flakes to finished and unfinished formal tools for each of the main tool stones is as follows: WRGG = 316 : 48, Flat Top chalcedony = 1,510 : 67, Dawson petrified wood = 107 : 31, Hartville Uplift chert = 307 : 51. When it is recalled that manufacture of a single Paleoindian point can produce roughly 179 flakes that would get caught in a ¼ in screen (Henry et al. 1976), it becomes apparent that many of the smaller interior flakes may be underrepresented. A number of factors may be proposed that may contribute toward the apparent underrepresentation of interior flakes. First of all, some flintknapping related to gearing up may have occurred at another location. Secondly, cleaning up activities by Paleoindians may have tended to collect items larger than five cm in maximum dimension, as has been noted for ethnographic foragers (O’Connell 1987:82). This would cause interior flakes to be underrepresented because interior flakes in the collection are, for the most part, less than 5 cm in maximum dimension. Finally, the lack of systematic screening during excavation of the Jurgens site would have contributed to an underrepresentation of the smaller size ranges of interior flakes.

Like Flat Top chalcedony, the observed frequency of early-stage debitage made from Hartville Uplift chert was significantly less than expected. Eight secondary flakes and two pieces of shatter comprise the early-stage debitage of Hartville Uplift chert. Artifacts of the above two tool stones demonstrate that raw material intended for use in gearing up arrived at the site in a relatively finished form with little cortex remaining. As mentioned, the greater-than-expected frequency of early-stage debitage of WRGG with cortex may be due to
incorporation of artifacts produced as part of a core-and-flake technology. Also, the greater-than-expected number of pieces of early-stage debitage from Dawson petrified wood is likely due to inclusion in the sample of artifacts made from locally available stream cobbles of the petrified wood that derive from South Platte River gravels.

Statistically significant standardized residuals are present in the rows of Table 10-9 that pertain to retouched tools. However, relationships among data relating to retouched tools is best examined in tables that compare retouched tool categories alone in the absence of the effect of large amounts of debitage. Such tables are presented later in this chapter.

Table 10-10 presents data comparing the artifactual composition of the sample of very rough-textured orthoquartzite from the Jurgens site and a combined sample of all other varieties of White River Group gravel. A chi-square test was run using data in the table and a chi-square value of 112.92 was obtained with a low associated probability (p = .000). This indicates that the differences between the two categories of tool stone as expressed in the observed frequencies of artifacts in each cell are highly unlikely to have occurred through chance alone. In the category that includes all varieties of WRGG besides very rough-textured orthoquartzite, early-stage debitage occurs much more commonly than expected and the frequency of late-stage debitage is less frequent than expected. This supports the thinking that varieties of WRGG besides very rough-textured orthoquartzite were used to produce expedient flake tools from stream cobbles. Reducing river cobbles of WRGG would produce a relatively high proportion of tested cobbles with cortex and decortication flakes in comparison to interior flakes.

In contrast, early-stage debitage of very rough-textured orthoquartzite is much less common than expected while late-stage debitage of this tool stone is more abundant. As discussed previously, evidence exists to suggest that very rough-textured orthoquartzite may occur naturally in comparatively large pieces. Knapping of relatively large stream-rounded cobbles of this tool stone would produce proportionally more interior flakes in comparison to
Table 10-10. Chi-Square Table Showing Very Rough-Textured Orthoquartzite and Other Varieties of Tool Stone from the White River Group Gravels by Artifact Category.

<table>
<thead>
<tr>
<th>Artifact Category</th>
<th>Cores, Tested Cobbles or Pebbles, Pieces of Shatter, and Flakes with Cortex (Including Utilized Specimens)</th>
<th>Count</th>
<th>Expected Count</th>
<th>Std. Residual</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Variety of Tool Stone from White River Group Gravels</td>
<td>Very Rough-Textured Orthoquartzite</td>
<td>All Other Varieties</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Count</td>
<td>27</td>
<td>55</td>
<td>82</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expected Count</td>
<td>60.7</td>
<td>21.3</td>
<td>82.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Std. Residual</td>
<td>-4.3</td>
<td>7.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interior Flakes (Including Utilized Specimens)</td>
<td>Count</td>
<td>271</td>
<td>45</td>
<td>316</td>
<td></td>
</tr>
<tr>
<td>Count</td>
<td>233.9</td>
<td>82.1</td>
<td>316.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Std. Residual</td>
<td>2.4</td>
<td>-4.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Informal Retouched Flake Tools and End Scrapers</td>
<td>Count</td>
<td>8</td>
<td>13</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Count</td>
<td>15.5</td>
<td>5.5</td>
<td>21.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Std. Residual</td>
<td>-1.9</td>
<td>3.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unfinished Bifaces (Stage 2), Finished (Stage 4) Bifaces, and Stemless Knives</td>
<td>Count</td>
<td>7</td>
<td>0</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Count</td>
<td>5.2</td>
<td>1.8</td>
<td>7.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Std. Residual</td>
<td>.8</td>
<td>-1.3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Projectile Point Preforms</td>
<td>Count</td>
<td>10</td>
<td>1</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Count</td>
<td>8.1</td>
<td>2.9</td>
<td>11.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Std. Residual</td>
<td>.7</td>
<td>-1.1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Projectile Points and &quot;Stemmed Knives&quot;</td>
<td>Count</td>
<td>22</td>
<td>7</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Count</td>
<td>21.5</td>
<td>7.5</td>
<td>29.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Std. Residual</td>
<td>.1</td>
<td>-.2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>345</td>
<td>121</td>
<td>466</td>
<td></td>
</tr>
<tr>
<td>Expected Count</td>
<td>345.0</td>
<td>121.0</td>
<td>466.0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
decortication flakes. Also, if most of the very rough-textured orthoquartzite was brought to
the site to gear up, it likely would have been in the form of unfinished bifaces with no cortex
or prepared blocky cores with little to no remaining cortex. This would also serve to increase
the proportion of interior flakes of this raw material relative to decortication flakes.

A disproportionately high number of informal retouched flake tools made of varieties
of WRGG other than very rough-textured orthoquartzite also supports the view that other
varieties of the local tool stone were favored for use in production of expedient tools. To
meet the recommendation of the chi-square test that no more than 20 percent of cells have
expected frequencies less than five, the separate rows for informal retouched flake tools and
end scrapers that appear in Table 10-9 were collapsed in Table 10-10. Only one of the
artifacts of WRGG is an end scraper and it is made of very rough-textured orthoquartzite. All
other artifacts of WRGG in the category are informal retouched flake tools. With this in
mind, it is relevant to note that the observed frequency of informal retouched flake tools of
other varieties of WRGG is much higher than expected. This is in agreement with the
assertion that local cobbles of WRGG would have been knapped during occupation of the site
by local people in order to make expedient flake tools. On the other hand, there are far fewer
than expected informal retouched flake tools of very rough-textured orthoquartzite. An
abundance of interior flakes of this raw material would be produced as a by-product of
gearing up. Therefore, the proportion of flakes of very rough-textured orthoquartzite that
were worked into informal retouched flake tools would be low relative to flakes of other
varieties of WRGG.

Table 10-11 presents data for a chi-square test comparing the main tool stones by
various categories of retouched tools. Data in the table was used to calculate a chi-square
statistic of 42.33, which has an associated probability of .000, indicating that the variation of
observed frequencies from expected counts is highly unlikely to have arisen through chance
alone. Examination of the table reveals that much of the total variation from expected
Table 10-11. Chi-Square Table Showing Main Tool Stone Types by Retouched Tool Category.

<table>
<thead>
<tr>
<th>Artifact Category</th>
<th>Main Tool Stone Types</th>
<th>White River Group Gravel</th>
<th>Flat Top Chalcedony</th>
<th>Dawson Petrified Wood</th>
<th>Hartville Uplift Chert</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Informal Retouched Flake Tools</td>
<td>Count</td>
<td>18</td>
<td>25</td>
<td>15</td>
<td>16</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>15.8</td>
<td>25.9</td>
<td>12.8</td>
<td>19.6</td>
<td>74.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>.6</td>
<td>-2</td>
<td>.6</td>
<td>-.8</td>
<td></td>
</tr>
<tr>
<td>End Scrapers</td>
<td>Count</td>
<td>1</td>
<td>41</td>
<td>18</td>
<td>27</td>
<td>87</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>18.5</td>
<td>30.4</td>
<td>15.0</td>
<td>23.1</td>
<td>87.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>-4.1</td>
<td>1.9</td>
<td>.8</td>
<td>.8</td>
<td></td>
</tr>
<tr>
<td>Finished (Stage 4) Bifaces and Stemless Knives</td>
<td>Count</td>
<td>5</td>
<td>6</td>
<td>1</td>
<td>5</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>3.6</td>
<td>5.9</td>
<td>2.9</td>
<td>4.5</td>
<td>17.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>.7</td>
<td>.0</td>
<td>-1.1</td>
<td>.2</td>
<td></td>
</tr>
<tr>
<td>Projectile Points and &quot;Stemmed Knives&quot;</td>
<td>Count</td>
<td>29</td>
<td>15</td>
<td>9</td>
<td>18</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>15.1</td>
<td>24.8</td>
<td>12.3</td>
<td>18.8</td>
<td>71.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>3.6</td>
<td>-2.0</td>
<td>-.9</td>
<td>-.2</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>53</td>
<td>87</td>
<td>43</td>
<td>66</td>
<td>249</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>53.0</td>
<td>87.0</td>
<td>43.0</td>
<td>66.0</td>
<td>249.0</td>
</tr>
</tbody>
</table>
frequencies is due to the degree to which observed frequencies of end scrapers and projectile points of WRGG and Flat Top chalcedony deviate from expected frequencies. Bands planning to participate in a communal kill should have had some conception of the number of points or preforms that their members would need to have in order to be equipped with sufficient hunting weaponry in finished or nearly finished form. Participating bands should also have been able to estimate the number of end scrapers or blocky cores that would have been needed to be well supplied with scraping tools or cores from which flake blanks for scrapers could be produced. If so, one might expect that the proportions of points and end scrapers in each of the main tool stones should be roughly similar. This is the situation with Dawson petrified wood and Hartville Uplift chert. In the samples of artifacts of these tool stones, end scrapers outnumber points and the observed frequencies of points and end scrapers do not vary much from the expected frequencies which may be thought of as the ideal numbers of points and end scrapers needed to be prepared for a large-scale bison hunt.

In contrast, the expected frequencies of points and end scrapers of WRGG and Flat Top chalcedony are so far from the expected frequencies that they require that an *ad hoc* explanation be proposed to account for why the observed frequencies are so different from expected. About 18 end scrapers of WRGG were expected, but only one was present in the Jurgens collection. As mentioned above, the end scraper was made of the very rough-textured orthoquartzite variety of WRGG, which is a variety believed to have been selected for gearing up. It would appear that very rough-textured orthoquartzite was avoided for use in the manufacture of end scrapers.

Evidence that orthoquartzite was avoided for making end scrapers in favor of other kinds of tool stone also comes from the Lindenmeier site. Tools in the assemblage from that site were classified into utilized flakes, single-edge tools, double-edge tools, and distal-edge tools (Wilmsen and Roberts 1978: Table 68). Single-edge tools and double-edge tools are equivalent to the artifact type of informal retouched flake tools used here, with the former
type of Wilmsen having been retouched on one lateral edge and the later having been worked on both. Distal-edge tools are basically the same as end scrapers. The tool types defined for the Lindenmeier assemblage were classified by Wilmsen according to the major tool stones recognized in the collection. These include quartzite, which is thought to be largely comprised of the locally available “Big Hole orthoquartzite,” chalcedony, which presumably is mostly composed of the local chalcedony, and jasper, which is the term used for Hartville Uplift chert. A distinct avoidance of orthoquartzite for the manufacture of end scrapers was noted in the Lindenmeier assemblage (Wilmsen and Roberts 1978:142, Table 68). The sample of orthoquartzite artifacts from the site consists of 104 utilized flakes, 79 single-edge tools, 37 double-edge tools, and only two distal-edge tools. A similar lack of end scrapers does not occur in the samples of the two microcrystalline tool stones. In fact, a preponderance of end scrapers was made of jasper. Of the 304 end scrapers tabulated, 219 were made of jasper (i.e. Hartville Uplift chert) (Wilmsen and Roberts 1978: 142, Table 68).

Avoidance of orthoquartzite in the manufacture of end scrapers at the Jurgens and Lindenmeier sites suggest this may be a real trend in lithic technology. The apparent pattern is cause to speculate that some quality of orthoquartzite caused end scrapers of this tool stone to not function as well as scrapers made of microcrystalline stone.

In contrast to end scrapers made of WRGG, projectile points of this raw material are far more frequent than expected. While about 15 points of WRGG were expected in the assemblage, 29 were actually present (Table 10-11). Production of projectile points prior to the hunt therefore used a disproportionately high amount of tool stone from locally available gravels. As will be discussed further below, most points were made of a variety of WRGG believed to have been used the most for gearing up, specifically very rough-textured orthoquartzite.

Trends regarding the relative abundance or absence of WRGG in the samples of end scrapers and points are opposite for Flat Top chalcedony. End scrapers of Flat Top
chalcedony are significantly more common than expected and projectile points are significantly less frequent (Table 10-11). A total of 30 end scrapers of Flat Top chalcedony are expected in the collection, but 41 are present. About 25 points of Flat Top chalcedony are expected in the assemblage, however, there are only 15.

One possible explanation of the unexpectedly high number of WRGG points and low number of WRGG end scrapers, on the one hand, and the unusually high number of Flat Top chalcedony end scrapers, on the other hand, is that the proportions of the artifact types of the two tool stones are somewhat related. The local band participating in a bison kill was evidently able to use the locally available orthoquartzite from White River group gravels to gear up with projectile points, but apparently orthoquartzite was avoided for producing the end scrapers that would be needed. If microcrystalline tool stone was preferred for making end scrapers, one might assume that the microcrystalline varieties of the local deposits of WRGG would have been used. Perhaps cobbles of microcrystalline varieties of WRGG were too small to efficiently produce sizable end scrapers or maybe some other reason existed for avoiding use of the local gravels. None of the end scrapers in the collection were made of cobbles of microcrystalline silicate from the local gravels. Given the above-described situation, the local band apparently would have needed to get microcrystalline stone for end scraper manufacture from a distant source in order to have microcrystalline stone suitable to produce the many end scrapers that would be needed to process the bison hides. It is not unreasonable to suppose that a small group of people from the local band may have been dispatched to collect Flat Top chalcedony and bring it back in order that adequate supplies of microcrystalline stone would be available for scraper manufacture. As will be demonstrated below, however, the proportions of flakes and utilized flakes of Flat Top chalcedony removed from blocky cores versus those removed from bifaces does not support the supposition that Flat Top chalcedony was used predominately for end scraper manufacture. Rather, substantial amounts of both end scrapers and projectile points were likely made of Flat Top
It is also possible that some of the artifacts of Flat Top chalcedony were brought in by a participating band that habitually ranged further down the South Platte when not involved in large-scale hunts.

A final noteworthy relationship evident in the data presented in Table 10-11 is the unexpectedly low number of points of Flat Top chalcedony. Again, analysis of the parent objects of Flat Top chalcedony flakes will demonstrate that an ample amount of this tool stone was used to manufacture bifacial artifacts and presumably this included projectile points. One possible explanation for the apparent lack of points of Flat Top chalcedony is that this tool stone was used to manufacture points intended to replace those broken during the hunt.

To further examine differences in artifact frequencies between the main tool stones that may provide some insight into the gearing up process, it is advisable to compare the frequencies of unfinished formal artifacts to finished specimens as is done in Table 10-12. Data in the table primarily serve to elucidate gearing up in regard to projectile point manufacture because unfinished points are recognizable as preforms. However, it is rarely possible to emphatically identify flakes that were produced in order to make end scrapers from other flakes resulting from another stone tool production process. If artifacts of Dawson petrified wood and Hartville Uplift chert represent tool kits brought in by visiting bands, one might expect that a certain proportion of the raw material brought into the site would end up as serviceable projectile points and a particular proportion will end up being point preforms that were rejected for one reason or another during the manufacturing process. The observed frequencies of points and preforms of Dawson petrified wood do not deviate significantly from expected frequencies. The observed frequencies of points made from Hartville Uplift chert also deviate little from expected. However, it is expected that four preforms of Hartville Uplift chert should be in the Jurgens assemblage, but none are. This is a highly unlikely situation as is indicated in Table 10-12 by a standardized residual of -1.9 (which has
Table 10-12. Contingency Table Showing Main Tool Stone Types by Unfinished and Finished Formal Tools.

<table>
<thead>
<tr>
<th>Main Tool Stone Types</th>
<th>White River Group Gravel</th>
<th>Flat Top Chalcedony</th>
<th>Dawson Petrified Wood</th>
<th>Hartville Uplift Chert</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unfinished Formal Tools</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unfinished Bifaces (Stages 2 and 3)</td>
<td>Count</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>1.7</td>
<td>2.4</td>
<td>1.1</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>2</td>
<td>-2</td>
<td>.8</td>
<td>-.6</td>
</tr>
<tr>
<td>Projectile Point Preforms</td>
<td>Count</td>
<td>11</td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>3.4</td>
<td>4.7</td>
<td>2.2</td>
<td>3.6</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>4.1</td>
<td>-1.3</td>
<td>-.8</td>
<td>-.9</td>
</tr>
<tr>
<td>Finished Formal Tools</td>
<td>End Scrapers</td>
<td>Count</td>
<td>1</td>
<td>41</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>21.3</td>
<td>29.3</td>
<td>13.8</td>
<td>22.6</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>-4.4</td>
<td>2.2</td>
<td>1.1</td>
<td>.9</td>
</tr>
<tr>
<td>Finished (Stage 4) Bifaces and Stemless Knives</td>
<td>Count</td>
<td>5</td>
<td>6</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>4.2</td>
<td>5.7</td>
<td>2.7</td>
<td>4.4</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>.4</td>
<td>.1</td>
<td>-1.0</td>
<td>.3</td>
</tr>
<tr>
<td>Projectile Points and &quot;Stemmed Knives&quot;</td>
<td>Count</td>
<td>29</td>
<td>15</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>17.4</td>
<td>23.9</td>
<td>11.2</td>
<td>18.5</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>2.8</td>
<td>-1.8</td>
<td>-.7</td>
<td>-.1</td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>48</td>
<td>66</td>
<td>31</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>48.0</td>
<td>66.0</td>
<td>31.0</td>
<td>51.0</td>
</tr>
</tbody>
</table>
an associated probability of .029). However, the complete lack of preforms of Hartville Uplift chert is thought to be a fortuitous result. Five points of Hartville Uplift chert found in Area 3 were matched with biface thinning flakes or interior flakes found in Areas 1 and 2 (Table B-2, MANs 1-2, 4-5, 7). This strongly suggests that preforms of Hartville Uplift chert were indeed on the site and flaked into projectile points.

The observed frequencies of points and preforms of WRGG and Flat Top chalcedony differ from expected frequencies. As mentioned, about 17 points of WRGG are expected, but 29 are present. Also, about three preforms of WRGG are expected, but 11 are in the assemblage. The standardized residuals associated with the above frequencies indicate the probability of obtaining the observed counts by chance alone is highly unlikely. The above information demonstrates that not only were points of the local WRGG very common at the site, the unexpectedly high number of preforms strongly suggests that many of the points were finished on the site. This confirms what has already been asserted based on the fact that many of the minimum analytical nodules from the artifact concentrations in Areas 1 and 2 are composed of biface thinning flakes of WRGG. Table 10-12 reiterates that points of Flat Top chalcedony are definitely less common than expected. Data presented in Table 10-12 should not be subjected to a chi-square test because over 20 percent of the cells have expected frequencies less than five. To determine if the observed frequencies of points and preforms of WRGG and Flat Top chalcedony deviate from expected values in a statistically significant manner, cells in Table 10-12 were collapsed into more inclusive categories.

Table 10-13 provides such a chi-square table comparing the main tool stones by frequencies of unfinished bifaces and finished bifacial tools. Most of the unfinished bifaces in Table 10-13 are point preforms and a large proportion of finished bifacial tools are projectile points. The chi-square statistic calculated from data in the table is 54.00 (p = .000). Examination of the standardized residuals in Table 10-13 indicates that much of the variation from expected values is due to higher than expected observed frequencies of unfinished
Table 10-13. Chi-Square Table Showing Main Tool Stones by Unfinished and Finished Formal Tools.

<table>
<thead>
<tr>
<th></th>
<th>Main Tool Stone Types</th>
<th>White River Group Gravel</th>
<th>Flat Top Chalcedony</th>
<th>Dawson Petrified Wood</th>
<th>Hartville Uplift Chert</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unfinished Formal Tools</td>
<td>Count</td>
<td>13</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>5.1</td>
<td>7.1</td>
<td>3.3</td>
<td>5.5</td>
<td>21.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>3.5</td>
<td>-1.2</td>
<td>-2</td>
<td>-1.9</td>
<td></td>
</tr>
<tr>
<td>Finished Formal Tools</td>
<td>Count</td>
<td>34</td>
<td>21</td>
<td>10</td>
<td>23</td>
<td>88</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>21.6</td>
<td>29.6</td>
<td>13.9</td>
<td>22.9</td>
<td>88.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>2.7</td>
<td>-1.6</td>
<td>-1.1</td>
<td>.0</td>
<td></td>
</tr>
<tr>
<td>Finished Unifacial Tools</td>
<td>Count</td>
<td>1</td>
<td>41</td>
<td>18</td>
<td>27</td>
<td>87</td>
</tr>
<tr>
<td>(End Scrapers)</td>
<td>Expected Count</td>
<td>21.3</td>
<td>29.3</td>
<td>13.8</td>
<td>22.6</td>
<td>87.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>-4.4</td>
<td>2.2</td>
<td>1.1</td>
<td>.9</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>48</td>
<td>66</td>
<td>31</td>
<td>51</td>
<td>196</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>48.0</td>
<td>66.0</td>
<td>31.0</td>
<td>51.0</td>
<td>196.0</td>
</tr>
</tbody>
</table>
bifaces and finished bifacial tools of WRGG. Much of the variation from expected values was also due to lower than expected frequencies of bifacial artifacts of Flat Top chalcedony. The low observed frequency of finished bifacial tools of Flat Top chalcedony may be statistically significant at the 95 percent confidence interval (standardized residual -1.6; p = .055). The low frequency of unfinished bifaces of Flat Top chalcedony is not statistically significant (standardized residual -1.2), but it only has an 11.5 percent chance of having occurred through chance alone.

In light of the above discussion, it can be said that the artifact composition of the sample of WRGG supports the thinking that the tool stone was used in gearing up operations, but data presented in one of the above tables appears contrary to the assertion made earlier (based on minimum analytical nodule analysis) that very rough-textured orthoquartzite was a particular variety of WRGG that was used for gearing up. Table 10-10 presents data used in a chi-square test comparing very rough-textured orthoquartzite to all other varieties of WRGG according to observed frequencies of various artifact categories. As can be seen in the table, the greater than expected number of point preforms of very rough-textured orthoquartzite and the less than expected quantity of preforms of other varieties of WRGG (Kalouse jasper in this case) provides less than resounding support for the idea that very rough-textured orthoquartzite was selectively use for gearing up because the deviations from expected counts are not statistically significant. Also, instead of demonstrating higher than expected frequencies of points of very rough-textured orthoquartzite and lower than expected frequencies of all other varieties of WRGG, observed and expected frequencies are virtually identical (Table 10-10). Consideration of the seven individual cases of points made of other varieties of WRGG reveals that most specimens are well made specimens of Morrison orthoquartzite (n = 3) or light-to-medium red orthoquartzite (n = 2) (Figure 7-6). Perhaps these two orthoquartzites were also selectively used for gearing up along with very rough-textured orthoquartzite. Further analyses were not conducted to test this possibility. It is
relevant to note, however, that of the 28 minimum analytical nodules from the artifact concentrations in Areas 1 and 2 that represent sets of flakes removed from bifaces, two nodules signify that bifaces of Morrison orthoquartzite were thinned on-site. This provides at least some support for the suggestion that other WRGG orthoquartzites besides the very rough-textured kind were preferentially used for gearing up.

ANALYSIS OF THE PARENT OBJECTS OF FLAKED STONE ARTIFACTS

For two basic reasons, certain flaked stone artifacts were examined to determine if the flakes from which they were manufactured derive from a biface or a blocky core. First, the parent object of end scrapers, flakes, and utilized flakes was determined to test the assertion of the alternative view that Plains Paleoindian lithic technology would have involved the manufacture and use of not only tools fashioned from bifaces, but also unifacial tools made by retouching flakes struck from blocky cores. Second, a sample of flakes and utilized flakes of the very rough-textured orthoquartzite variety of WRGG was compared to a sample of these artifact types made from all other WRGG varieties to assess if the parent objects of the artifacts support the hypothesis that the orthoquartzite variety was favored for use in the manufacture of bifacial artifacts as part of gearing up while the other varieties tended to be used in a core-and-flake technology.

Analysis of the parent object used in manufacture of end scrapers leads to the conclusion that this class of artifacts in the Jurgens collection was made by retouching flakes struck from blocky cores. Table 10-14 compares end scrapers made from the main tool stones by the type of parent object from which the scrapers were made. Of the 57 end scrapers for which the parent object could be determined, 56 were produced from a flake struck from a blocky core. One scraper of Dawson petrified wood was made by retouching a flake struck from a stream cobble or pebble. This artifact is one of those of Dawson petrified wood.
Table 10-14. Contingency Table Showing Main Tool Stones by Parent Object of End Scrapers.

<table>
<thead>
<tr>
<th>Parent Object of End Scraper</th>
<th>Main Tool Stones</th>
<th>Very Rough-Textured Orthoquartzite Variety of WRGG</th>
<th>Flat Top Chalcedony</th>
<th>Dawson Petrified Wood</th>
<th>Hartville Uplift Chert</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blocky Core or Stream Cobble / Pebble a</td>
<td>Count</td>
<td>1</td>
<td>28</td>
<td>12</td>
<td>16</td>
<td>57</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>.7</td>
<td>27.2</td>
<td>11.3</td>
<td>17.9</td>
<td>57.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>.4</td>
<td>.2</td>
<td>.2</td>
<td>-.4</td>
<td></td>
</tr>
<tr>
<td>Indeterminate (Blocky Core or Biface / Bifacial Core)</td>
<td>Count</td>
<td>0</td>
<td>13</td>
<td>5</td>
<td>11</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>.3</td>
<td>13.8</td>
<td>5.7</td>
<td>9.1</td>
<td>29.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>-.6</td>
<td>-.2</td>
<td>-.3</td>
<td>.6</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>1</td>
<td>41</td>
<td>17</td>
<td>27</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>1.0</td>
<td>41.0</td>
<td>17.0</td>
<td>27.0</td>
<td>86.0</td>
</tr>
</tbody>
</table>

a One end scraper of Dawson petrified wood with stream-rounded cortex had a stream cobble or pebble for a parent object. All other end scrapers had a blocky core as a parent object.
wood that probably was obtained from local exposures of South Platte River gravel. None of the scrapers examined was produced by retouching a flake detached from a biface or bifacial core. A total of 29 end scrapers examined did not possess attributes that allowed the parent object to be determined with confidence. Data of Table 10-14 affirms the alternative view’s assertion that blocky core reduction was an integral part of Paleoindian lithic technology, particularly in the context of large-scale bison hunts where processing of hides was planned. The data in the table therefore refutes the validity of the traditional view’s concept of a Paleoindian lithic technology that was based on bifacial cores in order to permit high mobility.

Comparing flakes and utilized flakes made from the main tool stones according to the different kinds of parent objects from which they originate helps to shed light on lithic technology as it relates to gearing up for a bison hunt. A chi-square table comparing samples of flakes and utilized flakes of the main tool stones based on the parent object of the flake is presented as Table 10-15. The table does not include data on the parent object of flakes and utilized flakes from excavated contexts in Area 1. Because the table is primarily intended to investigate lithic technology related to gearing up, only the very rough-textured orthoquartzite variety of WRGG is compared to the other main tool stones. In large part, the table was intended to compare two categories of parent object. One principally consists of blocky cores, but also includes stream cobbles or pebbles and angular pieces of tool stone. The other main category of parent object basically consists of bifaces, and in acknowledgment of the traditional view’s concept of a bifacial core-based lithic technology, the category also includes bifacial cores, although this is not meant to imply that it was possible to identify flakes removed from unfinished bifacial tools from those deriving from bifacial cores. An indeterminate category of parent object includes those flakes and utilized flakes that can be said to have come from either one of the above two categories. A final category of parent object includes unifaces. For reasons discussed below, flakes detached
Table 10-15. Chi-Square Table Showing Main Tool Stones by Parent Object of Flakes and Utilized Flakes.

<table>
<thead>
<tr>
<th>Parent Object of Flake or Utilized Flake</th>
<th>Main Tool Stones</th>
<th>WRGG (Very Rough-Textured Orthoquartzite Variety)</th>
<th>Flat Top Chalcedony</th>
<th>Dawson Petrified Wood</th>
<th>Hartville Uplift Chert</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blocky Core, Stream Cobble or Pebble, or Angular Piece of Tool Stone</td>
<td>Count</td>
<td>50</td>
<td>26</td>
<td>33</td>
<td>23</td>
<td>132</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>40.5</td>
<td>33.3</td>
<td>15.6</td>
<td>42.6</td>
<td>132.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>1.5</td>
<td>-1.3</td>
<td>4.4</td>
<td>-3.0</td>
<td></td>
</tr>
<tr>
<td>Biface or Bifacial Core</td>
<td>Count</td>
<td>103</td>
<td>94</td>
<td>26</td>
<td>135</td>
<td>358</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>109.7</td>
<td>90.2</td>
<td>42.4</td>
<td>115.6</td>
<td>358.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>-6</td>
<td>.4</td>
<td>-2.5</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>Indeterminate (Blocky Core or Biface / Bifacial Core)</td>
<td>Count</td>
<td>72</td>
<td>58</td>
<td>26</td>
<td>67</td>
<td>223</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>68.4</td>
<td>56.2</td>
<td>26.4</td>
<td>72.0</td>
<td>223.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>.4</td>
<td>.2</td>
<td>-.1</td>
<td>-.6</td>
<td></td>
</tr>
<tr>
<td>Uniface</td>
<td>Count</td>
<td>0</td>
<td>7</td>
<td>2</td>
<td>12</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>6.4</td>
<td>5.3</td>
<td>2.5</td>
<td>6.8</td>
<td>21.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>-2.5</td>
<td>7</td>
<td>-3</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>225</td>
<td>185</td>
<td>87</td>
<td>237</td>
<td>734</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>225.0</td>
<td>185.0</td>
<td>87.0</td>
<td>237.0</td>
<td>734.0</td>
</tr>
</tbody>
</table>
from unifaces are likely end scraper resharpening flakes. A chi-square value of 54.02 (p = .000) calculated from data in Table 10-15 indicates that the observed frequencies presented in the table as a whole deviate significantly from expected frequencies. Flakes and utilized flakes that derive from bifaces of Flat Top chalcedony are about 3.6 times as common as flakes of this tool stone that came from a blocky core (94 flakes from bifaces ÷ 26 flakes from blocky cores, etc. = 3.6) (Table 10-15). A similar relationship can be seen among the flakes and utilized flakes of very rough-textured orthoquartzite where those that were detached from bifaces are 2.1 times as common as those that were struck from blocky cores or stream cobbles or pebbles (103 flakes from bifaces ÷ 50 flakes from blocky cores, etc. = 2.1). From the above figures, one might tentatively suggest that finishing the tools needed to kill and process a large number of bison from the blocky cores and unfinished bifaces brought along on a large-scale bison hunt will typically result in considerably more biface thinning flakes than blocky core reduction flakes.

Judging from the standardized residuals in Table 10-15, it appears that much of the variation of observed frequencies from expected values may be attributed to the samples of Hartville Uplift chert and Dawson petrified wood. In comparison to Flat Top chalcedony and very rough-textured orthoquartzite, the proportion of biface thinning flakes of Hartville Uplift chert is much greater. Flakes detached from bifaces are about 5.9 times as common as those that were struck from blocky cores (135 flakes from bifaces ÷ 23 flakes from blocky cores, etc. = 5.9). End scrapers of Hartville Uplift chert are common, numbering 27 in total (Table 10-11). The reader will recall that one set of refitting artifacts and one minimum analytical nodule provide evidence that blocky cores of Flat Top chalcedony were knapped on-site to produce flake blanks that were then retouched into end scrapers. Comparable evidence that blocky cores of Hartville Uplift chert were knapped on-site to produce end scrapers is lacking. From the above information, one might cautiously suggest that unfinished pieces of
Hartville Uplift chert brought into the site tended to be in the form of bifaces rather than blocky cores.

The sample of flakes and utilized flakes of Dawson petrified wood differs greatly from those of the other main tool stones because flakes detached from bifaces are actually slightly less common (n = 26) than flakes struck from blocky cores, stream cobbles or pebbles, or angular pieces of tool stone (n = 33). This unexpected result may in part result from inclusion of artifacts made of the Dawson petrified wood variety of the local South Platte River gravel into the sample of Dawson petrified wood artifacts believed to have been procured from primary sources in the Palmer Divide area. As discussed previously, it is evident that some artifacts in the sample of Dawson petrified wood were made by retouching flakes struck from stream rounded pieces of the tool stone which were likely procured from local gravel deposits along the South Platte. Pebbles and cobbles of the petrified wood from the river gravels could be further worked into blocky cores. Dawson petrified wood artifacts with stream-rounded cortex are possibly the result of the use of tool stone from river gravels to make flakes to be retouched into tools as part of a core-and-flake technology. Although 21.7 percent of Dawson petrified wood artifacts with cortex have a stream-rounded cortex (Table 10-5), it was suggested above that this figure may over-represent the amount of tool stone from local gravel because manuports of the tool stone in the collection are in the size range of pebbles or small cobbles and knapping rocks of this size would be expected to produce a disproportionally high amount of decortication flakes. To the contrary, the fact that flakes or utilized flakes of Dawson petrified wood that came from blocky cores comprise a small majority of such artifacts that could be assigned to a particular parent object would strongly suggest that rounded stream cobbles may indeed have been the source of a large proportion of all artifacts of this tool stone. Base on the above discussion, the sample of artifacts of Dawson petrified wood should not be viewed as the best candidate for studying the lithic technology of gearing up. Rather, this tool stone, as well as those from the White
River Group gravel, likely contain relatively larger proportions of artifacts not produced as part of gearing up with formal tools needed for a large-scale hunt.

Data in Table 10-15 relating to flakes and utilized flakes that derive from unifacial artifacts or “unifaces” is most likely relevant to understanding the use of end scrapers in processing hides obtained as a result of a large-scale bison hunt. Among the flakes and utilized flakes examined to determine the parent object of the artifact, a total of 21 specimens were identified as having been removed from a uniface. About six flakes or utilized flakes of very rough-textured orthoquartzite are expected in the assemblage, but none were present. A standardized residual of -2.5 indicates that the absence is real, having a probability of .006 of occurring by chance alone. The lack of flakes removed from unifaces of very rough-textured orthoquartzite is likely simply a result of there being very few end scrapers that were made of this raw material. An unexpectedly high number of flakes or utilized flakes were made of Hartville Uplift chert (n = 12) (Table 10-14). The associated standardized residual of 2.0 indicates that it is highly unlikely that this many specimens of Hartville Uplift chert would have occurred by chance alone (p = .023). The preponderance of uniface resharpening flakes of Hartville Uplift chert noted in Table 10-14 remains enigmatic.

Five of the flakes or utilized flakes removed from unifaces counted in Table 10-15 are worth special mention because all had an associated remark entered into the comments section of the artifact analysis form indicating that they were likely removed from a scraper. All are made of Hartville Uplift chert. All five are from Areas 1 or 2, which provides support for the argument that these areas were nearest to the encampment and that hides would have been scraped in or near camp. Three artifacts are from the ground surface. Two are from Area 1 [catalog # 30196 (Item 70 of 132) and catalog # 30196 (Item 67 of 132)]. Both had a remark entered in the comments section of the analysis form indicating that they might be a scraper resharpening flake. The third artifact from the ground surface is from Area 2 [catalog # 30197 (Item 134 of 203)]. It had the following remark entered on the analysis form:
“Parallel striae on the striking platform are likely from end scraper use.” Two interior flakes are from excavated contexts in Area 2. Both are from excavation unit 10F60, which was centered over the western cluster of the artifact concentration in Area 2, so evidently the resharpening flakes were cleaned up from a work area in or near the encampment and discarded in a trash dump along with the thinning flakes from many bifaces. One of the excavated flakes has a proximal edge (which is the former working edge of the worn unifacial tool) that is rounded and polished from use and has striations aligned perpendicular to the edge, a characteristic suggestive of hide working (catalog # 23095, Field Specimen F23). The other excavated flake may or may not have been removed from a scraper that was used on a hide. The striking platform is completely flat and the former working edge of the unifacial tool has been rounded from use (catalog # 23095, Field Specimen F81).

Having compared flakes and utilized flakes of the main tool stones by parent object for insights into gearing up, the parent objects of flakes and utilized flakes of various categories of WRGG will now be considered to further evaluate the thought that the sample of artifacts of this tool stone is comprised of a mixture of artifacts indicative of gearing up and other artifacts that may have been produced using a core-and-flake technology to manufacture expedient flake tools. Table 10-16 compares very rough-textured orthoquartzite to all other varieties of WRGG according to the parent object of flakes and utilized flakes. A chi-square test run on data presented in the table indicates the variation of observed frequencies from expected counts is highly unlikely to have occurred by chance alone ($\chi^2 = 48.56$, $p = .000$). In the sample of flakes and utilized flakes of very rough-textured orthoquartzite, more than the expected number were removed from bifaces and less than expected were struck from blocky cores, etc. (Table 10-16). This situation conforms to the thinking that very rough-textured orthoquartzite was a variety of WRGG that was used especially to gear up for large-scale bison hunting by producing a lot of bifacial artifacts which probably included many projectile points. In the artifact sample comprised of all other
Table 10-16. Chi-Square Table Showing Very Rough-Textured Orthoquartzite and Other Varieties of Tool Stone from the White River Group Gravels by Parent Object of Flakes and Utilized Flakes.

<table>
<thead>
<tr>
<th>Parent Object of Flake or Utilized Flake</th>
<th>Variety of Tool Stone from White River Group Gravels</th>
<th>Very Rough-Textured Orthoquartzite</th>
<th>All Other Varieties</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blocky Core, Stream Cobble or Pebble, or Angular Piece of Tool Stone</td>
<td>Count</td>
<td>50</td>
<td>51</td>
<td>101</td>
</tr>
<tr>
<td>Expected Count</td>
<td>75.0</td>
<td>26.0</td>
<td>101.0</td>
<td></td>
</tr>
<tr>
<td>Std. Residual</td>
<td>-2.9</td>
<td>4.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biface or Bifacial Core</td>
<td>Count</td>
<td>103</td>
<td>16</td>
<td>119</td>
</tr>
<tr>
<td>Expected Count</td>
<td>88.4</td>
<td>30.6</td>
<td>119.0</td>
<td></td>
</tr>
<tr>
<td>Std. Residual</td>
<td>1.6</td>
<td>-2.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indeterminate (Blocky Core or Biface / Bifacial Core)</td>
<td>Count</td>
<td>72</td>
<td>11</td>
<td>83</td>
</tr>
<tr>
<td>Expected Count</td>
<td>61.6</td>
<td>21.4</td>
<td>83.0</td>
<td></td>
</tr>
<tr>
<td>Std. Residual</td>
<td>1.3</td>
<td>-2.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>225</td>
<td>78</td>
<td>303</td>
</tr>
<tr>
<td>Expected Count</td>
<td>225.0</td>
<td>78.0</td>
<td>303.0</td>
<td></td>
</tr>
</tbody>
</table>
varieties of WRGG, more than the expected number of flakes and utilized flakes were struck from blocky cores, etc. and less than expected were detached from bifaces. This fact supports the idea that stream cobbles of the other varieties of WRGG, particularly the microcrystalline varieties, would have been selected to be worked into blocky cores from which expedient flake tools could be made.

The concept that locally available stream cobbles from various sources would have been exploited by Paleoindians of the Jurgens site as raw materials for blocky cores from which expedient flake tools could be produced may be further developed by considering the kinds of artifacts that were made from cobbles obtained from the South Platte River gravels. Table 10-17 gives a tally of the kinds of artifacts made from tool stones thought to have been obtained from deposits of SPRG, including white-to-light gray metaquartzite, other metaquartzite, and off-white-to-light brown tuff. The artifacts are primarily of types that are arguably produced when flakes are struck from stream cobbles. These include tested cobbles, blocky and bifacial cores, and decortication flakes.

FLAKED STONE ARTIFACTS FROM VERY DISTANT SOURCES

Mapping the very distant sources of several tool stones in the assemblage serves to elucidate the long-distance social connections of the plains people who occupied the Jurgens site. Proponents of the alternative view maintain that tool stones from very distant sources may have arrived at sites as a result of cultural mechanisms that served to move raw material and artifacts great distances among peoples who were interacting with one another by way of individuals visiting far off groups or through the maintenance of long-distance exchange networks. If this is a valid theoretical perspective, it is interesting to note that the tool stones from very distant sources in the Jurgens assemblage denote that some sort of long-distance interaction, either direct or indirect, had occurred between the people of the group assembled.
Table 10-17. Artifacts Made of Tool Stone Varieties from the South Platte River Gravels.

<table>
<thead>
<tr>
<th>Artifact Type</th>
<th>White-to-Light Gray Metaquartzite</th>
<th>Other Metaquartzite</th>
<th>Off-White-to-Light Brown Tuff</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tested Cobble or Pebble</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Blocky Core</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Bifacial Core</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Secondary Flake</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Interior Flake</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Utilized Primary Flake</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Informal Retouched Flake Tool</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Wedge</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>4</td>
<td>5</td>
<td>3</td>
<td>12</td>
</tr>
</tbody>
</table>
for bison hunting and far off groups living in all parts of the Great Plains as well as the plains of the Wyoming Basin. Tool stones from very distant sources are indicative of social connections between occupants of the site and other plains people in the Wyoming Basin (Wamsutter oölitic chert), Northwest Plains (Ft. Union porcellanite), Northern Plains (Knife River flint), Central Plains (Smoky Hill jasper), and Southern Plains (Alibates agate and Edwards chert). The beveled tool of an unsourced raw material is noteworthy for providing further evidence of some form of long-distance social contact between the western plains people assembled at the site and inhabitants of the eastern Central Plains. Figure 10-3 illustrates the long-distance social connections evident in the collection by dotted lines originating from the Jurgens site and radiating outward toward the very distant sources located throughout the Great Plains and Wyoming Basin. Sometimes this interaction involved the movement of stone over tremendous distances (Figure 7-1).

It is relevant to note that stone from distant high-quality sources in and around the intermontane basins do not appear at all in the Jurgens collection. Included are the Middle and North park sources where Table Mountain jasper, Kremmling chert, and Windy Ridge orthoquartzite are available. It is interesting to note that the source of Flat Top chalcedony is located 114 km east-northeast of Jurgens, and the source of the closest major Middle Park tool stone (Table Mountain jasper) is situated at a comparable distance of 117 km from the site in the opposite direction, but on the other side of the Front Range (Figure 10-3). From the Jerry Craig site in Middle Park, it is known that the western plains peoples, who made Cody points, sometimes cooperated with mountain peoples, who used Angostura points, to carry out communal bison hunts in the intermontane basins. Upon leaving Middle Park prior to the height of the cold-season and returning to their respective wintering grounds, both peoples would be expected to have had some amount of tool stone from the park, which would have remained in the tool kit for some time. The complete lack of any tool stone in the Jurgens collection that can be definitely assigned to a Middle Park source suggests that visits
to the park by people of the western plains for communal bison hunting may not have been an annual event. In light of the fact that the main tool stones in the Jurgens collection are all from local and distant sources on the Plains, the bison kill represented by the bonebeds at Jurgens may be suggested to have involved only bands of western Plains peoples. It is noteworthy that tool stones from very distant sources in the Jurgens collection that range as far away as 328 to 905 km from the site (Table 10-3) are all in regions that would likely have been occupied year-round by other plains people. In contrast, tool stones from closer sources lying in distant lands in Middle and North Parks that range from 114 to 170 km from the site are absent from the assemblage. The intermontane basins would have been occupied only seasonally by both people of the western plains and by mountain people. If the artifacts from very distant sources in the Jurgens collection are indicative of the on-going long-distance social contacts that connected groups of Paleoindians via an exchange network or visitation by individuals or small groups from surrounding bands, then evidently the contact was normally with other plains peoples.

The basic comparative methods used to examine artifacts of local and distant tool stones for signs of band aggregation should also prove useful for investigating cultural mechanisms thought to be responsible for moving stone from very distant sources across the landscape. One method involves making comparisons of the artifact composition of samples of tool stones from sources situated within defined distances from the site that theoretically reflect the areas occupied by a local band, neighboring bands, and bands inhabiting very distant areas. In this case, tool stone available from distant sources will be compared to stone from very distant sources. The other method to be used entails examining samples of debitage made of tool stones from distant and very distant sources for signs of the unfinished forms in which supplies of the tool stones were transported (i.e. blocky cores or bifaces).

Before applying these methods of analysis, data on the diversity of artifact types in which the various tool stones from very distant sources occurs will be presented and
discussed. These data are given in Table 10-18. Two basic ways that alternative-minded archaeologists have proposed to explain the apparent movement of stone from very distant sources across the Plains include the former existence of some manner of exchange network and transport of unfinished stone and finished artifacts via the movement of individuals and small groups moving among established bands. It is interesting to note that three of the six tool stones from very distant sources are represented in the Jurgens collection by a seemingly greater number and wider variety of artifact types. These include Knife River flint, Alibates agate, and Edwards chert (Table 10-18). Artifacts made of these tool stones are commonly reported from Paleoindian and later sites on the Plains. It should be noted, however, that greater diversity of artifact types can be directly related to the quantity of artifacts present, but the several samples of tool stones from very distant sources present in the Jurgens assemblage and the low numbers of artifacts in each tool stone type makes it practically impossible to investigate this possible relationship with regression analysis. Though the possibility exists that the greater artifact diversity of Knife River flint, Alibates agate, and Edwards chert may simply be a function of sample size, the greater quantities of these tool stones, the higher number of artifact types made of the raw materials, and the common presence of these tool stones in Paleoindian assemblages from sites throughout the Plains gives cause to speculate that these particular raw materials were especially widely distributed in an exchange network. Other very distant tool stone sources are represented in the Jurgens collection by only a single artifact. These include a utilized interior flake of Smoky Hill Jasper, a point of Wamsutter oölitic chert, and another point of Fort Union porcellanite. The above information suggests that perhaps different mechanisms that may have moved stone long distances across the Plains are responsible for the artifacts from very distant sources (i.e. both an exchange network and visitation by individuals and small groups).

If the Jurgens assemblage was produced through aggregation of bands, the presence of small amounts of tool stones from very distant sources spread throughout the Great Plains
Table 10-18. Artifacts in the Jurgens Assemblage of Tool Stones from Very Distant Sources.

<table>
<thead>
<tr>
<th>Artifact Category</th>
<th>Knife River Flint</th>
<th>Smoky Hill Jasper</th>
<th>Alibates Agate</th>
<th>Edwards Chert</th>
<th>Wamsutter Oolithic Chert</th>
<th>Ft. Union Porcellanite</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary Flakes (Including Utilized Specimens)</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Interior Flakes (Including Utilized Specimens)</td>
<td>6</td>
<td>1</td>
<td>4</td>
<td>10</td>
<td>-</td>
<td>-</td>
<td>21</td>
</tr>
<tr>
<td>Informal Retouched Flake Tools</td>
<td>4</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>End Scrapers</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Unfinished Bifaces (Stages 2 and 3)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Stemless Knife ?</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Drill</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Projectile Point Preforms</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Projectile Points</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>16</td>
<td>1</td>
<td>8</td>
<td>12</td>
<td>1</td>
<td>1</td>
<td>39</td>
</tr>
</tbody>
</table>
may be best explained as different groups bringing stone that they had acquired by trade with them to a gathering of people intent on communal hunting. For the purpose of illustration, it was suggested that the presence of Hartville Uplift chert in the collection may represent participation of a band that normally ranged in the North Platte drainage. The occurrence of artifacts of Knife River flint from North Dakota would most reasonably be explained as resulting from a band from the North Platte drainage bringing stone acquired in trade to a rendezvous planned in the South Platte watershed. The presence of Dawson petrified wood in the assemblage may represent participation of a band with a habitual range situated to the south of Jurgens, somewhere in the upper reaches of the South Platte drainage on the Plains and possibly even further south in the drainage of the Arkansas River in the area of Colorado Springs. This hypothetical band from the south would be the most likely to have acquired some artifacts of Alibates agate and Edwards chert in an exchange network and brought them to the aggregation of bands that established a camp at Jurgens.

Large size of available pieces of tool stone may have been a factor that encouraged the distribution of particular tool stones in long-distance exchange networks. As discussed previously, Edwards chert and Knife River flint is reported to occur in large pieces. Conversely, literature available on Smoky Hill jasper, Wamsutter oölitic chert, and Fort Union porcellanite does not note that these tool stones occur in especially large clasts. Occurrence of a tool stone in large pieces may have allowed production of large bifacial artifacts that may have been especially sought after items of exchange. Bamforth (2009b) provides evidence to support the suggestion that projectile points may have been a class of artifacts that traveled in long-distance exchange networks more so than other tools.

Flakes of Edwards chert from the Jurgens site are of a size range suggesting they were removed from bifacial artifacts of considerable size. Of the 10 interior flakes or utilized interior flakes of Edwards chert from the site, eight display attributes sufficient to allow the parent object to be determined. Seven flakes were detached from a biface and one was struck
from a blocky core. The flakes from bifaces are relatively large, ranging in maximum dimension from 1.9 to 7.4 cm and averaging 3.6 cm. The largest specimen is illustrated in the published site report (Wheat 1979:Figure 60 a-c). The long and wide character of the flake suggests it was produced by soft hammer percussion. Presence of fossil inclusions in some of the biface thinning flakes of Edwards chert, but not others, suggests that more than one biface was flaked on-site. If the flakes were removed from point preforms, the bifacial artifacts may have been of considerable size.

In combination, the seven flakes or utilized flakes of Knife River flint present in the collection are also suggestive of fairly large unfinished bifacial artifacts. One utilized secondary flake did not exhibit attributes that would allow its parent object to be determined definitely, but presence of cortex on the artifact suggests it most likely derives from a blocky core, rather than a biface. Attributes of five of the interior flakes or utilized interior flakes permit the parent object to be determined and all were removed from a biface. These flakes from bifaces range in maximum dimension from 1.2 to 4.0 cm and average 2.5 cm. The size of the flakes suggests that if the flakes were detached from point preforms, those bifacial artifacts may have been fairly large. That long complete points or large preforms of Knife River flint may have been transported from the modern state of North Dakota along an exchange network that extended as far south as northeast Colorado is supported by a Cody point in the Bert Mountain collection from the Claypool site that measures 12.6 cm in length. The measurement was taken from a plastic cast that is one of a series of Paleoindian points made by J. A. Eichenberger and sold in the 1970s by what if now the Denver Museum of Nature and Science. An illustration of the point that is slightly larger than actual size is provided in Jennings (1977:Figure 12, left). The Bert Mountain collection is now housed at the Smithsonian Institution.

Some discussion is in order regarding how the tool stone from very distant sources is to be compared with raw material from distant sources. Because the samples of very distant
tool stones are too small to constitute representative samples by themselves, it was necessary
to combine all six samples to create a sample of a size that could be considered representative
of very distant tool stones (n = 39). In combining samples, there is some danger that the
products of different cultural mechanisms responsible for transporting stone long distances
may be conflated. If so, distinct cultural processes that may someday be distinguishable from
one another because they tended to move different kinds of artifacts will go unrecognized.
The suggestion was made that Knife River flint, Alibates agate, and Edwards chert were tool
stones that may have moved in exchange networks. If this suspicion is warranted, the
combined sample of very distant tool stones from Jurgens may best characterize Late
Paleoindian exchange on the Plains as opposed to the movement of individuals or small
groups because 36 of the 39 artifacts in the sample are of these three raw materials (Table 10-18).

In the case of the Jurgens assemblage, another concern in regard to comparing a
sample of artifacts of stone from very distant sources with raw material of distant origin is the
question of which of the later best typifies the tool kit that would have been brought to a
rendezvous for a large bison hunt by a visiting band or procured through exchange by people
preparing for a hunt. It was reasoned that the sample of artifacts of Flat Top chalcedony may
not be the best example because a disproportionately high amount of end scrapers were
evidently made of this material, possibly to offset the near absence of such artifacts of local
WRGG. Furthermore, the unsettling high percentage of artifacts with stream rounded cortex
and flakes from blocky cores in the sample of Dawson petrified wood raises the concern that
this tool stone may be a mixture of distant stone collected to gear up and local river cobbles
used in a core-and-flake technology. For these reasons, it was decided to use the sample of
Hartville Uplift chert to represent the kinds and proportions of artifacts made of stone from
distant sources that would have been brought into a site or obtained through trade by a
participating band in preparation for large-scale bison hunting.
Table 10-19 compares the combined sample of tool stones from very distant sources to artifacts of Hartville Uplift chert in terms of the kinds and proportions of artifacts present. The reader will recall that the closest sources of Hartville Uplift chert fall within the distant category, but other sources extend further away from the site and are actually considered to be very distant from the site. The artifact composition of samples of tool stones from distant and very distant stones is remarkably similar with the exception of points and preforms. At first, this was surprising. The much greater frequency of Hartville Uplift chert artifacts implies that stone was procured at the source by people who brought it in quantity to a bison hunt. This situation would imply that people would be able to procure stone in various forms (i.e. blocky cores as well as bifaces). A preconceived notion that stone acquired in an exchange network would have been available in a more restricted range of unfinished forms may be incorrect. If much of the tool stone from very distant sources was indeed acquired in an exchange network, it apparently was readily available in the form of both blocky cores and bifaces. The similarity in the kinds and proportions of artifacts that hypothetically were acquired by inherently different methods (procurement at the source versus exchange) may simply reflect that the kind and proportion of stone tools needed for a large-scale bison hunt included certain amounts of bifacial tools, like points and knives made by shaping bifaces, as well as required numbers of unifacial tools, such as end scrapers and informal retouched flake tools made by retouching flakes struck from blocky cores.

Though it may be asserted that tool stone from very distant sources was available through exchange networks in forms that permitted the production of all manner of bifacial and unifacial artifacts, there can be no denying that points and preforms of tool stones from very distant sources are overrepresented in the Jurgens sample. Data in Table 10-19 on the frequency of artifact types in the samples of stone from distant and very distant sources is presented for illustrative purposes. To test if the overrepresentation of points and preforms in the sample of very distant stone is statistically significant, cells of Table 10-19 were collapsed
Table 10-19. Contingency Table Showing Tool Stones from Distant and Very Distant Sources by Artifact Category.

<table>
<thead>
<tr>
<th>Artifact Category</th>
<th>Tool Stones from Distant and Very Distant Sources</th>
<th>Hartville Uplift Chert (Distant Source)</th>
<th>Tool Stones from Very Distant Sources</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pieces of Shatter, and Secondary Flakes (Including Utilized Specimens)</td>
<td>Count</td>
<td>10</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>10.0</td>
<td>1.0</td>
<td>11.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>.0</td>
<td>.0</td>
<td></td>
</tr>
<tr>
<td>Interior Flakes (Including Utilized Specimens) and Informal Retouched Flake Tools</td>
<td>Count</td>
<td>323</td>
<td>26</td>
<td>349</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>317.6</td>
<td>31.4</td>
<td>349.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>3</td>
<td>-1.0</td>
<td></td>
</tr>
<tr>
<td>End Scrapers</td>
<td>Count</td>
<td>27</td>
<td>3</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>27.3</td>
<td>2.7</td>
<td>30.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>-.1</td>
<td>-.2</td>
<td></td>
</tr>
<tr>
<td>Unfinished Bifaces (Stages 2 and 3)</td>
<td>Count</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>.9</td>
<td>.1</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>.1</td>
<td>-.3</td>
<td></td>
</tr>
<tr>
<td>Projectile Point Preforms</td>
<td>Count</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>1.8</td>
<td>.2</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>-1.3</td>
<td>4.3</td>
<td></td>
</tr>
<tr>
<td>Finished (Stage 4) Bifaces and Stemless Knives</td>
<td>Count</td>
<td>5</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>5.5</td>
<td>.5</td>
<td>6.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>-.2</td>
<td>.6</td>
<td></td>
</tr>
<tr>
<td>Projectile Points and &quot;Stemmed Knives*&quot;</td>
<td>Count</td>
<td>18</td>
<td>5</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>20.9</td>
<td>2.1</td>
<td>23.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>-.6</td>
<td>2.0</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>384</td>
<td>38</td>
<td>422</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>384.0</td>
<td>38.0</td>
<td>422.0</td>
</tr>
</tbody>
</table>
to produce a two-by-two table comparing tool stones from distant and very distant sources by points and preforms versus all other artifact classes (Table 10-20). Even after collapsing Table 10-19 as much as possible, the data in Table 10-20 still do not comply with the recommendation that a chi-square table have fewer than 20 percent of cells with an expected frequency of less than five. For this reason, a Fisher exact probability test was used to calculate the chance of obtaining the observed frequencies in Table 10-20 by chance alone. Results of the statistical test indicate that the likelihood of obtaining the observed frequencies by chance alone are extremely low (p = .005). Consequently, data from the Jurgens site support the hypothesis that points and preforms were transported in long-distance exchange networks much more than other kinds of artifacts.

Table 10-21 further explores the similarity of artifacts of tool stones from very distant sources with those of a tool stone available from distant sources (Hartville Uplift chert) by comparing the parent objects of flakes, utilized flakes, and expedient flake tools. The parent objects of flakes of tool stones from different distant sources were compared previously using samples composed of flakes and utilized flakes. To increase the sample size of tool stones from very distant sources so that a chi-square test could be run, the parent objects of not only flakes and utilized flakes, but also informal retouch flake tools were compared between samples of distant and very distant stone. To meet the chi-square test recommendation of having fewer than 20 percent of the cells in the table contain expected frequencies of less than five, the row in Table 10-21 containing flakes removed from unifaces was excluded from analysis and a chi-square test was run on the resulting table. The calculated chi-square statistic (2.42) and associated probability (p = .30) verify what can be seen by simple visual inspection of Table 10-21: that samples of distant and very distant stone are remarkably similar in the proportions of artifacts produced from blocky cores versus those made from bifaces. Flakes, utilized flakes, and informal retouched flake tools of Hartville Uplift chert that were removed from bifaces are 4.6 times as common as those that were struck from a
Table 10-20. Fisher Exact Probability Table for Distant and Very Distant Tool Stones by Projectile Points and Related Artifacts Versus All Other Artifacts.

<table>
<thead>
<tr>
<th>Artifact Category</th>
<th>Count</th>
<th>Expected Count</th>
<th>Std. Residual</th>
<th>Tool Stones from Distant and Very Distant Sources</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Hartville Uplift Chert (Distant Source)</td>
<td>Tool Stones from Very Distant Sources</td>
</tr>
<tr>
<td>Projectile Points, Preforms, and &quot;Stemmed Knives&quot;</td>
<td>18</td>
<td>22.7</td>
<td>-1.0</td>
<td>7</td>
<td>25</td>
</tr>
<tr>
<td>All Other Flaked Stone Artifact Types</td>
<td>366</td>
<td>361.3</td>
<td>.2</td>
<td>32</td>
<td>398</td>
</tr>
<tr>
<td>Total</td>
<td>384</td>
<td>384.0</td>
<td>.2</td>
<td>39</td>
<td>423</td>
</tr>
</tbody>
</table>
Table 10-21. Contingency Table Showing Distant and Very Distant Tool Stones by Parent Object of Flakes, Utilized flakes, and Informal Retouched Flake Tools.

<table>
<thead>
<tr>
<th>Parent Object of Flake, Utilized Flake, or Informal Retouched Flake Tool</th>
<th>Tool Stones from Distant and Very Distant Sources</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hartville Uplift Chert (Distant Source)</td>
<td>Tool Stones from Very Distant Sources</td>
</tr>
<tr>
<td>Blocky Core, Stream Cobble or Pebble, or Angular Piece of Tool Stone</td>
<td>Count</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>30.4</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>-.1</td>
</tr>
<tr>
<td>Biface or Bifacial Core</td>
<td>Count</td>
<td>138</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>140.8</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>-.2</td>
</tr>
<tr>
<td>Indeterminate (Blocky Core or Biface / Bifacial Core)</td>
<td>Count</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>69.9</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>.4</td>
</tr>
<tr>
<td>Uniface</td>
<td>Count</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>12.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>.0</td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>253</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>253.0</td>
</tr>
</tbody>
</table>
blocky core (138 flakes from bifaces ÷ 30 flakes from blocky cores, etc. = 4.6) (Table 10-21). Similarly, flakes, utilized flakes, and informal retouched flake tools of tool stones from very distant sources that derive from a biface were 5.0 times as frequent as those struck from blocky cores (15 flakes from bifaces ÷ 3 flakes from blocky cores, etc. = 5.0). These figures further strengthen the suggestion made above that the organization of lithic technology used in killing and processing a large number of bison appears to have demanded that the tool kit contain a certain proportion of bifacial tools (points, knives, etc.) prior to the hunt in order to kill and butcher the bison that were to be procured and that a set amount of unifacial tools (end scrapers, informal retouch flake tools, etc.) also be made so that the animals’ hides could be scraped and various processing and maintenance tasks requiring the use of an informal flake tool could be performed. Both stone that was hypothetically procured in bulk at the source and raw material believed to have been acquired in lesser amounts via an exchange network were used in similar fashion to produce certain amounts of unifacial and bifacial tools.

PROJECTILE POINT STYLE AS EVIDENCE FOR AGGREGATION

A final set of analyses was designed to explore whether possible stylistic attributes of projectile points can serve as another means by which aggregation of bands for communal hunting may be demonstrated. Statistical tests were performed to verify or refute the impression that points made from tool stones with sources in the South Platte drainage (WRGG, Flat Top chalcedony, and Dawson petrified wood) tend to have certain possible stylistic attributes while points from the main tool stone in the North Platte drainage (Hartville Uplift chert) possess differing attributes.

It was hypothesized that points made from tool stones with sources in the South Platte drainage tended to have non-patterned flaking while points produced from raw material
obtained in the North Platte drainage most commonly displays parallel flaking. Table 10-22 presents data on the frequency of points from South Platte and North Platte sources according to type of flaking pattern. Because the hypothesis predicts the direction of test results (i.e. that points of South Platte stone should have significantly more non-patterned flaking and points of North Platte stone will have more parallel flaking) a one-sided Fisher Exact Probability test is appropriate. The test result indicates that the observed frequencies evident in Table 10-22 are very likely to have occurred by chance alone. In fact, inspection of the table demonstrates that the trend for points of South Platte stone to display non-patterned flaking and the greater inclination of points made from North Platte stone to exhibit parallel flaking are such slight tendencies that it is difficult to understand why this impression was developed at all.

A second hypothesis concerning projectile point styles that has ramifications for the idea of Paleoindian band aggregation is that points of South Platte tool stones seem to have primarily lenticular cross sections, but projectile points of North Platte stone demonstrate a tendency to possess diamond-shaped cross sections. Table 10-23 gives frequency data on points of tool stones from the South Platte and North Platte drainages by projectile point cross section. A one-sided Fisher exact probability test was run and produced significant results in that the probability of the observed frequencies occurring by chance alone is extremely low ($p = .014$). If a band that normally operated within a range situated north of the range used by a local band had geared up with Hartville Uplift chert prior to aggregating for bison hunting in the South Platte drainage, then the predominance of points of Hartville Uplift chert with a diamond-shaped cross section could be explained as the handiwork of a flintknapper from the northern band who manufactured points for participating hunters in the band using a style of point manufacture that was not indigenous to the South Platte drainage. The fact some of the points of North Platte stone have lenticular cross sections and some of the points of South
Table 10-22. Fisher Exact Probability Table Showing River Drainages in Which Tool Stones of Projectile Points Originated by Type of Flaking Pattern.

<table>
<thead>
<tr>
<th>River Drainage in Which Tool Stone Used in Artifact Manufacture Originated</th>
<th>Flaking Pattern Type</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Non-patterned Flaking</td>
<td>Parallel Flaking</td>
<td>Total</td>
</tr>
<tr>
<td>South Platte Drainage</td>
<td>Count</td>
<td>20</td>
<td>12</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>19.2</td>
<td>12.8</td>
<td>32.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>.2</td>
<td>-.2</td>
<td></td>
</tr>
<tr>
<td>North Platte Drainage</td>
<td>Count</td>
<td>7</td>
<td>6</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>7.8</td>
<td>5.2</td>
<td>13.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>-.3</td>
<td>.4</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>27</td>
<td>18</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>27.0</td>
<td>18.0</td>
<td>45.0</td>
</tr>
</tbody>
</table>


Table 10-23. Fisher Exact Probability Table Showing River Drainages in Which Tool Stones of Projectile Points Originated by Type of Cross Section.\(^a\)

<table>
<thead>
<tr>
<th>River Drainage in Which Tool Stone Used in Artifact Manufacture Originated</th>
<th>Cross Section Type</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>Lenticular</td>
<td>Diamond-Shaped</td>
<td>Total</td>
</tr>
<tr>
<td>South Platte Drainage</td>
<td>Count</td>
<td>25</td>
<td>12</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>21.0</td>
<td>16.0</td>
<td>37.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>.9</td>
<td>-1.0</td>
<td></td>
</tr>
<tr>
<td>North Platte Drainage</td>
<td>Count</td>
<td>4</td>
<td>10</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>8.0</td>
<td>6.0</td>
<td>14.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>-1.4</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>29</td>
<td>22</td>
<td>51</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>29.0</td>
<td>22.0</td>
<td>51.0</td>
</tr>
</tbody>
</table>

\(^a\) One projectile point with a plano-convex cross section was excluded from the table.
Platte stone have diamond-shaped cross sections may be explained by sharing of tool stones among participating bands after having joined together.

A third hypothesis concerning possible point style attributes asserts that points made from South Platte tool stones tend to have slightly concave basal edges, but projectile points of the North Platte stone most frequently possess straight basal edges. Table 10-24 compares points of tool stones from the South and North Platte drainages by type of basal edge. A one-sided Fisher exact probability test was run and results indicate that the observed frequency distribution may very well have arisen through chance alone (p = .223). It is concluded that basal edge type is not an attribute of point style that can be shown to vary between the North and South Platte drainages.

CHAPTER SUMMARY AND CONCLUDING REMARKS

Working from the alternative perspective, an interpretation of the Jurgens site as the product of a single occupation by a large aggregated group of people intent on communal hunting was supported with evidence from analysis of the artifact assemblage. The collection is partly composed of formal tools needed to kill and process a large number of bison as well as manufacturing debris produced through formal tool manufacture that involved making both bifacial tools and unifacial ones produced through reduction of blocky cores. The fact that points, end scrapers, and other formal tools are in large part made from tool stones acquired from distant high-quality sources is in line with the thinking that multiple bands aggregated to carry out a large-scale bison kill. A dramatic falloff in the quantity of tool stone from high-quality sources in very distant lands further supports the interpretation of the Jurgens assemblage as the product of cooperation between a local band and neighboring bands, all of which brought tool stone from their home ranges to gear up for bison hunting. Some of the assemblage is demonstrative of the use of locally available stream cobbles to
Table 10-24. Fisher Exact Probability Table Showing River Drainages in Which Tool Stones of Projectile Points Originated by Type of Basal Edge.\textsuperscript{a}

<table>
<thead>
<tr>
<th>River Drainage in Which Tool Stone Used in Artifact Manufacture Originated</th>
<th>Type of Basal Edge</th>
<th>Count</th>
<th>Expected Count</th>
<th>Std. Residual</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Platte Drainage</td>
<td>Straight</td>
<td>21</td>
<td>22.5</td>
<td>-.3</td>
</tr>
<tr>
<td></td>
<td>Slightly Concave</td>
<td>11</td>
<td>9.5</td>
<td>.5</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>32</td>
<td>32.0</td>
<td></td>
</tr>
<tr>
<td>North Platte Drainage</td>
<td>Count</td>
<td>10</td>
<td>8.5</td>
<td>.5</td>
</tr>
<tr>
<td></td>
<td>Slightly Concave</td>
<td>2</td>
<td>3.5</td>
<td>-.8</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>12</td>
<td>12.0</td>
<td></td>
</tr>
</tbody>
</table>

\textsuperscript{a} A projectile point and a stemmed knife with slightly convex basal edges were excluded from the table.
manufacture informal tools using a so-called core-and-flake technology. This is interpreted as representing the use of available lower quality tool stone to produce expedient flake tools needed in daily camp life or gearing up activities not requiring the use of formal tools in order to conserve the supplies of stone from high-quality sources.

Examination of a number of manos and grinding slab fragments in the collection revealed that these seemingly out-of-place ground stone artifacts were likely used in an activity related to processing hides acquired in a communal kill. The ground stone tools were used to break up and pulverize hematite and limonite to produce powdered ochre, a substance that may have been used to preserve fresh hides for later processing.

An artifact refitting study and minimum analytical nodule analysis supports the view that the three widely separated areas of the site are middens produced during a single occupation of the site by a large group of people involved in large-scale bison hunting. Contemporary use of all three middens is demonstrated by refitted artifacts and minimum analytical nodules which together constitute several connections between neighboring areas of the site. Consideration of the artifacts and faunal remains present in the three areas supports the view that Areas 1 and 2 principally received trash from a camp area and Area 3 primarily served as a midden where waste from nearby bison butchering operations was discarded. Refitting and minimum analytical nodule analysis also supported the site interpretation by demonstrating the manner in which activities related to communal hunting were carried out in various parts of the site. Points manufactured in or near the camp were used in a communal bison kill in the field and returned to the site where they were deposited along with bison remains in the butchering midden or discarded in a camp midden as hunting weaponry was refurbished. Flakes struck from blocky cores were retouched to produce end scrapers used mostly on fresh hides in or near the camp area. Debitage produced when gearing up with bifacial and unifacial artifacts was dumped in trash concentrations in the camp middens along with tools that were broken or no longer needed.
The alternative view’s assertion that tool stone was transported long distances across the Plains in exchange networks or through travel by individuals or small groups finds support in the Jurgens assemblage in the form of small numbers of artifacts made from tool stones originating in very distant high quality sources spread throughout the Great Plains. The suggestion that participating bands brought tool stones they had acquired by trade with them to an aggregation offers a plausible explanation for much of the tool stone from very distant sources. Comparison of the sample of artifacts made of stone from very distant sources with a larger sample of artifacts from a raw material originating from a distant source reveals a basic similarity in terms of the kinds of artifacts brought to a large-scale bison hunt. However, overrepresentation of projectile points in the sample of tool stones from very distant sources supports the assertion that this class of artifact was widely traded across the Plains.

Finally, a preliminary analysis of attributes of projectile points thought to reflect regional stylistic differences proved promising as a potential method of providing another line of evidence to demonstrate that communal hunting sometimes involved aggregation of human groups. Specifically, the type of cross section of Cody points in the Jurgens assemblage was found to vary significantly between the sample of points made of stone from sources in the South Platte drainage and those points made of chert from the North Platte watershed. This supports the interpretation based on tool stone sourcing that people indigenous to both river drainages participated in the communal hunt represented at Jurgens.

The alternative theoretical perspective was found to be capable of producing a plausible interpretation of the Jurgens assemblage as the product of occupation by multiple Paleoindian bands that operated within ranges not unlike those of ethnographically documented foragers. Others may reasonably assert that the case for the Jurgens assemblage being the product of occupation by multiple distant bands is not definitive. In their view, the site may instead be interpreted as resulting from a large aggregation of people that had sent
task groups out to acquire tool stone from distant high-quality sources to gear up. Though alternative theory and methods have yet to be able to definitively distinguish between competing explanations proposed from this theoretical perspective, an important point to be stressed is that at no time in the analysis of the Jurgens site was data found to be simply contrary to the expectations of the alternative view. With this thought in mind, I now turn to evaluating expectations developed under the traditional view’s concept of a frugal lithic technology to assess if the traditional model of land use performs as well as the alternative.
CHAPTER 11
THE FRUGAL LITHIC TECHNOLOGY CONCEPT AND THE JURGENS SITE

During analysis of the Jurgens collection, data was collected to evaluate the traditional view’s position that support for the theoretical construct of a highly mobile land use strategy should be found in various aspects of lithic technology that were intended to permit frugal consumption of tool stone and free Paleoindians from having to visit lithic sources as much as later peoples. These hypothetical aspects of lithic technology include: 1) selection of microcrystalline tool stone over granular varieties, 2) emphasis on the use of bifacial tools and production of tools from bifacial cores, and 3) manufacture and use of tools specially designed to be resharpened many times. Essentially the same methods of analysis use to develop an alternative interpretation of the Jurgens assemblage will be used to evaluate the concept of a frugal Paleoindian technology. These include examining relevant data in contingency tables and employing basic statistical tests designed to assess if relationships apparent in contingency tables are statistically valid (i.e. not likely to be the result of random chance).

THE PURPORTED EMPHASIS ON MICROCRYSTALLINE STONE

As pointed in the previous chapter, orthoquartzites comprise a substantial portion of the Jurgens collection. Very rough-textured orthoquartzite is the raw material of 21.4 percent of the assemblage by weight and Morrison orthoquartzite and light-to-medium red very fine-
grained orthoquartzite account for 1.5 and .6 percent, respectively. In total, 23.5 percent of the assemblage is composed of orthoquartzites believed to derive from local gravels.

As more fully discussed in Chapter 10, orthoquartzite is common in the local gravel deposits and evidently was selected over microcrystalline cobbles for use in gearing up. Orthoquartzite comprises only 38 percent of a sample 99 artifacts comprised of debitage and retouched flake tools counted at a procurement site of WRGG (5WL5), but accounts for 82 percent of the WRGG artifacts from Jurgens, according to artifact count (Table 10-4). Very rough-textured orthoquartzite is by far the most common variety of tool stone from the White River Group gravels in the Jurgens collection. Evidence was cited in Chapter 10 to support the contention that this raw material can occur in large clasts, a characteristic that may have been a factor in this particular variety of tool stone having been chosen for use in gearing up. Furthermore, evidence presented in the previous chapter suggests that the two other varieties of orthoquartzite mentioned above may have been used as well to make finely made points to gear up for bison hunting. On the other hand, there is not similar support for the contention that the several varieties of microcrystalline tool stones from the White River Group gravels were used in gearing up. Evidence from Jurgens therefore strongly suggests that if orthoquartzites were the kind of stone most suitable for gearing up by a Paleoindian band, it was indeed used for this purpose over local microcrystalline tool stones.

Traditional thinkers would reason that microcrystalline tool stone was selected over orthoquartzite because the former variety can be more successfully flaked, thus allowing for the high level of resharpening and recycling needed for high mobility. Assessments by contemporary flintknappers of the ease with which pieces of the main tool stones can be flaked and the degree to which each raw material can be successfully flaked without unwanted breakage would have been useful information to evaluate traditional thinking. This was beyond the scope of the study, but another quality that affects the success with which a tool stone may be flaked is the prevalence of flaws in the material and this characteristic of
stone may be easily quantified by simply noting the presence or absence of various kinds of flaws during the course of artifact analysis. These data were collected for all the artifacts, except those from excavated contexts in Area 1 which were analyzed in an expedited fashion.

Table 11-1 presents data on the frequency of inclusions in the main tool stones comprising the Jurgens collection. Because the intent here is to compare the prevalence of flaws in orthoquartzite with that of microcrystalline stones, only the artifacts of the very rough-textured orthoquartzite variety of WRGG are included in the comparisons to follow. Inclusions present in the main tool stones are often spherical in shape or are small fossils, but also include other kinds (with the exception of veins, which are discussed below). Standardized residuals in Table 11-1 indicate that very rough-textured orthoquartzite has significantly less than the expected number of inclusions, but Flat Top chalcedony has more. A chi-square test run on the data in Table 11-1 demonstrates that the observed frequencies are not likely to have occurred by chance alone ($\chi^2 = 59.86, p = .000$). From this, it may be concluded that a causal relationship exists between raw material type and frequency of inclusions with Flat Top chalcedony having greater than expected numbers of inclusions and very rough-textured orthoquartzite possessing far fewer.

Data on the occurrence of a specific kind of inclusion within the material, that being quartz-filled veins, is presented in Table 11-2. The flaw is believed to occur when cracks form in the stone which are later filled when silica (quartz) is precipitated out of solution. Originally, data on the frequency of veins were encoded as “other” flaws, but upon completion of analysis, veins were found to be the only variety of raw material flaw not anticipated prior to analysis. Significantly less than expected frequencies were observed in artifacts of very rough-textured orthoquartzite ($n = 0$) and Flat Top chalcedony ($n = 0$), denoting that this kind of flaw may not occur whatsoever or is very rare in these tool stones. Veins filled with quartz were significantly more common than expected in artifacts of Dawson petrified wood and Hartville Uplift chert. Because more than 20 percent of the cells
Table 11-1. Chi-Square Table Comparing Samples of Main Tool Stones by Frequency of Artifacts with Inclusions in the Raw Material.

<table>
<thead>
<tr>
<th>Inclusions</th>
<th>Very Rough-Textured Orthoquartzite Variety of WRGG</th>
<th>Flat Top Chalcedony</th>
<th>Dawson Petrified Wood</th>
<th>Hartville Uplift Chert</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent</td>
<td>Count</td>
<td>274</td>
<td>227</td>
<td>119</td>
<td>281</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>247.5</td>
<td>257.3</td>
<td>121.1</td>
<td>275.1</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>1.7</td>
<td>-1.9</td>
<td>-0.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Present</td>
<td>Count</td>
<td>4</td>
<td>62</td>
<td>17</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>30.5</td>
<td>31.7</td>
<td>14.9</td>
<td>33.9</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>-4.8</td>
<td>5.4</td>
<td>0.5</td>
<td>-1.0</td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>278</td>
<td>289</td>
<td>136</td>
<td>309</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>278.0</td>
<td>289.0</td>
<td>136.0</td>
<td>309.0</td>
</tr>
</tbody>
</table>
Table 11-2. Contingency Table Comparing Samples of Main Tool Stones by Frequency of Artifacts with Quartz-Filled Veins in the Raw Material.

<table>
<thead>
<tr>
<th>Other Flaws</th>
<th>Main Tool Stones</th>
<th>Very Rough-Textured Orthoquartzite Variety of WRGG</th>
<th>Flat Top Chalcedony</th>
<th>Dawson Petrified Wood</th>
<th>Hartville Uplift Chert</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent</td>
<td>Count</td>
<td>278</td>
<td>289</td>
<td>129</td>
<td>301</td>
<td>997</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>273.9</td>
<td>284.7</td>
<td>134.0</td>
<td>304.4</td>
<td>997.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>.2</td>
<td>.3</td>
<td>-.4</td>
<td>-.2</td>
<td></td>
</tr>
<tr>
<td>Present</td>
<td>Count</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>8</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>4.1</td>
<td>4.3</td>
<td>2.0</td>
<td>4.6</td>
<td>15.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>-2.0</td>
<td>-2.1</td>
<td>3.5</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>278</td>
<td>289</td>
<td>136</td>
<td>309</td>
<td>1012</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>278.0</td>
<td>289.0</td>
<td>136.0</td>
<td>309.0</td>
<td>1012.0</td>
</tr>
</tbody>
</table>
in Table 11-2 have expected counts less than 5, one of the recommendations regarding use of the chi-square test could not be met. However, a strong tendency for veins to be completely absent in some tool stones and most common in other raw materials is evident through mere visual inspection of Table 11-2.

Data on the occurrence of pockets of irregular material among the main tool stones is given in Table 11-3. Standardized residuals indicate that significantly less than expected frequencies of artifacts with irregular material occur in the samples of very rough-textured orthoquartzite and Hartville uplift chert and significantly more than the expected number of artifacts of Dawson petrified wood have pockets of irregular material. A chi-square test on data in the table indicates the observed frequencies are unlikely to have resulted through random chance ($\chi^2 = 38.57, p = .000$).

Table 11-4 exhibits frequency data for the occurrence of cavities in the main tool stones. Cavities in raw material commonly are partially lined with small quartz crystals. Standardized residuals in the table demonstrate that a significantly less than expected number of artifacts of very rough-textured orthoquartzite were observed with cavities while a significantly greater than expected quantity of artifacts of Flat Top chalcedony are flawed by cavities. Results of a chi-square test on data in the table demonstrate that the frequencies are unlikely to have occurred by chance alone ($\chi^2 = 7.69, p = .053$). Although the chi-square value is not significant at the .05 significance level, the likelihood that data in the table represents a real, causal relationship between the kind of raw material and the presence (or absence) of cavities is a strong possibility.

Data on the occurrence of internal structural planes in the main tool stones is given in Table 11-5. As implied by the name, internal structural planes are flat surfaces believed to have been formed in the tool stone at the time of formation. Sometimes a thin layer of silica is evident on the plane, but in most cases, it is not. Upon encountering an internal structural plane, a fracture initiated by a flintknapper may follow the zone of weakness along the plane.
Table 11-3. Chi-Square Table Comparing Samples of Main Tool Stones by Frequency of Artifacts with Areas of Irregular Material.

<table>
<thead>
<tr>
<th>Irregular Material</th>
<th>Main Tool Stones</th>
<th>Very Rough-Textured Orthoquartzite Variety of WRGG</th>
<th>Flat Top Chalcedony</th>
<th>Dawson Petrified Wood</th>
<th>Hartville Uplift Chert</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent</td>
<td>Count</td>
<td>273</td>
<td>252</td>
<td>82</td>
<td>288</td>
<td>895</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>245.9</td>
<td>255.6</td>
<td>120.3</td>
<td>273.3</td>
<td>895.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>1.7</td>
<td>-.2</td>
<td>-3.5</td>
<td>.9</td>
<td></td>
</tr>
<tr>
<td>Present</td>
<td>Count</td>
<td>5</td>
<td>37</td>
<td>54</td>
<td>21</td>
<td>117</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>32.1</td>
<td>33.4</td>
<td>15.7</td>
<td>35.7</td>
<td>117.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>-4.8</td>
<td>.6</td>
<td>9.7</td>
<td>-2.5</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>278</td>
<td>289</td>
<td>136</td>
<td>309</td>
<td>1012</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>278.0</td>
<td>289.0</td>
<td>136.0</td>
<td>309.0</td>
<td>1012.0</td>
</tr>
</tbody>
</table>
Table 11-4. Chi-Square Table Comparing Samples of Main Tool Stones by Frequency of Artifacts with Cavities in the Raw Material.

<table>
<thead>
<tr>
<th>Cavities</th>
<th>Very Rough-Textured Orthoquartzite Variety of WRGG</th>
<th>Flat Top Chalcedony</th>
<th>Dawson Petrified Wood</th>
<th>Hartville Uplift Chert</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent</td>
<td>Count</td>
<td>276</td>
<td>276</td>
<td>131</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>270.0</td>
<td>280.7</td>
<td>132.1</td>
<td>300.1</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>.4</td>
<td>-.3</td>
<td>-.1</td>
<td>0</td>
</tr>
<tr>
<td>Present</td>
<td>Count</td>
<td>2</td>
<td>13</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>8.0</td>
<td>8.3</td>
<td>3.9</td>
<td>8.9</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>-2.1</td>
<td>1.6</td>
<td>.6</td>
<td>.0</td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>278</td>
<td>289</td>
<td>136</td>
<td>309</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>278.0</td>
<td>289.0</td>
<td>136.0</td>
<td>309.0</td>
</tr>
</tbody>
</table>
Table 11-5. Chi-Square Table Comparing Samples of Main Tool Stones by Frequency of Artifacts with Internal Structural Planes in Raw Material.

<table>
<thead>
<tr>
<th>Internal Structural Planes</th>
<th>Main Tool Stones</th>
<th>Very Rough-Textured Orthoquartzite Variety of WRGG</th>
<th>Flat Top Chalcedony</th>
<th>Dawson Petrified Wood</th>
<th>Hartville Uplift Chert</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>269</td>
<td>287</td>
<td>126</td>
<td>299</td>
<td>981.0</td>
</tr>
<tr>
<td>Absent</td>
<td>Expected Count</td>
<td>269.5</td>
<td>280.1</td>
<td>131.8</td>
<td>299.5</td>
<td>981.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>.0</td>
<td>.4</td>
<td>-.5</td>
<td>.0</td>
<td></td>
</tr>
<tr>
<td>Present</td>
<td>Count</td>
<td>9</td>
<td>2</td>
<td>10</td>
<td>10</td>
<td>31</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>8.5</td>
<td>8.9</td>
<td>4.2</td>
<td>9.5</td>
<td>31.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>.2</td>
<td>-.2.3</td>
<td>2.9</td>
<td>.2</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>278</td>
<td>289</td>
<td>136</td>
<td>309</td>
<td>1012</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>278.0</td>
<td>289.0</td>
<td>136.0</td>
<td>309.0</td>
<td>1012.0</td>
</tr>
</tbody>
</table>
and result in an undesired fracture or breakage of the piece being worked. Internal structural planes may be distinguished from naturally occurring cracks because the later normally have a curvilinear alignment. Significantly less than the expected number of artifacts of Flat Top chalcedony with internal structural planes were observed and significantly more than the expected quantity was recorded for the sample of Dawson petrified wood. Artifacts of very rough-textured orthoquartzite with internal structural planes are about as common as expected. Chi-square test results show that the observed frequencies in the table are not likely to have occurred purely by chance. ($\chi = 13.96$, $p = .003$).

Finally, data on the frequency of cracks in the main tool stones is given in Table 11-6. Dawson petrified wood has significantly more than the expected number of cracks and Hartville Uplift chert is significantly free from cracks. The observed frequency of cracks in very rough-textured orthoquartzite is very close to the number that is expected. A chi-square test verifies that the figures seen in the table are not likely to have occurred by chance alone ($\chi = 12.63$, $p = .006$).

The above tables demonstrate that the dominant variety of orthoquartzite used by occupants of the Jurgens site was relatively free of flaws that adversely affect the ability of a raw material to be successfully flaked. Flat Top chalcedony has more than the expected number of inclusions. Hartville Uplift chert contains more than the expected quantity of veins. Though a microcrystalline stone, Dawson petrified wood is a poor tool stone in comparison to the other main tool stones, at least from the standpoint of the prevalence of raw material flaws. The tool stone contains more than the expected number of veins, pockets of irregular material, internal structural planes, and cracks. In contrast to the above microcrystalline tool stones, the very rough-textured orthoquartzite variety of WRGG is relatively free of defects, as it contains no type of flaw in frequencies greater than expected.

Based on data from the Jurgens assemblage, it may be concluded that the traditional view’s assertion that relatively poor flaking quality inherent to all varieties of orthoquartzite
Table 11-6. Chi-Square Table Comparing Samples of Main Tool Stones by Frequency of Artifacts with Cracks in Raw Material.

<table>
<thead>
<tr>
<th>Cracks</th>
<th>Main Tool Stones</th>
<th>Very Rough-Textured Orthoquartzite WRGG</th>
<th>Flat Top Chalcedony</th>
<th>Dawson Petrified Wood</th>
<th>Hartville Uplift Chert</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Absent</td>
<td>Count</td>
<td>269</td>
<td>278</td>
<td>126</td>
<td>306</td>
<td>979</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>268.9</td>
<td>279.6</td>
<td>131.6</td>
<td>298.9</td>
<td>979.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>.0</td>
<td>-.1</td>
<td>-.5</td>
<td>.4</td>
<td></td>
</tr>
<tr>
<td>Present</td>
<td>Count</td>
<td>9</td>
<td>11</td>
<td>10</td>
<td>3</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>9.1</td>
<td>9.4</td>
<td>4.4</td>
<td>10.1</td>
<td>33.0</td>
</tr>
<tr>
<td></td>
<td>Std. Residual</td>
<td>.0</td>
<td>.5</td>
<td>2.6</td>
<td>-2.2</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>278</td>
<td>289</td>
<td>136</td>
<td>309</td>
<td>1012</td>
</tr>
<tr>
<td></td>
<td>Expected Count</td>
<td>278.0</td>
<td>289.0</td>
<td>136.0</td>
<td>309.0</td>
<td>1012.0</td>
</tr>
</tbody>
</table>
cause this kind of raw material to always be avoided by Paleoindians in preference to microcrystalline stone is not an empirically verifiable belief. To the contrary, orthoquartzites that are believed to have been available in the local environment of the Jurgens site were well suited for use in gearing up (especially the very rough-textured variety). Accordingly, these materials make up a substantial amount of the Jurgens assemblage. Orthoquartzites from exposures of WRGG were apparently preferred to the microcrystalline cobbles that would have also been present in the gravel sources exploited. Finally, very rough-textured orthoquartzite is demonstrably better than the microcrystalline tool stones from distant sources used in gearing up, at least in so far that it contains fewer flaws that can adversely affect knapping success.

EVALUATING THE “BIFACE ARGUMENT”

As with the purported emphasis on microcrystalline stone, the traditional argument that bifacial cores were the centerpiece of Paleoindian technology is not supported by data from the Jurgens site. In the assemblage, blocky cores (n = 12) are more frequent than bifacial cores (n = 2) (Table 11-7). As can be seen from the table, the assemblage does contain a considerable number of unfinished and finished bifacial artifacts. Included are 16 projectile point preforms and a total of 76 points when “stemmed knives” are added to the sample of projectile points. There are also three unfinished bifaces, four finished (Stage 4) bifaces that were in a condition such that they might have been used, and 14 artifacts classified as stemless knives. Although there are a considerable number of bifacial artifacts, this should not be considered evidence in support of the traditional view. If the alternative interpretation of the Jurgens assemblage is correct and it was produced by a large group of people engaged in a bison hunt, it is not unexpected that the collection would contain
Table 11-7. Frequency of Blocky Cores, Bifacial Cores, and Other Bifacial Artifacts in the Jurgens Assemblage.

<table>
<thead>
<tr>
<th>Artifact Type</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blocky Core</td>
<td>12</td>
</tr>
<tr>
<td>Bifacial Core</td>
<td>2</td>
</tr>
<tr>
<td>Unfinished (Stage 3) Biface</td>
<td>2</td>
</tr>
<tr>
<td>Finished (Stage 4) Biface</td>
<td>4</td>
</tr>
<tr>
<td>Unfinished Biface (Indeterminate Stage)</td>
<td>1</td>
</tr>
<tr>
<td>Projectile Point Preform</td>
<td>16</td>
</tr>
<tr>
<td>Projectile Point</td>
<td>60</td>
</tr>
<tr>
<td>Stemmed Knife</td>
<td>16</td>
</tr>
<tr>
<td>Stemless Knife</td>
<td>14</td>
</tr>
<tr>
<td>Drill</td>
<td>2</td>
</tr>
</tbody>
</table>
numbers of points and knives as well as bifacial artifacts that were broken or otherwise rejected during manufacture of the above artifact types.

As argued in the previous chapter, analysis of the parent object of flakes and utilized flakes of those tool stones that were principally brought to the site by bands participating in a bison hunt revealed that the raw materials were flaked on the site in the form of both blocky cores and bifaces. This is in keeping with the expectation that both bifacial and unifacial tools would be needed to kill and process a large number of bison. The samples of flakes and utilized flakes compared included Hartville Uplift Chert, Dawson petrified wood, Flat Top chalcedony, and the very rough-textured variety of WRGG. For all tool stone types except Dawson petrified wood, flakes detached from bifaces are more common than those struck from blocky cores (Table 10-15). From this, it may be suggested that gearing up for a bison hunt in general produces more debitage indicative of bifacial tool manufacture than flakes characteristic of unifacial tool production. In contrast, flakes of Dawson petrified wood struck from blocky cores were found to be slightly more frequent than those detached from bifaces (Table 10-15). It was suggested that the sample of Dawson petrified wood may include not only artifacts of stone from primary sources produced to gear up with formal tools, but also artifacts resulting from employment of a core-and-flake technology to meet informal tool needs. From the above analysis of the prevalence of flaws in the main tool stones, it might be speculated that another factor that may have contributed to a relatively low number of bifaces of Dawson petrified wood having been knapped on-site is the possibility that the common occurrence of veins, pockets of irregular material, internal structural planes, and cracks in this raw material made it less suited for making bifacial tools in comparison to the other main tool stones.

Parent object analysis of flakes, utilized flakes, and expedient flake tools of stone from very distant sources was found to be similar to that of most of the main tool stones in that a majority of debitage had been removed from bifaces, rather than blocky cores. A case
was made that stone from very distant sources was not procured by entire bands having visited the sources to gear up, but rather ultimately arrived on-site via other cultural mechanisms. Be that as it may, the observation that most of the debitage of stone from very distant sources was also in the form of bifacial reduction flakes suggests that gearing up for a large-scale hunting produces debitage that is dominated by bifacial reduction flakes. From the above discussion, it should be apparent that the prevalence of bifacial reduction flakes should not be taken as evidence supporting the biface argument of the traditional view, but rather as being indicative of but one aspect of Plains Paleoindian lithic technology, specifically, gearing up for a bison hunt.

The end scrapers from the Jurgens site comprise a class of artifacts that was also produced in preparation for activities related to a large-scale bison hunt, and it is important to note that they were almost exclusively made by retouching flake blanks struck from blocky cores. The parent object of flake blanks used to manufacture 57 end scrapers could be determined with confidence. Of these, 56 flake blanks were stuck from blocky cores and one came from a stream cobble or pebble. No flake blanks were made from a flake that was classified as having been definitely struck from a biface (Table 10-14). It is suggested that pressure exerted on end scrapers during use in processing hides would have imposed a functional requirement that end scrapers be made from thick flakes so as to counter forces that can break scrapers in their lengthwise direction when in use. Flakes detached from bifaces are generally thin, but a blocky core can be reduced in a manner such that a number of thick flakes may be removed, particularly from a corner of the core. From the above discussion, it should be apparent that manufacture of hide scraping tools was an integral part of the lithic technology necessary for a successful bison hunt when processing of hides was planned and that this particular aspect of Paleoindian lithic technology as expressed at the Jurgens site was evidently based solely on the reduction of blocky cores.
Analysis of the parent object of flakes and utilized flakes of varieties of tool stone from the locally available White River Group gravels supports the supposition that Paleoindians also made use of lower quality local tool stone to meet informal tool needs by means of a lithic technology that emphasized the reduction of blocky cores over manufacture of bifacial tools. Flakes detached from bifaces of the very rough-textured variety of WRGG were found to be much more common than expected, but flakes struck from blocky cores and stream-rounded clasts of other varieties of WRGG were much more prevalent than expected. (Table 10-16). This observation was interpreted as supporting the view that the very rough-textured orthoquartzite variety of the locally available gravels was a particular variety selected for use in gearing up, whereas the other varieties of tool stone were more suited for producing expedient flake tools.

In summary, it may be stated that analysis of the parent object of flakes and flake-based artifacts has demonstrated that Paleoindian technology varied in that it involved the reduction of both blocky cores and bifaces and that the alternative view offers a better explanatory model to account for this variability. Under an alternative interpretation of the Jurgens assemblage, the lithic technology of Paleoindians involved in large-scale bison hunting was based on reduction of both bifaces and blocky cores, but in general, it can be said that debitage produced during an occupation of a camp associated with large-scale bison hunting and processing will be composed principally of flakes detached from bifaces. If hides were to be processed, one aspect of lithic technology related to a large-scale hunt involved the exclusive use of blocky cores to produce the necessary end scrapers. Analysis of the parent object of the varieties of WRGG was the basis for suggesting that Paleoindian lithic technology also involved proportionally greater reliance on the reduction of blocky cores when making use of lower quality local tool stone to meet informal tool needs. Though the above scenario is far from being proven, the main point to be made here is that the alternative view at least allows a possible explanation to be suggested that attempts to
account for the observed variability in the frequencies of debitage deriving from bifaces versus that originating from blocky cores. On the other hand, the biface argument of the traditional view maintains that there was little to no variability in Paleoindian technology in that it was in all situations typified by bifacial reduction as bifacial cores produced the flake blanks for both unifacial and bifacial tools. This view simply cannot be justified given the evidence from Jurgens indicating that the reduction of blocky cores was an important and integral part of Paleoindian lithic technology.

CONSIDERING THE CLAIM FOR HIGH LEVELS OF RESHARPENING

As more fully explained in Chapter 9, comparing the lengths of projectile points and end scrapers of stone from very distant sources to those made of raw material from local and distant sources is one way to test the validity of the traditional view that Paleoindian lithic technology was specially designed to permit high mobility through the manufacture and use of tools that could be resharpened many times. Reasoning from the traditional view, one could assert that if the band that produced the Jurgens site actually procured stone from a very distant source when it was in the area at some time in the past, tools made of that stone would have been in the tool kit longer than stone from local or distant sources. Points and end scrapers of stone from very distant sources should therefore have been subjected to a greater amount of resharpening and consequently tend to be shorter than tools made of local and distant stone. Points and end scrapers made of tool stones from local and distant sources were divided into four samples. Complete points (n = 15), fragmentary points (n = 39), whole end scrapers (n = 61), and broken end scrapers (n = 26) were plentiful enough to be plotted on histograms to suggest the shape of a frequency distribution, although only two of the samples number over 30 and might reasonably be considered to be representative samples. As will be shown below, the distributions do not appear to be normal with the
possible exception of the frequency distribution of broken end scraper length. Very few complete and fragmentary points and end scrapers of raw material from very distant sources were present in the collection, ranging in number from a single artifact to a sample of only four. Because of these small quantities, statistical tests capable of measuring the strength of any difference in artifact length between the two categories of distance to tool stone source could not be performed. However, the histograms produced do permit the comparison to be made through simple visual inspection of graphs.

Figure 11-1 compares the lengths of 15 complete points of stone from local and distant sources with the length of a whole point from a very distant source. The sample of points of stone from local and distant sources used in the four comparisons of artifact length include those of Flat Top chalcedony, Dawson petrified wood, Hartville Uplift chert, and the particular variety of WRGG believed to have been used the most in gearing up operations. By comparing just this particular variety of WRGG, only several points made of other varieties were excluded from analysis. The point of stone from a very distant source is made of Ft. Union porcellanite. The mean length of complete points made from local and distant stone is 4.1 cm. Measuring nearly seven cm in length, the complete point from a very distant source clearly does not conform to the expectation of the traditional view that points from very distant sources should actually be shorter than points from local and distant sources as a result of having been subjected to more episodes of resharpening.

Under the traditional view, fragmentary points of stone from very distant sources should also reasonably be expected to be shorter on average than broken points of local and distant sources. Points may be broken in use by fractures that traverse the artifact near the tip, in the midsection area, or near the basal edge. If points of very distant stone were generally shorter prior to a hunt in comparison to points of local and distant stone, then fragments of points of raw material from very distant sources produced by breakage during use should also be shorter on average. The lengths of 39 fragmentary points of local and
Figure 11-1. Histogram comparing lengths of complete points of tool stones from local and distant sources with length of a complete point of a tool stone from a very distant source.
distant stone is compared to the lengths of four point fragments of raw material from very distant sources in Figure 11-2. The point fragments from very distant sources include two specimens of Knife River flint, one of Edwards chert, and one of Wamsutter oölitic chert. Figure 11-2 indicates that the lengths of points belonging to the two categories of distance to source are virtually identical. Broken points of local and distant stone average 3.4 cm in length and those from very distant sources have a mean length of 2.9 cm. Therefore, data from the Jurgens site do not support the expectation of the traditional view that point fragments of stone from very distant sources should be appreciably shorter due to greater resharpening.

The traditional view further expects that end scrapers of stone from very distant sources will also tend to be substantially shorter as a result of having been subjected to greater amounts of resharpening. Figure 11-3 compares the lengths of 61 complete end scrapers of local and distant tool stones to the lengths of two complete scrapers made of stone from a very distant source, specifically Knife River flint (KRF). The lengths of scrapers in the two samples are virtually identical with the mean length of scrapers of local and distant stone being 4.7 cm and that of KRF scrapers being 4.6 cm. The traditional expectation that end scrapers from the very distant sources should be appreciably shorter is therefore not supported by data from Jurgens.

The average length of fragmentary end scrapers that are broken in the lengthwise dimension might also reasonably be expected to be appreciably shorter than the mean length of scrapers from local and distant tool stones if indeed the traditional concept of a frugal Paleoindian lithic technology is valid. A total of 27 end scrapers were fragmentary in the lengthwise dimension. Presumably, the fragmentation occurred during use of the scrapers. If indeed end scrapers of very distant stone had been subjected to more resharpening than scrapers of local and distant stone, and as a consequence were generally shorter prior to breakage, then one might expect that fragmentary end scrapers of very distant stone would
Figure 11-2. Histogram comparing lengths of fragmentary points of tool stones from local and distant sources with lengths of fragmentary points from very distant sources.
Figure 11-3. Histogram comparing lengths of complete end scrapers of tool stones from local and distant sources with lengths of complete end scrapers from a very distant source.
also tend to be shorter than broken end scrapers of local and distant stone. Figure 11-4 compares the lengths of end scrapers from the Jurgens site that were broken in the lengthwise direction according to distance to source of the raw material. A total of 26 of the broken end scrapers are made of stone from local or distant sources. One was made of a tool stone from a very distant source, having been produced from Edwards chert. The length of the fragmentary end scraper of Edwards chert is 3.0 cm and is nearly identical to the average length of the end scraper fragments of local or distant stone (3.2 cm). From the above, it may be concluded that the length of the fragmentary end scraper from Jurgens is not appreciable shorter than the lengths of scrapers of local or distant stone. The traditional concept of a frugal lithic technology therefore cannot be supported by data on end scraper or projectile point length from the Jurgens site.

RELEVANCE OF THE NUMBER AND DISTRIBUTION OF VERY DISTANT SOURCES OF TOOL STONE

A final observation pertinent to evaluating the credibility of the traditional view is the number and distribution of very distant sources of tool stone. If the number of very distant sources represented in the Jurgens collection numbered but a few and were all situated in a certain direction from the site, then the traditional interpretation that the movement of a single band within a huge range is suggested could at least be a reasonable hypothesis. However, tool stone from very distant sources present in the Jurgens collection came from six sources distributed throughout a broad span of the compass. From the source of Wamsutter oolitic chert, which is located west-northwest of the site in the Wyoming Basin, the very distant sources of stone extend in a clockwise direction through the Northwest Plains (Ft. Union porcellanite), the Northern Plains (Knife River flint), the Central Plains (Smoky Hill jasper), and are also on the Southern Plains where the sources of Alibates Agate and Edwards chert lie in a south-southeasterly direction from the site. The quantities of stone from very distant
Figure 11-4. Histogram comparing lengths of fragmentary end scrapers of tool stones from local and distant sources with length of a fragmentary end scraper of a tool stone from a very distant source.
sources are minuscule compared to stone from local and distant sources. Therefore, to interpret the Jurgens collection from a strict traditional perspective where the stone in a Paleoindian assemblage was collected by a single band during visits to the sources, one would have to suggest that a band traveled throughout a huge, roughly arc-shaped area that required the band to walk across the Wyoming Basin plus all regions of the Great Plains in the coterminous United States! For whatever reason, apparently little stone was collected from the lithic sources visited until the band entered the plains of northeast Colorado and southeast Wyoming, where it gathered large quantities of stone. The above interpretation would seem to be untenable in that it requires that a single band walk tremendous distances such that the thought of a group of men, women, and children doing this on an annual basis stretches the bounds of what is physically possible for humans to do. The interpretation is also unpalatable for archaeologists seeking to demonstrate some sort of causal explanation of prehistoric land use patterns because the above-described movements of a band and their raw material collection practices would seem to defy any attempt to explain their behavior with reference to what is known about the ways that ethnographic hunter-gatherers operated in general.

On the other hand, the alternative interpretation of the tool stone composition of the Jurgens assemblage offers an explanation that links basic characteristics of the tool stone composition of the assemblage to behaviors that are well documented among ethnographically studied hunter-gatherers. For example, that the bulk of tool stone is from local and distant sources may be parsimoniously explained by aggregation of participating bands because the seasonal coalescing of unacculturated bands of hunter-gatherers for communal hunting is a well documented feature of many foraging peoples. Secondly, long-distance social interaction and exchange is known among recent foraging peoples and provides a parsimonious explanation of the small amounts of tool stone in the Jurgens collection from very distant sources throughout the Great Plains. There is no reason to
believe that aggregation for communal hunting, long-distance social interaction between
bands by individuals or small groups, and the maintenance of exchange networks are forms of
behavior that would be peculiar to only ethnographically known foragers. Rather, they are
general-level behaviors that reasonably can be expected to have been common to modern
Homo sapiens living a hunting and gathering way of life in all times and all places.

CHAPTER SUMMARY AND CONCLUDING REMARKS

The traditional view that Paleoindian technology was specially designed to permit
high mobility was tested with data from the Jurgens site and found to be unsupported. The
thinking that Paleoindians preferentially selected microcrystalline stones over granular
varieties, such as orthoquartzites, in order to permit greater success in the resharpening and
recycling of tools as part of a highly mobile lifestyle was found to be unsubstantiated.
Existing evidence suggests that although orthoquartzite accounts for a minority of the cobbles
of tool stone in the local exposures of White River Group gravel, it comprises most of the
WRGG artifacts from Jurgens and was preferentially used over microcrystalline cobbles in
gearing up operations. Data on the prevalence of various kinds of flaws in the main tool
stones seriously questions the generalization that microcrystalline stone in all cases allows
greater control in flaking than granular raw material. Three of the main tool stones in the
Jurgens assemblage are microcrystalline rocks and all three contain anywhere from one to
four kinds of flaws occurring in frequencies greater than expected. In contrast, the very
rough-textured orthoquartzite variety of WRGG is relatively free of flaws with no kind of
defect present in greater than expected quantities.

The traditional view’s assertion that Paleoindian technology emphasized the use of
bifaces and was centered on the reduction of bifacial cores was also found to be lacking in
support. The amount of bifacial artifacts in the assemblage was not unusually high
considering the site is associated with the activity of large-scale bison hunting, which requires that many points and knives be on hand to kill and butcher a lot of game animals. Instead of supporting the expectation that the technology of the Jurgens site was based on the reduction of bifacial cores, an analysis of the parent object of flake-based artifacts demonstrates that the lithic technology basically entailed reduction of bifaces (not necessarily bifacial cores) as well as a plentiful quantity of blocky cores.

Finally, the traditional thinking that Paleoindian technology was specially designed for high mobility through the use of tools that allowed for frugal consumption of tool stone via an especially high level of resharpening was tested and found to be unsupported. Under the traditional view, points and end scrapers of stone form very distant sources should have been subjected to a greater amount of resharpening and thus be demonstrably shorter than comparable artifacts of local and distant stone. However, point and end scraper length was shown to not vary with distance to tool stone source.

A final observation relevant to evaluating the credibility of the traditional view is the number and distribution of very distant sources of stone, as well as the relative amount of raw material from these sources in comparison to closer ones. A strict traditional interpretation of the above information would seemingly require a band to travel over distances that are simply not within the realm of human physical capabilities. Furthermore, a strict traditional interpretation would envision that a band first partially circled around local and distant areas before entering those areas and then collected a lot more tool stone than they previously had. How this manner of band movement and change in raw material needs might be explained with reference to any kind of possible environmental or cultural causal factor that is known to have characterized foraging societies in general is not apparent.

The analysis presented in Chapters 10 and 11 demonstrate that ideas developed from the alternative perspective are capable of providing an empirically supported interpretation of Paleoindian land use as seen from the Jurgens site, but concepts meant to bolster the
traditional view cannot be verified with data from the assemblage. From this, one can reasonably conclude, based on the Jurgens site alone, that the alternative view offers a better explanatory model than traditional thinking.

But ending the discussion here would be premature. A case can be made that the Jurgens site is the result of occupation by an aggregation of bands, some of which brought in quantities of stone from distant sources. Participation of a local band is suggested by the presence in the assemblage of a particular variety of tool stone from exposures of White River Group gravel (very rough-textured orthoquartzite). This possibility is less than certain because the location of the particular source exploited in order to gear up remains unknown. If it is assumed for the purpose of illustration that the source of WRGG was located within the range of the local band, then a communal hunt planned exclusively for members of the local band could conceivably produce an assemblage dominated by local stone, rather than be composed of mostly stone from distant sources with only a minority of the assemblage composed of local stone, as is the case at Jurgens. The above implies that the tool stone composition of a single-occupation site can differ dramatically, depending upon whether the assemblage was produced by an aggregation of bands intent on communal hunting or a group composed only of members of the local band. Furthermore, the suggestion was made that although local gravels were exploited, a high-quality source of stone was not present close to the site and that this entered into the decision of visiting bands to bring their own stone with them. To fully understand how social aggregation and raw material availability affects the tool stone composition of assemblages, it is necessary to consider not only adequate numbers of assemblages from sites produced by both aggregated groups and non-aggregated groups, but also numbers of collections from sites located in environments where a quality source is locally available as well as from places where it is not. Once this is accomplished, archaeologists may be more confident in the explanatory potential of the alternative view and
the need to incorporate social and raw material availability considerations into any future efforts to model Paleoindian land use.
CHAPTER 12
EVALUATING COMPETING VIEWS WITH EXISTING LITERATURE

Using information on sites reported in existing literature to judge the relative validity of the two views will require determining if each site is in an environment with high-quality stone available locally and classifying the sites into the site categories developed to evaluate the views. Current information on tool stone availability is summarized in Chapter 7 and uncertainties regarding whether particular sites have a high-quality source of tool stone in their local environment are discussed in Chapter 8. One of the first tasks of this chapter is to place sites into general site categories that include: sites related to communal hunts, campsites not related to large-scale hunts, and sites at lithic sources. This proved to not be a straightforward exercise. May of the sites here classified as related to communal hunts were not presented as such in print by the original site investigators. Therefore, some discussion is necessary to justify why some sites were classified as they were. Some assemblages are from reported sites that were not attributed to site types by original site investigators. These sites were assigned to one of the categories used here based on published information on the site and its artifactual and faunal content and some explanation is provided to justify the classification.

The first section of the chapter will discuss each site, justify its classification, and present data on the tool stone composition of its artifact assemblage. For each site, available data on tool stone composition will be summarized in a table that breaks down the assemblage by artifact and tool stone type. The relative frequency of tool stones falling into
categories of local, distant, and very distant were tabulated based on artifact count data presented in the site reports.

The second section compares these data to theoretical expectations for the tool stone composition of assemblages developed from both theoretical perspectives. A better fit between the data and the expectations of the alternative view is demonstrated, thus affirming the findings of the Jurgens site analysis.

Once the alternative view is affirmed as the superior explanatory theoretical perspective, it is used in the third section to interpret the tool stone composition of each assemblage to assess the scale of Paleoindian land use. Toward this end, concepts of group aggregation, trade, etc. are invoked to offer interpretations of the tool stone composition of assemblages from the various kinds of sites.

Finally, an interpretation of the regularity of Paleoindian land use is presented. The assessment is based largely on the tool stone composition of assemblages from clustered Paleoindian sites of various kinds. The idea developed in previous chapters that land use in the study area involved regularity in that regional abandonment and communal hunting normally occurred each year during particular times of the year will be briefly reviewed.

SITE CLASSIFICATION AND DATA ON TOOL STONE COMPOSITION OF ASSEMBLAGES

Kersey Cluster

Jurgens Site

The Jurgens site and the tool stone composition of its assemblage are briefly reviewed here for comparison with nearby sites in the Kersey cluster. Jurgens consists of three bison bone deposits here interpreted as middens that were used contemporaneously at a temporary hunting camp of a large group of people involved in communal bison hunting.
According to artifact count, the tool stone composition of the assemblage is composed of 17.3 percent local tool stones and 80.6 percent is various raw materials from distant sources. The tool stones from distant sources include Dawson petrified wood (6.2 percent), which is primarily from sources on the Palmer Divide to the south, Flat Top chalcedony (60.2 percent) from a source to the east down the South Platte drainage, and chert from sources to the north in the Hartville Uplift (14.2 percent) of the North Platte drainage. Miniscule amounts of tool stones from very distant sources throughout the Plains and Wyoming Basin are also present in the assemblage.

**Frazier Site**

Situated between one and two km west of Jurgens, the Frazier site is here interpreted as another campsite related to large-scale bison hunting that is located along the edge of the Kersey terrace. The valley of the South Platte is below and to the north of the site. The site produced nine Agate Basin points and therefore dates to early Paleoindian times. Though excavated in the 1960s, only recently has the artifact assemblage of 1,158 artifacts been reported in detail in a master’s thesis by Slessman (2004). Remains of a minimum of 50 bison are reported from the bonebed, based on 50 left astragali; seven from the ground surface and 43 from the excavations (Slessman 2004:31). Bison dentition studies indicate that the communal hunt occurred around January. Other faunal remains include eight bone specimens of wolf or dog and one of deer (Slessman 2004:Table 1).

Some discussion is in order to convey the general structure of the site and to tentatively assess the number of occupations represented. Maximum dimensions of the main excavation block at the site are 36 m east-west by 17 m north-south. Bison bone is distributed in concentrations throughout this area (Borresen 2002:Figure 5.1). Artifacts are primarily confined to the western half of the excavation block. The artifacts occur in several concentrations measuring between a few to several meters in maximum dimension. Some of
these are composed of concentrations of both debitage and stone tools (Slessman 2004:Figures 66-67). Rather than representing places where tools were made, used, and discarded, it seems more likely that the artifact concentrations are primarily middens where both tools and flakes were discarded, as was argued for the Jurgens site. Slessman (2004:138, Figure 69) identified a total of 46 artifact refits, both within and between artifact concentrations. I take this to be evidence supporting an interpretation that the trash concentrations are contemporaneous.

The kinds of artifacts collected from the site, along with the presence of a fire feature, support an interpretation of the site as a temporary hunting camp where bison procured in a communal kill were processed. A fire feature located in the western half of the excavation block provides evidence that the site was used as a camp. In a scaled photograph of the feature, it appears to be a circular pit filled with charcoal-stained sediment. The feature measures roughly one meter in diameter and is of unknown depth (Slessman 2004:Figure 22). If found in an Archaic or Late Prehistoric site, it would not be surprising were the feature to be labeled as a roasting pit. The feature is situated within a few meters of an artifact concentration that I would suggest represents part of a midden (Slessman 2002:Figures 67, 74). Burned bison bone fragments were found at various locations throughout the western half of the excavation block (Borresen 2002:72; Slessman 2004:Figure 74). All together, the above information suggests to me that the hearth is associated with occupation of a temporary hunting camp by people involved in processing bison procured during a communal hunt. Use of the feature for cooking may have proceeded or been concurrent with dumping of trash in the general area. The fact that a fire feature is present in a part of the site that I would interpret as having essentially served as a trash disposal area does not necessarily contradict this interpretation, as will be seen below in discussion of the Allen site. The kinds of artifacts discarded support an interpretation of the site as a hunting camp where bison were processed for both meat and hides. Among the artifacts are nine points and 23 end scrapers.
Finally, the presence of ochre at a number of locations throughout the excavation block provides additional support for the interpretation of the Frazier assemblage as the product of a single occupation by people involved in a bison hunt. As mentioned in discussion of the Jurgens collection, sites related to large-scale Paleoindian bison kills often produce ochre or ochre-stained artifacts. Pieces of red or yellow ochre were noted in the records from five excavation units at Frazier and a few of the artifacts in the collection are stained with a red residue (Slessman 2002:139, Figures 70-71).

Information presented by Slessman (2004) suggests that the Jurgens and Frazier sites might be basically similar in regard to the local tool stone types present. Data on the tool stone composition of the Frazier assemblage is presented in Table 12-1. Slessman classified a majority of the collection (67 percent) into one of two tool stone categories that are likely comprised mostly of local orthoquartzites and cherts. I suspect these local raw materials are equivalent to stone in the Jurgens collection that I have identified as deriving from White River Group gravels.

A number of lines of evidence affirm the suggestion that most of the artifacts classified into Slessman’s quartzite category might be made of various kinds of orthoquartzite from the White River Group gravels. Slessman (2004:57) states that, “[a] large portion of the quartzite sample is a yellow and gray medium-grained material that resembles Morrison Formation quartzite.” He goes on to say that, “[t]his material outcrops… along the South Platte River in the vicinity of the Frazier site” (Slessman 2004:57). I am unaware of any primary outcrops of Morrison orthoquartzite on the plains of northeast Colorado and their occurrence seems unlikely because the Morrison Formation in the vicinity of the Frazier site is deeply buried beneath Cretaceous and younger rocks. However, Morrison orthoquartzite is available locally from exposures of White River Group gravel in northeast Colorado. That WRGG is the likely source of the Morrison orthoquartzite in the Frazier site is suggested by a photograph of an artifact of this material that displays a stream rounded and battered cortex.
Table 12-1. Tool Stone and Artifact Composition of the Frazier Assemblage.a

<table>
<thead>
<tr>
<th>Tool Stone Type</th>
<th>Flake</th>
<th>Piece of Shatter</th>
<th>Pot Lid</th>
<th>Blocky Core or Tested Cobble (Modified Cobble of Slessman)</th>
<th>Utilized Flake (Edge Modified Flake Tool)</th>
<th>Informal Repeated Flake Tool (Retouched Flake Tool and Side Scraper)</th>
<th>End Scraper (Discal Scraper or Distal-Lateral Scraper)</th>
<th>Bifaces Except Projectile Points (Unhafted Bifaces)</th>
<th>Projectile Point (Unhafted Flakes)</th>
<th>Total Number of Artifacts</th>
<th>Distance to Tool Stone Source Used in Analysis (km)</th>
<th>Relative Distance to Tool Stone Source</th>
<th>Percent of Assemblage Composed of Local Stone</th>
<th>Percent of Assemblage Composed of Nonlocal Stone According to Artifact Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quartzite (mostly from White River Group gravels?)</td>
<td>391</td>
<td>34</td>
<td>2</td>
<td>1</td>
<td>69</td>
<td>24</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>528</td>
<td>68a</td>
<td>mostly Local ?</td>
<td>45.6</td>
<td>67.1 percent Local ?</td>
</tr>
<tr>
<td>Unidentified Cherts (mostly from White River Group gravels?)</td>
<td>213</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>19</td>
<td>6</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>249</td>
<td>68a</td>
<td>mostly Local ?</td>
<td>21.5</td>
<td></td>
</tr>
<tr>
<td>Petrified Wood (contains at least one artifact of Dawson petrified wood and possibly non-Dawson from local sources)</td>
<td>36</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>48</td>
<td>90f</td>
<td>Local and Nonlocal ?</td>
<td>4.1</td>
<td>4.1 percent Local or Nonlocal ?</td>
</tr>
<tr>
<td>Flat Top Chalcedony</td>
<td>9</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>7</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>25</td>
<td>115</td>
<td>Distant</td>
<td>2.2</td>
<td>28.8 percent Nonlocal ?</td>
</tr>
<tr>
<td>Hartville Uplift Chert</td>
<td>115</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>8</td>
<td>13</td>
<td>11</td>
<td>3</td>
<td>6</td>
<td>157</td>
<td>220</td>
<td>Distant</td>
<td>13.6</td>
<td></td>
</tr>
<tr>
<td>Alibates Agate</td>
<td>127</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>12</td>
<td>3</td>
<td>6</td>
<td>1d</td>
<td>1d</td>
<td>151</td>
<td>572</td>
<td>Very Distant</td>
<td>13.0</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>891</td>
<td>44</td>
<td>4</td>
<td>4</td>
<td>119</td>
<td>54</td>
<td>23</td>
<td>10</td>
<td>9</td>
<td>1,158</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Percent of Assemblage</td>
<td>76.9</td>
<td>3.8</td>
<td>.3</td>
<td>.3</td>
<td>10.3</td>
<td>4.7</td>
<td>2.0</td>
<td>.9</td>
<td>.8</td>
<td>100.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

a  Adapted from Slessman (2004:Tables 2, 6-7).
b  Measured to point between Holiday Springs and Kalouse source areas.
c  Possible local sources are unrecorded. Measurement is to closest point of Dawson petrified wood primary source area in Palmer Divide area.
d  Of two bifaces classified as unhafted bifaces by Slessman (2004:Table 6), one is said to be likely a point preform and the other is said to be likely a point fragment (Slessman 2004:84,86).
(Slessman 2004:54, 56, Figure 44 catalog # A1558.913, Appendix B). Most of the remaining orthoquartzite in Slessman’s quartzite category is not labeled with a specific source name, but he states that, “[t]hese materials may also derive from local Morrison Formation outcrops…” Again, outcrops of the Morrison Formation are unlikely to occur locally, but the non-Morrison orthoquartzites in the assemblage may derive from the local exposures of WRGG. This possibility is bolstered by a photograph of an artifact classified simply as “quartzite” that has a rounded and battered cortex (Slessman 2004:54, 56, Figure 54 catalog #1992.132, Appendix B). The important point to be made from the above is that even though Slessman’s identification of the geologic source of most of the orthoquartzites in the Frazier assemblage may be in error, he is correct in identifying this material as primarily of local origin. As used by Slessman, however, the category of quartzite is somewhat of an assortment of tool stones from sources that lie at varying distances from the Frazier site. A few artifacts in the category are made of a gray orthoquartzite that Slessman (2004:57) suggests may be from the Spanish Diggings source area.

Slessman’s category of unidentified cherts cannot be emphatically equated with one of the tool stone types defined for the Jurgens site, given information available in his thesis, but I suspect that most of this stone is comprised of the microcrystalline varieties from the White River Group gravels. Slessman (2004:58) states that, “[t]he majority of the unidentified chert materials are likely derived from locally available Madison formation Mississippian chert sources.” It is true that Mississippian and Pennsylvanian limestones, such as the Madison Formation of Mississippian age, are prolific chert producing formations, but the Madison Formation does not outcrop locally in northeast Colorado. Perhaps Slessman is referring to the Paleozoic cherts that are available locally in the White River Group gravels of Tertiary age, as discussed in Chapter 7. I will assume that exposures of WRGG are the local source of Paleozoic chert to which Slessman refers and that his category of “unidentified cherts” is most likely principally composed of microcrystalline varieties of
However, it should be noted that the category of unidentified cherts apparently includes a small amount of microcrystalline stone of various types that might originate from distant or very distant sources, but which could not be identified with confidence. Included are Knife River flint, Edwards chert, and others listed by Slessman (2004:56).

According to Slessman, of the artifacts of petrified wood in the collection, only the single projectile point of this material may be classified as Dawson petrified wood with confidence. The remaining artifacts are said to belong to one of three varieties. Slessman notes that artifacts of these varieties are known to originate along the South Platte River in the general vicinity of the Frazier site, citing local avocational archaeologist Louis Klein as the source of this claim. No other information on the local petrified wood sources is provided.

Tool stones that are definitely from nonlocal sources account for 29 percent of the Frazier collection. Raw material form distant sources include Hartville Uplift chert and Flat Top chalcedony. Unlike the Jurgens collection where Flat Top chalcedony accounts for a majority of the assemblage (60 percent), only two percent of the Frazier artifacts are of this raw material. Hartville Uplift chert accounts for 14 percent of the Frazier assemblage. For being a tool stone from a very distant source, Alibates agate accounts for an unusually high proportion of the assemblage (13 percent).

Powars Site

Three kilometers south of Frazier is another early Paleoindian encampment known as the Powars site which arguably was associated with large-scale bison hunting. The site produced a large sample of Folsom points and related manufacturing debris. It is situated on a very low ridge in a currently inactive sand dune field. North of the site is the relatively flat terrain of the Kersey terrace. South of the site, the land slopes gently toward higher ground south of the South Platte River valley. The site was dug in the 1930s by Wayne Powars, an
artifact collector from Greeley who recovered a collection of over 2,000 artifacts (Cassells 1997:74). The assemblage is now stored at the Smithsonian Institution. A total of 25 points, 58 preforms, and 186 channel flakes are present in the collection (Jodry 1999:Table 51). The large numbers of projectile points and artifacts indicative of point manufacture strongly suggest that the site likely served as a camp for people involved in large-scale bison hunting.

Test excavation of the site by the Smithsonian Institution determined that the site was deflated by wind erosion and was essentially a surface deposit. According to Roberts (1937:72), “[b]ones are sparse, and the few examples recovered are so fragmentary that they are of no value in determining the animals represented.” This statement would seem to support the idea that if a bison bonebed were once present, it was likely destroyed by exposure to weathering during one or more episodes of wind deflation.

Data relating to the tool stone types represented in the sample of 269 points and point-related artifacts were collected by Jodry (1999:Tables 48, 51) and is presented in Table 12-2. These data are less than ideal for interpreting Paleoindian land use because points and related manufacturing debris may contain a higher proportion of stone brought into the site from nonlocal sources by various cultural mechanisms. Furthermore, half of the artifacts in the sample are not attributed to a source. Nevertheless, the data is minimally usable for interpreting Paleoindian land use if the potential biases are kept in mind.

For example, about half of the artifacts could not be assigned to a source by Jodry and could be made of local tool stones. Archaeologists have become proficient in recognizing the tool stones from high-quality sources throughout the Plains. The varieties of tool stones here subsumed under White River Group gravel are not among the well known materials and if local materials are common in the sample of points and related artifacts, they may not have been identifiable as local stone. One variety of tool stone from the White River Group is Holiday Springs chalcedony, which can be very similar to Kremmling chert. A small percentage of the sample of points and related manufacturing debris was identified by
Table 12-2. Tool Stone Composition of Folsom Points, Preforms, and Channel Flakes from the Powars Site. 

<table>
<thead>
<tr>
<th>Tool Stone Type</th>
<th>Total Number of Artifacts</th>
<th>Distance to Tool Stone Source Used in Analysis (km)</th>
<th>Relative Distance to Tool Stone Source</th>
<th>Percent of Sample of Points, Etc. Composed of Tool Stone Type, According to Artifact Count</th>
<th>Percent of Sample of Points, Etc. Composed of Local Versus Nonlocal Stone, According to Artifact Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dawson Petrified Wood</td>
<td>2</td>
<td>86</td>
<td>distant</td>
<td>.7</td>
<td>50.2 percent Nonlocal</td>
</tr>
<tr>
<td>Flat Top Chalcedony</td>
<td>11</td>
<td>117</td>
<td>distant</td>
<td>4.0</td>
<td></td>
</tr>
<tr>
<td>Kremmling Chert</td>
<td>5</td>
<td>149</td>
<td>distant</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>Hartville Uplift Chert</td>
<td>116</td>
<td>223</td>
<td>distant</td>
<td>43.1</td>
<td></td>
</tr>
<tr>
<td>Washington Pass Chert</td>
<td>1</td>
<td>609</td>
<td>very distant</td>
<td>.3</td>
<td></td>
</tr>
<tr>
<td>Knife River Flint</td>
<td>1</td>
<td>763</td>
<td>very distant</td>
<td>.3</td>
<td></td>
</tr>
<tr>
<td>Tool Stone of Unknown Source</td>
<td>133</td>
<td>-</td>
<td>-</td>
<td>49.8</td>
<td>49.8 percent of Unknown Source</td>
</tr>
<tr>
<td>Total</td>
<td>269</td>
<td>-</td>
<td>-</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

\(^a\) Adapted from Jodry (1999:Tables 48, 51).
Jodry as Kremmling chert from its distant source in Middle Park, but might actually be local stone.

Besides Kremmling chert, the other tool stones from distant sources identified by Jodry in the Powars collection are the three raw materials from Plains sources that are present in varying amounts in the other Kersey cluster sites. Included are Dawson petrified wood from the south, Flat Top chalcedony from the east, and Hartville Uplift chert from the north. By far the most prevalent tool stone from distant sources in the Powars collection is Hartville Uplift chert, which accounts for 43 percent of the sample.

Finally, very small amounts of tool stones from two very distant sources are present in the sample. Included is Knife River flint from its source in the Northern Plains and Washington Pass chert from the Colorado Plateau.

Lindenmeier Site

The Lindenmeier site is perhaps the best known of all the study sites and yet is among the least understood in regard to its relevance to Paleoindian land use. Excavated in the 1930s and 1940s, the site has long been known among archaeologists and the interested public as a large Folsom site. Because Lindenmeier was excavated during the early years of American archaeology, our current understanding of the site is handicapped by the fact that excavation recording procedures and collection policies were not up to today’s standards. For this reason, it is difficult to readily classify Lindenmeier as either a site that is or is not associated with large-scale bison hunting. Some archaeologists believe the site is best considered to be related to large-scale hunting while others would characterize it as a campsite that is not necessarily associated with communal hunting. To complicate matters, it is possible the site saw multiple episodes of use during Folsom times. Episodes of site use may have included occupations by relatively large groups of people involved in communal hunting as well as occupations by smaller groups subsisting by means of more generalized
hunting and gathering. Rather than exclude the site from analysis, I will here review the reason behind each point of view and in a following section will interpret the tool stone composition of the assemblage from both perspectives to the extent possible.

The Lindenmeier site may be characterized as a multicomponent campsite situated at a spring in an upland area overlooking an expanse of the South Platte River drainage to the south. During Folsom times, occupation took place along a gently sloping swale that drains to the east-southeast. Extensive excavations have determined that Folsom cultural material occurs in a number of areas distributed along the swale for a distance of 700 m. Immediately south of the swale is a steep slope that leads down to the plains below. Folsom occupation occurred during a time when a soil was forming in the swale under moist conditions. Consequently, Folsom material is associated with a black, organic-rich paleosol. Today, a deep arroyo has been cut in the bottom of the swale. A modern spring in the bottom of the arroyo may have served as a source of water in the swale under the wetter conditions of the Folsom period. Juniper is present on nearby slopes and it is likely that firewood was also available in the site vicinity in Folsom times. Late Paleoindian, Archaic, and Late Prehistoric points from the site document that the spring attracted occupation throughout prehistory. Archaeological investigations at the site have focused on the Folsom component and not much is known of the other time periods.

Analysis of excavation records by Wilmsen has produced evidence for multiple Folsom occupations (Wilmsen and Roberts 1978). The depths of Folsom artifacts were plotted in relation to stratigraphic boundaries in two block excavations in the central portion of the site (Areas I and II). This operation revealed two Folsom occupation layers in Area I and three in Area II.

From a consideration of the bison bone deposit present, reasons exist to suggest that at least one of the occupations of the site may have been related to large-scale bison hunting, but this is not certain. Sites in the study area that undoubtedly related to large-scale hunting
have a dense bonebed containing the remains of many bison that arguably were killed *en masse*. Large areas of the Lindenmeier site have been excavated and Folsom-aged deposits containing bison bone were uncovered. Unfortunately, following the excavation policies of the day, the uncovered bone material was discussed in excavation notes, mapped in a cursory manner, and then discarded. Bone scatters were mapped in Areas I and II, but the number of bison represented is unknown. Photographs of scattered bone in Areas I and II demonstrate that much of the bone is fragmented, presumably from having been broken to extract marrow (Wilmsen and Roberts 1978:Figures 160-162, 163-166; Roberts 1937:Figures 65, 67).

Paleoindian bonebeds that indisputably represent large-scale hunting typically demonstrate less bone breakage, a higher density of bone, and sometimes contain articulated units that may represent segments of carcasses that were stripped of meat. The scatters of bison bone fragments in Areas I and II conceivably are from animals taken in large kills, but have been processed for marrow and discarded in a midden at a camp. If so, one would expect that study of tooth eruption and wear patterns would indicate the kill occurred during the height of the cold-season, which is when Folsom communal kills would have normally been held on the Central Plains. Discard of the bone recovered from Areas I and II, however, precludes determining the time of year during which the bison were killed.

The character of bison bones uncovered in an excavation block at the eastern end of the site that is known as the Bison Pit is more comparable to bone deposits at sites definitely associated with large-scale hunts. Here, the partially articulated remains of at least nine bison were uncovered. According to Roberts (1936:14), “[m]any of the bones, including several legs, were still articulated when uncovered (pl. 3, fig 1). The remains of one creature were found with a forequarter, most of the ribs from one side, and the vertebral column still intact. The skull in a somewhat damaged condition, was nearby.” From the articulated nature of bone in the Bison Pit and the presence of what is likely a quarter of an articulated bison skeleton, it can be reasonably suggested that this portion of the site represents a midden.
where faunal remains from a large-scale bison kill were discarded. Further support for this possibility comes from Roberts’ (1936:20) claim that most of the point tips recovered during excavations in 1934 and 1935 came from the Bison Pit. In contrast to point fragments from camp refuse, which should be dominated by point bases from repair of broken hunting weaponry, the greater proportion of tips reported for the Bison Pit is here interpreted as having resulted from the incompletely processed bison remains having had point tips embedded in them when they were discarded in an area later to be named the Bison Pit.

From the large number of points, preforms, and end scrapers recovered, one might suggest that the manufacture and repair of hunting weaponry, as well as processing of hides, were emphasized site activities, but this too is not conclusive evidence that the site is related to communal hunting. A large number of points and preforms have been recovered from the site. The Smithsonian Institution alone collected a total of 665 and others exist in smaller collections (Wilmsen and Roberts 1978:102). A total of 328 “distal edge tools,” a tool category that is probably in large part synonymous with end scrapers were recovered by the Smithsonian (Wilmsen and Roberts 1978:Table 49). From the above, one might reason that an activity such as communal hunting, which would have required tools for killing many bison and processing their hides, is represented. However, by today standards, very large excavation blocks were dug by the original site investigators. For example, Area II alone totals 401 m², which is equivalent to an area measuring 20 m by 20 m. The large numbers of points and end scrapers could therefore simply reflect that the site was a repeatedly occupied campsite at which lots of artifacts were discarded during the course of daily life and general subsistence activities.

A final observation that would tend to favor the interpretation of the Lindenmeier occupations as having been at least in part related to communal bison hunting is the presence of red and yellow ochre and ground stone artifacts with ochre staining (Wilmsen and Roberts 1978:126). Ochre is associated with sites that are definitely related to large-scale bison
hunting, so the presence of this material at Lindenmeier would tend to favor the interpretation
that at least one occupation was attributable to people engaged in communal hunting.

The supposition that Lindenmeier was a favored camp is supported by characteristics
of the black paleosol in which it occurs. The stratum was exposed in an excavation block in
the western end of the site known as Pit 13. According to Cotter (1978:182), “[t]his test pit
revealed a compact stratum 21 inches (53 cm) thick… This stratum was full of charcoal, and
yielded many stone chips and scraps of bone.” Description of a thick cultural level as full of
charcoal would suggest a level of habitation beyond that which would result from use of the
site as a temporary hunting camp, even if the camp was occupied by a large group of people.
Furthermore, the contents of the cultural level suggest it represents a trash disposal area. If
so, it is relevant to note that the level is thick and unlikely to have been produced during just
one episode of site use.

The possibility that Lindenmeier could be a campsite produced through repeated
occupation by relatively small groups not involved in communal hunting may be supported
by attributes of the points recovered from the black stratum. As discussed in Chapter 8,
Bamforth (1991b) has noted a significantly higher proportion of fluted Folsom points in
relation to unfluted points at sites associated with large-scale kills in comparison to sites that
are not. From this, he reasons that skilled flintknappers made fluted points for use by all the
hunters participating in communal kills. In comparison to sites in Bamforth’s sample that are
definitely related to communal hunting, the sample of points from Lindenmeier contains a
high proportion of unfluted points. In a sample of 322 points from the site in the Smithsonian
collection that are classified as Folsom points, 79 (or 25 percent) are unfluted. If an
occupation of Lindenmeier is related to communal hunting, many fluted points would be
produced and discarded. On the other hand if indeed the unfluted points present were made
by hunters of average flintknapping skill who discarded them during occupations of the site
by small groups not involved in communal hunting, this would account for the substantial
proportion of unfluted points present. The relatively few illustrated unfluted points from the Folsom component display flaking suggestive of an average level of flintknapping skill (Wilmsen and Roberts 1978:Figures 110-111). If the other unfluted points in the Folsom assemblage are primarily of average workmanship, this would support the suggestion that part of the collection is the product of site occupation unrelated to large-scale bison hunting. On the other hand, if the unfluted points principally display well executed collateral flaking, the work of above average flintknappers, who may have produced points for groups engaged in communal hunting, might be represented, in which case the interpretation of the site as related to communal hunting would be supported (see Chapter 8).

In light of the above discussion, it may be stated that reasons exist to support the assertion that the Folsom component was produced through multiple occupations of a campsite by relatively small groups not involved in communal hunting, but the view that one or more occupations by large groups engaged in communal hunting is also a defensible position. For this reason, the meaning of the tool stone composition of the Lindenmeier assemblage for Paleoindian land use will be interpreted from the perspective of both classifications of site function.

As discussed in detail in the section on the tool stones of the Boxelder Creek drainage in Chapter 7, the current state of knowledge on tool stone sources in the local area of the Lindenmeier site suggests that the site is not situated in an environment with a documented high-quality source of tool stone. Locally available tool stones are present from primary sources in hogbacks located as close as four to 10 km west of the site as well as from secondary sources in flat lying Tertiary beds in the vicinity of the site. A large source of reddish orthoquartzite said to derive from the Dakota formation is reported in the early literature, but the source remains undocumented. Recent reconnaissance located small sources of both gray and reddish orthoquartzite, but not the large source of reddish orthoquartzite rumored to exist. A chalcedony is also reported in early literature as occurring
in primary sources that are thought to be in the Ingleside Formation and in secondary sources in the Tertiary beds. No primary sources of this raw material were located during recent survey work, but secondary sources of alluvial pebbles of a gray chalcedony were recorded in Tertiary outcrops in the vicinity of Lindenmeier. The local raw materials are useable tool stones and are present in the Lindenmeier assemblage. Based on current information, however, there is not a documented high-quality source of tool stone in the local area.

A number of sources of information on the Lindenmeier site discuss the tool stone composition of the Folsom assemblage. Each has its positive and negative aspects and will be discussed in turn. The main site report classified the large collection of the Smithsonian into raw material types, and the equivalence of these categories to named tool stone types can sometimes be surmised (Wilmsen and Roberts 1978). A more recent study clarifies the nature of the local tool stones (Newton and LaBelle 2008). Importantly, information provided by Ambler (1999) allows a collection from the site to be classified into tool stone types from known or suspected sources lying in local, distant, and very distant lands. Finally, a number of authors discuss various tool stones from distant and very distant sources not mentioned in the above studies, the most comprehensive list being that of Jodry (1999:Tables 48, 51).

Wilmsen classified the Smithsonian collection into the main raw material categories of quartzite, chalcedony, and jasper and also had a number of miscellaneous categories (Wilmsen and Roberts 1978:114, 120-121, Tables 44, 48-49). This source of information is good in that large numbers of artifacts were tallied, so possible trends in raw material use observable in the data are not of uncertain validity due to small sample sizes. Also, the Lindenmeier collection includes a large sample of 1,048 waste flakes and therefore is able to address the question of the tool stone composition of the debitage. The information is less than ideal because artifacts are assigned to general raw material types, rather than to named tool stones from specific sources. The category of quartzite can probably safely be assumed
to be comprised principally of locally available orthoquartzite that ultimately derives from the Dakota Sandstone and artifacts classed as jasper are likely primarily composed of Hartville Uplift chert. Wilmsen notes that jasper does not occur in quantity in outcrops closer than 150 km from the site. This is the approximate distance to recorded jasper sources in the Hartville Uplift, so he was probably referring to this raw material. The category of chalcedony is less informative on the tool stone composition of the assemblage because it probably includes both the local chalcedony and artifacts made from stone acquired from the distant source of Flat Top chalcedony.

Another source of information on the tool stone composition of the Lindenmeier assemblage is provided by Newton and LaBelle (2008) who provide information on tool stones in their raw material classification of tools excavated by what is now the Denver Museum of Nature and Science from Pit 13. This study has the advantage of potentially clarifying the nature of local tool stone use because both men were involved in recent survey work in the Lindenmeier area and are familiar with the local raw material. According to Newton and LaBelle (2008), the local stone is primarily the red orthoquartzite and gray chalcedony discussed above. They also list a number of other kinds of stone that is, or may be, local in origin. A less-than-ideal aspect of the preliminary report on their efforts to source artifacts from Pit 13 is the high percentage of tools that could not be sourced with confidence. Of the 147 tools examined 34 (or 23 percent) are from local sources, 18 (or 12 percent) are from nonlocal sources, which the researchers define as lying greater than 20 km from the site, and 95 (or 65 percent) are from unidentified sources.

Finally, Ambler (1999) provides a useful synopsis of the tool stone composition of a collection from the site that belonged to Roy Coffin and was donated to the Fort Collins Museum by his heirs. For the purposes of my study, the data provided by Ambler fortunately may be tabulated according to various tool stone types, most of which can be confidently assigned to local, distant, or very distant sources (Table 12-3). The Coffin family discovered
Table 12-3. Tool Stone and Artifact Composition of Worked Pieces in the Coffin Collection from the Lindenmeier Site

<table>
<thead>
<tr>
<th>Tool Stone Type</th>
<th>Informal Retouched Flake Tool (Modified Flake, Graver, Notch, End, Side, or False End of Ambler)</th>
<th>End Scraper (End Scraper and End-Side Scraper)</th>
<th>Bifaces Except Projectile Points and Preforms</th>
<th>Projectile Points and Preforms</th>
<th>Chipped Flakes</th>
<th>Total Number of Artifacts</th>
<th>Distance to Tool Stone Source Used in Analysis</th>
<th>Relative Distance to Tool Stone Source</th>
<th>Percent of Collection Composed of Tool Stone Type, According to Artifact Count</th>
<th>Percent of Collection Composed of Local Versus Nonlocal Stone, According to Artifact Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unidentified Quartzite (mostly local orthoquartzite ?)</td>
<td>10</td>
<td>0</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>17</td>
<td>?</td>
<td>Local ?</td>
<td>5.5</td>
<td>8.4 percent Local</td>
</tr>
<tr>
<td>Unidentified Chalcedony (mostly local chalcedony ?)</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>6</td>
<td>9</td>
<td>?</td>
<td>Local ?</td>
<td>2.9</td>
<td></td>
</tr>
<tr>
<td>Petrified Wood (contains one point and one end scraper of Dawson petrified wood)</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>7</td>
<td>155a</td>
<td>Local or Nonlocal ?</td>
<td>2.3</td>
<td>28.2 percent Local or Nonlocal</td>
</tr>
<tr>
<td>Unidentified Chert</td>
<td>26</td>
<td>13</td>
<td>9</td>
<td>9</td>
<td>23</td>
<td>80</td>
<td>?</td>
<td>Local or Nonlocal ?</td>
<td>25.9</td>
<td></td>
</tr>
<tr>
<td>Flat Top Chalcedony</td>
<td>16</td>
<td>26</td>
<td>0</td>
<td>7</td>
<td>26</td>
<td>75</td>
<td>147</td>
<td>Distant</td>
<td>24.3</td>
<td>63.4 percent Nonlocal</td>
</tr>
<tr>
<td>Hartville Uplift Chert</td>
<td>46</td>
<td>54</td>
<td>3</td>
<td>2</td>
<td>15</td>
<td>120</td>
<td>161</td>
<td>Distant</td>
<td>38.8</td>
<td></td>
</tr>
<tr>
<td>Alibates Agate</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>651</td>
<td>Very Distant</td>
<td>.3</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>102</td>
<td>97</td>
<td>20</td>
<td>20</td>
<td>70</td>
<td>309</td>
<td>-</td>
<td>-</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>Percent</td>
<td>33.0</td>
<td>31.4</td>
<td>6.5</td>
<td>6.5</td>
<td>22.7</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

a Adapted from Ambler (1999:Table 17). Excludes seven flakes and 17 utilized flakes presented in Amber’s table. The denticulate in Ambler’s table was later determined to be a utilized flake (Ambler 1999:67-69).

b Judging from line drawings in Ambler (1999:Figure 24), point preforms are included in Ambler’s “point” category.

b Possible local sources of petrified wood are reported. Measurement is to closest point of Dawson petrified wood primary source area in the Palmer Divide region.
the Lindenmeier site and brought it to the attention of the Smithsonian Institution. Between the discovery of the site in 1924 and 1938, the Coffins collected artifacts from the surface and excavated artifacts from the Folsom artifact-bearing black stratum in between field seasons by the Smithsonian (Ambler 1999:2; Wilmsen and Roberts 1978:1). The recovery of the collection through undocumented surface collection and non-systematic excavation is less than ideal because later Paleoindian and post-Paleoindian occupations are known from the site, so there is some concern that the collection may include some amount of non-Folsom material. This concern is not considered great because the Folsom material was recovered from the distinctive black stratum, so it seems likely that the amateur archaeologists involved could have amassed a collection comprised principally or entirely of Folsom artifacts. Of the more than 300 artifacts in the collection, most are tools with only seven waste flakes and 16 utilized flakes present, so debitage is sorely underrepresented in the collection. The flakes in the Coffin collection were excluded from consideration of the worked pieces from the site and the large sample of flakes in the Smithsonian collection was used to make rudimentary statements about the tool stone composition of the debitage.

A positive aspect of the Coffin collection is that Roy was a professor of geology at what is now Colorado State University and he recognized the archaeological potential of sourcing stone from the site. Coffin (1937:10, 1951) was the first to note the presence of local chalcedony and orthoquartzite among the artifacts from Lindenmeier. The artifacts in the Coffin collection are therefore important for substantiating the claim that local materials are represented at the Lindenmeier site. Ambler includes categories of quartzite and unidentified chalcedony in her classification of tool stone in the Coffin collection and it is here assumed that these categories largely equate to the local raw materials discussed by Coffin.

Ambler’s study is also important because it quantifies the amounts of tool stones from distant sources, thus permitting the question of whether gearing up may be represented
in the assemblage to be addressed, at least in a preliminary way. Stone that derives from distant sources is mostly Flat Top chalcedony or Hartville Uplift chert with some Dawson petrified wood also present.

A number of authors discuss tool stones from very distant sources in the Lindenmeier collections. Presumably these artifacts occur in very small quantities. Jodry (1999:Tables 48, 51) reports that a number of tool stones from nonlocal sources are present among the 264 points, 397 preforms, and 991 channel flakes she examined in the Smithsonian collection. To the distant tool stones identified by Ambler (1999), which all come from sources on the Plains, Jodry adds a tool stone from a distant source in Middle Park, namely Kremmling chert, which outcrops 144 km from the site in a southwesterly direction. It should be noted that Holiday Springs chalcedony, a variety of tool stone from distant sources of White River Group gravel on the Plains of northeast Colorado, can be very similar in appearance to Kremmling chert. Six tool stones from very distant sources are listed by Jodry. These raw materials are listed here with the distance and direction to their source given in parentheses: Knife River flint (713 km north-northeast), Smoky Hill jasper (401 km east), Edwards chert (983 km south-southeast), Jemez obsidian (576 km south-southwest), Washington Pass chalcedony (638 km southwest), and Trout Creek jasper (248 km south-southwest). Other site investigators have noted the presence of a few more types of tool stones from very distant sources among the Folsom artifacts from the site. As noted, Ambler (1999:Table 17) records the occurrence of Alibates agate (653 km south-southeast), Coffin (1951:5) remarks that Wamsutter oölitic chert is present (261 km west-northwest), and Wilmsen (1974:114) states that Yellowstone obsidian is also present (615 km northwest). All together, the very distant sources of stone are situated in virtually all directions from the site and are distributed throughout an immense area that includes parts of the Northern, Central, and Southern Plains, the Colorado Plateau, the Southern Rocky Mountains, the Wyoming Basin, and the Middle Rocky Mountains.
Jones-Miller Site

The Jones-Miller site is a bonebed associated with communal bison hunting that is situated at the head of a shallow swale on a terrace along the Arikaree River in northeast Colorado. A large sample of over 100 Hell Gap points was recovered from the site. The Arikaree is a tributary of the Republican River, the lower reaches of which lie off to the east. The watersheds of the Solomon and Smoky Hill rivers are east-southeast of the site. The Republican, Solomon, and Smoky Hill rivers all drain generally to the east and are within the drainage of the Kansas River. To the northwest of the site lies the South Platte drainage (Figure 5-1). Remains of about 250 bison are present in the bonebed based on the estimated number of mandibles (Reher ca. 1983:94). As discussed in Chapter 8, the bonebed is here interpreted to be the product of two bison kills, one of which occurred around November, the other having taken place sometime around mid-January to mid-February. With respect to when large-scale bison hunting normally occurred on the Central Plains during Agate Basin and Hell Gap times, one kill can be said to have transpired early in the hunting season and other was a late kill (Figure 8-6). An assemblage of over 130 flaked stone artifacts was recovered and it is dominated by projectile points. Included in the collection are 104 points, 11 informal retouched flake tools (“side scrapers or cutting tools”), one end scraper with an unusual amount of polish on the distal end, and at least 14 other artifacts of unspecified type (Stanford 1984:628). All sediment recovered during excavation was water screened. An unspecified number of apparently small flakes described as retouch flakes (Stanford 1984:617) were recovered and are probably not included in the artifact totals. One of the “points” illustrated has uneven edges and appears to be a preform (Stanford 1984:Figure 6 e). The presence of only one scraper with polish from use suggests that hide processing was not an emphasized activity at the site. The bonebed is here interpreted as a midden associated with a hunting camp where butchered bison remains and artifacts from two kills were discarded.
Data on the tool stone composition of the assemblage is limited, but sufficient to allow Paleoindian land use to be interpreted. The site was excavated by the Smithsonian Institution in the 1970s, but has yet to be fully reported. Tool stones present in the assemblage include Flat Top chalcedony, Smoky Hill jasper, Hartville Uplift chert, Alibates agate and “…various silex [siliceous] materials found in secondary deposits as gravels and chert cobbles” (Stanford 1984:628). According to Stanford (1984:634), Smoky Hill jasper “…constituted one of the major raw material resources utilized by the Jones-Miller flint knappers. Although many source areas were examined, only one, located in Trego County, Kansas, had the complete range of [color] variation found at Jones-Miller.” From the site, the closest source of Smoky Hill jasper mapped in the literature is situated 153 km to the east-northeast in the drainage of Medicine Creek, a tributary of the Republican River in Nebraska. It is not known if the Medicine Creek source area is among those visited by Stanford. The source visited in Trego county is not further discussed, but it is relevant to note that the county is relatively small, measuring only 47 km east-west by 48 km north-south. Distance to the source visited by Stanford may therefore be estimated by measuring to the center of Trego County, which lies 218 km east-southeast of the site in northwest Kansas within an area drained by the Smoky Hill River and its tributaries. Knowing whether the Smoky Hill jasper in the Jones-Miller collection originated from the Trego county source or the closer source area in the Medicine Creek drainage is not crucial for producing an accurate interpretation of land use because both classify as distant sources and both are situated generally east of the site.

Hester and Grady (1977:92, Figure 5) received information on the tool stone composition of the assemblage in a personal communication with the principal investigator (Dennis Stanford) which they present in a cumulative line graph. The y-axis plots the percentage of the collection composed of each of the five tool stones and the x-axis shows the distance to sources, measured in miles. Presumably, the percentages are based on artifact
count. Although Hester and Grady do not name the tool stones which together comprise the assemblage, it is possible to identify the tool stones with a high degree of confidence based on the distance from the site to each source. From this, the percent of the assemblage falling in each raw material category can then be determined by simply reading the graph.

Hester and Grady’s graph therefore served as the source of data on the tool stone composition of the Jones-Miller assemblage presented in Table 12-4. An explanation of how data in the table was inferred from the graph is provided below. According to Hester and Grady’s graph, about 50.5 percent of the collection is made of stone from a source located 94 mi from the site. I measure the distance from the site to Flat Top Butte at 92 mi (148 km). From this observation, 50.5 percent of the assemblage can be confidently said to be comprised of Flat Top chalcedony. The graph indicates that 28 percent of the collection is of stone originating from a source located 114 mi from the site. I measure the distance from the site to the closest corner of Trego County at 116 mi, so 28 percent of the artifacts can be safely assumed to be made of Smoky Hill jasper. Hester and Grady (1977:92) state that, “…nearby sources (within 75 miles) account for less than 20 percent of the materials.” More precisely, their graph indicates that 18 percent of the assemblage is comprised of stone from these sources and since 75 miles equates to 121 km, the stone may have come from both local and distant sources. Because Hartville Uplift chert and Alibates agate derive from very distant sources, the stone from local and distant sources can only be the cobbles of siliceous stone from gravel deposits mentioned by Stanford. The gravel sources are not discussed further in the literature, but it is worth noting that the Ogallala Formation and the White River Group are stratigraphic units known to produce gravel deposits bearing cobbles of tool stone. Furthermore, local and distant outcrops of the Ogallala Formation occur around the site and distant exposures of the White River Group are present to the west, northwest, and north of the site (Tweto 1979). As close as can be determined by Hester and Grady’s (1977:Figure 5) graph, 1.5 percent of the assemblage is comprised of stone from a source situated 173 mi
Table 12-4. Tool Stone Composition of Jones-Miller Collection.\(^a\)

<table>
<thead>
<tr>
<th>Tool Stone Type</th>
<th>Distance to Tool Stone Source Used in Analysis (km)</th>
<th>Relative Distance to Tool Stone Source</th>
<th>Percent of Assemblage Composed of Tool Stone</th>
<th>Percent of Assemblage Composed of Local Versus Nonlocal Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siliceous Tool Stones from Gravel Deposits</td>
<td>within 121</td>
<td>Local and Distant</td>
<td>18</td>
<td>18 percent Local or Nonlocal</td>
</tr>
<tr>
<td>Flat Top Chalcedony</td>
<td>148</td>
<td>Distant</td>
<td>50.5</td>
<td></td>
</tr>
<tr>
<td>Smoky Hill Jasper (from unspecified source in Trego County, Kansas)</td>
<td>218(^b)</td>
<td>Distant</td>
<td>28</td>
<td>82 percent Nonlocal</td>
</tr>
<tr>
<td>Hartville Uplift Chert</td>
<td>340</td>
<td>Very Distant</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>Alibates Agate</td>
<td>465</td>
<td>Very Distant</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>-</td>
<td>-</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

\(^a\) Adapted from Hester and Grady (1977:Figure 5) and Stanford (1984:628, 634). Collection excludes flakes and is dominated by projectile points.  
\(^b\) Measured to center of Trego County.
(278 km) from the site. This tool stone is probably Hartville Uplift chert, the nearest source of which actually lies at a distance of 340 km to the northwest. Finally, the graph indicates that 2.0 percent of the assemblage is composed of a tool stone that originates from a source located 250 mi (402 km) from the site. This raw material is most likely Alibates agate, with nearest sources lying more accurately at about 465 km to the south of the site.

**Medicine Creek Cluster**

Archaeological investigations within the study area that ultimately contributed much toward a better understanding of Paleoindian land use began during the late 1940s and early 1950s with the excavation of three Paleoindian sites to be impacted by reservoir construction. The drainage basin of Medicine Creek was attractive for habitation by prehistoric foragers and farmers not only for its permanent supply of water and diversity of wild plant and animal food resources, but also because of the presence of scattered high-quality outcrops of Smoky Hill jasper that provided an abundant supply of large pieces of tool stone. Medicine Creek is a wooded, permanent stream in southwest Nebraska that flows south-southeast into the Republican River. Lime Creek is a permanent tributary stream that flows east through open uplands to its confluence with Medicine Creek. Reconnaissance of the area to be affected by reservoir construction on Medicine Creek resulted in the discovery of the Allen site along the main stem of the drainage system as well as the Red Smoke and Lime Creek sites, situated near one another along Lime Creek.

The Allen site is interpreted as basically a thick midden deposit of a campsite. The camp itself is thought to have been situated on a stream terrace close to the gallery forest lining Medicine Creek. Geomorphological studies of the late Pleistocene and Holocene deposits in the Medicine Creek drainage suggests that outcrops of Smoky Hill jasper would not have been exposed close to the site at any time during the Paleoindian period (Bamforth 2002b:76-77). Quantities of waste flakes, blocky cores, and unfinished bifaces in the
assemblage indicate that manufacture of stone tools was an important site activity, but the location of the site next to the tree-lined main stream in an area lacking nearby tool stone is one of the reasons for characterizing the site as primarily a residential base where tool manufacture using the local stone took place (Bamforth 2007). Stratigraphic and artifact refitting studies have determined that many and relatively frequent occupations of the site are represented in the thick cultural deposit which accumulated during a period encompassing essentially the entire Paleoindian period.

The sites along Lime Creek are situated much closer to known outcrops of jasper than is the Allen site. The Red Smoke and Lime Creek sites are located close to one another in an area where outcrops of Smoky Hill jasper occur nearby. Bamforth (2002b:76) notes that an outcrop of jasper occurs within 100 yards (91 m) of Red Smoke. The Lime Creek site is located only 500 m east of Red Smoke (Knudsen 2002:Figure 7.1). Davis (1962:67) states that a jasper outcrop is but a few hundred yards southeast of the Lime Creek site. (To quantify Davis’ qualitative statement of “a few hundred yards” in the tables to follow, the distance to the closest jasper outcrop from the Lime Creek site is taken to be 300 m). Due to geomorphological changes that have occurred since Paleoindian times, one can not be certain that the closest outcrops are those exploited by the occupants of the Red Smoke and Lime Creek sites. Nevertheless, the fact remains that the sites along Lime Creek are close to high-quality outcrops of jasper and it is likely that the same was true during Paleoindian occupation of the sites. The Allen site is located 1.8 km east-southeast of the Lime Creek site, so it is possible that jasper outcrops situated up the Lime Creek drainage were exploited for tool stone by people camped at the Allen site. It is also possible, however, that stone was procured from other jasper outcrops located nearby. The Smoky Hill Chalk member of the Niobrara Formation outcrops throughout the lower reaches of both Medicine Creek and Mitchell Creek, a major tributary to the east (Roper 2002b:3), so it is likely that multiple jasper outcrops were available to occupants of the Allen site.
The Lime Creek sites are in an environmental setting conducive to camping and
evidence from the sites indicates that some habitation occurred there. Drinking water is
available from Lime Creek, a permanent stream, and trees lining the creek offer a source of
firewood. Four or more hearths are reported from Zone V at Red Smoke and two are noted in
one of the levels (Zone III) at the Lime Creek site (Davis 1962:Figure 38; Knudson 2002:99).
Faunal remains of various kinds of animals are reported from Zone V at Red Smoke and
Zone I at the Lime Creek site and presumably represent food remains from meals consumed
on-site.

Another manner in which the sites along Lime Creek differ from Allen is in the
frequency of occupation represented. Stratigraphic studies at the Allen site demonstrate that
dense cultural deposits at the site are about one meter thick (Bamforth 2007:Figures 8.4 –
8.5). The cultural deposits are well dated and refitting studies demonstrate that frequent
reoccupation of the site from 10,600 ± 620 to 8670 ± 90 B.P. The Allen site therefore is
indicative of repeated occupation throughout approximately two millennia. In contrast,
stratigraphically separate cultural levels are defined for the Red Smoke and Lime Creek sites,
suggesting more episodic occupation of these sites.

Seven cultural levels are defined for the Red Smoke site with a large majority of
cultural material having been recovered from the level designated Zone V (Roman numeral
two, a.k.a. Zone 88 in the field records) (Knudsen 2002). A total of 36 points known for
certain to have come from Zone V are here classified as concave-based lanceolate points and
two are Cody points (Knudsen 2002:Figures 7.7 - 7.8, 7.10 – 7.11). Radiocarbon dating of
charcoal and burned bone from a hearth in the level produced a date falling within the range
of acceptable Cody dates (8830 ± 130 B.P.) (Knudsen 2002:Table 7.2; May 2007:36, Table
3.8).

Three cultural levels are defined for the Lime Creek site with by far the most cultural
material again coming from one level, designated Zone I (Roman numeral one) (Davis 1962;
Hicks 2002). Three points recovered from Zone I have square bases and are here classified as Cody points (Hicks 2002:37-38, Figure 3.1 top row). Two other points from Zone I are not readily classified into defined types. Radiocarbon dating of a sample of soil humates from Zone I produced a date within the known date range for the Cody period (9220 ± 510 B.P.) (May 2007:30-31:Table 3.6).

The above information supports the view that Paleoindian use of the Red Smoke and Lime Creek sites was episodic and relatively intense during the period when Cody and concave-based lanceolate points were both in use on the Central Plains. Discussion of the relevance of the Lime Creek sites to understanding Paleoindian land use will focus on Zone V at Red Smoke and Zone I of the Lime Creek site.

Bamforth’s (2002b) interpretation of the kind of occupations represented by Zone V of Red Smoke and Zone I of Lime Creek differs from the interpretation presented here. Part of the uncertainty surrounding how to best characterize the occupations at the Red Smoke site in particular stems from the fact that analysis and write up of the collections is not complete. For example, basic quantitative data on the kinds and numbers of stone tools recovered from the site have yet to be published, in part because the lithic assemblage is very large. At the time of writing, the faunal assemblage from the site is being studied, but findings have yet to be published. Currently available information on the faunal assemblage is limited to basic verbal descriptions.

Much of the difference in the site interpretations stems from fundamentally different conceptual frameworks for understanding the three Medicine Creek sites as products of a land use pattern. I prefer to conceptualize the sites as all having been basically campsites that saw different amounts of reoccupation by groups of differing size. The Allen site was reoccupied many times throughout more than two millennia by small groups. In my view, the levels to be analyzed at Red Smoke and Lime Creek may have been occupied much less frequently by larger groups intent on communal bison hunting. Bamforth sees the three sites as
fundamentally distinct parts of a single pattern of land use characteristic of a single group of people. In Bamforth’s view (2002b, personal communication 2012; Hicks 2002), the two Lime Creek sites are best thought of as workshops at quarries where limited residential activities occurred. Zone I at the Lime Creek site and Zone V at Red Smoke might well represent gearing up for a large-scale hunt, but it would be by a small task group originating from a habitation site like Allen. After gearing up, small groups from Medicine Creek would head off to join a larger aggregation of people for communal bison hunting.

Methods capable of assessing the relative number of occupations represented by levels at the Lime Creek sites may be employed in the future to try and determine which interpretive framework is better. If, for example, refitting or MANA studies are able to suggest that the levels are the product of a single occupation or at most a few episodes of use, then the thinking that the levels were produced by large groups will be supported. On the other hand, if the levels are shown to be the result of many episodes of site use, the thinking that they were produced by small work groups originating from frequently reoccupied sites like Allen would be favored.

In the discussion to follow, the selected levels at the Lime Creek sites will be interpreted as the product of single occupations by potentially large groups intent on preparing for communal hunting and supporting evidence will be presented. Based on this understanding, the meaning of the tool stone composition of the assemblages to Paleoindian land use will then be interpreted. Should future refitting studies or similar investigations demonstrate that the levels actually resulted from many occupations, the interpretations of land use will, of course, have to be rethought.

Allen Site

Since its excavation in the 1940s, the importance of the Allen site to understanding Plains Paleoindian land use went largely unrecognized until the 1980s when funding first
became available through the Bureau of Reclamation for a long overdue in-depth analysis and write up of the site collection. A governmental report on excavations had been produced and field documentation was adequate to allow analysis of the stored lithic and faunal collections. Results of analysis are presented in a volume edited by Bamforth (2007).

The Allen site proper is interpreted as principally a trash disposal area associated with a campsite on a river terrace along Medicine Creek. Excavations exposed cultural material within a triangular area of approximately 118 m². The total excavated area was relatively small, for 118 m² equates to an area measuring only 10.9 m by 10.9 m. As mentioned, the lithic and faunal material was recovered from a one-meter-thick cultural deposit. Recent radiocarbon dating of stored charcoal samples has provided a series of dates for the deposit. A systematic refitting study demonstrated that few refitting flake sequences are present and they occur principally in concentrations composed of debitage. Refitted artifacts did not occur in widely separated vertical proveniences, indicating that the deposit was intact with very little vertical displacement of buried artifacts. Yet the locations of the artifact concentrations remained in the same places throughout thick segments of the deposit, suggesting that stone and bone debris had been repeatedly discarded in trash disposal areas visible on the ground surface throughout long periods of time during which many occupations of the site had occurred. Hearths were exposed at various depths in the deposit and tended to occur in areas clear of debris. Because the concentrations of artifacts and bone are best interpreted as accumulations of trash in places where debris was carried and dumped, the hearths likely represent fires built in an area peripheral to where most camp activities occurred, rather than being the foci of site activities around which trash was discarded (Bamforth and Becker 2007b:140-145).

Radiocarbon dating and stratigraphic studies establish a basic chronological framework for the time period during which the Allen site was occupied. A total of 20 hearths denoted by ash stains and oxidized sediment were distributed vertically throughout
the cultural deposits, but produced no charcoal. Near the bottom of the cultural deposit is a dark layer that is a paleosol representing a period of soil formation and landscape stability. Several hearths were excavated at various depths below the paleosol. Hearths are concentrated in the paleosol which is designated Occupation Level 1 (OL 1). Overlying this is the Intermediate Zone (IZ), representing a period of greater sediment deposition. Near the top of the cultural deposit is another dark paleosol, referred to as Occupation Level 2 (OL 2). Fortunately, the original site investigators saved charcoal from areas designated “features.” As used by the original site investigators, the term “feature” was not used to refer to non-portable archaeological material, such as hearths. Rather, the word was used to refer to items found in association with one another during excavation. Recent radiocarbon dating of the charcoal has helped to establish the site chronology (May 2007:20-25). Charcoal from two features in OL 1 produced dates of 10,600 ± 620 and 10,270 ± 360 B.P. Soil humates in a sediment sample from a hearth in the Intermediate Zone slightly below OL 2 produced a date of 9470 ± 80 B.P. This date is at the beginning of the Cody period. Occupation Level 2 is dated by a radiocarbon assay on charcoal from a hearth at 8680 ± 460 B.P. and another date of 8670 ± 90 was run on scattered charcoal from the level. These dates occur within the Cody period. Hearths underlying OL 1 are not dated but the observation that OL 1 produced dates in the Folsom period is the basis for reasoning that the earliest occupations of the site may date to early in the Paleoindian period. Therefore, it may be stated that the cultural deposit at the Allen site represents occupation throughout what is essentially a large majority of the Paleoindian period.

A total of nine points of various types and vertical provenience helps to place the cultural deposit within the current understanding of point type succession on the Central Plains. Only six points have specific vertical provenience information. Points associated with OL 1 include an Agate Basin point, a possible Hell Gap point, a leaf-shaped specimen, and a concave-base point. Bamforth (2002b:71) suggests that some of the Allen site points
can be interpreted as less sophisticated versions of the concave-based points from Red Smoke. Another concave-based point was recovered from the Intermediate Zone. The last point with specific vertical provenience is a heat-damaged point without a base from OL 2 which can not be typed with confidence. Three points were recovered from the cultural deposit without specific vertical provenience. Included are a concave-base point with diagonal flaking, another point with diagonal flaking said to have a reworked base, and a miniature leaf-shaped point.

The small and diverse sample of points from the Allen site allows general and tentative statements to be made regarding the point types discarded at the site and the geographic distribution of those types. Some points are of types that are better known from the Plains to the west of the site. Included in this category are the Agate Basin and possible Hell Gap points from OL 1. The two leaf-shaped points are difficult to assign to a particular defined type. Specimens of concave-based points came from OL 1 and the Intermediate Zone and might also be associated with OL 2, considering that at least one specimen is from a non-specific vertical provenience. Points that can be generally classified as concave-based lanceolate points are known from sites in the eastern half of the Central Plains and in the deciduous woodlands further east.

Another artifact class besides points must be contemplated when assessing the cultural affiliation of the site occupants and that is the beveled tool (Bamforth 2002b, 2007). Of a total of 283 worked pieces (e.g. tools, cores, unfinished bifaces, etc.) in the Allen assemblage, no items are classifiable as end scrapers (Bamforth and Becker 2007a:Table 10.1). A total of 23 artifacts are classified as beveled tools. Use wear analysis has demonstrated that beveled tools were used as hide scraping tools (Bamforth and Becker 2007a:170-173) and in this regard, they may be generally considered to be functionally equivalent to end scrapers. Beveled tools are reported in the literature of Dalton and post-Paleoindian sites in regions to the east and south of the site where such tools are referred to as
Dalton adzes or Clear Fork gouges and seem to have served as wood-working tools. Thus, while points in the Allen site suggest cultural affiliation between site occupants and regions both to the east and west, hide scraping tools imply affiliation only with regions to the east only. When one recalls that existing evidence suggests that points (or unfinished bifaces destined to be worked into points) were transported in exchange networks over great distances more so than other kinds of artifacts, one is even more tempted to affiliate the indigenous people of the Medicine Creek drainage with Paleoindian cultural groups to the east rather than those known to the west. Much remains to be done to achieve a better understanding of Paleoindian social groups on the Plains, but Bamforth (2007:252-253) is correct to observe that study of multiple artifact types, not just points, will be required.

Consideration of the faunal assemblage indicates that the Allen site may be classified as a campsite that is not associated with large-scale bison hunting. Analysis of faunal remains supports the view that throughout time, occupants of the Allen site engaged in subsistence activities that involved hunting of small numbers of big game species and also use of smaller game animals. Remains of a minimum of 17 bison, 12 deer, and eight antelope where distributed vertically throughout the cultural deposits (Hudson 2007:Table 12.4). Since the cultural deposit represents occupations that occurred throughout roughly two millennia of radiocarbon time, the killing of individual big game animals or small numbers of animals is indicated. Grazing herbivores that spend much time in the grassland of the uplands away from the creeks were taken (bison and antelope), as were browsers (deer) that favor the wooded and brushy habitat along streams. A variety of small game species were present in the cultural deposit (Hudson 2007:Table 12.1). Only the more commonly occurring species are noted here. Small game species represented in number throughout the deposit included those that arguably served as food and again includes animals that prefer more open grasslands away from the creeks (e.g. prairie dogs and jack rabbits), as well as species that prefer brushy habitat along the stream bottoms (e.g. cottontail rabbits). Other
small mammals occur in small numbers throughout the cultural deposit and they may have been procured wholly or partly for their pelts. Included are coyotes and badgers. The small game food resources and furbearers are not likely to have been hunted with spears, but rather are the kind of animals that are best procured by other means, such as snaring. A variety of birds occur as well. Some bones of Canadian geese occurred at all depths and likely represent a minor source of food.

Several fragmentary ground stone artifacts in the Allen site collection imply that some amount of plant food resources may have also been processed on-site. These artifacts include a total of three grinding slab fragments and four manos.

Evidence relating to the relative size and composition of the human groups that occupied the site suggests that throughout its long history of occupation, group size was comparatively small and consisted of men, women, and children. The faunal record from the Allen site is indicative of small-scale hunting of big game throughout the two millennia represented by the cultural deposits. As suggested previously, large-scale bison hunts would normally require the labor of one or more bands. The lack of a bonebed and the evidence for the taking of big game in small numbers is more in keeping with the assertion that small human groups occupied the site. In reference to the species composition of the faunal assemblage, Bamforth (2007:238) observes that, “…hunter-gatherer societies typically divide labor along age and sex lines, with large-mammal hunting virtually always the province of adult males and the hunting or other acquisition of other species sometimes carried out by men but more often carried out by women and children. If we are willing to assume a similar division of labor in Paleoindian society, the range of species taken at the site implies it was occupied by men, women, and children.” Presence of a deciduous human tooth in the site collection further substantiates the claim that the human groups occupying the site were composed of entire families, including children. Further support for the contention that the human groups occupying the site were composed of both adults and younger people is seen in
the fact that bifacial artifacts from throughout the cultural deposit demonstrate both proficient flint knapping ability, thought to be indicative of the presence of adults, as well as artifacts arguably produced by novice flint knappers who would likely have been adolescents learning the craft (Hicks 2002).

The artifact composition of the Allen assemblage confirms that the site served as a camp where flint knapping of the local jasper occurred. Table 12-5 presents data on the artifact and tool stone composition of the Allen assemblage. Use of the locally available jasper to manufacture stone tools is seen in the fact that of the 283 worked pieces of flaked stone, there are 19 blocky cores of jasper (seven percent of worked pieces) and 110 unfinished bifaces or point preforms (39 percent of worked pieces). The assemblage is also comprised of tools used in acquisition or processing of animal resources. Nine points were recovered (six of which are of the local jasper) and 23 beveled tools were excavated, all of which are of jasper. As mentioned, the beveled tools were used to scrape hides. Fragments of three grinding slabs and four manos imply that some plant foods were ground on-site.

The tool stone composition of the artifact assemblage presented in Table 12-5 reveals a preponderance of local material. Of the 11,360 artifacts in the assemblage, the locally available Smoky Hill jasper comprises 99 percent. If the jasper outcrop mentioned by Davis (1962:67) is taken to be 300 m from the Lime Creek site, then the closest outcrop to the Allen site recorded in published literature would be 1.5 km away. However, it should be remembered that other local outcrops are likely available in the lower reaches of the Medicine Creek drainage and could have been used by people camped at the Allen site. One fragmentary ground stone artifact of indeterminate type is made of friable sandstone which Conyers (cited in Bamforth 2007:186) suggests is available from local exposures of the Niobrara Formation. Two flakes in the collection derive from a stream cobble of petrified wood. Bamforth and Becker (2007a: 176) cite Holen as the source of the suggestion that a possible source of the nonjasper microcrystalline materials in the collection is the gravel
Table 12-5. Tool Stone and Artifact Composition of Flaked and Ground Stone Artifacts in the Allen Assemblage.

<table>
<thead>
<tr>
<th>Tool Stone Type</th>
<th>Flakes and Utilized Flakes (Unmodified Flakes from Blades)</th>
<th>Blocky Cores</th>
<th>&quot;Pieces Esquillees&quot;</th>
<th>Informal Retouched Flake Tools (Edge Modified Flakes)</th>
<th>Projectile Point Preforms</th>
<th>Projectile Points</th>
<th>Backed Tools</th>
<th>Drills (Perforators)</th>
<th>Other Tools</th>
<th>Unidentifiable Flaked Stone Artifacts (Choppers)</th>
<th>Grinding Stone : Flakes</th>
<th>Manos</th>
<th>Unidentifiable Grinding Tools</th>
<th>Total Number of Artifacts</th>
<th>Distance to Tool Stone Source Used in Analysis (km)</th>
<th>Relative Distance to Source of Tool Stone</th>
<th>Percent of Assemblage Composed of Local Stone, According to Artifact Count</th>
<th>Percent of Assemblage Composed of Nonlocal Stone, According to Artifact Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoky Hill Jasper</td>
<td>10,989 (7)</td>
<td>19</td>
<td>9</td>
<td>80</td>
<td>90</td>
<td>8</td>
<td>20</td>
<td>6</td>
<td>23</td>
<td>5</td>
<td>11</td>
<td>6</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>11,268</td>
<td>1.4</td>
</tr>
<tr>
<td>Friable Sandstone from Niobrara Formation ?</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0</td>
<td>local 0</td>
</tr>
<tr>
<td>Petrified Wood Cobbles</td>
<td>2 (1)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>53</td>
<td>local 0</td>
<td>-</td>
</tr>
<tr>
<td>Chalcedony, Chert, and Unknown Material</td>
<td>14 (5)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>16</td>
<td>?</td>
<td>?</td>
<td>.1</td>
</tr>
<tr>
<td>Flat Top Chalcedony or Table Mountain Chert</td>
<td>3 (2)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>268/357</td>
<td>very distant</td>
<td>0</td>
</tr>
<tr>
<td>Hartville Uplift Chert</td>
<td>60 (60)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>60</td>
<td>421</td>
<td>very distant</td>
<td>.5</td>
</tr>
<tr>
<td>Alibates Agate</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<td>1</td>
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<td>0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>518</td>
<td>very distant</td>
<td>0</td>
</tr>
<tr>
<td>Flint Hills Chert</td>
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<td>0</td>
<td>0</td>
<td>0</td>
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<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>292</td>
<td>very distant</td>
<td>0</td>
</tr>
<tr>
<td>Cretaceous Indurated Sandstone</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>4</td>
<td>1</td>
<td>8</td>
<td>300 – 400</td>
<td>very distant</td>
<td>.1</td>
<td></td>
</tr>
<tr>
<td>Total Number of Artifacts</td>
<td>11,068</td>
<td>19</td>
<td>9</td>
<td>80</td>
<td>90</td>
<td>8</td>
<td>20</td>
<td>9</td>
<td>23</td>
<td>5</td>
<td>11</td>
<td>7</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>11,360</td>
<td>-</td>
</tr>
<tr>
<td>Percent of Assemblage</td>
<td>97.4</td>
<td>.2</td>
<td>.1</td>
<td>.7</td>
<td>.8</td>
<td>.1</td>
<td>.2</td>
<td>.1</td>
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<td>.0</td>
<td>.0</td>
<td>100.0</td>
<td>-</td>
<td>-</td>
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</tr>
</tbody>
</table>

aData from Bamforth and Becker (2007a:176-178, Tables 10.1, 10.15) and Bamforth (2007:184-187, Table 11.2). Flake total from Bamforth (2002b:Table 6.1).
deposits along the Platte River. Based on this information, the source of the petrified wood cobbles is here tentatively thought to have been obtained locally because the closest point of the Platte River is 53 km away from the site to the north-northeast.

A very small amount of the assemblage (.1 percent) is comprised of a total of 14 flakes of unidentified chalcedony, chert, and an unknown material (Bamforth and Becker 2007a:Table 10.15). According to the authors, “[t]he great majority of these flakes appear to have been removed from late-stage bifaces, which suggests that the tools these flakes were struck from were made from relatively large pieces of raw material. This could indicate that a bedrock source is more likely and that these pieces indicate some form of long-distant contacts or travel: much of the flakeable stone available in the Platte gravels occurs as fairly small and often fractured pieces that are unsuitable for biface manufacture” (Bamforth and Becker 2007a:176-177). Because of the uncertainty of the source or sources of these tool stones, the raw material category is considered to be either local or nonlocal in Table 12-5. This will not seriously affect interpretation of the tool stone composition of the assemblage since these raw materials comprise such a small amount of the collection.

The remainder of the assemblage is composed of a variety of tool stones from very distant sources that together comprise only .6 percent of the collection. Like the artifacts of raw material from unidentified sources, most are flakes removed from bifaces. A total of 60 flakes are of Hartville Uplift chert. Bamforth and Becker (2007a:176, Table 10.15) refer to this tool stone as Mississippian chert or Madison chert, but both Mississippian and Pennsylvanian limestones of the Hartville Uplift produce similar appearing cherts and the Mississippian limestone in the uplift is now known as the Guernsey Formation, rather than the Madison (Love and Christiansen 1985). The raw material of three flakes is identified as chalcedony from the White River Group. Knudson (2002:115-116) discusses multiple sources of this stone which she refers to in aggregate as White River Group Silicates or WRGS. The closest sources to the Allen site are the Flat Top chalcedony quarry in the South
Platte drainage of Colorado and Table Mountain, which is situated just south of the North Platte River in Wyoming and would have been along a route following the river between the Hartville Uplift and the site (Figure 5-1). One projectile point in the Allen assemblage is of Alibates agate.

The raw material of a pot lid that possibly came off of a biface is variously identified as Permian / Flint Hills chert or Nehawka chert (Bamforth 2007:239; Bamforth and Becker 2007a:177). Holen (1991:401, Figure 23.1) defines the two tool stones as different types that derive from separate geographical areas. Permian or Flint Hills chert is light-to-dark gray and derives from a number of limestone formations outcropping in the Flint Hills, which form a north-south band of higher terrain running from southeast Nebraska, through eastern Kansas, and into northeast Oklahoma. Nehawka chert is generally light gray to nearly black with a “rice-grain” appearance from numerous foraminifera fossil inclusions. Holen (1991:401, Figure 23.1) maps its occurrence near the confluence of the Platte and Missouri rivers in southeast Nebraska and southwest Iowa, but he describes its area of occurrence as also including northeast Kansas and northwest Missouri. Regardless of its proper raw material classification, the single pot lid demonstrates contact between people at the Allen site and groups who had access to stone from very distant sources situated generally to the east.

Finally, most of the ground stone artifacts were made from indurated sandstone said to originate from an unspecified Cretaceous formation. Lawrence Conyers (cited in Bamforth 2007:186) suggests that the sandstone of these ground stone artifacts would have originated from one of two possible sources, both of which lie 300 to 400 km from the Allen site. One source is east of the site in an area west of the city of Lincoln in eastern Nebraska. The other is west-northwest of the site in the area north of Scottsbluff, Nebraska.
Red Smoke Site, Zone V

Although the existing collections and excavation records for the Red Smoke site have not been analyzed and reported to the same extent as the Allen site, information that is to be found in existing literature will be used to consider the possibility that Zone V represents one to a few occupations of the site by a group of people intent on large-scale bison hunting. This statement will be justified in detail below. In brief, the possible interpretation is supported by the relatively large number of points recovered from the cultural level and the dominance of bison bone in the faunal assemblage. A reason that the possibility of gearing up and occupation by a potentially large group was initially considered for the sites along Lime Creek has to do with the basic theoretical expectation of the alternative view that high-quality sources of stone should have been visited not only by small groups involved in more generalized subsistence activities, but also by larger groups that were more intent on gearing up for large-scale bison hunts.

Consideration of the size of a human group represented at a site and the basic mode of subsistence of that group is relevant to understanding how the site fits into prehistoric land use patterns. In the case of the Medicine Creek drainage, the way that a relatively small group positions itself on the landscape to exploit plant, animal, and tool stone resources available in an environment would be expected to differ from the manner in which a task group or relatively large group intent on gearing up would situate itself in the environment. As a residential base, it is perhaps significant that the Allen site is situated on the main stream of the lower reaches of the Medicine Creek drainage. By camping at this position on the landscape, site occupants would have been centrally located with respect to food resources found along the gallery forest north and south of the site as well as those of the grasslands lying to the east and west. In addition, jasper outcrops in Lime Creek and elsewhere in the lower Medicine Creek drainage would have been easily accessible. The fact that the people who produced Zone V at the Red Smoke site chose to camp right at a jasper outcrop rather
than in a location on the main stem of Medicine Creek suggests that ease in procuring tool stone may have been more of a determining factor in camp location than positioning the group in a location advantageous for procuring a wide array of food resources. The Red Smoke site is situated 2.4 km west-northwest of the Allen site (Davis 1962:Figure 2). By locating camp on a permanent tributary of Medicine Creek with jasper outcrops close at hand, the people who produced Zone V could save themselves having to make daily round trips of over 4.8 km in length, which is what they would have had to do if they had camped on Medicine Creek. Camping on the main stem may have been advantageous for a small group of people subsisting on a wide range of food resources, but the dominance of bison bones in Zone V at Red Smoke and other evidence to be discussed below implies that the group of people camped there were more intent on gearing up with tool stone in order to engage in large-scale bison hunting somewhere in the surrounding countryside.

The Red Smoke site is located on the north bank of the present course of Lime Creek and was discovered, excavated, and preliminarily reported upon as a result of the same reservoir construction project that prompted excavation of the Allen site. Cultural material was recovered from excavations measuring 43 m east-west by 19 m north-south. Of the eight cultural levels present at the site, the six lowest levels (designated Zones I through VI) are Paleoindian in age and occur throughout a vertical depth of 3.7 m. The uppermost two levels, Zones VII and VIII, are not radiocarbon dated, but a stemmed or broadly corner-notched point from Zone VII indicates they are post-Paleoindian in age. A sample of soil humates from Zone II produced a date of 9820 ± 80 B.P. and charcoal from a fire hearth in Zone VI yielded a date of 7970 ± 210 B.P. Thus, the Red Smoke site records intermittent occupation during the final 1,850 + years of Paleoindian presence on the Central Plains.

The discussion here will focus on the level that produced by far the most cultural material: Zone V. The zone averages .3 m in thickness and is interspersed with thin colluvial silt lenses (Knudsen 2002:Table 7.1). Based on this information, both Knudsen (2002:99)
and Bamforth (2002b:72) suggest that multiple occupations are represented. Future artifact refitting studies and geoarchaeological investigations should be directed toward clarifying whether the Zone V represents a single season of occupation that was affected by slope wash prior to burial or multiple occupations occurring throughout a number of years. A total of 93 m² of the level was excavated (Knudson 2002:99). This equates to an area measuring 9.6 m by 9.6 m and for purposes of inter-site comparisons, it is worth noting that this is similar in size to the excavations at the Allen site, which equate to an area measuring 10.9 m by 10.9 m. That people camped at the Red Smoke site during the time represented by Zone V is demonstrated by the presence of four or more hearths (Knudsen 2002:99). A total of 36 concave-based lanceolate points were recovered from Zone V as were two Cody points (Knudson 2002:Table 7.3). More points may have come from Zone V because 17 known from the site are not assigned to a specific zone. Charcoal and burned bone collected from a hearth in Zone V produced a date of 8830 ± 130 B.P. (Knudson 2002:99, Table 7.2; May 2007:36, Table 3.8).

Available evidence suggests that archaeological material in Zone V was found in concentrations of artifacts and bone that may have been trash deposits. Knudson (2002:99) states that, “[w]ithin Zone 88 [V] there were piles of lithic debitage, often mixed with fragmentary bison bones…” To this, Bamforth (2002b:68) adds that, “…artifact concentrations in Zone 88 [V] mix together whole and broken bison bone with large amounts of stone flaking debris.” He further suggests that the concentrations, as at the Allen site, were secondary refuse deposits (Bamforth 2002b:67-68).

If occupants of Zone V were focused on producing a lot of points for bison hunting, there should be a higher proportion of unfinished and presumably rejected bifaces in the assemblage in comparison to the Allen site collection which, on the whole, may be characterized as being the product of replenishing stone tools needed for a wide range of subsistence and manufacturing activities and not particularly a collection of artifacts.
indicative of gearing up for a large hunt. Of the 283 worked pieces in the Allen assemblage, 90 (or 32 percent) are unfinished bifaces (Table 12-5). When discussing the artifacts from Zone V, the original site investigator stated that, “[t]he most common artifacts are blades and choppers, making up 267 fragments and complete artifacts, or 53 percent of the total worked flint from this zone” [Davis (1954:68), cited in Knudson (2002:102)]. In the artifact classification systems of the 1950s, the term “blade” referred to bifaces and in the days prior to use wear studies, early stage, unfinished bifaces were erroneously thought to be tools for chopping. Given these changes in terminology, existing literature does suggest that unfinished bifaces are comparatively more common among the Zone V artifacts.

The proportionally high amount of bison bone relative to other species in the Red Smoke faunal collection supports the idea that occupation of the site was related to large-scale bison hunting. Although precisely quantified data on the faunal material from Zone V is not yet available, Bamforth (1991a:365) estimates that bison accounts for over 90 percent of the fauna in all of the levels at Red Smoke. A strong case is made for small-scale hunting of bison by the relatively small human groups that occupied the Allen site throughout the Paleoindian period. Occupation Level 2 at the Allen site falls into a time period that is temporally equivalent to Zone V at Red Smoke as demonstrated by the fact that the two acceptable radiocarbon dates from OL 2 (8680 ± 460 and 8670 ± 90 B.P.) are within one or two standard deviations of the date from Zone V (8830 ± 130 B.P.). Bison comprise eight or nine percent of the faunal assemblage from OL 2, according to the number of identified specimens (Hudson 2007:Figure 12.3). If small groups of foragers living during the time period produced an assemblage comprised of between eight and nine percent bison bone when involved in a subsistence economy that included small-scale hunting, then an assemblage produced by foragers of the same time period and cultural group that is comprised of over 90 percent bison implies that a greater emphasis on bison hunting is represented. The presence of a dense bison bonebed comparable to temporary hunting camps
such as Jurgens, Frazier, and Jones-Miller is not indicated in the Red Smoke literature. This suggests that killing of an entire herd of bison may not be represented in the faunal assemblage. Rather, one would be justified in suggesting that the remains of bison and other species may represent smaller scale hunting of big game animals conducted in order to feed a comparatively large group of people amassed at Zone V to gear up for upcoming large-scale bison hunting.

The possibility that people camped at the Red Smoke site to gear up for large-scale bison hunting were supplied with meat from numbers of bison killed somewhere in the surrounding countryside is supported by the number and condition of the points that were discarded with the bison bone in the possible midden of Zone V. As noted previously, the total area excavated at Allen was similar to that of Zone V of Red Smoke. The Allen site represents trash discarded during a majority of the Paleoindian period by people involved in generalized foraging activities. A total of only nine points were discarded at the Allen site. Zone V of Red Smoke may represent large-scale bison hunting during a much shorter time in the Paleoindian period. During this time, a minimum of 38 points were discarded. The condition of the points supports the thinking that they were discarded along with bones of the animals they were used to kill. Of the 38 points, 28 (or 74 percent) were broken and included 22 bases (58 percent), two midsections (five percent), and four tips (11 percent) (Knudson 2002:Table 7.3). Ten points (or 26 percent) were complete when discarded, though some appear to have been reworked and so were not in the best condition (e.g. Knudson 2002:Figure 7.10 a, c). The large numbers of points from Zone V and the broken and less-than-pristine condition of many of them therefore supports the idea that site occupants returned to the site with parts of bison and hunting weaponry in need of repair.

If further analysis of the assemblage from Red Smoke confirms the possibility that Zone V records the activities of a group intent on large-scale bison hunting, this could in turn lead to new insights about subsistence patterns simply because future researchers will be
aware of seasonal differences in subsistence and be looking for their expression in the archaeological record of all kinds of sites. In a recent article about Plains Paleoindian communal bison hunting strategies, Bamforth (2011) argues that most bonebeds do not mark the actual location of a bison kill, as has been previously thought. Rather, the bonebeds primarily denote the location of temporary hunting camps where meat from bison killed in a surround somewhere in the field was processed. It is reasonable to assume that on some occasions, scouts from an aggregated group that had completed gearing up at a tool stone source located a bison herd close to source and the people were able to successfully surround and kill a herd without breaking camp at the lithic source. Ethnographic reports attest to the likelihood that if the kill was made within several miles of camp, carcasses segments could be brought back with the assistance of dogs equipped with travois. If this were the case with the occupants of Zone V, then it would be expected that meat would have been stripped from bone and the bone would be discarded in a midden, forming a dense bonebed at the site as was done at hunting camps far from a source area. The fact that a dense bonebed is not reported for the Red Smoke site suggests that the substantial amount of bison hunting that evidently was occurring while people were camped at the site may be evidence of on-going smaller-scale bison hunting that was carried out while gearing up so as to supply a large group of people with adequate food. Although the alternative view encourages that archaeologists focus more attention on the littler known aspects of subsistence economy and social organization thought to have prevailed throughout most of the year on the Great Plains, there is still much to learn about the nature of communal hunting. So as not to overlook evidence that may contribute to a better understanding of land use, archaeologists need to be aware that faunal and artifactual indications of communal hunting may have a different expression at sites situated near lithic sources than they do at dense bonebeds far from a lithic source.
Information available on the Red Smoke assemblage indicates that collection of artifacts from all cultural levels are very similar in tool stone composition in that all are nearly totally comprised of the locally available Smoky Hill jasper with other materials occurring in very small frequencies. The site assemblage is said to be composed of over 100,000 pieces of debitage and 1,861 tools (Knudson 2002:140-141). It is here assumed that the debitage is probably comprised mostly of waste flakes and the “tools” include artifacts such as blocky cores and unfinished bifaces which were not actually used as tools and so are perhaps better labeled as worked pieces. Information on the tool stone composition of the assemblage available in Knudson (2002) is in two forms.

The first source of information is a table that presents the raw materials of the 64 points from the site (Knudson 2002:Table 7.3). The tool stone composition of 38 points that definitely came from Zone V is presented here in Table 12-6. A total of 36 points are concave-based lanceolate points and two are Cody points. The sample of points is dominated by Smoky Hill jasper, with 30 of the concave-based lanceolate points made of this locally available raw material.

A second source of information on the tool stone composition of the Red Smoke assemblage comes from Knudson’s (2002) narrative on the nonjasper tool stones present, in which she quantifies the number of tools made of each material. One possible exception is a green quartzite. The number and kind of artifacts made of this raw material is not quantified. Considering that most nonjasper artifacts from the neighboring Allen site are waste flakes, it is assumed that Knudson’s information on the raw material composition at Red Smoke pertains only to the sample of 1,861 worked pieces and that the nonjasper artifacts in the sample of over 100,000 flakes were not tallied. In total, only 17 nonjasper tools are mentioned by Knudson. These include 12 points and 5 flake tools. If these 17 artifacts are subtracted from the 1,861 total worked pieces, then 1,844 (or 99 percent of the worked
<table>
<thead>
<tr>
<th>Tool Stone Type</th>
<th>Dalton Points</th>
<th>Cody Points</th>
<th>Total Number of Points</th>
<th>Distance to Tool Stone Source Used in Analysis (km)</th>
<th>Relative Distance to Tool Stone Source</th>
<th>Percent of Collection Composed of Tool Stone Type, According to Artifact Count</th>
<th>Percent of Collection Composed of Local Stone, According to Artifact Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoky Hill Jasper</td>
<td>30</td>
<td>0</td>
<td>30</td>
<td>.1</td>
<td>local</td>
<td>78.9 percent</td>
<td>78.9 percent</td>
</tr>
<tr>
<td>Petrified Wood</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>?</td>
<td>?</td>
<td>2.6</td>
<td>5.2 percent</td>
</tr>
<tr>
<td>Unidentified Olive Gray Chert, Possibly from a Gravel Source</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>?</td>
<td>?</td>
<td>2.6</td>
<td>2.6</td>
</tr>
<tr>
<td>Nehawka Chert</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>330</td>
<td>very distant</td>
<td>2.6</td>
<td>2.6</td>
</tr>
<tr>
<td>Flat Top Chalcedony or Table Mountain Chert</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>268 / 357</td>
<td>very distant</td>
<td>2.6</td>
<td>2.6</td>
</tr>
<tr>
<td>Hartville Uplift Chert</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>421</td>
<td>very distant</td>
<td>2.6</td>
<td>15.7 percent</td>
</tr>
<tr>
<td>Spanish Diggings Orthoquartzite</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>445</td>
<td>very distant</td>
<td>2.6</td>
<td>2.6</td>
</tr>
<tr>
<td>Alibates Agate</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>518</td>
<td>very distant</td>
<td>5.3</td>
<td>5.3</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>36</strong></td>
<td><strong>2</strong></td>
<td><strong>38</strong></td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Percent of Collection</strong></td>
<td><strong>94.7</strong></td>
<td><strong>5.3</strong></td>
<td><strong>100.0</strong></td>
<td>-</td>
<td>-</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

*a* Data from Knudson (2002:Figure 7.3).
pieces) are made of Smoky Hill jasper. The percentage of Smoky Hill jasper in the Allen site assemblage is also over 99 percent.

The tool stones represented in the 17 nonjasper worked pieces discussed by Knudson include the seven nonjasper tool stones in the sample of points from Zone V and two other tool stones. One raw material is represented by a point of moss agate that Knudson (2002:111) suggests originates from the same general area as Nehawka chert. Another tool stone not present among the points from Zone V is Edwards chert, which is present in the Red Smoke collection in the form of a flake tool.

Knudson (2002:101) states that “some” of the Red Smoke artifacts are made of a green quartzite which is here assumed to be Ogallala orthoquartzite from local sources. Wedel (1986:30-31) reports that an olive green to greenish gray quartzite outcrops from the Ogallala Formation at many local and distant sources east-southeast of the site along the Republican River. He also mentions a report of a local source east of the town of Cambridge, Nebraska, which is located 13 km south-southeast of the site at the confluence of Medicine Creek and the Republican River. From the sources along the Republican River mentioned by Wedel, Holen (1991:401, Figure 23.1) extends the source area of this raw material southward to distant areas in Kansas. Holen notes the stone is generally coarse-grained and both he and Wedel indicate that its use for stone tool manufacture was restricted to larger cutting, scraping, and chopping tools. From the above information, the green quartzite in the Red Smoke assemblage mentioned by Knudson is assumed to most likely derive from local sources.

Two tool stones in the point collection from Zone V may be from either local or nonlocal sources. One point is made of petrified wood. In reference to two flake tools of petrified wood, Knudsen (2002:111) states that, “[b]oth of the flake tools could have been made on river cobbles or from surface remains.” If this means that the petrified wood of the flake tools was obtained from a gravel deposit, a local source would seem to be more likely.
Knudson then discusses various very distant sources of petrified wood in Colorado but does not definitely state that the points derive from these sources. One point is made of olive gray chert. In her table on points, the notation “gravel source?” is made in reference to this point, implying to me a possible local source (Knudson 2002:Table 7.3). Elsewhere, she seems to refer to the stone as “unlabeled chert” and suggests it may derive from the very distant outcrops of Nehawka chert (Knudson 2002:111).

The remaining six points from Zone V can be confidently assigned to various very distant sources (Figure 12-6). One concave-based lanceolate point is made of Nehawka chert from the lower Platte drainage in southeast Nebraska. Another is made from either Table Mountain chert, acquired from its source in the North Platte drainage in southeast Wyoming, or from Flat Top chalcedony, which would have originated from its source in the watershed of the South Platte in northeast Colorado. A third concave-based lanceolate point is from Hartville Uplift chert from sources further up the North Platte drainage in southeast Wyoming. One Cody point is made of Spanish Diggings orthoquartzite from the Hartville Uplift. Finally, Alibates agate from the Southern Plains is the raw material of one concave-based lanceolate point and one Cody point.

**Lime Creek Site, Zone I**

Situated 500 meters to the east down Lime Creek from the Red Smoke site is the Lime Creek site. The stratigraphic column exposed at the site includes a series of eight paleosols. Three of these contained cultural levels that are distributed throughout a vertical distance of 2.74 m (Davis 1962:Figure 5). The uppermost level is designated Zone III and has not been radiocarbon dated. However, a nearly complete preform from the cultural deposit is similar to the Frederick type in outline form (Davis 1962:Figures 20 a, 30). The faunal assemblage from Zone III is dominated by bison. The middle cultural level, designated Zone II, produced meager archaeological material and remains undated.
By far the most cultural material came from Zone I, which will be the focus of analysis and discussion. Zone I is the lowest level and produced points of the Cody type and others that are less confidently classified. Two points with excellent parallel flaking are here assigned to the Cody type (Davis 1962:63-64, Figure 10 a-b). One is made of Hartville Uplift chert and the other is of chert from an unidentified source (Hicks 2002:Appendices C-D). A third specimen is a short point with a square base that was made by reworking a flake of Smoky Hill jasper (Davis 1962:Figure 10 c; Hicks 2002:Appendices C-D) and is here classified as a Cody point. The remaining two points are crudely made and difficult to assign to a particular type with confidence, but they do exhibit attributes that are common to Cody points. One point was made by reworking a flake of Smoky Hill jasper (Davis 1962:63, Figure 19 a; Hicks 2002 Appendices C-D). One basal corner is a right angle like typical Cody points, but the other corner is rounded. The final point is a fragment made of Smoky Hill jasper with parallel lateral edges, like typical Cody points (Davis 1962:63, Figures 19 a, 22; Hicks 2002:Appendices C-D). It appears as though a break facet that extends diagonally from one lateral edge to the other was subsequently retouched in a crude fashion. A total of 15 point preforms with straight basal edges can be specifically identified as preforms for Cody points (Hicks 2002). The large number of preforms and numerous bifaces discarded earlier in the manufacturing process is the basis for inferring that the Cody occupation entailed gearing up for large-scale hunting.

Two sources of information were consulted regarding the archaeology of the Lime Creek site and its artifact and faunal collections. Davis (1962) published an initial report on site investigations. More recently, Hicks (2002) provides data on the tool stone and artifact composition of the lithic assemblage and uses a more contemporary artifact classification than Davis. As with Zone V at Red Smoke, Zone I at Lime Creek produced far more artifacts than other levels. Presence of at least four hearths in Zone I indicates that people camped on-site. Material from Zone I occurred in all the excavation areas at the site (lettered A through
C). Lime Creek currently forms a semi-circular bend at the site with the apex of the loop toward the north. Lateral stream erosion has formed very tall, vertical cutbanks on the west, north, and east sides of the bend. Once Lime Creek was diverted for construction of Medicine Creek Dam, a basically north-south oriented excavation block was excavated along the east side of the bend and is designated Excavation A. A map of Zone I in Excavation A shows cultural material occurring in a concentration which might be a midden deposit (Davis 1962:Figure 36). Excavation B is contiguous with Excavation A and extends to the northeast in a bulldozer trench excavated down to the cultural levels. At a distance of 16 m to the north, Excavation C is a linear excavation block aligned northwest-southeast. Known site dimensions are 47 m north-south by 24 m east-west. In total, 1,475 ft² of Zone I was excavated. This equates to 137 m² or an area measuring 11.7 m by 11.7 m. The areas excavated at both Zone I of the Lime Creek site and the Allen site are similar in size. This is fortunate because it permits comparison of the quantity of specimens of various artifact types between the two sites in order to investigate presumed functional differences.

The total size of the artifact assemblage, including flakes, has yet to be tallied, but worked pieces in the collection are discussed by Davis (1962) and Hicks (2002). Davis (1962:Table I) enumerates 128 worked pieces of flaked stone from Zone I. Hicks (2002:Appendix C) examined 118 worked pieces from the zone. Worked pieces classified by Davis as miscellaneous unifacials (equivalent to utilized flakes) were excluded by Hicks because edge damage on flakes can result from causes unrelated to use, such as trampling. Several formal tools reported in the assemblage were apparently not in the collection Hicks examined. Davis (1962:Table I, Figure 13 a-b, e-h) lists six end scrapers and three “end-and-side scrapers” from Zone I and provides a photograph showing some of the end scrapers and end-and-side scrapers, but only two end scrapers were examined by Hicks (2002:Appendices C-D). This minor discrepancy should not seriously affect interpretation of the assemblage.
Data on the artifact and tool stone composition of the Zone I assemblage given in Table 12-7 provides insights into the major activities performed on-site and one of these evidently was the mass production of projectile points from the local jasper. Zone I produced 57 unfinished bifaces of stages 1, 2, or 3, five bifaces of indeterminate stage, three projectile points preforms that cannot be assigned to a specific type, and 15 Cody point preforms. In total, as many as 80 artifacts are essentially artifacts that were rejected sometime during the process of flintknapping a number of Cody points or other biafficly flaked tools. As mentioned, the 80 artifacts were recovered from within block excavations that together are equivalent to an area measuring 11.7 by 11.7 m. By comparison, 90 unfinished bifaces and 20 point preforms were recovered from block excavations at the Allen site which are equivalent to an area measuring 10.9 by 10.9 m. Even though a greater number of unfinished bifaces and preforms (n = 110) were collected from an excavated area of comparable size at Allen, it must be remembered that the assemblage from that site accumulated over the course more than two millennia and the Zone I deposit at the Lime Creek site was deposited over a much shorter period of time that perhaps spans as little as one large-scale bison hunting season. Assuming that the point manufacturing process more often resulted in the production of a successfully completed point rather that a manufacturing reject, the presence of 80 possible point manufacturing discards implies that the manufacture of hundreds of Cody points could be represented in the Zone I assemblage. A precise estimate of the number of points made on-site obviously cannot be provided, but the evidence available is suggestive of the mass production of projectile points to gear up for bison hunting.

Theoretically, gearing up at a source area may have been performed by groups of various sizes and composition, among which are task groups composed of adult flintknappers and aggregated groups composed of a mix of all kinds of people gathered together for a bison hunt. If indeed point manufacturing rejects and other by-products of stone tool production were discarded in a midden as suggested, this would imply that a sizable group was camped
Table 12-7. Tool Stone and Artifact Composition of Ground Stone Artifacts and Worked Pieces of Flaked Stone Artifacts from Zone I of the Lime Creek Site.¹

<table>
<thead>
<tr>
<th>Tool Stone Type</th>
<th>Black Cores</th>
<th>Bladed Retouched Flake Tools/Molded Items</th>
<th>EndScrapers</th>
<th>Bifacial Tools</th>
<th>Wedges</th>
<th>Unfinished Blades (Stage 1, 2, and 3)</th>
<th>Blades, Full Form Stage</th>
<th>Finished Blades (Stage 4 Bifaces)</th>
<th>Projectile Point Preforms</th>
<th>Cody Point Preforms</th>
<th>Cody Points</th>
<th>Points</th>
<th>Scrapers</th>
<th>Absorbers</th>
<th>Harpoons/Arrows</th>
<th>Total Number of Artifacts</th>
<th>Distance to Tool Stone Source Used in Analysis (km)</th>
<th>Relative Distance to Tool Stone Source</th>
<th>Percent of Assemblage Composed of Tool Stone Type, According to Artifact Count</th>
<th>Percent of Assemblage Composed of Local Vs. Nonlocal Stone, According to Artifact Count</th>
<th>Percent of Assemblage Composed of Local Vs. Nonlocal Stone, According to Artifact Count</th>
<th>Percent of Assemblage Composed of Local Vs. Nonlocal Stone, According to Artifact Count</th>
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<td>1</td>
<td>57</td>
<td>5</td>
<td>3</td>
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<td>15</td>
<td>1</td>
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<td>5</td>
<td>111</td>
<td>3 ± local</td>
<td>93.3</td>
<td>94.1 percent Local</td>
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<td>0</td>
<td>1</td>
<td>1</td>
<td>?</td>
<td>local ?</td>
<td>.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Unidentified Chert</td>
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<td>1</td>
<td>?</td>
<td>?</td>
<td>.8</td>
<td></td>
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<td>Flat Top Chalcedony or Table Mountain Chert (? “Chalcedony” of Hicks)</td>
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<td>1</td>
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<td>0</td>
<td>1</td>
<td>268 / 357</td>
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<td>6</td>
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<td>-</td>
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<tr>
<td>Percent of Collection</td>
<td>3.4</td>
<td>10.9</td>
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<td>8</td>
<td>.8</td>
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<td>.8</td>
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<td>100.0</td>
<td>-</td>
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</tbody>
</table>

¹ Data from Hicks (2002:Appendices C and D).
at the site for a long enough period that cleaning up and disposal of debris took place. Furthermore, bones of a variety of species were recovered from Zone I but the site report does not mention if the concentration of cultural material in Excavation A was composed of both artifacts and bones. If so, then this would imply that hunting and carcass processing activities were on-going. This in turn would be more in keeping with the idea of an aggregated group of people being present, rather than a smaller task group composed of flint knappers sent out by the main group to collect stone from a source and bring it back in the form of blocky cores and bifaces. Some members of an aggregated group camped at the site to gear up would have to be involved with on-going subsistence activities to feed everyone present. Although a task group of adults would need to eat as well, it seems more likely that a small special-purpose group would be provisioned with food preserves to be able to travel to and from the lithic source and to engage in flintknapping without having to spend time foraging for food. In any case, it seems unlikely that a small task group would generate the quantity and diversity of faunal remains that seems to be indicated in the site report (see below). Finally, the several end scrapers reported from Zone I would suggest that processing the hides of animals occurred on-site, an activity that also is more characteristic of a foraging group rather than a task group intent on stone tool production.

Other evidence supporting the view that Zone I represents gearing up by Cody people rests on the fact that bifaces from the Lime Creek site as a whole demonstrate a higher level of craftsmanship in comparison to the sample from the Allen site. Since the Allen site was occupied by small groups of foragers, one would expect artifacts made there to display primarily average workmanship with expert skill evident on fewer worked pieces. Gearing up would have been performed principally by expert flintknappers who mass produced artifacts to be used by others participating in the hunt and subsequent processing activities. In comparison to the sample of bifaces from the Allen site, bifaces from the Lime Creek site would be expected to demonstrate more regular flake scar patterns indicative of the greater
control in flintknapping possessed by expert flintknappers. Hicks (2002:86-90) presents data demonstrating a tendency for unfinished bifaces, finished bifaces, and point preforms from the Lime Creek site to exhibit greater regularity in flaking pattern in comparison to bifaces from Allen, thus confirming the expectation.

Artifactual evidence from Zone I may support the supposition that the occupants of the site prepared for large-scale bison hunting by gearing up, but unlike the faunal assemblage from Zone V of the Red Smoke site, bones from Zone I do not provide direct evidence for subsistence activities having been dominated by the hunting of bison. Davis (1962:61) notes that bones of beaver and antelope comprise most of the Zone I faunal material. Hudson (2007:215) notes that the beaver remains display evidence of having been heavily butchered. Also present in the faunal assemblage are very small numbers of bone fragments of bison, deer, elk, jackrabbit, prairie dog, raccoon, and coyote or dog (Davis 1962:61). One might suggest from the above that the Cody people camped at the Lime Creek site engaged in on-going fairly small-scale hunting of a variety of game animals while gearing up for bison hunting. In particular, antelope and beaver were procured, the later species having been more likely trapped than hunted. The several end scrapers from the level would suggest that some processing of animal hides also took place.

The lack of quantities of bison bones in the Zone I faunal assemblage is not necessarily at odds with the assertion that Cody occupants of the site were involved in large-scale bison hunting. If bison happen to be near a lithic source when an aggregation of people were there gearing up, it is possible that some bison would have been procured by hunters using techniques that would result in the acquisition of smaller numbers of prey than surrounding an entire herd. Bison carcasses segments obtained by stalking, ambush, or perhaps even small-scale surrounds could have been transported back to camp at the lithic source via assistance of dogs. This is the hypothetical scenario suggested for Zone V at Red Smoke. On the other hand, if herds of bison were not in the area when people were gearing
up, the lack of plentiful bison bones at a camp situated near a lithic source is not necessarily
evidence that the occupation is unrelated to large-scale bison hunting.

Further indications of gearing up are suggested by the artifacts present. Though only
one shaft abrader was found, it is the kind of artifact that is never reported in great quantities
and arguably is material evidence for the production of wooden shafts used in the
manufacture of hunting weaponry. Similar examples are reported from Cody sites with dense
bonebeds that more obviously are associated with large-scale bison hunting, including
Jurgens, Hudson-Meng, and Horner (Agenbroad 1989:Figure 35; Frison 1987:Figure 7.23;
Wheat 1979:Figure 70). One ground stone artifact is here classified as simply an abrader
(Hicks 2002:Figure 4.3, catalog # 8312).

Two remaining ground stone artifacts, one fragmentary, the other complete, are about
the right size and shape to have functioned as manos and are here classified as such (Hicks
2002:Figure 4.3, catalog # 7583 and 7584). Manos are not the kind of artifact one would
think of as being usually discarded during an occupation related to large-scale bison hunting.
However, the Jurgens site produced a number of grinding slabs and handstones that may have
functioned as manos and some of these were used to pulverize ochre, an activity that is
associated with large-scale bison hunting. Therefore, the presence of manos at Zone I of
Lime Creek does not invalidate the possibility that the cultural level is related to gearing up
for communal hunting.

As with the other two Medicine Creek assemblages, the tool stone composition of the
collection of worked pieces of flaked stone artifacts from Zone I of the Lime Creek site is
dominated by locally available stone with very small amounts of tool stones from very distant
sources also present. Locally available Smoky Hill jasper accounts for 93 percent of the
collection of worked pieces of flaked stone and ground stone artifacts from Zone I (Table 12-
7). One hammerstone of petrified wood is in the collection. In the discussion of the Red
Smoke and Allen assemblages, suggestions of the possible existence of local sources of
petrified wood in cobble form were reviewed. Because hammerstones are normally large, heavy artifacts that can be readily obtained from deposits of stream gravels, the source of the petrified wood is tentatively classified as local. More information on the local sources of petrified wood rumored to exist is needed. One point is made of unidentified chert from a non-specified source and is classified in Table 12-7 as local or nonlocal tool stone. Based on a color photograph of the point (Hicks 2002:Appendices C-D, catalog # 7551), the raw material is an opaque tan chert with dark brown mottling. Two flaked stone raw materials are considered to be from very distant sources, as is the sandstone raw material for the ground stone artifacts. Hicks (2002:Appendices C-D) classifies one end scraper as chalcedony and judging from the color photograph of the artifact, the raw material is here considered to be Flat Top chalcedony or Table Mountain chert. The tool stone of one point is identified by Knudson (2002:123) as Hartville Uplift chert. The orangish red splotch visible on the color photograph of this dark brownish red point is characteristic of Hartville Uplift chert and confirms Knudson’s identification [compare photograph of the Lime Creek point illustrated in Hicks (2002:Appendices C-D, catalog # 7554) with photograph of a point from the Jurgens site illustrated in Figure 7-14 of this document]. Finally, the four ground stone artifacts are here assumed to be made of indurated Cretaceous sandstone from very distant sources, based on the fact that a large majority of ground stone artifacts from the Allen site were identified to be this material.

Hell Gap Cluster, Particularly Locality V

Of the combined set of many Paleoindian components investigated at the cluster of four sites or “localities” at Hell Gap, the Cody component at Locality V was chosen to examine Paleoindian land use because it was the only one where the tool stone composition of the assemblage had been tabulated at the time this project began (Knell 1999). Information on the tool stone composition of the assemblage has been recently revised (Knell
et al. 2009). Analysis of the Cody level at Locality V determined that the cultural deposit is relevant to understanding Paleoindian land use related to large-scale bison hunting.

To evaluate the veracity of this interpretation, it is crucial that the Cody occupation at Locality V be understood in relation to the site complex as a whole by seeking to answer the question of why Hell Gap was a special place that attracted repeated occupation throughout the Paleoindian period. In contrast to the interpretation of the Cody level at Locality V as reflecting an occupation related to large-scale bison hunting, Knell et al. (2009:173-176) state that the faunal remains from the Cody occupation indicate that one bison was killed in the late spring or early summer, four died during the height of summer, and one was procured in the fall. They further suggest that determination of whether the Cody occupation represents a single continuous occupation or periodic visits to the site over the course of several years cannot be resolved. In agreement with the interpretation of Locality V by Knell et al., Rapson and Niven (2009a:119) examined bison dentitions from the Hell Gap site complex in general and conclude that each component at all four localities represents multiple kill events of either individual bison or small groups that occurred over an unknown period of time.

Recent investigations at the Hell Gap site complex have recently been written up in a detailed report by a team of archaeologists and in summing up the volume, Kornfeld and Larson (2009:6-7) note that most authors interpret the components as representing intermittent small-scale occupations. The above leaves one with the impression that Hell Gap site was a special place because it was a good place for Paleoindians to camp when operating in small groups involved in generalized foraging that included small-scale bison hunting. My interpretation of Locality V is at odds with the findings of others and maintains that Hell Gap may have been special because it was a good place for Paleoindians to camp when preparing for large-scale bison hunting. The Hell Gap site complex is an important set of sites and correctly characterizing them as a special place for small groups involved in generalized foraging or aggregated groups engaged in large-scale bison hunting is necessary for achieving an
accurate understanding of Paleoindian land use in the study area. By posing the question of why Hell Gap was special, I do not mean to oversimplify factors affecting Paleoindian land use, but merely aim to stress that in order to correctly interpret land use from evidence present at a site, it is necessary to accurately characterize the subsistence economy of site occupants and to consider evidence that may reflect the social setting in which the occupation occurred, specifically the relative size of the group that produced a cultural deposit.

Multiple lines of evidence will be presented to support the thinking that occupations of Hell Gap were related to communal bison hunting. First, the idea that the Hell Gap sites are in an environmental setting amenable to camping and gearing up will be developed. A basic method of evaluating ideas on site function is to consider the kinds of artifacts present. The feasibility of this method of analysis is hampered by the fact that the artifact composition of only a few of the components at the Hell Gap sites has been tabulated. Nevertheless, the method was employed to the extent possible. General support for the idea of gearing up for hunting was garnered at Locality V and elsewhere by noting evidence for manufacture of bifacial artifacts (particularly points) as well as blocky core reduction. Somewhat unexpectedly, evidence for post-hunt activities such as repair of hunting weaponry and hide processing was noted by the presence of discarded points and end scrapers, particularly at Locality V. Other items of material culture besides stone tools may shed light on site function. The presence of quantities of ochre has been discussed as a possible indicator of sites related to large-scale bison hunting. With this in mind, the frequent occurrence of ochre in many of the components at Hell Gap will be noted. Finally, the faunal assemblages from the components were reviewed to assess the extent to which bison hunting was an emphasized subsistence activity. This review again revealed a somewhat unexpected result for sites at lithic sources in that the faunal collections document considerable evidence for bison hunting.
Two basic explanations for the unexpected evidence for hunting of bison and processing of hides at sites near sources may be proposed, both of which would require refitting studies or similar analyses to determine which is the more plausible in each case. The deposits of bison bone at Hell Gap sites are not the dense bonebeds containing the remains of dozens of animals as is the case at sties associated with large-scale bison hunting away from lithic sources. In many cases, only a few to several bison are represented in the faunal assemblage from the Hell Gap components. On the other hand, comparison of faunal collections from cultural levels at Hell Gap to the faunal assemblage from the Allen site will be shown to support the view that the level of bison hunting evident at Hell Gap is above that seen in cultural deposits produced by groups that were arguably involved in a more generalized subsistence strategy. One possible explanation for the level of bison hunting at Hell Gap is that some bison were killed to feed a relatively large group of people preparing for a communal kill. The evidence for post-hunt activities may indicate that bison hides obtained during hunting activity were processed. The above scenario would be supported if refitting studies were to show that the individual Hell Gap levels were produced during single occupations. Another possible explanation for the level of bison hunting evident would be if the group had carried out a successful communal kill somewhere afield and returned to the campsite to process hides and perhaps gear up for another communal hunt. If meat had been stripped from bison carcass sections at temporary hunting camps and most bones discarded there as well, this could explain the presence of bones from relatively few bison in the Hell Gap levels. Evidence for multiple occupations in each level provided by refitting studies or other means would tend to favor this possible explanation.

Regardless of which explanation for the level of bison hunting evident at Hell Gap may prove better, support for the thinking that the hunting and post-hunt activities were performed by a group involved in communal hunting can be provided by demonstrating that the bison were killed during the large-scale bison hunting season. With this in mind, dental
ages determined for the specimens of bison dentition recovered from the Hell Gap levels will be graphed to illustrate the time of year that the animals were killed.

A number of topics must first be addressed in order to then make the case that cultural levels at Hell Gap are principally related to large-scale bison hunting. The history of investigations at the site cluster will be briefly reviewed to point out the variable state of information about the localities currently available in existing literature. Then, evidence supporting the classification of the four Hell Gap sites (a.k.a. localities) as camps situated near high-quality sources of tool stone will be presented. Next, the four Paleoindian localities will be discussed and disagreements about the number of cultural levels present will be addressed and resolved. For reasons discussed in Chapter 8, levels at Localities I and II that produced both fluted Folsom points and unfluted points variously referred to as Midland or Goshen points will be referred to simply as the Folsom levels. Evidence supporting the view that the cultural levels at all localities were principally associated with large-scale bison hunting will then be reviewed to the extent possible, given the varying amounts of information currently available for the four sites.

To begin discussion of the Hell Gap site complex, it will be helpful to briefly review the history of investigations. Work at the site primarily occurred during two periods that are here called the early and recent projects. The early project was a joint effort of four main personalities who collaborated during several seasons of fieldwork from 1959 to 1966. Henry Irwin and Cynthia Irwin-Williams were working on doctoral degrees at Harvard University and the former wrote his dissertation on Plains Paleoindian chronology based in large part on his work at Hell Gap. A third collaborator was George Agogino, who held a temporary appointment as a professor at the University of Wyoming at the beginning of the project. Finally, the project geoarchaeologist was C. Vance Haynes who was involved in doctoral studies at the University of Arizona during part of the project. Haynes continued work on the geoarchaeology of the site complex during the recent project, which provided a
certain level of continuity to the study of the cultural stratigraphy of Hell Gap. The findings of the early project were summarized in an oft-cited journal article (Irwin-Williams et al. 1973). No final report on the early project was produced. The recent project began in the 1980s, when George Frison began working through an archaeological conservancy to acquire much of the Hell Gap site complex. He and a number of colleagues at the University of Wyoming later collaborated to amass the collections and records from the early project, analyze them as best as possible, and produce a detailed report that will be the first in a series (Larson et al. 2009). This publication was primarily concerned with describing and providing a basic interpretation of the site complex and with discussing the archaeology of Locality I as well as the Cody component at Locality V. Later publications will presumably be dedicated to the still poorly understood Localities II and III.

The environmental setting of the four Paleoindian sites supports their basic classification as campsites. All four sites (designated Localities I, II, III, and V) are situated along an intermittent stream or one of its tributaries. The positioning of the sites along the stream was evidently influenced by the presence of springs that would have offered a source of drinking water. The pedologist who studied soil development at Hell Gap notes that weak spring activity is present near Localities I, II, and V (Reider 2009:69). He further states that during the Folsom occupation, extensive wet meadows with through-flowing water were present along the stream. The site complex is situated just inside the eastern edge of the hilly, wooded region of the Hartville Uplift. Firewood is readily available in the open woodland environment in which the site cluster occurs.

The campsites of Hell Gap are situated near several sources of tool stone. As part of the early project, John Saul visited tool stone sources near Hell Gap and elsewhere in the Hartville Uplift. A map of the tool stone sources plots a source about one km northwest of the Hell Gap site cluster and several others are within a radius of eight km to the west, northwest, and north. As discussed below, the tool stone sources are likely where Hartville
Uplift chert is available from limestone formations. A final report on the tool stone sources was never published, so the nature of the sources is basically unknown. If they prove to be high-quality sources, this would support the thinking that Hell Gap was considered a special place because it was in an advantageous location for groups intent on communal bison hunting to gear up.

The location of Paleoindian localities at Hell Gap will now be reviewed and the numbers of cultural levels present at each locality will be assessed. The dichotomous terrain of the Hell Gap area, with wooded hills to the west and flat grasslands to the east, is the result of a basically north-south aligned fault that uplifted relatively flat-lying Mississippian and Pennsylvanian limestone formations to the west. In the area of Hell Gap, a north-south Precambrian granite ridge that is lower in elevation than the uplifted limestones lies immediately to the east of the fault. The main intermittent stream at the site complex is unnamed on maps, but for convenience is referred to by the project geoarchaeologist as Hell Gap Creek. The stream flows east off the uplifted limestones to the granite ridge and there bends to the south.

On the northeast side of the bend in the creek is the relatively little-known Locality III which is principally important for early excavations that uncovered Agate Basin and Hell Gap occupations. Folsom channel flakes were recently found on the surface of Locality III, suggesting that a Folsom component may also be present (Kornfeld et al. 2002:86, Figure 29 c, d). Relatively little is published on the Hell Gap and Agate Basin deposits along the creek, but Irwin-Williams et al. (1973:45) note that a cultural deposit containing mixed Agate Basin and Hell Gap materials is present along the creek with the deposit differentiating into a lower Agate Basin level and an overlying Hell Gap level away from the streambed. Some specimens of bison dentition assigned to the Hell Gap component at Locality III were assigned to a specific dental age and are discussed below.
Locality V contains a definite buried Cody level and other Paleoindian components may also be present, but they are not well understood. The Cody deposit is situated on the west side of a tributary that flows south along the fault trace and joins with the main stem of Hell Gap Creek to the south (Haynes 2009a:Figure 3.3). Located about 100 m south-southeast of Locality III, the Cody level was discovered in the 1960s when an east-west backhoe trench was dug across the Hell Gap Creek valley. In 1964 and 1965, the main excavation block at Locality V was dug down to the Cody level. Excavation of the Cody level revealed an archaeological deposit containing bison bone and plentiful artifacts, including 21 Cody points. An Agate Basin point was reportedly recovered from the backhoe trench that uncovered the buried Cody level (Knell 1999:10). It is uncertain if the reported Agate Basin point was retrieved in association with the Cody level. Among the Cody points illustrated from Locality V is a non-Cody point base that shares some attributes with Agate Basin points, but is wider than known specimens of the type (Knell et al. 2009:Figure 11.2 w). As discussed in greater detail in Chapter 8, if the illustrated non-Cody point is the one found in the backhoe trench in the 1960s and said to be an Agate Basin point, the artifact may be better classified as an Angostura point, a type that is coeval with Cody points. If so, Locality V might prove to have an Angostura component. To add to the uncertainty surrounding the cultural components present at Locality V, Kornfeld et al. (2002:4, 6) note that in the 1980s or 1990s, an archaeological crew from Eastern Wyoming College of Torrington recovered a Paleoindian point from a soil profile at Locality V. Presumably a cut was made along a stream bank in order to draw a soil profile, but the exact spatial relationship of the profile to the excavation block that uncovered the Cody level is not reported. A photograph demonstrates that the point collected from the profile definitely is of the Agate Basin type (Kornfeld et al. 2002:Figure 6 i). In conclusion, it may be stated that Locality V contains a definite Cody component, a possible Angostura component, and a possible Agate Basin component.
Located 260 m south of the main excavation block at Locality V is Locality II. It is situated on a narrow strip of land between a cliff formed along the granite ridge to the east and Hell Gap Creek to the west. North of the site is flatter terrain that may have been the area actually inhabited by people. South of the site, the creek bends to the east and cuts through the granite ridge.

An excavation block of substantial size was dug at Locality II during the early project because several stratified Paleoindian levels were present. Much of the information concerning Paleoindian chronology that was gathered during the early project came from Localities I and II because these sites both had several Paleoindian levels present. Renewed excavation and reporting has focused on Locality I, so much of what can now be said about Locality II is necessarily based on a brief discussion provided in the summary article (Irwin-Williams et al. 1974) and on more detailed discussions in the recent report that deal only with specific aspects of the site. In the recent report, there is no chapter devoted to Locality II that provides a general discussion, a map of excavations, or soil profiles. Haynes (2009a) provides a brief discussion of the cultural and natural stratigraphy defined for the site as well as a schematic illustration of the stratification present. Multiple early Paleoindian components were present in stratum E and one Late Paleoindian component was present in overlying stratum F. Seven Paleoindian levels were defined: Level I is in stratum F and Levels II through VII are superposed in Stratum E. As detailed below, geological and other evidence suggest that to some extent, Paleoindian artifacts and bone present in the levels defined at Area II may have been affected by post-depositional alluvial transport. In this regard, it is worth mentioning that the physical setting of Locality II is such that in contemporary times, the area is prone to flooding during periods of unusually high precipitation as seen in the fact that excavations were flooded by Hell Gap Creek in 1964 (Knudson 2009:27). Little mention is made of the Angostura (a.k.a. “Lusk”) level in the
recent report. Finally, a discussion of the bison bone from the Agate Basin component is provided by Byers (2009).

The earliest Paleoindian cultures at Locality II are represented by the three lowest levels (V, VI, and VII). These are thin, dark layers of carbonaceous silt; one is 3 cm thick, another is only 5 mm in thickness, and the thickness of the third is not given (Haynes 2009a:45, Figure 3.8; Knudson 2009:Table 2.2). The lowest level (VII) was so affected by soft sediment deformation that it was actually folded over on itself. Radiocarbon dates obtained on carbonaceous material from within or adjacent to the three lowest levels are in the Folsom time range and slightly later: 10,930 ± 200, 10,690 ± 500, 10,290 ± 500, and 10,090 ± 200 B.P. Hashizume (2009) uses Irwin’s (1968) classification of projectile points from Hell Gap in his discussion of projectile point breakage patterns and provides detailed line drawings of selected projectile points from all localities. According to Hashizume, 10 points from Locality II were classified as Midland points by Irwin. As correctly pointed out by Bradley (2009a:263), however, one of the illustrated “Midland points” is actually a Clovis point. As discussed in Chapter 8, sites like the Cooper site illustrate that alluvial transport and redeposition of cultural material can make multiple cultural levels out of one original deposit. Post depositional disturbance of the lowest levels at Locality II is suggested by the thinness of the three lowest levels and is demonstrated by the folded nature of the lowest level. With this in mind, it is best to consider the three lowest levels as representative of a minimum of two occupations, based on the presence of two kinds of temporally diagnostic points: Clovis and Folsom. The above discussion presents an image of Locality II in Clovis and Folsom times as a sometimes waterlogged area that on other occasions was affected by post-depositional alluvial disturbance from Hell Gap Creek. Some bison bone, including specimens of dentition, from the 1960s faunal collection was assigned by the recent project to the “Midland” component.
The early project produced maps asserting that archaeological features consisting of arrangements of post molds had been found in the “Midland” component in two locations (Knudson 2009:Figure 2.9). Apparently the post molds were indicated by small circular areas of soil of different color from the surrounding matrix. The map of one feature shows a small circular arrangement of post molds that varies in diameter from 1.25 to .9 m. A cross section of a particular post mold on this map (as well on maps of other purported arrangements of post molds from Hell Gap) is meant to demonstrate that sediment of differing color marking the post molds is about 3 inches in diameter and limited in depth (less than one inch) and thus the post molds are genuine and not natural phenomena such as rodent burrows. The map of the other feature in the “Midland” component suggests it may have originally been a circular arrangement of post molds and that about half were destroyed by erosion. The remaining portion is shown as a semi-circular arrangement of post molds measuring about 4.5 m in maximum dimension.

The claim that intact post molds of structures made of a framework of wooden poles are present at Locality II suggests that undisturbed sediment is present and this is at odds with the evidence suggesting that Folsom aged sediment and the cultural material it contains may have been redeposited by running water. The question of whether the features observed and mapped by the early project were genuinely the remains of structures may be difficult to resolve. On one side of the issue, there is arguably evidence for disturbance of the sediment. However, on the other side of the controversy, no original excavation documentation has been presented to support the claim that what were observed by members of the early project were in fact post molds. Taking photographs of post molds in cross section is part of standard archaeological field documentation. If no photodocumentation or other objective supporting evidence for the claim of structures can be produced, I would strongly suggest that the claims be considered to be of questionable validity.
Higher in the stratigraphic column of Locality II is an Agate Basin component. In some parts of Locality II, there is but one level that contains Agate Basin points, but in the center of the excavation block, this level separates into two that are numbered III and IV (Irwin-Williams et al 1973:45). The divergence into two levels is highly suggestive that artifacts and bone of the Agate Basin component in Locality II have been affected by alluvial transport and redeposition. Apparently the changing number of cultural strata across the excavation block was observed when collecting the relatively abundant bison bone from the Agate Basin component because some bison bone analyzed by the recent project is said to have come from the upper Agate Basin level, some from the lower Agate Basin level, and some is classified as coming from the Agate Basin component in general. Analysis of bones present in the Agate Basin assemblage by Byers (2009) suggests that bone elements known to be more susceptible to alluvial transport are underrepresented. The presence of red ochre was noted in the Agate Basin component (Knudson 2009:28). This, in combination with the abundance of bison bone in the Agate Basin component is cause to suspect that the bison may have been procured through communal hunting. Considering the evidence for post-depositional disturbance of both Folsom and Agate Basin components, the possibility that the relatively small amount of bison bone in the Folsom component derives from the Agate Basin level and was mixed in with Folsom artifacts must be acknowledged.

As with the Folsom component, the presence of archaeological features composed of post molds is noted for the Agate Basin levels. The map provided suggests that two arrangements of postmolds are present in the same area. One is circular and varies from 1.9 to 2.2 meters in diameter. The other occupied the same basic location as the first, is shown as a semi-circular arrangement of post molds, and is of similar size to the first. Together, the two features are suggestive of two structures made with wooden poles that were set up at the same location on different occasions. However, as with the claims for wooden structures in the “Midland” component, the presence of intact features in the Agate Basin component is
not supported by objective evidence such as photographs showing the purported postmolds in cross section. Claims for the presence of intact features in the Agate Basin component are contrary to evidence that the Agate Basin aged sediment and the cultural material it contains was redeposited by running water. Since there is evidence to support the claim for redeposition and no objective excavation documentation to support the thinking that structures were present, I again recommend that others be skeptical of the claim that structures were present on the site in Agate Basin times.

Still higher in the stratigraphic section was Level II. Irwin-Williams et al. (1973:45) assign the level to the Hell Gap culture. Hashizume (2009:Figure 18.1) illustrates two Hell Gap points from the level. However, Haynes (2009a:45) refers to the level as a Hell Gap/Alberta level. The term “Alberta” is here considered to be a variety of Cody point and if indeed Hell Gap and Cody points were both recovered from the level, some mixing of cultural components would be indicated. A radiocarbon date of 10,240 ± 300 B.P. was obtained on carbonaceous residue from the level (Haynes 2009a:45). This date is much younger that accepted dates for either Alberta or Hell Gap points and again is suggestive of the possibility that cultural material of varying ages were mixed together and redeposited in Level II. A small amount of bison bone was recovered from Level II relative to the Agate Basin component and includes some specimens of dentition. Considering the evidence of mixing of cultural material of different ages in Level II, the possibility that the bison bone was redeposited from the earlier Agate Basin component must be acknowledged.

The uppermost Paleoindian manifestation at Locality II is the Angostura component of Level I, which is within stratum F. Large filled-in stream channels are illustrated in Haynes’ (2009a:Figure 3.8) schematic soil profile at the contact of strata E and F. One channel is labeled as having contained a redeposited Agate Basin point. The evidence for cutting and filling of channels is further evidence that alluvial processes have disturbed Paleoindian deposits in Locality II. Level I is in that portion of stratum F above the filled-in
channels. Four Angostura (a.k.a. Lusk) points and one Cody point remain in the artifact collection from Locality II, although the level from which they derive is not specified (Bradley 2009b). Hashizume (2009:Figure 18.1) illustrates a Cody point from Locality II, but some confusion exists about the provenience of the specimen because the same point is illustrated by Knell et al. (2009:Figure 11.12, s) as having come from Locality V.

Locality I is located in a small canyon cut by Hell Gap Creek through the granite ridge. The locality is located 310 m downstream of Locality II and is situated where the stream makes a bend to the north. Locality I itself is a stratified series of what appear to be midden deposits along the north side of the creek. A broad, flat area north of the bend in the creek may have served as the likely camping area. This suggestion is nicely illustrated by an aerial photograph taken during the time of the early project that shows the excavation block down by the creek and the white tents of the archaeologists set up in the flat area north of the bend in the creek (Haynes 2009a:Figure 3.4). Maps showing the distribution of bone and artifacts comprising the various cultural levels show that the density of cultural material varies across the midden (Byrnes 2009:Figure 14.2; Irwin 2009:Figures D.1 – D.6). Concentrations of cultural material evident on some of the maps is reminiscent of those noted by Wheat at the Jurgens site and suggest to me that dumping of trash may be represented. The summary article (Irwin-Williams et al. 1973) leaves the reader with the impression that the Paleoindian cultural levels at Locality I are stratified with little to no vertical distance between them. The early project determined that the sequence of Paleoindian levels, from early to late, is as follows: Folsom (includes both fluted and unfluted points), Agate Basin, Hell Gap, Alberta, Cody, and finally, two Frederick levels occur at the top of the Paleoindian deposits. This cultural sequence will be taken to be correct, unless justifiable evidence to the contrary is presented in available literature.

Such evidence is presented by Kornfeld (1999) who illustrates a Clovis preform found in excavation unit V-5 at a depth of 9 ft, 11 in below datum. A map of the lowest
cultural level, identified as Goshen by Irwin (2009:Figure D.6), is labeled as being at 8 ft (presumably below datum). The position of excavation unit V-5 is shown on the above map by Irwin. Most of the excavation done in Locality I stopped in or above the Folsom level when the early project ended in 1966. Considering that the Clovis preform was evidently found about two feet lower in elevation below datum than cultural material mapped as Folsom or “Goshen,” it can be stated that a Clovis cultural level of unknown extent also exists at Locality I.

A famous photograph of the proposed Paleoindian levels in Locality I taken at the end of the 1966 field season allows the depth and nature of the cultural deposits to be inferred (Kornfeld and Larson 2009:Figure 1.6). The photograph is of a wall of an unexcavated portion of Locality I known as the Witness Block and shows the natural stratification and cultural levels, which are labeled. Evident in the photograph is the fact that the levels are indeed either stacked right on top of one another or separated by only small vertical distances. The precise top and bottom of each level is marked with a nail. The early project excavated the site according to the English system of measurement. Unfortunately, no scale in feet or inches was placed in the area photographed. Nevertheless, a pointing trowel that appears to have a standard 6” blade and a slightly worn tip provides scale in the photograph. A Marshalltown trowel with an unworn 6” blade measures 28 cm in length. By comparison, the worn pointing trowel in the photograph is estimated to have been 27 cm long. Based on the assumption that the trowel in the photograph is 27 cm long, a scale for the photograph can be made using an engineer scale. From this operation, the combined Paleoindian levels are estimated to measure 1.4 m in thickness.

Evidence from both the early and recent projects can now be reviewed to assess the number and cultural affiliation of Paleoindian levels present at Locality I and to assess whether the encampments represent occupation of small groups involved in generalized foraging or potentially larger groups engaged in large-scale bison hunting. To consider if
occupations at Hell Gap are related to bison hunting, the relative amount of bison bone in the faunal assemblage will be noted for each level, when this is possible. Finally, the presence of red ochre in certain levels will be noted on the grounds that this substance may often have been associated the activities of groups engaged in large-scale bison hunting.

Evidence exists to suggest the cultural material in the Folsom level at Locality I may be related to large-scale bison hunting, even though few bison are represented in the collection. Bones of a minimum of four bison are present (Rapson and Niven 2009a:Tables 9.1, 9.3). The amounts of bone of various kinds of animals from levels in Locality I was quantified by counting the number of specimens attributable to each kind. Some bone fragments were identifiable to species, including bison, deer, antelope, elk, and a number of smaller animals. Bone fragments not identifiable to species were classified into two body size classes; one that includes bison and elk (class 4) and another that includes deer and antelope (class 3). Elk was identified only in the Hell Gap level. The dominance of bison in the faunal collection from the Folsom level is demonstrated by the fact that 90 percent of the collection is composed of bone from bison or a similar sized animal (Rapson and Niven 2009a:Table 9.1, 2009b:Table I.14). The possibility that the bison were procured during the large-scale bison hunting season is supported by the fact that limited excavations in the Folsom level during the recent project recovered two spheres of red ochre, one of which was found on a granite slab (Kornfeld et al. 2002:55, Figure 23). Specimens of bison teeth assigned to dental ages are among the bones recovered, therefore the supposition that the Folsom level was produced during the large-scale bison hunting season may be tested.

The Agate Basin level in Locality I may also be related to large-scale bison hunting even though the remains of few bison are present. A minimum of three bison are represented in the faunal collection (Rapson and Niven 2009a:Tables 9.1, 9.3). Bone classifiable as bison or a similar sized animal comprise 94 percent of the faunal collection from the level (Rapson and Niven 2009b:Table I.15). The possibility that the animals were killed during the large-
scale bison hunting season is supported by the observation that red ochre stains are shown on soil profiles drawn of the north and east walls of Locality I within in the natural stratum (E2) in which the Agate Basin level occurs (Haynes 2009b:Figure G.2). Specimens of bison teeth assigned to dental ages are among the bison faunal material recovered from the level, so the above possibility can be tested.

Faunal material recovered from the overlying Hell Gap level indicates that bison hunting was a relatively important subsistence activity carried out by the occupants of Locality I during this time period, although only a small number of bison are present. Bones of a minimum of three bison are present in the faunal collection (Rapson and Niven 2009a:Tables 9.1, 9.3). Of the total faunal assemblage recovered from the Hell Gap level, 90 percent is composed of specimens identified as bison or similar sized animal (Rapson and Niven 2009a:Table 9.1, 2009b:Table I.16). This figure may be somewhat inflated because some elk bone fragments are included in the number of bone fragments of size class 4. No specimens of bison dentition are reported from the Hell Gap level, so the possibility that the bison were killed during the large-scale bison hunting season can not be tested.

The relative amount that bison contributed to the diet of site occupants during the episodes of site occupation represented by overlying cultural levels can not be differentiated because faunal collections from levels were combined and analyzed as a unit. The bone analyzed was from levels indentified as Alberta, Eden-Scottsbluff, Frederick, Archaic, and Late Prehistoric. The combined faunal collection includes bone from a minimum of two bison, as well as a minimum of one deer and one antelope (Rapson and Niven 2009a:Tables 9.1, 9.3). Of the total faunal collection from the combined levels, 67 percent of specimens are classified as bison or similar sized animal and 25 percent is classed as deer, antelope, or similar-sized animal (Rapson and Niven 2009a:Table 9.1, 2009b:Table I.17). These data indicate that bison continued to be an important element of the diet for site occupants during the multiple episodes of site occupation that occurred intermittently throughout the broad
time period represented by the combined faunal collections. One specimen of bison dentition said to probably be from the lower Frederick level identified by the early project is present and was assigned a dental age, so the possibility the a site occupation during Frederick times took place during the large-scale bison hunting season of terminal Paleoindians times can be tested.

According to the culture history proposed by directors of the early project, above the Hell Gap level in Locality I is an Alberta level which is directly overlain by a Cody level, but evidence indicates the Alberta and Cody levels are one and the same. The members of the early project used the term Cody level to refer to a cultural stratum that they believed contained two kinds of square-base points: Eden and Scottsbluff. They further thought that an underlying level produced specimens of another kind of square-base point, known as Alberta, which they believed to pre-date Eden and Scottsbluff points. As part of the recent project, Knell (2009:180) plotted the vertical provenience information for artifacts attributed to the Alberta and Cody occupations by the early project and found that, “occasionally the boundary between the cultural components crosscut major artifact concentrations.” Because the two cultural levels proposed by the early project are not physically separated, I take this to be evidence that there is but one cultural level that included all three kinds of square-based points. Further evidence that the two levels proposed by the early project are one and the same is seen in the fact that the horizontal distribution of artifacts assigned to the Alberta level corresponds to the distribution of artifacts in the Eden-Scottsbluff level (Larson 2009:Figures 15.10 -15.11). As suggested earlier, the different kinds of square-base points are best considered as varieties of Cody points. Therefore, the Alberta and Cody levels of the early project are considered to be one and same and will be herein referred to simply as the Cody level.

Though relatively little supporting evidence is available for the Cody level, the extent to which occupants of the site may have been involved in bison hunting may be suggested
and evidence offered to support the claim that bison were killed within the social context of a human group intent on communal hunting. Because the faunal analysts combined faunal material from the level with that from overlying levels, it is not possible to assess how much of the faunal collection is composed of bison remains. It is relevant to note, however, that a total of 12 Cody points were recovered from the level in Locality I (Hashizume 2009:Table 18.1). Based on the map of the excavation block (Kornfeld and Larson 2009:Figure 1.5), it is estimated that 200 yd² were excavated in Locality I. This equates to 167 m² which in turn may be conceptualized as an area measuring 12.9 m by 12.9 m. For comparison, it may be noted that throughout a time period lasting two millennia, numerous occupations of the Allen site by small groups resulted in the discard of a total of nine points of various types in an area measuring 10.9 m by 10.9 m. The discard of 12 Cody points at Locality I during what may have been a single occupation of the site therefore argues that the hunting of big game was an important part of the subsistence activities that took place in the vicinity of the site. Evidence that the hunting may have occurred during a time when Cody people were aggregated for large-scale bison hunting is seen in the fact that points from Locality I are well made (Knell 2009:Figures 12.4, 12.9). Bamforth (1991b) has argued that points from bonebeds associated with large-scale bison hunting are better made than points from other kinds of sites because skilled flint knappers produced points for all hunters participating in a communal hunt. With one exception (Knell 2009:Figure 12.9 e), the 11 Cody points illustrated from Locality I are highly symmetrical and most exhibit patterned flaking (Knell 2009:Figures 12.4, 12.9). These attributes support the thinking that the points were produced by flintknappers of above average skill. A final observation that would support the possibility that the Cody level may be the product of an occupation by a group of people involved in large-scale bison hunting is the fact that one of the well made Cody points has red ochre adhering to one face (Muniz 2005:Appendix B, image hg loc 1 – ES-378 face 2).
Above the Cody level in Locality I is the Frederick component which also may be tentatively suggested as representing occupation by Paleoindians who were camped at Hell Gap during the large-scale bison hunting season. The early project determined that two Frederick levels were present (Irwin-Williams et al. 1973:45), but it is important to note that no evidence, such as a graph showing artifact frequency with depth in a particular excavation unit, is presented to document this claim. Some evidence is available relating to the question of how much bison hunting was occurring during the time that the site was occupied. As with the Cody component, it is not possible to state the relative amount of bison bone in the Frederick component because the faunal collection was combined with bone from overlying and underlying levels. However, the combined sample did suggest that a majority of meat supplied to the camp during Cody through Late Prehistoric times came from bison, although the small sample size (a minimum of two bison, one deer, and one antelope) obviously poses serious restrictions on making statements about diet that are specific to just one of the four components that were combined. Better evidence that hunting of big game comprised a good amount of the food consumed by site occupants comes from the observation that 10 Frederick points were discarded at Locality I (Hashizume 2009:Table 18.1). As with the comparable number of Cody points from the underlying level, the 10 points of the Frederick type that were deposited during two occupations [according to Irwin-Williams et al.(1973)] would suggest that big game hunting was an important subsistence activity when compared with the nine points discarded within a somewhat smaller area of midden deposit by numerous Paleoindian occupations that occurred over the course of two millennia at the Allen site. Two Frederick points illustrated in sufficient detail display attributes suggesting that they were made by flintknappers of at least above average skill. One illustrated Frederick artifact is a nearly completed preform that is unusually thin (Knudson 2009:Figure 2.8 a) and the other is the basal fragment of a point (Knudson 2009:Figure 2.9 b). Both artifacts exhibit well controlled collateral flaking. This provides some support for the thinking that the Frederick
component may have been produced by an aggregated group intent on large-scale bison hunting, but of course the illustrated points do not necessarily share the same level of flintknapping skill as the eight points not illustrated in sufficient detail.

Having reviewed the sequence of Paleoindian levels in Locality I defined by the early project and modified it accordingly based on available evidence, a controversy surrounding the number of occupations attributable to the early Paleoindian cultural deposits that developed during the recent project must be addressed and resolved. Sellet (2001) argues for multiple occupations of Locality I by Folsom, “Goshen,” and Agate Basin peoples. In an effort to illuminate the number and vertical positioning of cultural levels containing Folsom, “Goshen,” and Agate Basin points at Locality I, Sellet plotted the depth measurements to artifacts excavated from a 10-yard-long segment of one-yard-square excavation units in row P of the excavation block. He found that within an 18-inch vertical distance were five peaks in artifact frequency that contained varying numbers of Folsom, “Goshen,” and Agate Basin points (Sellet 2001:Figure 4). Based on the kinds of points found in the peaks of artifact density, Sellet argues that Locality I was the scene of a sequence of occupations by early Paleoindian groups that used various contemporaneous point types. From bottom to top, the sequence of occupations and the cultural affiliation of the episodes of site use proposed by Sellet are as follows: Folsom-Goshen, Agate Basin-Folsom, unknown, Folsom, and Goshen.

If natural and cultural strata existing across the 10-yard segment of row P are perfectly horizontal, then Sellet’s reconstruction would be justified. However, soil profiles drawn along the north and west walls of the 10-yard segment of row P demonstrate that strata dip to the southeast (Haynes 2009b:Figure G.2; Kornfeld and Larson 2009:Figures 1.5, 1.7). Because of the sloping nature of the cultural strata and the variable horizontal density of artifacts in the midden deposit, simply graphing the depths of artifacts found in a 10-yard segment of row P will produce a series of peaks in artifact frequency. However, these peaks do not represent a series of site occupations. They are the result of high-density clusters of
artifacts that were produced when artifacts were dumped on sloping ground surfaces used for trash disposal during Folsom and Agate Basin times. As mentioned above, the famous photograph of the Paleoindian strata exposed in a wall of the excavation block demonstrates that the cultural strata are essentially stacked right on top of one another, with little vertical distance separating them. Because of the stacked positioning of the Paleoindian deposits and the sloping nature of the ground surface during both Folsom and Agate Basin times, plotting the depths of diagnostic fluted and unfluted Folsom points along with the depths of Agate Basin points and all other Folsom and Agate Basin artifacts recovered from the 10-yard segment of row P could very well produce a series of peaks in which diagnostic Agate Basin points from the overlying cultural stratum occur in a peak of artifact frequency positioned in between other peaks containing fluted and unfluted Folsom points from the underlying cultural stratum, as was observed by Sellet. In light of the above facts regarding the characteristics of the cultural and natural strata in Locality I, Sellet’s suggested sequence of early Paleoindian occupations should be disregarded by future researchers investigating Locality I. Rather, the most parsimonious explanation of the facts related to the Locality I cultural is that the site has one Folsom level and one Agate Basin level.

Though Sellet’s sequence of site occupations suffers in part from his use of vertical provenience information over an area fully 10 yards in length, the basic method of graphing artifact density with depth is a sound way to define site occupations and its application during the recent project resulted in evidence that verifies the culture chronology proposed by the early project with one modification. During the recent project, a stratigraphic column along the north wall of the Locality I excavation block sampled for small faunal remains also produced small flakes or “microflakes.” The frequency of microflakes at various depths below datum was plotted. Peaks in artifact density occur throughout a vertical distance of 1.4 m (Kornfeld et al. 2002:47, Figure 18 a). This is the same vertical distance within which the Paleoindian levels in Locality I are known to occur, based on the 1966 photograph. Thus, the
peaks in artifact density can safely be said to represent the Paleoindian occupations. Six peaks are present on the graph and, from bottom to top, represent the Folsom, Agate Basin, Hell Gap, Cody, and Frederick occupations. The fact that only one peak is present at the top of the Paleoindian deposits is here taken as evidence that only one Frederick occupation, not two, occurred at Locality I. The six levels are hypothesized to represent trash discarded during occupations of the site related to large-scale bison hunting. This hypothesis will be tested with data on the time of year during which the bison represented in the occupation levels at Locality I and elsewhere at Hell Gap were killed. First, however, a stronger case will be made that Paleoindian occupations at Hell Gap may have been related to large-scale bison hunting based on a consideration of the faunal and artifactual material recovered from the Cody level at Locality V.

Cultural remains present in the excavated portion of the Cody level exposed in the main excavation block at Locality V include a deposit of bison bone and artifacts. The density of bone and artifacts is substantial and varies horizontally (Knell et al. 2009:Figure 11.17). These characteristics are highly suggestive of a trash deposit.

Unlike the bonebeds in Colorado discussed above that are situated far from a source area, the bison bone deposit at Locality V is not a dense concentration of bones. As previously explained, the lack of a dense bonebed may reflect a different level of bison hunting, with the dense bonebeds principally indicative of killing of an entire herd of bison and the less dense bonebeds at source areas representative of smaller scale hunting of bison in order to supply meat to an aggregated group camped out at a source area to gear up for a large-scale kill.

The amount of bison represented in the Locality V midden supports the thinking that use of the site and the surrounding area was somehow related to large-scale bison hunting because one might suggest that more bison are represented that would be expected if the cultural level resulted from occupation by a small group that killed some bison as part of
generalized foraging activity. At the Allen site, two millennia of Paleoindian period is represented by a meter-thick midden cultural deposit uncovered in an excavation block of a size that is equivalent to an area measuring 10.9 m by 10.9 m and during this time, the remains of 17 bison were discarded (Bamforth 2007:116; Hudson 2007:Table 12.4. At Locality V, 46.8 m² were excavated (Knell 1999:12) which is equivalent to an area measuring 6.8 m by 6.8 m. In this area, which is smaller than that excavated at the Allen site, the remains of a minimum of seven bison were discarded (Knell 1999: 19) during what may very well have been a single occupation.

The level of bison hunting indicated by the remains in the Locality V midden is more consistent with the suggestion that a number of bison were killed by a group of people that were somehow involved in communal hunting. As mentioned, if Paleoindians had killed an entire herd of bison nearby, a dense bonebed containing the remains of more than seven animals would be expected. Presence of a number of bison that is intermediate in size between what might be expected for occupation by a small group and what would be expected if an entire herd was killed in a surround is perhaps more in keeping with the idea that hunters from a group camped near the Locality V midden to gear up for communal hunting killed a number of bison to provision the camp with meat. Alternatively, a group that had made a successful communal kill somewhere afield and processed the carcasses at a temporary hunting camp may have returned to camp at Hell Gap, bringing with them mostly meat stripped from bone, but also some carcass segments.

The fact that the bison were killed during the usual large-scale bison hunting season for Cody times on the Central Plains also supports the interpretation that the bison were slaughtered to supply meat to an aggregated group intent on large-scale bison hunting. Dental ages were assigned to specimens of bison teeth from the Cody level at Locality V (Rapson and Niven 2009b:Tables I.28 – I.29). Graphing the range of dental ages assigned to each specimen of dentition that could be assigned to a specific portion of the year allows one
to visually display the time of year during which the bison were killed. For some dental specimens, the faunal analysts could assign the specimen to an age group, but not a particular time of year. For example, a dental specimen from a bison that is known from stage of tooth eruption to be a two-year old animal, but because of the condition of the teeth, could not be determined to have died at a certain time of year based on tooth wear, was assigned a dental age of 2.0 - 2.9 yr in the above cited tables. Dental specimens for which the time of year could not be determined were excluded from the following histograms that graph the range of dental ages assigned to bison dentition from the cultural levels at Hell Gap. Also, for two specimens of mandibular dentitions from Locality V, the data presented by Rapson and Niven (2009b:Table I.28) suggest that the specimens are from a provenience below the Cody level. However, the reports on the Cody level by Knell (1999) and Knell et al. (2009) indicate bison bone from the main excavation block only came from the Cody level, so these two specimens of dentition were included in a graph of the dental ages assigned to a total of eight specimens of bison dentition from Locality V. The resulting histogram approximates a normal curve with the mean of the distribution between $N + .3$ yr and $N + .4$ yr. These dental ages suggest that the bison were killed around August (Figure 12-1). This time occurs within the large-scale bison hunting season on the Central Plains during the Cody period (Figure 8-4).

As explained in Chapter 8, the mean of the normal distribution approximated by the histogram in Figure 12-1 denotes the time of year that the bison were killed in a single event, or a series of closely spaced events, even though the spread of the histogram covers most of the year. The methods use to determine the dental ages of specimens of bison dentition introduce a substantial amount of imprecision into the estimates. Nevertheless, graphing all specimens of dentition from a sample of adequate size will produce a histogram that approximates a normal distribution with the mean positioned at the time of year when the bison were killed.
Number of Bison Teeth Assigned to Dental Age

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<td></td>
<td>mid-to-late Spring</td>
<td>Summer</td>
<td>Fall</td>
<td>Winter</td>
<td>early Spring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 12-1. Histogram of dental ages assigned to mandibular and maxillary bison teeth from the Cody component at Locality V of the Hell Gap site cluster. Data from Rapson and Niven (2009b:Tables I.22, I.26, I.28 – I.29). Number of specimens of bison dentition plotted on graph: eight. Minimum number of bison from component: seven. These data approximate a normal curve and suggest that the bison were killed around August. This time of year falls within the large-scale bison hunting season on the Central Plains during Cody and Dalton times as determined by analysis of dental ages of bison teeth reported from sites with dense bonebeds. Compare with Figure 8-4.
The supposition that an aggregated group of Cody people camped near Locality V were gearing up for large-scale bison hunting is supported by the kinds of artifacts present in the assemblage. Table 12-8 presents data on the relative frequency of artifact classes and tool stone types present in the Cody assemblage from Locality V. The table indicates how the terms used to describe artifact classes relate to those used by Knell et al. (2009:Table 11.1). An appreciation of the amount of gearing up for large-scale hunting that might be represented in the assemblage may be gained by calculating prevalence of cores in the assemblage, based on the understanding that such artifacts may represent production of informal flake tools and end scrapers needed to process bison meat and hides. Furthermore, an appreciation of the relative frequency of unfinished bifaces and Cody point preforms in the assemblage should provide a rough measure of the amount of bifacial artifact production that took place to prepare needed hunting weaponry and bifacial knives. To produce such estimates it would be best to compare the prevalence of the above artifact classes among the total number of worked pieces. From the total number of artifacts in Table 12-8 may be subtracted the number of flakes, utilized flakes, and hammerstones to arrive at the total number of worked pieces (n = 215). The supposition that gearing up is represented in the Locality V artifact assemblage is supported by the observation that 24 (or 11 percent) of the worked pieces are classified as cores. Unfinished bifaces discarded in the midden are also common, with the 35 specimens recovered accounting for 16 percent of the worked pieces. A total of 19 Cody point preforms from the assemblage account for nine percent of the worked pieces and suggest that much of the bifacial reduction on-site was directed toward the production of hunting weaponry. Finally, three hammerstones in the collection may relate to stone tool production.

Other artifacts in the collection are arguably non-functional or unwanted finished tools and projectile points discarded after they were used to kill the bison and process their hides. A total of 21 Cody points in the assemblage account for 10 percent of the worked
Table 12-8. Tool Stone and Artifact Composition of Worked Pieces and Flakes over 1.5 cm in Maximum Dimension from the Cody Component at Locality V of the Hell Gap Site Complex.a

<table>
<thead>
<tr>
<th>Tool Stone Type</th>
<th>Manufacturing Debris</th>
<th>Flaked Stone Tools</th>
<th>Hammers/Scrapers</th>
<th>Total Number of Artifacts</th>
<th>Distance to Tool Stone Source Used in Analysis (km)</th>
<th>Relative Distance to Tool Stone Source</th>
<th>Percent of Collection Composed of Tool Stone Type, According to Artifact Count</th>
<th>Percent of Collection Composed of Local Versus Nonlocal Stone, According to Artifact Count</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flakes (Debitage)</td>
<td>Blocky Core</td>
<td>&quot;Bifacial Core&quot;</td>
<td>Unfinished Bifaces</td>
<td>Flaked Stone Tools</td>
<td>End Scrapes</td>
<td>Finished Bifaces (Bifacial Tools)</td>
<td>Cody Points</td>
</tr>
<tr>
<td>Hartville Uplift Chert</td>
<td>2,855</td>
<td>13</td>
<td>5</td>
<td>2</td>
<td>26</td>
<td>12</td>
<td>58</td>
<td>59</td>
</tr>
<tr>
<td>Spanish Diggings Orthoquartzite</td>
<td>165</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Arikarree Chert</td>
<td>907</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>7</td>
<td>4</td>
<td>15</td>
<td>24</td>
</tr>
<tr>
<td>Local Stream Cobbles</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Unidentified Tool Stones (Includes Two Artifacts of Petrified Wood)</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Table Mountain Chert</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Tongue River Silicified Sediment</td>
<td>47</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>3,985</td>
<td>17</td>
<td>7</td>
<td>2</td>
<td>35</td>
<td>19</td>
<td>81</td>
<td>88</td>
</tr>
<tr>
<td>Percent of Collection</td>
<td>93.0</td>
<td>.4</td>
<td>.2</td>
<td>.0</td>
<td>.8</td>
<td>.4</td>
<td>1.9</td>
<td>2.0</td>
</tr>
</tbody>
</table>

aData from Knell et al. (2009:168, Table 11.1). Table excludes one non-Cody point. The type of tool stone used to manufacture this point is not specified (Knell et al. 2009:167-168).
End scrapers number 19, accounting for nine percent of worked pieces. Muniz (2009) conducted a use wear study of tools from the Cody occupations at Localities I and V. He found that the majority of tools with use wear indicative of contact with certain substances in assemblages from both sites were used in butchery and hide working activities that involved tool contact with meat, fresh hide, and bone. The similarity in the kinds of use wear present at both sites adds support to the supposition that the Cody occupation present at Locality I may also relate to bison hunting. Of the 19 end scrapers from Locality V, only one displayed use wear indicative of use on hide. According to Muniz, however, this low percentage is not unusual in comparison to samples of end scrapers in other Cody assemblages from sites with bonebeds and so this is not necessarily at variance with the claim that hides of bison killed to supply the group with meat were processed on-site.

Having developed the argument that the cultural level at Locality V is related to occupation of the Hell Gap area by Cody people to gear up for large-scale bison hunting, the hypothesis that Hell Gap was a special place that attracted repeated occupation by Paleoindians of all time periods who were intent of gearing up for bison hunting may now be tested by determining if the occupations occurred during the large-scale bison hunting season. The reader will recall that the large-scale bison hunting season on the Plains varied between northerly and southerly latitudes. At all times in the Paleoindian period, the methods of meat preservation practiced by Paleoindians theoretically varied with latitude such that people in more northerly latitudes were able to take advantage of sufficiently cold temperatures at the height of the cold-season to preserve meat, but the warmer temperatures in more southerly regions would have necessitated that people living there had to go through the effort of making jerky prior to the coldest time of year if they intended to preserve some of the meat for the ensuing lean time of year. The reader will also recall that the Hell Gap site complex is situated near the transition between the Central Plains and the more northerly sections referred to as the Northwestern Plains (basically the plains of Montana and parts of
Wyoming) and the Northern Plains (essentially North Dakota, South Dakota, and the northwest corner of Nebraska). Furthermore, the timing of large-scale bison hunting on the Plains varied between Early and Late Paleoindian periods. With the warming of the climate throughout the Paleoindian period, the imaginary line north of which preservation of meat via cold-storage was possible would have moved to the north. Simply put, paleoenvironmental data on the post-Clovis early Paleoindian climate of the Plains indicates that people living on the Southern Plains would have experienced temperatures comparable to those of today, while populations on the Central, Northern, and Northwestern Plains would have lived under colder climatic regimes. Sometime within the Cody period of Late Paleoindian times, climatic conditions throughout the Plains had warmed to the point that they were roughly comparable to those of today.

The model of the seasonal timing of large-scale bison hunting indicates that specimens of bison dentition from Cody and later occupations of the Hell Gap site complex represent animals killed during the large-scale bison hunting season. One specimen of dentition from a calf said to have come from a probable Frederick context in Locality I was assigned a dental age of .3 to .5 yr (Rapson and Niven 2009b:Table I.28). If the middle dental age in this range (.4 yr) is taken as the time of year that the calf was killed, then the animal would have died around August or September (Figure 8-2). Under the modern-like climatic conditions of terminal Paleoindian times, it is expected that temperatures at the latitude of Hell Gap during the height of the cold season were insufficiently cold to permit short-term shortage of meat, so large-scale bison hunting would have been conducted earlier in the year when meat could be preserved by drying. The model contends that earlier in the Late Paleoindian period during Cody times, large-scale bison hunts on the Central Plains were held from early June through late October (Figure 8-4). This is a time of year when preservation of meat by drying is necessary. On the Northern and Northwestern Plains during Cody times, the timing of large bison hunts suggests that both cold-weather short-term
storage of meat and preservation through drying were practiced in those latitudes. At the Hudson-Meng site in northwest Nebraska, bison were killed around October (Figure 8-3). At this time of year, drying is necessary to preserve meat. Further north at the Carter/Kerr-McGee site in northeastern Wyoming, bison were killed around early December (Figure 8-3). At this time of year, preservation of meat through cold-storage may have been possible. As discussed above, bison represented in the Cody level at Locality V were killed around August (Figure 12-1). This conforms to the model because Cody people living at the latitude of Hell Gap would be expected to have held large-scale bison hunts prior to the height of the cold season so that meat obtained could be preserved through drying.

Data on the seasonal timing of most of the earlier Paleoindian occupations at Hell Gap are also in conformance with the model. The bison killed during the Hell Gap occupation at Locality III were killed around December (Figure 12-2). Bison represented by bones recovered from the Agate Basin occupation level at Locality I were killed around November (Figure 12-3). The months of November and December fall within the usual time of year during which the large-scale bison hunting season occurred on both the Central and Northwestern Plains during Hell Gap and Agate Basin times (i.e. from around early November to mid-February) (Figures 8-5 and 8-6). Bison from the Folsom occupation of Locality I were killed around December (Figure 12-4). Under the model, Folsom large-scale kills on the Central, Northern, and Northwest Plains are expected to have usually occurred during the height of the cold-season. This expectation is based solely on theoretical expectations of the model because prior to considering evidence from Hell Gap, no data was available from the Central Plains. Furthermore, the single datum from the Northwest Plains did not provide resounding support for model because the Folsom occupation of the Agate Basin site complex in northeast Wyoming took place in the later half of winter (Figure 8-8). Also, the datum for the Folsom period on the Northern Plains does not conform to the model because the Folsom occupation of the Mill Iron site took place around May (Figure 8-8).
Figure 12-2. Histogram of dental ages assigned to mandibular bison teeth from the Hell Gap component at Locality III of the Hell Gap site cluster. Data from Rapson and Niven (2009b:Tables I.21, I.28). Number of specimens of bison dentition plotted on graph: two. Minimum number of bison from component: five, based on the number of bison in annual age groups (Rapson and Niven 2009b:Table I.28). These data suggest the bison were killed around December. This time of year falls within the large-scale bison hunting season on the Central Plains during Agate Basin and Hell Gap times as determined by analysis of dental ages of bison teeth reported from sites with dense bonebeds. Compare with Figure 8-6.
Figure 12-3. Histogram of dental ages assigned to mandibular bison teeth from the Agate Basin component at Locality I of the Hell Gap site cluster. Data from Rapson and Niven (2009b:Tables I.28 – I.29). Number of specimens of bison dentition plotted on graph: four. Minimum number of bison from level: three (Rapson and Niven 2009a:Table 9.3). These data suggest the bison were killed around November. This month falls within the large-scale bison hunting season on the Central Plains during Agate Basin and Hell Gap times as determined by analysis of dental ages of bison teeth reported from sites with dense bonebeds. Compare with Figure 8-6.
Figure 12-4. Histogram of dental ages assigned to mandibular and maxillary bison teeth from the “Goshen”-Folsom component at Locality I of the Hell Gap site cluster. Data from Rapson and Niven (2009b:Tables I. 28 – I.29). Number of specimens of bison dentition plotted on graph: four. Minimum number of bison from level: four. These data suggest the bison were killed around December. Comparative data from dense bison bonebeds on the Central Plains is lacking but the model developed in Chapter 8 predicts that December would have been within the time of year when large-scale bison hunting usually took place on the Central Plains during Folsom times (i.e. during the coldest part of the year from mid-fall to mid-winter).
With these problems in mind, it is reassuring to note that data on the time of year during which bison were killed during the Folsom occupation of Locality I at Hell Gap provides much needed support for the model.

Data on the time of year during which bison were killed during the Agate Basin occupation represented in Locality II does not conform to the model. The usual time of year for large-scale bison hunts on both the Central and Northwestern Plains during Agate Basin times would have been during the height of the cold season, based on data indicating that the occupation of the Frazier site on the Central Plains occurred around January and data demonstrating that occupation of the Agate Basin level at the Agate Basin type site on the Northwest Plains also took place around January (Figures 8-5 and 8-6). In contrast, data on the time of year during which bison were killed during the Agate Basin occupation represented at Locality II indicates that people were at Hell Gap around July or August (Figure 12-5). The fact that the histogram presented in Figure 12-5 approximates a normal curve with a mean centered about a specific time of year supports the thinking that only one Agate Basin occupation is represented at Locality II. A total of ten specimens of bison dentition were used to produce the histogram in Figure 12-5. Six specimens of bison dentition from Locality II were assigned an unusually long dental age of 5.7 – 6.2 yr by the faunal analysts and were not used to produce histograms. These specimens include four from the Agate Basin component, two from the Hell Gap component, and one from the Folsom component (Rapson and Niven 2009b:Table I.28). Plotting the dental age ranges assigned to a very small sample of just two specimens of bison dentition from the Hell Gap component still forms a histogram that approximates a normal curve with the mean centered at July or August (Figure 12-6). The fact that the two specimens of bison dentition said to have come from the Hell Gap level also plot to the same time of year as the more numerous Agate Basin specimens confirms the suspicion that some bone from the Agate Basin levels was redeposited in the Hell Gap level. The dental age range assigned to a single specimen of
Figure 12-5. Histogram of dental ages assigned to mandibular and maxillary bison teeth from the Agate Basin component at Locality II of the Hell Gap site cluster. Data from Rapson and Niven (2009b:Tables I.28 – I.29). Number of specimens of bison dentition plotted on graph: ten. Histogram excludes four specimens that were each assigned an unusually long dental age range of 5.7 – 6.2 yr. Minimum number of bison from component based on dentition: 13 (Byers 2009:Table 10.2). These data approximate a normal curve and suggest that the bison were killed around July or August. This time of year falls outside the usual large-scale bison hunting season on the Central Plains during Agate Basin and Hell Gap times as determined by analysis of dental ages of bison teeth reported from sites with dense bonebeds. Compare with Figure 8-6.
Figure 12-6. Dental ages assigned to mandibular and maxillary bison teeth from the Hell Gap component at Locality II of the Hell Gap site cluster. Data from Rapson and Niven (2009b:Tables I.28 – I.29). Number of specimens of bison dentition plotted on graph: two. Histogram excludes one specimen assigned an unusually long dental age range of 5.7 – 6.2 yr. Minimum number of bison from component: three, based on counts of dentition. The dental age of the teeth indicate that the bison were killed during a time of year that was outside the usual large-scale bison hunting season on the Central Plains during Hell Gap times. See Chapter 8. The time of year that the bison of the Hell Gap component were killed is similar to the season that bison of the underlying Agate Basin component were slaughtered, suggesting that some bone from the Agate Basin component was redeposited with cultural material of the Hell Gap component.
bison dentition said to have come from the Folsom component plots to the same general time of year covered by the bulk of dental ages assigned to the more numerous Agate Basin specimens (Figure 12-7). This confirms the suspicion that some bone from the Agate Basin component was mixed in with the underlying Folsom levels. From the above information, it can be concluded that all the bison bone recovered from Locality II is best attributed to one Agate Basin occupation that took place somewhere near Locality II.

Though not definitive, the evidence that is available suggests that the Agate Basin occupation of Locality II is related to an occupation of Hell Gap by an aggregated group intent on large-scale bison hunting. One line of supporting evidence is the observation that in Locality II are the bones of more bison than would be expected from an occupation by a small human group involved in generalized foraging. No published map of the entire Locality II excavation block is available, but the outline of the excavations are indicated on a scaled map of the Hell Gap area by Haynes (2009:Figure 3.3) and permit the total area excavated to be roughly estimated at 190 m². This is equivalent to an area measuring 13.8 m by 13.8 m. Byers (2009:139) reports that a minimum of 14 bison are represented in the bone from the Agate Basin component. This is indeed a minimum number because some bison bone was displaced into the Folsom and Hell Gap levels. As a basis for comparison, it may be recalled that numerous occupations of the Allen site throughout two millennia of the Paleoindian period by small groups involved in generalized foraging resulted in the deposition of bones from 17 bison within an excavated area equivalent to an area measuring 10.9 m by 10.9 m. In comparison, during a single Agate Basin occupation of Locality II, the remains of a minimum of 14 bison were discarded and after subsequent post-depositional movement and redeposition, were recovered from an excavation block of a size equivalent to an area measuring 13.8 m by 13.8 m. From this, it may be concluded that the Agate Basin occupants camped near Locality II were involved in a considerable amount of bison hunting and this in turn provides indirect support to the thinking that a possibly large group intent on
Figure 12-7. Dental ages assigned to a single specimen of maxillary bison teeth from the unfluted Folsom (“Midland”) component at Locality II of the Hell Gap site cluster. Data from Rapson and Niven (2009b:Table I.29). Graph excludes a specimen of mandibular bison teeth assigned an unusually long dental age of 5.7 – 6.2 yr (Rapson and Niven 2009b:Table I.28). Minimum number of bison from component: three, based on number of specimens of dentition falling into separate yearly age groups (Rapson and Niven 2009b:Tables I.28 – I.29). The dental ages assigned to the maxillary teeth indicate that the bison was killed during a time of year that would have been outside the usual large-scale bison hunting season on the Central Plains during Folsom times. See Chapter 8.

The time of year that the bison in the Folsom component was killed is similar to the season that bison in the overlying Agate Basin component were slaughtered, suggesting that some bone from the Agate Basin component was mixed in with cultural material of the Folsom component.
preparing for a large-scale bison kill was present at the site. A second line of evidence that may support the possibility that the Agate Basin occupation was related to large-scale bison hunting is fact that red ochre was noted to be present in the Agate Basin levels at Locality II. (Knudson 2009:28).

If indeed Agate Basin peoples camped near Locality II around July or August were intent on large-scale bison hunting, this in turn would suggest that in this case, communal hunting occurred outside the time of year during which this subsistence activity usually took place. That being said, the occurrence of one large-scale hunt outside the usual communal hunting season proposed by the model for Agate Basin times on the Central and Northwest Plains does not invalid the model.

When considered as a whole, available evidence from existing literature best supports the hypothesis that, in general, the Hell Gap area was a special place that attracted repeated occupation by Paleoindians because it was a good place for groups of people to camp while gearing up for large-scale bison hunting. This hypothesis is, of course, not intended to be a final synopsis for the Hell Gap site complex. It is, however, meant to be a general statement that seeks to accurately characterize the role that the site complex played in the land use patterns of Paleoindians. It may not apply to all occupations of the site. For example, for both Localities I and II, the presence of a Clovis occupation is known only from a single diagnostic point that was not demonstrably found in an occupation layer that might be suggestive of occupation by a large group of people. So, future research may prove that the statement does not apply to Clovis and perhaps other occupations of Hell Gap. Available evidence does suggest, however that the hypothesis applies to most of the occupations. The amount of evidence supporting the hypothesis varies from one occupation to the next. I believe that a strong case was made for applicability of the hypothesis to the Cody occupation at Locality V, where multiple lines of evidence were available in the literature to provide support. For the other occupations, less information is provided in the literature and the
hypothesis that they too are related to occupation by aggregated groups intent on gearing up for large-scale bison hunting is correspondingly less certain. Still, some support for the hypothesis is provided by evidence from the study of bison dentition that showed that five of six occupations took place during the large-scale bison hunting season. The sixth occupation did not occur during the expected time frame, but some support was found for the possibility that indeed an aggregated group intent on large-scale bison hunting occupied the site, but for an unknown reason this subsistence and social event took place at an unusual time of year.

The tool stone composition of the assemblage from Locality V will now be described so that it’s meaning in terms of Paleoindian land use may be interpreted, given the understanding that the artifacts are the product of an occupation related to large-scale bison hunting. A majority of the assemblage is comprised of tool stones from outcrops of Paleozoic limestones and Mesozoic sandstone formations on the Hartville Uplift itself, but a substantial amount is apparently comprised of chert from exposures of a flat-lying Tertiary formation on the vast expanse of plains to the east of Hell Gap.

The predominant locally available tool stone is Hartville Uplift chert, which comprises 71 percent of the assemblage, according to artifact count (Table 12-8). Knell et al. (2009) refer to this raw material as Mississippian chert. As pointed out by Reher (1991), chert from the Hartville Uplift derives from formations that are partly or wholly limestones and are of both Mississippian (Guernsey Formation) and Pennsylvanian age (Hartville Formation). Over most of the Hartville Uplift, the Hartville formation overlies the Guernsey formation, but the later is exposed along the eastern edge of the uplift (Love and Christiansen 1985). Therefore, most of the numerous chert sources mapped by Reher (1991:Figure 16.2) are outcropping from the Hartville formation of Pennsylvanian age. Saul (1969:Figure 1) maps a tool stone source one km northwest of Hell Gap as well as seven other sources situated within 8 km of Hell Gap to the west, northwest, and north. Comparison of Saul’s map of tool stone sources with the geological map of Wyoming by Love and Christiansen
indicates that the sources mapped by Saul are outcropping from exposures of limestone and are likely sources of Hartville Uplift chert.

Though not a tool stone, red ochre that likely is from a local source was reportedly observed during excavation of the Cody level at Locality V (Knudson 2009:28) and is also present on two artifacts in the collection. The source of Sunrise red ochre is located 10 km south-southwest of Locality V near an abandoned iron mining community of the same name. The ochre is a specular variety which can occur naturally in a shiny, metallic-appearing form and differs from other ochres in that the red pigment produced from it is more of a blood red (Tankersley et al. 1995). One unfinished biface in the assemblage retains a heavy coating of red ochre in places and an informal retouched flake tool has a light ochre stain (Knell 1999:21; Knell et al. 2009:Figure 11.6, left). The ochre on the artifacts from Locality V was not analyzed in an effort to source the pigment. However, samples of ochre that included a natural piece of ochre and ochre coating a bone fragment, both from unspecified levels at Locality I, were examined macroscopically and microscopically and the chemical composition of the ochre was determined through X-ray diffraction. In all respects, the ochre from Hell Gap matched specimens of ochre from the Sunrise source (Tankersley et al. 1995).

Since a connection between Locality V at Hell Gap and a local source of ochre is a possibility, a brief discussion of evidence for contemporary Paleoindian use of an ochre quarry at the Sunrise source is in order. The ochre quarry is known as the Powars II site and a wide variety of Paleoindian point types were collected there in the 1930s by Wayne Powars, the artifact collector for whom the Powars site of the Kersey cluster is also named. None of the points from the site were classified by the original site investigators as Cody points, but photographs of three points with parallel lateral edges and slightly concave basal edges suggest that a Cody component may be present (Stafford 1990:33-34, Figure 3.6 u-w). One point with diagonal flaking that is missing the base was not assigned to a type, but appears to be classifiable as an Angostura point (Stafford 1990:34, Figure 3.6 d).
Another local Hartville Uplift tool stone, Spanish Diggings orthoquartzite, accounts for only four percent of the assemblage from Locality V. Knell et al. (2009) refer to the tool stone as Cloverly-Morrison orthoquartzite. On the state geological map of Wyoming (Love and Christiansen 1985), the general source area of Spanish Diggings orthoquartzite is mapped as an area where both the Cloverly Formation (Cretaceous) and Morrison Formation (Jurassic) outcrop. However, Spanish Diggings orthoquartzite is only known to derive from the Cloverly Formation (Reher 1991), so use of the term Cloverly-Morrison orthoquartzite is probably not a good idea, since it implies the tool stone also comes from the Morrison Formation. As measured to the Spanish Diggings quarries (Reher 1991:Figure 16.3), the source of this raw material is situated 27 km northwest of Locality V.

A substantial amount of the Locality V assemblage is said to derive from the Arikaree Formation of Miocene age. Knell et al. (2009:Table 11.1) label the tool stone simply as Miocene chert. The tool stone is not described in the literature in detail, nor are sources well documented, therefore it is not discussed in Chapter 7. The chert is here referred to as Arikaree chert after the formation from which it derives. Miller (2009:412) states that the stone is, “…commonly clear to white, with variations of red and purple[,] some dark brown.” Apparently because of the reddish and purplish hues of this stone, it is sometimes difficult to distinguish from Table Mountain chert. In his discussion of tool stones present in the Hell Gap assemblages, Miller (2009:41) apparently included Table Mountain chert in his conception of Arikaree chert. He indicates that Arikaree chert is, “…referred to as Table Mountain chert west of the [Hartville] uplift.” However, Table Mountain chert derives from Oligocene rocks of the White River Group. Its source is along the North Platte River on Table Mountain in southeast Wyoming near the border with Nebraska. As noted by Knudson (2002:115-116), Table Mountain chert is one of three sources where similar appearing microcrystalline silicate stone outcrops from the White River Group, the other two being Flat Top Butte in Colorado and sources of a tool stone known as Scenic chalcedony in the West.
Horse Creek and Nelson Butte area of southwest South Dakota (Myers 1985:62-63, Figure 1; Nowak and Hannus 1985). Knudson refers to these tool stones collectively as White River Group silicates or WRGS. Apparently WRGS can indeed sometimes be distinguished from Arikaree chert because Knell identifies some artifacts from Locality V as being made from WRGS (Knell 2004, Knell et al. 2009). I will assume the WRGS artifacts identified by Knell to be from the Table Mountain source because it is by far the closest source of the three. The validity of Arikaree chert as a tool stone that is distinct from WRGS is supported by Knell (2004:157) who notes that outcrops of Arikaree chert occur on the plains 30 to 45 km east of the Hell Gap site complex. To assist other archaeologists in recognizing Arikaree chert, the tool stone should be better defined in the literature. Recording the sources reported east of the Hartville Uplift on state site forms is also recommended.

The three hammerstones in the collection are said to be of local stream cobbles. The raw material of the hammerstones were identified as cobbles of diorite, metaquartzite, and unspecified quartzite that are available in local secondary deposits (James Miller, cited in Knell et al. 2009:168).

Only six flaked stone artifacts of the Locality V assemblage are of tool stones that could not be identified as to source and so are not classifiable as either local or nonlocal. These include two artifacts of petrified wood (Knell et al. 2009:160). As discussed below, artifacts of Tongue River silicified sediment in the collection may in part derive from outcrops of the Fort Union Formation in the Powder River Basin. Miller (1991b:466) comments that petrified wood reported from the Powder River Basin probably derives from the Ft. Union Formation, so there is some possibility that the petrified wood at Hell Gap originated from the Ft. Union Formation in the Powder River Basin.

Table Mountain chert from a distant source in southeast Wyoming is the raw material of only .3 percent of the assemblage. As mentioned in the discussion of Arikaree chert, some artifacts in the assemblage are identified as WRGS and the artifacts are here assigned to the
closest source of WRGS on Table Mountain along the North Platte. Table Mountain is 76 km from Locality V and therefore just barely classifies as a distant tool stone source. The discussion of the raw materials present in the assemblage provided in the final report on Locality V (Knell et al. 2009:Table 11.1) lists no projectile points of WRGS, but an earlier publication states that at least two were present (Knell 2004:177). Data presented in the final report is used here.

One percent of the Locality V assemblage is of Tongue River silicified sediment that is here considered to be from nonlocal sources in the Powder River Basin. Miller (2009:411-412) identifies some artifacts in the Hell Gap assemblage as Tongue River silicified sediment (or TRSS), but he contends that the tool stone has local sources. In an earlier publication, Miller is cited as the authority who identified the raw material in the Locality V assemblage (Knell 1999:50, Table 4.1). Miller referred to the stone as porcellanite and orthoquartzite from the Ft. Union and Wasatch formations. Knell et al. (2009:Table 11.1) include both the microcrystalline and granular forms of this tool stone under the heading of Ft. Union-Wasatch orthoquartzite. Miller (2009:411) cites the Love and Christiansen (1985) geological map of Wyoming to support his assertion that, “[t]hese materials are considered local, with formations outcropping within one to several kilometers of the site.” He further states that the formations producing TRSS are exposed in the Hartville Uplift (Miller 2009:412).

I am skeptical of the claim made for local sources of TRSS for two reasons. First, Miller’s (2009) policy of assuming that a particular tool stone is available wherever the formation in which it occurs is shown to be present according to a geologic map is a dubious practice. Second, the Love and Christiansen map does not show the Ft. Union nor the Wasatch formations as outcropping within several kilometers of the Hell Gap site cluster nor anywhere else in the Hartville Uplift. The closest outcrops of the formations in question shown on the Love and Christiansen map are northwest of the Hartville Uplift in the Powder River Basin, with the closest exposures of the Ft. Union and Wasatch formations being 50 km
and 58 km away from Locality V, respectively. According to an earlier publication by Miller, “[i]n the Powder River Basin of Wyoming and eastern Montana, the Fort Union has three members: the Tullock, Lebo, and Tongue River (in ascending order)… The tool stones in the Fort Union are predominantly fossil soils or silcretes — orthoquartzites and porcellanites… In the Powder River Basin and northern Plains, Tongue River ‘silicified sediment’ was an important tool stone. The designation is somewhat misleading, as the process that formed the silcrete in the Fort Union in the Paleocene Epoch continued into the Early Eocene, and similar silcretes formed in the Wasatch Formation at least in the Powder River Basin” (Miller 1991b:465-466). If sources of TRSS are present in the southernmost tip of the Powder River Basin, then the tool stone may be present in the local environment of Locality V. Pending identification of actual sources in the southern tip of the basin, currently available information in published literature suggests sources of TRSS lie in distant or even very distant lands, relative to Locality V. Therefore, the TRSS artifacts in the Locality V assemblage are here considered to originate from nonlocal sources in the Powder River Basin.

The term Tongue River silicified sediment is used here instead of Ft. Union-Wasatch orthoquartzite for a number of reasons. TRSS has priority in the literature and the term is more widely recognized by Plains archaeologists. The term indicates that the tool stones are essentially the same stone that is known from the Powder River Basin as well as parts of North and South Dakota (Ahler 1977). Finally, even though the term Ft. Union-Wasatch orthoquartzite more accurately denotes the formations in which the tool stone is found, the term Tongue River silicified sediment indicates that the raw material occurs in both microcrystalline and granular forms.

One of 17 blocky cores in the collection was identified as Phosphoria chert by James Miller in an early report on analysis of the Locality V tool stones (Knell 1999:50, Table 4.1), but the final report makes no mention of this raw material (Knell et al. 2009:159-160, Table
When discussing the raw material in the Hell Gap assemblages in general, Miller (2009:413) states that Phosphoria chert is commonly purple to maroon with light blue or green inclusions and can also be clear to milky in color. Based on current information in published literature, an artifact of Phosphoria chert in the Locality V assemblage would have derived from a very distant source area with the closest being along the western base of the Bighorn Mountains in the Bighorn Basin of north-central Wyoming. Huckell (1989:169) mentions a source of Phosphoria chert near Shell, Wyoming. This town lies 345 km northwest of Locality V. Since the final report categorizes the 17 blocky cores into various tool stone types and Phosphoria chert is not one of the recognized categories, I will assume that the raw material of the core was reclassified into one of the types discussed above. The color range of Hartville Uplift chert does include shades of purple and maroon, so perhaps the raw material was later determined to be of this tool stone.

Casper Site

Lying just north of the North Platte River is a Paleoindian bonebed that takes its name from Casper, Wyoming, the city in which it is located. The site is situated on a Pleistocene river terrace and just within the edge of a large dune field. To the south of the river lie the Laramie Mountains which extend to the southeast and then bend to the south to continue southward to Colorado where they join the Front Range. Downriver in an east-southeast direction lies the Hartville Uplift. To the west lies the Wyoming Basin. West of the site, the river slowly bends to the south around the northern end of the Laramie Mountains and heads generally southward to its source in North Park of Colorado. North of the Casper site lie the seemingly endless lowlands of the Powder River Basin.

The site consists primarily of a bison bonebed affiliated with the Hell Gap time period, but evidence suggests that a minor Clovis component may also be present. Bones of a minimum of 74 bison were recovered during the first of two field seasons and a total of 70
Hell Gap points were collected from the bonebed, which is preserved in the remnant of a once larger blowout depression. Bison teeth were assigned a dental age of N + .6 yr, indicating a herd was killed around November. A bison metatarsal was radiocarbon dated using the conventional method and produced a date of 10,060 ± 170 B.P. Scattered charcoal from the bonebed produced a date of 9830 ± 350 B.P. Considering the unreliability of dates from bone when using the conventional method, the date on charcoal, even though not collected from a hearth, provides the most accurate estimate of the age of Hell Gap occupation. The site was discovered in the spring of 1971 when a dune on private land was leveled in preparation for constructing an industrial plant. After the land was leveled, artifact collectors from Casper examined the site area, found a Clovis point on the ground surface, and discovered the bison bone deposit through exploratory digging. Archaeologists from the University of Wyoming excavated much of the bonebed later that year and published a detailed site report (Frison 1974). Excavations of the remainder of the site took place in 1976 when it was threatened with destruction by more construction. Work accomplished during the second field season is summarized in an article concerning camel bones recovered from the site (Frison et al. 1978).

The setting of the bonebed in the bottom of a blowout that arguably was at the mouth of a parabolic sand dune suggests the possibility that a bison herd was actually killed within the sandy depression by hunters who took advantage of the local terrain to help detain the bison so that they could be speared. Under modern climatic conditions, the prevailing southwesterly winds have formed a number of northeast-southwest aligned parabolic dunes in the vicinity of the site. Blowouts orientated northeast-southwest form at the mouth of the parabolic dunes. Steep slopes of loose sand typically form along the lateral and leeward sides of the blowouts. The lateral sides of the blowouts are immediately flanked by the arms of parabolic dunes. The main bodies of the parabolic dunes can extend for hundreds of meters in the leeward direction (to the northeast). Geomorphological studies at the site demonstrate that the bonebed was preserved in a trough-shaped sand layer deposited in the bottom of the
blowout itself (Albanese 1974:Figure 4.4). Originally, the bison were thought to have been driven from a distance into the natural trap formed by the parabolic dune (Frison 1974). More recently, however, Bamforth (1991) has argued that most Paleoindian bonebeds represent use of the surround hunting method, as opposed to driving of herds into traps or over cliffs. In light of this, it is possible that bison killed at the Casper site may have been surrounded by hunters who then maneuvered the herd into the blowout to help detain the animals during the slaughter. In either case, the location of the bonebed in the bottom of the blowout strongly implies that the presence of a parabolic dune was used to advantage by Paleoindian hunters who killed a bison herd at this location.

The kinds and proportions of bones present at the site support the view that the blowout was the actual location of the bison kill. Theoretically, certain kinds of bones are more likely to have been left at the actual site of a large-scale bison kill. If tongues were removed from mandibles at the kill site, mandibles should be common. This evidently was the case at the Casper site where mandibles are the most common bone element. A minimum of 74 bison were recovered in the 1971 field season, as indicated by the presence of 62 left mandibles and teeth from 12 other left mandibles. Cut marks were present on the medial side of most mandibles, suggesting that they had been discarded after the attached tongues had been removed for food (Frison 1974:48). Crania are also relatively common at the site. A total of 58 crania or parts thereof are present in the 1971 faunal collection. Included are 23 crania and parts of another 35, as recognized by presence of the appropriate teeth and durable petrous portions of the skull (Frison 1974:64). Apparently some skulls were broken apart by Paleoindians, perhaps to retrieve the brains for food or for use in tanning hides. Pelvises are another element of the skeleton that likely would be left at a large-scale kill site and the pelvis is a common skeletal element in the faunal collection. Approximately 59 pelvises are represented in the 1971 faunal collection. Included in this number are 36 pelvises articulated
with segments of vertebral columns, 11 right innominates, eight right ischia, and four fragments possessing the right acetabulum (Frison 1974:Table 1.2, Figure 1.32, frontispiece).

The kinds of artifacts recovered from the site further support the interpretation of the Casper site blowout as the actual location where the bison were killed. Projectile points are by far the most common type of tool. A total of 70 points were recovered as were 48 “impact flakes” produced when the points hit a bison. Some fragments of impact flakes were matched with the corresponding flake scar on the point. Several informal retouched flaked tools believed to have been used in the butchering process were also retrieved from the sand. Included are five specimens found in 1971 and at least one more found in 1976. A total of 260 artifacts are classified as resharpening flakes that are thought to have been produced when dulled butchering tools were rejuvenated. Finally, 25 hammerstones were present among the bones. These are believed to have been used in dismemberment and to break open limb bones to extract marrow for food. The hammerstones are stream cobbles of quartzite, granite, and chert that are thought to have been procured locally from river terraces along the North Platte (Frison 1974:28-29, 101-102).

Finally, the distribution of artifacts also supports the characterization of the Casper site as the actual location of the bison kill. Four sets of two clusters of resharpening flakes were identified which demonstrate that the flakes were not discarded in a midden, rather they were removed from the edges of dulled butchering tools in separate episodes of tool resharpening at the location where the tools were used.

The tool stone composition of the collection of Hell Gap points from the Casper site is reported in sufficient detail to allow land use to be interpreted. A large percentage of the point collection is comprised of stone classifiable as orthoquartzite and dendritic jasper. Considering that investigating land use by examining only projectile points is a method that has been shown to potentially bias results in favor of a view of use of large ranges, it is reassuring to note Frison’s (1974:100-101) observation that, “[t]he tools and sharpening
flakes are divided almost equally between the chert-jasper and quartzite categories and appear to represent the same sources as the projectile points…” Frison (1974) and Bradley (1974) both give their thoughts on possible sources of the tool stones present in the assemblage. As part of his dissertation on land use related to communal bison kills on the Northwest Plains throughout prehistory, Reher examined the 70 points from Casper, classified them into general raw material categories, such as “dendritic jasper,” and provides distance measurements to the presumed sources of tool stone (Reher and Frison 1980:Table 25). This information on distances to sources in combination with Frison and Bradley’s narratives which refer to various named tool stone types, permits the tool stone composition of the point collection to be determined with some level of confidence.

Frison (1974:100) states that, “[q]uite likely some of the red quartzites used were from quarries in the Shirley Basin about 50 miles south and slightly east of the Casper site.” Reher recognizes two varieties of quartzite from the site, which he refers to simply as Quartzite 1 and Quartzite 2, and lists their source as being located 75 km (47 mi) from the site. Considering that the distance to the sources of these varieties of quartzite is comparable to that given by Frison, I will assume that these varieties of quartzite are equivalent to the red quartzite said to have come from the Shirley Basin, but will use Frison’s distance of 50 mi, or 80 km (Table 12-9).

Frison (1974) and Bradley (1974) both suggest that some of the quartzite in the point collection may derive from the Spanish Diggings quarries in the Hartville Uplift, but the findings of the later study by Reher suggests that this is not the case. Reher apparently did not identify any of the raw materials from the Casper site as coming from the Spanish Diggings source area. It is relevant to note that Reher was familiar with the qualities of this tool stone, having identified it at the nearby Glenrock Bison Jump, a Late Prehistoric bison kill site situated 34 km east of the Casper site, as well as at two other late bison jumps included in his dissertation project (Reher and Frison 1980:Table 25).
Table 12-9. Tool Stone Composition of Hell Gap Points from the Casper Site

<table>
<thead>
<tr>
<th>Tool Stone Type</th>
<th>Total Number of Points</th>
<th>Distance to Tool Stone Source Used in Analysis (km)</th>
<th>Relative Distance to Tool Stone Source</th>
<th>Percent of Point Collection Composed of Tool Stone Type, According to Artifact Count</th>
<th>Percent of Point Collection Composed of Local Versus Nonlocal Stone, According to Artifact Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hartville Uplift Chert</td>
<td>37</td>
<td>144</td>
<td>distant</td>
<td>52.9</td>
<td>100 percent Nonlocal</td>
</tr>
<tr>
<td>Quartzite from Shirley Basin</td>
<td>29</td>
<td>80</td>
<td>distant</td>
<td>41.4</td>
<td></td>
</tr>
<tr>
<td>Ft. Union Porcellanite</td>
<td>1</td>
<td>140 +</td>
<td>distant or very distant</td>
<td>1.4</td>
<td>100 percent Nonlocal</td>
</tr>
<tr>
<td>Knife River Flint</td>
<td>3</td>
<td>577</td>
<td>very distant</td>
<td>4.3</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>70</strong></td>
<td><strong>-</strong></td>
<td><strong>-</strong></td>
<td><strong>-</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Much of the tool stone comprising the point collection is composed of varieties of microcrystalline stone believed to derive from sources in the Hartville Uplift. Bradley (1974:192) suggests that dendritic jasper in the point collection may be found at the “Hell Gap quarry sites.” This implies that the Hartville Uplift is the source area. Reher reports that dendritic jasper is a common raw material in the point collection, comprising 22 points (or 31.4 percent) and he measures the distance to the source at 150 km. I measure the straight-line distance from the Casper site to the Hell Gap site complex at 149 km, thus confirming the suspicion that the Hartville Uplift is the source area for dendritic jasper, at least according to Reher. Lesser amounts of microcrystalline stone in the point collection are labeled as agate and chert by Reher who lists the associated distances to the sources of these raw materials as also being 150 km from the Casper site. A total of 12 points, or 17.1 percent, are of agate and three, or 4.3 percent, are of chert. From this, it may be reasoned that Reher identifies the other forms of microcrystalline stone in the point collection as being within the range of variation of materials found in the Hartville Uplift. All three varieties of microcrystalline tool stone are here subsumed under the rubric of Hartville Uplift chert (Table 12-9).

Both Frison and Bradley, however, make statements suggesting that alternative source areas for microcrystalline stone in the Casper assemblage may lie along the flanks of the Laramie Mountains. Frison (1974:100) states that, “[m]ost of the jaspers and cherts are probably derived from the almost unlimited quantities of materials found on both sides of the Laramie Range 50 to 100 miles [80 – 161 km] southeast of the Casper site. There are literally hundreds of areas that have been quarried and the range of colors and textures are so varied that even from the same quarry there is enough difference to make it extremely difficult if not impossible to trace materials from site back to quarry.” Bradley (1974:192) suggests that some stone may be “chalcedonic cherts that are common in the Laramie area…” This statement would place the source of some tool stone on the west side of the Laramie...
Mountains. Should future study of the tool stones comprising the assemblage demonstrate that an appreciable amount of the collection in fact derives from the Laramie Mountains, then ideas on Hell Gap land use as represented at the Casper site will have to be modified accordingly.

The tool stone of one point is identified and as porcellanite from the Powder River Basin (Frison 1974:99; Reher and Frison 1980:Table 25). Reher lists the distance to the source of porcellanite as 50 km (Reher and Frison 1980:Table 25) and exposures of the parent formation (the Ft. Union Formation) do occur in the Powder River Basin within 50 km to the northeast of the Casper site. As discussed in Chapter 7, however, recorded porcellanite sources occur within a broad area in the northern portion of the basin. At its closest, this area is 140 km from the site. The source area continues into Montana and lies at distances well over 225 km from the site, therefore the source of the porcellanite point is here considered to lie in either distant or very distant lands (Table 12-9).

Three points and one of the five informal retouched flake tools found in 1971 are of Knife River flint from a very distant source. The distance from the Casper site to the center of the KRF source area is 577 km.

**Western Middle Park Cluster**

**Upper Twin Mountain Site**

The Upper Twin Mountain site is a bison bonebed located in western Middle Park that dates to the Folsom time period and produced only unfluted points (Frison et al. 1995; Kornfeld and Frison 2000; Kornfeld et al. 1999). The site is located in moderately sloping terrain in an upland setting near a drainage divide between the Troublesome Creek and Muddy Creek watersheds. It is situated in a bowl at the head of an unnamed ephemeral drainage that drains eastward toward Troublesome Creek. The site is currently in open grassland country with some scattered brush nearby. Just north of the site lies a steep
northeast-southwest aligned ridge on the divide between the watersheds. The site is located on generally eastward sloping terrain within an area affected by a landslide prior to occupation. At the site location, a so-called slump-block landslide occurred when a block of earth slid downslope along an underground concave surface that faces upward toward the ground surface [compare diagram of slump-block landslide in Hunt (1974:Figure 17.25 a) to schematic cross section of geomorphology and stratification at the Upper Twin Mountain site (Kornfeld et al. 1999:Figure 3)]. This type of landslide generally occurs when the ground is saturated with water and produces a block near the top of the slide that has rotated backward with a jumbled mass of earth situated at the lower end (Hunt 1974:143-144; 560-562). A depression on the slope may form between the slumped block and the jumbled earth. It is in such a depression that the bonebed at the Upper Twin Mountain site was deposited.

Geoarchaeological study has revealed the processes that have preserved and shaped the current condition of the site. Following deposition in the depression of a landslide scar, the bonebed was covered with sheet wash alluvium of stratum I. Two bison long bones from the bonebed were pretreated using a protocol developed for radiocarbon dating using accelerator mass spectrometry and yielded reliable dates of 10,470 ± 50 and 10,240 ± 70 B.P. Study of the orientation of the long axes of the bones suggests that the bonebed may have been affected by slope wash to some extent prior to burial. Erosion of upslope portions of the bonebed followed by eolian sedimentation produced the overlying stratum II which contains small bone fragments in its lower portion. Two dates on scattered charcoal collected at or above the stratum I/II contact are probably from natural fires and place the resumption of sedimentation at around 6015 ± 55 or 5230 ± 210 B.P. Three overlying eolian strata were subsequently deposited to a maximum depth of about one meter above the bonebed.

The limited excavations completed to date produced the remains of a relatively large number of bison. Two irregularly shaped excavation blocks were dug close together within the depression of the landslide scar. Bison bone was recovered from both excavations. The
extent of the bonebed is unknown. The larger of the excavation blocks measures six meters north-south by four meters east-west. About three meters to the southwest lies the other excavation block, measuring a maximum of three meters north-south by three meters east-west. Along with two test pits measuring one meter by one meter each, excavations covered a total of 28 m², which is equivalent to an area measuring 5.3 m by 5.3 m. From this area, bones representing a minimum of 15 bison were recovered, based on the quantities of mandibular teeth falling into yearly age groups defined by tooth eruption and wear patterns (Todd et al. 1996:165).

A consideration of the distribution of dental ages determined for bison mandibles indicates that the bonebed represents a single large-scale bison kill that occurred in early fall. As discussed in Chapter 8, the time of year that the bison were killed is best estimated to be around October or November.

Bamforth (2011) has convincingly argued that most Paleoindian bison bonebeds are representative of temporary hunting camps and not the actual site of the bison kill, an interpretation that has been commonly suggested by others. Earlier, Kornfeld et al. (1999) suggested that the bonebed at the Upper Twin Mountain site is at the actual location of the bison kill, but they puzzled over the depth of the depression seemingly not being sufficiently deep to serve as a trap for bison and suggested that the environment at the time of occupation may have been more wooded, allowing for construction of a bison pound. Pollen from the bonebed and three overlying strata do demonstrate greater frequencies of pine pollen during the Folsom period compared to later in the Holocene. Unfortunately, a pollen sample from the ground surface was not analyzed to compare the modern pollen rain to that of prehistoric times. Nevertheless, evidence for increased precipitation during Folsom times discussed in Chapter 6 would support the view that trees grew closer to the site than at present. Today, the closest stand of conifer trees is about 200 m from the site. The original site investigators suggested that the site was in a pine forest at the time of occupation and the depression was
used in conjunction with a corral built around the slump using trees rather than cut posts (Kornfeld et al. 1999:671).

However, the situation of being trees in closer proximity to the site during Folsom times could also be relevant when considering the credibility of the view that the bonebed was a midden at a temporary hunting camp. Bamforth (2011) has argued that the surround was a common hunting technique employed by Paleoindians. I suggested in Chapter 8 that carcass segments of bison killed in a surround may have been transported far from the site of the actual kill to a camp, citing ethnographic examples of Plains foragers using dogs to transport carcass segments up to several miles to a camp. My intent here is simply to suggest that if archaeologists are having difficulty explaining the Upper Twin Mountain bonebed as the site where bison were killed, it is advisable to try interpreting the site as a midden of a temporary hunting camp and see if this hypothetical scenario is better supported by evidence from the environmental setting and the site itself. If Paleoindians successfully surrounded and killed a herd of bison in the flat, open terrain of the Troublesome or Muddy Creek drainages, they may have wanted to camp near a source of firewood, particularly considering that the time of year was around October or November and the climate of Folsom times was colder than that of today. Currently, there is no source of firewood at the location of the site. Isolated patches of conifer forest on the north slope of the ridge dividing the Troublesome and Muddy Creek drainages are the only source of substantial firewood for a considerable distance in all directions. It is reasonable to suggest that in the wetter climate of Folsom times, lower tree line in Middle Park would have been depressed in elevation and isolated patches were more extensive. Therefore, the Upper Twin Mountain site would have been located closer to a potential source of firewood that it is presently.

If the Upper Twin Mountain bonebed is indeed an area where trash was discarded at a temporary hunting camp, one might expect evidence for campfires or other fire features. Though not associated with large-scale bison hunting, the hearths reported in the trash deposit
at the Allen site demonstrate that fires for cooking or other purposes may have been established in areas peripheral to the main living area. Also, at the Frazier site (which is definitely associated with a large-scale bison kill) a deep fire feature that arguably functioned as a roasting pit was found in a part of the site where scattered bone and artifact concentrations are here interpreted as constituting a secondary trash disposal area. With these thoughts in mind, it is relevant to note that a dark circular area that initially was thought to indicate the presence of a hearth was encountered during excavation of the Upper Twin Mountain site, but later was decided to have resulted from a recent range fire set to improve graze for livestock and wildlife. The possible hearth was plotted on a map of the bone distribution within the excavation blocks as a dashed circle ranging from 58 to 65 cm in diameter. According to the map caption, “[t]he dotted line is a burned area first thought to represent a feature (hearth), but is probably the result of the recent controlled burn episode” (Frison et al. 1995:Figure 15). It is difficult to evaluate the validity of the hearth with the information given, but it is worth noting that if a bush on the ground surface above the bonebed caught fire, it might have left some burned roots at the depth of the bonebed, but it would not be expected to leave a circular burned area.

If the Upper Twin Mountain site was indeed part of an encampment, it is reasonable to expect that a source of drinking water would have been nearby. The setting of the site in an upland environment without permanent streams suggests that such a potential source of water may have been a spring. Under the wetter climatic conditions documented for Folsom times, it is not unreasonable to suppose that springs may have been present that are now dried up. The depression in which the site is located was formed by a slump-block landslide that occurred sometime before the Folsom occupation. It is pertinent to note that slump-block landslides commonly form when the ground becomes saturated to the point of liquefaction, at which time the slope may give way and slump downward (Hunt 1974:144, 561). Furthermore, a map of the site shows a small intermittent gully beginning within the area of
the slump (Frison et al. 1995:Figure 14). The above thoughts and observations suggest it is not outlandish to suggest the possibility that during Folsom times, a spring may have been located at the site or somewhere within a reasonable walking distance.

The kinds of stone tools found during excavation are those that are arguably related to killing and butchering a number of bison and support an interpretation of the site as being a midden at a temporary hunting camp. A limited range of artifacts was recovered from the site and includes points, informal retouched flake tools, and artifacts here labeled as hammerstones (Table 12-10). The points were used to kill bison and the informal retouched flake tools may have been used in butchering. Four artifacts classified by the original site investigators as “choppers” (Kornfeld and Frison 2000:147), implying they were used to chop up bison carcasses. They are medium sized cobbles that have a few flake scars. Four flakes from such artifacts were recovered, but do not refit to the tools. The original site investigators suggest the flakes represent the manufacture or maintenance of “choppers.” However, the flakes may have resulted from the use of the cobbles as hammerstones. Some fragmentary humeri, radii, and femurs from the site demonstrate impact fractures suggesting that they had been broken apart by blows from a heavy rock to extract marrow (Frison et al.1995:12, Table 10, Figure 27). Similar use of cobbles and large flat rocks as hammerstones and anvil stones to break open limb bones to extract marrow has been documented at the Cattle Guard site, a Folsom site in the San Luis Valley of Colorado associated with a large-scale bison kill (Jodry and Stanford 1992). In light of the above information, the tools from the Upper Twin Mountain are here classified as hammerstones, rather than choppers. Finally, it should be noted that an apparently spherical stream pebble varying from 5.5 to 5.9 cm in diameter is illustrated among the artifacts from the site and labeled as a hammerstone (Kornfeld and Frison 2000:Figure 14c). The artifact is not described or further discussed, however. It is here included in Table 12-10 as a
Table 12-10. Tool Stone and Artifact Composition of the Assemblage from the Upper Twin Mountain Site. a

<table>
<thead>
<tr>
<th>Tool Stone Type</th>
<th>Debitage</th>
<th>Stone Tools</th>
<th>Total Number of Artifacts</th>
<th>Distance to Tool Stone Source Used in Analysis (km)</th>
<th>Relative Distance to Tool Stone Source</th>
<th>Percent of Assemblage Composed of Local Versus Nonlocal Stone, According to Artifact Count</th>
<th>Percent of Collection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Blocky Cores</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kremmling Chert</td>
<td>0</td>
<td>37</td>
<td>0</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>47.37</td>
</tr>
<tr>
<td>Windy Ridge Orthoquartzite</td>
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<td>34</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>36.84</td>
</tr>
<tr>
<td>Table Mountain Jasper</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>4.21</td>
</tr>
<tr>
<td>Tuff</td>
<td>0</td>
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<td>4</td>
<td>0</td>
<td>0</td>
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<td>Granodiorite</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1.05</td>
</tr>
<tr>
<td>Unspecified Tool Stone</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1.05</td>
</tr>
<tr>
<td>Unknown Tool Stone</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2.11</td>
</tr>
<tr>
<td>Total</td>
<td>1</td>
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<td>4</td>
<td>6</td>
<td>4</td>
<td>5</td>
<td>100.00</td>
</tr>
<tr>
<td>Percent of Collection</td>
<td>1.05</td>
<td>78.95</td>
<td>4.21</td>
<td>6.32</td>
<td>4.21</td>
<td>5.26</td>
<td>100.00</td>
</tr>
</tbody>
</table>

a Data from Kornfeld and Frison (2000).
hammerstone, but its smaller size suggests that it may have served to flake stone artifacts rather than to break bison limb bones.

The kinds of debitage present are also consistent with an interpretation of the bonebed as a temporary hunting camp (Table 12-10). One core is reported, and judging from line drawings of the specimen, it may be classified as a blocky core (Kornfeld et al. 1999:Figure 9 h). Quantities of flakes were also recovered. Some are small flakes measuring at most a few millimeters in maximum dimension and are thought to result from retouching or resharpening of bifacial tools (Kornfeld and Frison 2000:146). Based on the context of the flakes among the bones of 15 bison, it is reasonable to suggest they may have resulted from resharpening tools dulled during butchering operations. Other debitage from the site is more variable and includes pieces of shatter. As a group, these pieces of debitage are indicative of the production of flakes from cores (Kornfeld and Frison 2000:147). One illustrated flake looks as though it might have been struck from a large biface, however (Kornfeld and Frison 2000:Figure 9 e). Combined with the blocky core and the informal retouched flake tools from the site, it is suggested that the manufacture of flake tools for butchering bison carcasses may be represented.

With one possible exception, the tool stones present in the assemblage derive from local sources within Middle Park (Table 12-10). The three main tool stones of Middle Park are present in the assemblage (Figure 5-2). Included is Kremmling chert from the central portion of the large tract of sagebrush grassland in western Middle Park and Windy Ridge orthoquartzite from the forested mountains along the northern end of the western tract. These two raw materials are the most common tool stones in the assemblage, according to artifact count (Figure 12-10). From the site, the source of Kremmling chert in Barger Gulch is about 15 km to the south and the main source of Windy Ridge orthoquartzite lies 29 km to the northwest. The third main Middle Park tool stone, Table Mountain jasper, is also present in the assemblage, although in a much smaller quantity. Located in a tract of open sagebrush
grassland in eastern Middle Park, the main source of Table Mountain jasper lies 38 km east of the site. The artifacts identified as hammerstones are made of subrounded to subangular, medium sized cobbles. (Kornfeld and Frison 2000:147, Figure 14 d-g). The raw material of three specimens is identified as tephra (volcanic ash) from the Troublesome formation. In Table 12-10, this tool stone is classified as tuff (lithified volcanic ash). One of the hammerstones is a cobbble of igneous rock identified as granodiorite which is said to derive from “local secondary deposits” (Kornfeld et al. ca. 1994:21), which presumably refers to stream deposits. Based on its spherical shape (Kornfeld and Frison 2000, Figure 14 c), the smaller, pebble-sized hammerstone of unspecified raw material is here thought to also derive from local stream gravels. Finally, in their discussion of the flaked stone debitage, Kornfeld and Frison (2000:146) indicate that two flakes are of “unknown material” which is classified in Table 12-10 as local or nonlocal tool stone.

**Barger Gulch Site Complex, Locality B**

In the 1990s, the University of Wyoming conducted surveys and excavations of Paleoindian sites situated within the main Kremmling chert source area in western Middle Park. Much of the source area is in the lower reaches of Barger Gulch, an intermittent stream that drains generally north into the Colorado River between the valleys of the Blue River, situated to the west, and the Williams Fork, located to the east. A survey of the tracts of public land surrounding the site discovered 13 outcrops of Kremmling chert, two of which are said to be high-quality sources (Surovell et al. 2003:82-83:Figure 5.2).

Other Paleoindian sites, designated localities, are located in the source area near Locality B. Sites producing Folsom-age material are discussed here. Locality A is .9 km to the northwest and is a multicomponent site with evidence of a Cody occupation as well as a Folsom component that produced both fluted and unfluted points (Waguespack et al. 2006:Table 1.1, Figure 1.2). Locality A is near a high-quality source of Kremmling chert but
test excavations determined that the site has limited research potential. The following localities are uninvestigated. Locality C is a dense lithic scatter that produced a Folsom point. It is located .5 km northeast of Locality B, along an intermittent drainage that flows westward to Barger Gulch. Three other lithic scatters located in the dissected country east of Barger Gulch are said to have produced Goshen points. These sites are designated Localities D, H, and I and are between .2 and .8 km south and southeast of Locality B. From the above, it can be suggested that repeated use of the Kremmling chert source area by Paleoindians during the Folsom period is indicated by the survey results.

Locality B is comprised of two large basically oval-shaped artifact scatters on the north slope of a westward trending ridge. North and south of the ridge are ephemeral drainages that flow west to Barger Gulch. Notched post-Paleoindian projectile points and another point described as a non-Folsom Paleoindian point midsection were found on the ground surface higher on the ridge, immediately to the south of the Folsom material (Waguespack et al. 2006:7-8). Just north of the two artifact clusters assigned to the Folsom period is Locality J, which is comprised of artifacts eroding out of paleosols exposed in remnants of a late Pleistocene to early Holocene stream terrace that are preserved along the ephemeral drainage north of the ridge with the Folsom material. Locality J is believed to be of post-Folsom age based on stratigraphic evidence (Waguespack et al. 2006:6-7). Cluster 2 is a dense surface scatter of artifacts that produced three diagnostic Folsom artifacts. Measuring about 33 m northwest-southeast by 20 m northeast-southwest, Cluster 2 appears to be an entirely eroded concentration of Folsom artifacts (Surovell et al. 2003:72-78, Figure 4.2). Located about 45 m east of Cluster 2, Cluster 1 is described as a somewhat larger oval-shaped artifact concentration. Cluster 1 measures about 57 m west-northwest by east-southeast and 30 meters north-northeast by south-southwest. Artifacts are scattered on the ground surface at the ends of the oval-shaped Cluster 1. Test pits and two excavation blocks demonstrate that a buried layer of Folsom artifacts is present in between the scatters of
surface artifacts at the ends of Cluster 1. An irregularly shaped excavation block with maximum dimensions of 8 m by 6 m was excavated midway between the scatters of surface artifacts of Cluster 1 and is referred to as the Main Block. Nine meters to the east, an excavation block designated the East Block was dug just north of the eastern surface scatter of artifacts. The excavation block measured five meters by five meters.

Excavated portions of Cluster 1 are interpreted by the site investigators as representing a habitation area, complete with remains of a shelter and multiple hearths, but a critical review of the purported supporting evidence casts doubt on the accuracy of this assessment. The site investigators suggest that in the center of the Main Block is a hearth that was in the center of a habitation structure. A second hearth is identified in the northeast portion of the Main Block. In the center of the East Block, a third hearth was identified. When evaluating the validity of the purported features, it is important to take note of evidence indicating that the Folsom layer in parts of the block excavations has been deflated and artifacts exposed on the erosional surface were burned over by a series of natural fires.

The site stratigraphy and the variable position of the Folsom layer within the defined strata will be reviewed to provide the necessary background information. Roughly a meter of Quaternary sediment is preserved above bedrock. From top to bottom, the strata exposed at the site are designated Strata A through E (Mayer 2003). The uppermost two strata, designated A/B, are the most recent and were not radiocarbon dated. Deposition of stratum C, also known as the Barger soil, started forming by at least 6003 ± 64 B.P. and ended around 5178 ± 49 B.P., based on radiocarbon dates of the organic component of soil at the bottom and top of the stratum, respectively. Stratum D, also known as the Folsom soil, originally contained the Folsom artifact layer and still preserves cultural deposits unaffected by erosion in certain parts of the excavation blocks. Charcoal collected from the soil produced a date of 10,770 ± 70 B.P. Peaks in vertical artifact frequencies defined for each one meter by one meter excavation unit sometimes coincide with stratum D, indicating that the Folsom artifact
layer is intact, but in other areas, the peak in artifact frequency coincides with the top of stratum E, the underlying bedrock, demonstrating that stratum D has completely eroded away, leaving the artifact layer deflated on bedrock (Surovell et al. 2003:Figure 3.6; Waguespack et al. 2006:Figure 3.2). In other parts of the excavation blocks, the peak in vertical artifact frequency occurs in post-Folsom strata C or A/B, indicating that the original Folsom-age sediment has eroded away, leaving the artifacts concentrated on an erosional surface that has subsequently been incorporated in post-Folsom sediment. That the eroded ground surface with Folsom artifacts was episodically burned over by natural fires from Folsom times to some time in the 6000 ± B.P. time range is shown by the high proportion of burned artifacts present in the Folsom layer and nine radiocarbon dates on scattered charcoal associated with the peak in Folsom artifacts that date to post-Folsom times and range from 9420 ± 25 to 6880 ± 60 B.P. (Surovell et al. 2003:59-69, Figure 8.7; Waguespack et al. 2006: Figure 3.10).

The claim that a hearth is present in the central part of the Main Block is based largely on the presence of a high concentration of burned artifacts and bone. There was no concentration of charcoal, ash, or oxidized sediment at the location of the purported hearth. In their interpretation of the activities represented, site investigators seem to operate under the implicit understanding that the flint knapping activities that produced the flakes in the concentration occurred around a now-eroded hearth and that the episodes of tool use and animal food processing that resulted in the discard of stone tools and bone fragments in the concentration also occurred at a hearth such that the former presence of the hearth is now indicated by a concentration of burned artifacts and bone. Ethnoarchaeological study of modern day foragers demonstrates that trash can be discarded at hearths during short-term occupations (e.g. Binford 1978b), but other studies indicate that during longer-term occupations, foraging peoples commonly clean up the debris produced in habitation and work areas and discard it in middens located peripheral to the places where the habitation and work
actually takes place (e.g. O’Connell 1987). Previous discussion of the Jurgens, Frazier, and Hell Gap sites, strongly suggests that middens are a common feature of sites occupied by aggregations of people involved in large-scale bison hunting and that such features vary in density with concentrations of material occurring where trash was dumped.

In light of the above, is it highly likely that the concentration of burned artifacts and bone thought to represent a former hearth is simply the result of more cultural material being in the particular location of interest because it was dumped there as trash. The burned condition of the artifacts and bone likely resulted from one or more natural fires that burned over the site. A map of the distribution of burned and unburned artifacts in the Main Block shows that burned artifacts occur throughout the block, not just by the purported hearth (Surovell et al. 2003:Figure 8.7). Also, there appears to be a correlation between areas where burned artifacts are concentrated and areas where burned bone is most common (Surovell et al. 2003:Figure 8.8). From the above observations, it is reasonable to conclude that the concentration of burned artifacts and bone is not representative of the location of a former hearth around which trash was discarded. Rather, the concentration is the result of a lot of artifacts and bone having been dumped at that location within a midden which was subsequently subjected to natural fires.

In a later publication, the purported hearth is interpreted as having been centered in the middle of a circular habitation structure (Surovell and Waguespack 2007). The argument for the former presence of a habitation structure is based on the assertion that the concentration of burned artifacts and bone is indeed a hearth which would have been centrally located with respect to surroundings walls of a habitation structure. Two smaller concentrations of artifacts are said to represent concentrations of artifacts pushed up against the walls of the structure. In light of the above discussion, the smaller concentrations are best considered to be simply expressions of the differential density of artifacts that is typical of the trash disposal areas at the site.
Another hearth said to be present in the center of the East Block is of questionable validity for similar reasons and will be refuted here primarily because this helps to demonstrate that a large midden is present at the site. The purported hearth is said to be marked by a concentration of burned artifacts and bone as well as a slight charcoal stain measuring 64 by 40 cm, but there was no indication that the stain was contained within a pit. Burned artifacts and bone are most dense at the concentration said to mark the hearth, but also occurs throughout the East Block excavations (Waguespack et al. 2006:Figures 3.9-3.10). As with the purported hearth in the Main Block, the concentration of burned artifacts and bone actually could have resulted from trash having been dumped in that location within the larger trash scatter with subsequent natural burning causing a lot of burned cultural material to now be present in that location. The charcoal stain without a pit might be feature fill cleaned out from a hearth elsewhere and dumped in the concentration. To support the claim that the stain and associated material is indeed a hearth, the site investigators note that flakes of three types of relatively common non-Kremmling chert artifacts are differentially distributed around the hearth with each scatter of tool stone being indicative of brief episodes of knapping. However, there is considerable overlap in the distribution of flakes of the various tool stones, suggesting that it is possible that the differing distribution of flakes of the three tool stones simply results from separate loads of trash containing different amounts of the various tool stones all having been dumped in the same basic location.

The hearth said to be present in the northeast part of the Main Block does appear to be genuine, but it was radiocarbon dated to post-Folsom times (Waguespack et al. 2006:15-22). The feature is represented by an intense charcoal stain in a circular depression measuring about 37 cm in diameter with oxidized sediment adjacent to the charcoal stain. The top of the hearth is at an arbitrary site elevation of 91.50 m, which would put it in about the right stratigraphic position to be associated with the Folsom layer, according to nearby soil profiles (Surovell et al. 2003:Figure 3.1), but this is difficult to ascertain with certainty, in
part because the sediment deposited at the site is shallow. A split charcoal sample sent to
different radiocarbon dating labs produced dates of 8420 ± 40 and 8246 ± 54 B.P. In
combination, the available evidence would suggest the hearth dates to a post-Folsom
Paleoindian occupation of the site. The site investigators reject this possibility, but the
presence of later archaeological features and material does not diminish the importance of the
site.

The above review would suggest that rather than uncovering evidence of a Folsom
living space with a habitation structure and hearths, the artifact and bone scatter revealed by
excavations in Cluster 1 is arguably part of a large midden produced during occupation of the
site by a large group of people. Table 12-11 presents data on the artifact and tool stone
composition of the assemblage excavated from Cluster 1. The table was constructed by
combining data on the assemblage from the Main Block excavations and test pits in and near
Cluster 1 dug during the first five field seasons (Surovell et al. 2003:102, Tables 5.1-5.2) with
data on artifacts recovered from the East Block during the two ensuing field seasons
(Waguespack et al. 2006:33-34, Tables 3.2-3.3). When tabulating artifacts, the site
investigators combined end scrapers and informal retouched flake tools (including gravers)
into the category “flake tool.” Data from the two block excavations were combined because
of indications that the blocks cover parts of the same midden. The East Block is 9 m east of
the Main Block and a one meter by one meter test pit dug in between the block excavations
suggests that buried cultural material is continuous between them (Waguespack et al.
2006:56-58, Figure 1). Also, the presence of the three most common non-Kremmling chert
tool stones in both the Main and East Blocks suggests that both areas received trash during
the same occupation. As elaborated below, the non-Kremmling chert tool stones are Trout
Creek jasper, pink translucent chert, and what is thought to be quartz crystal. To appreciate
the numbers of various kinds of artifacts presented in Table 12-11, it is first necessary to gain
some idea of the size of the area from which the assemblage was recovered. Excavations in
Table 12-11. Tool Stone and Artifact Composition of Assemblage from Locality B at the Barger Gulch Site Complex. a

<table>
<thead>
<tr>
<th>Tool Stone Type</th>
<th>Mostly Manufacturing Debris</th>
<th>Flaked Stone Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>------------------------------------------------------</td>
<td>-----------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Kremmling Chert</td>
<td>45,980</td>
<td>3,491</td>
</tr>
<tr>
<td>Petrified Wood from Middle Park</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Windy Ridge Orthoquartzite</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Quartz Crystal</td>
<td>71</td>
<td>1</td>
</tr>
<tr>
<td>igneous Rock</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Morrison Quartzite</td>
<td>11</td>
<td>1</td>
</tr>
<tr>
<td>Pink Translucent Chert (Flat Top Chalcedony ???)</td>
<td>88</td>
<td>0</td>
</tr>
<tr>
<td>Opaque, Weakly Banded, Gray-to-Brown Chert</td>
<td>143</td>
<td>0</td>
</tr>
<tr>
<td>Other Tool Stone (Includes Point of Dark Yellow-Orange Mottled Chert)</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>Coarse Brown Chert</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Pink Dendritic Chert</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Red and Yellow Translucent Chert</td>
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<td>0</td>
</tr>
<tr>
<td>Speckled Chert</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>Sandstone</td>
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<td>0</td>
</tr>
<tr>
<td>Trout Creek Jasper</td>
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<td>0</td>
</tr>
<tr>
<td>Dawson Petrified Wood</td>
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<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>46,573</td>
<td>3,494</td>
</tr>
<tr>
<td>Percent of Collection</td>
<td>91.87</td>
<td>6.39</td>
</tr>
</tbody>
</table>

a  Data from Surrovell et al. (2003:102, Tables 5.1 - 5.2); Waguespack et al. (2006:33-34, Tables 3.2 - 3.3).
the Main Block during the first five seasons totaled 40 m² and test pits in and near Cluster 1 totaled 18 m² (Waguespack et al. 2006:Figure 1). A total of 25 m² was excavated in the East Block. In sum, 83 m² was excavated, which equates to an area measuring 9.1 m by 9.1 m. Within the area encompassed by the excavations, a lot of debris from flint knapping was deposited, as seen by the presence of 50,067 flakes.

Gearing up for large-scale bison hunting may be suggested by noting the presence of large quantities of artifacts that are manufacturing debris arguably from production of bifacial points and knives, as well as debitage from the manufacture of unifacial tools (including end scrapers) for use in butchering and hide processing. Within the excavated areas were 45 mostly blocky cores, and 40 primarily unfinished bifaces that likely are manufacture rejects (Table 12-11). That a considerable amount of the biface manufacturing that took place at the site was directed toward production of hunting weaponry is seen in the fact that 25 ruined projectile point preforms and 147 channel flakes were recovered. A total of 322 artifacts are informal retouched flake tools and 21 are end scrapers. Finally, an unspecified number of tools that some may classify as “notches” or “spokeshaves” may be evidence of the production of wooden shafts for use in hunting weaponry, although no use wear study was conducted to assess if these artifacts were in fact used on wood (Surovell et al. 2003: 94, Figure 5.6).

Evidence for production of red ochre powder also supports the idea of occupation by a human group intent on large-scale bison hunting. As discussed in Chapter 8, evidence for production of powdered ochre at Locality B and other sites suggests a possible correlation between sites occupied by people involved in large-scale bison hunting and production of ochre powder to prepare for some activity that required the use of this mineral in powdered form. A total of 56 pieces of ochre, ranging in size from .5 to 3.3 cm in maximum dimension, were found in the excavations (Surovell et al. 2003:104-105; Waguespack et al. 2006:34-35). Nine artifacts classified as abrading stones were found and are essentially
tabular fragments of sandstone with adhering ochre or striations from use on one or more surfaces. They may have been used to grind pieces of hematite into a powder.

Besides preparing for a large-scale hunt, other evidence from the excavations in Cluster 1 supports the idea that people camped nearby were also involved in some amount of ongoing hunting of bison. A small amount of bone was recovered, but the evidence suggesting that much of the Folsom layer is present in sediment of post-Folsom age on an erosional surface gives support to the thinking that more bone may have once been present, but was completely disintegrated when exposed on the ground surface for long periods of time. A total of 1,470 bone fragments were found, the majority of which are less than 5 cm in maximum dimension and cannot be identified as to species represented (Surovell et al. 2003:105-106; Waguespack et al. 2006:34-35). Identifiable fragments of a vertebra, a metapodial, and four other fragments of limb bones are from a bison-sized mammal. Three rib fragments are indentified as deriving from a medium-to-large mammal. A single bison molar was recovered and, incidentally, should be examined to determine if it can provide much needed data on the season of site occupation. A minimum of just one bison is represented by the single molar, but the presence of 21 discarded Folsom points suggests that the amount of hunting that took place during site occupation is underrepresented by the small quantity of preserved bone. Destruction of some of the bone once present likely occurred through prolonged exposure on the ground surface. Some bone apparently was buried quickly and was preserved because it remained buried until excavated. Lack of any preserved portion of a dense bonebed would tend to favor the thinking that faunal remains and points from Locality B are demonstrative of on-going hunting conducted in order to feed the human group present, rather than being indicative of a successful large-scale bison kill.

The condition of the points suggests that broken hunting weaponry was returned to the site in the hafts of spears or in carcass segments and then discarded in the midden. Of the 21 points, 17 are basal fragments, two are tips, and two are complete points with reworked
tips (Surovell et al. 2003:102; Waguespack et al. 2006:33). Basal fragments suggest that points broken in the haft while hunting in the field were returned to camp and discarded. One basal fragment is particularly noteworthy because channel flake fragments refit to both faces, indicating that the point was finished on-site, broken while hunting in the field, and finally, the basal fragment was returned to camp where it was removed from the haft and discarded. Though not definitive, presence of point tips may signify transport of big game carcass segments back to camp where the tips eventually ended up in the trash.

Recovery of 21 end scrapers from the excavations supports the view that hides of animals killed afield were processed on-site. Use wear analysis of the end scrapers noted that four specimens demonstrate edge modification resulting from use on dry hide, one exhibits edge properties similar to those of an experimental end scraper used on wet hides, and one specimen demonstrates polish most indicative of wood working (Daniele 2003).

The possibility that the midden of Cluster 1 was produced by a large group of people is bolstered by the observation that the relatively large assemblage was recovered from a small percentage of the area encompassed by the surface expression of Cluster 1. As mentioned, Cluster 1 is roughly an oval-shaped distribution of surface artifacts measuring 57 m by 30 m. The size of the midden can be very roughly estimated by calculating the area of the oval shaped area in which it occurs using the formula for the area of an ellipse: length times width times .785 = (57 m) (30 m) (.785) = 1,342.35 m². The total area excavated in Cluster 1 was calculated above as 83 m². Dividing this figure by the estimated area of Cluster 1 suggests that possibly that only 6 percent of the midden has been excavated. This in turn implies that the midden may be fairly large and perhaps was produced by a large group of people.

The environmental setting of the site provides further support to the idea that Locality B was produced by an aggregated group of people intent on gearing up for large-scale bison hunting with the local tool stone. Based on the positioning of the Red Smoke and Lime
Creek sites within one to a few hundred meters of tool stone outcrops, I suggested above that a group intent on gearing up would have camped as close as possible to a high-quality tool stone source. The presence of a live stream (Lime Creek) permitted people to camp very near the lithic sources exploited. The Hell Gap site cluster is in a more arid environment than are the Medicine Creek sites. As discussed in the section on Hell Gap, groups of Paleoindians would not have been able to camp right at high-quality lithic sources on the Hartville Uplift, but instead had to camp at the closest sources of drinking water which evidently were seeps along Hell Gap Creek near Localities I, II, and V. Barger Gulch is also presently in a semi-arid environment, as seen in the fact that the drainage normally is an intermittent stream with flowing water in it only when the winter snows melt in the spring and after downpours. Study of the buried soils at the site revealed evidence supporting the idea that during the wetter climate of Folsom times, a source of drinking water was present at the site. According to Reider (1998:67), “a paleo-Aquoll (wet meadow soil) occurs near the excavation area of Locality B, indicating the presence of active springs.”

Surovell et al. (2003) suggest that Locality B should not be considered a quarry site because it is not positioned close to a high-quality source. However, the relatively arid environment in which the site occurs may have prevented people from camping close to a high-quality source. The authors note that, “Locality B is not located adjacent to any large high quality sources of this material, the closest of which lie over 1 km away to the east and northwest. This observation suggest[s], as we have argued previously that procurement of chert was not the primary impetus for the occupation. In other words, Barger Gulch should not be considered a quarry site” (Surovell et al. 2003:83). Judging from the map of sources provided by Surovell et al. (2003:Figure 5.2), the closest high-quality sources of Kremmling chert are both about 1.1 km from the site. Minor sources of Kremmling chert mapped by Surovell et al. (2003:Figure 5.2) occur about 200 m northwest and 300 m southeast of the site. Review of data from Locality V of the Hell Gap site complex permitted a strong case to
be made in support of the idea that Paleoindians camped near the site had geared up for large-scale bison hunting using the locally available Hartville Uplift chert. Existing literature notes that the eight closest sources of this tool stone are located from 1½ to 8 km from Locality V, although the literature does not record if the sources may be considered to be high-quality.

Considering that the sources of Hartville Uplift chert exploited at Hell Gap are not right at the Localities where the stone was worked, the fact that Locality B of the Barger Gulch site complex is located 1.1 km from the closest high-quality sources of Kremmling chert should not be considered as an abnormally long distance from raw material. Nor should this be taken as evidence that procuring local tool stone to gear up was not an important site activity that factored into the decision of Paleoindians to camp where they did. In semi-arid environments like the Hell Gap area and Barger Gulch where drinking water is not present in permanent streams but rather is available only at scattered springs, it may simply have been more efficient for a large group of people to camp at one of the springs in the vicinity of one or more high-quality sources and then send some people to go and get a load of blocky cores and roughed out bifaces. Once a supply of tool stone was procured, flint knappers would have sufficient raw material to last a number of days. On the other hand, if a large group of people camped at a high-quality source, the group would like have to send people to fetch water on a daily basis. To summarize, the location of the site in the main source area for Kremmling chert offers some support for the notion that the occupation may be related to gearing up for a large-scale hunt.

Being situated in a source area, it is not surprising that the tool stone composition of the Locality B assemblage is dominated by the local chert, but a diverse array of other tool stones are present in very small amounts and a few may be indentified to nonlocal sources. Kremmling chert comprises 98.8 percent of the assemblage, according to artifact count, with other tool stones from local sources in Middle Park occurring in very small amounts (Table 12-11). A diversity of other tool stones that I classify as being from either local or nonlocal
sources comprises only .7 percent. Included in this category are three tool stones said by Surovell et al. (2003) and Waguespack et al. (2006) to be local, but no evidence is given to support the claim. Also included in the category is unsourced stone believed by the original site investigators to be from nonlocal sources outside Middle Park. Judging in part from the description of one of these tool stones as a pink translucent chalcedony, the material may be from a very distant source if it proves to be Flat Top chalcedony (see below). Finally, small amounts of artifacts that total .5 percent of the assemblage are classified as deriving from definitely nonlocal sources with the main primary sources located in distant lands. Included in this category are tool stones identified as Trout Creek jasper and Dawson petrified wood.

Tool stones considered to derive from local sources include the preponderance of Kremmling chert and two other raw materials that are both represented by only one small flake each. The site investigators grouped flakes, pieces of shatter, and pot lids from the site according to size, with debitage smaller that 2 cm in maximum dimension here referred to as small flakes and debitage larger than 2 cm here called large flakes. As mentioned, Kremmling chert is one of the three main tool stones used by prehistoric people in Middle Park and is available from high-quality sources as close as 1.1 km from the site. One of the local materials is a brown petrified wood that Surovell et al. (2003:84) note is similar to naturally occurring pieces observed in the Barger Gulch catchment. The bedrock outcropping in the Barger Gulch drainage is the Troublesome Formation (Miocene). Richards (1941:27) reports on petrified logs eroding from the Troublesome Formation elsewhere in Middle Park. The other local material is identified by site investigators as Windy Ridge orthoquartzite. This raw material is the second of the main tool stones used in the park. The main primary source of the tool stone is 43 km northwest of Locality B. The relative lack of this major Middle Park tool stone in the Locality B assemblage contrasts with the fairly common occurrence of the material in the assemblage from Upper Twin Mountain. The third major Middle Park tool
stone, Table Mountain jasper from the eastern portion of the park, is not present in the Locality B assemblage at all.

Among the eleven uncommon tool stones with unknown or uncertain sources that are here grouped as coming from either local or nonlocal sources is a material described by the site investigators as simply quartz. Seeing as though the common crystalline form of quartz that occurs as constituents of igneous rock (such as granite) and as the main mineral in some intrusive dykes and sills does not fracture in a concoidal manner, it is assumed here that the raw material is transparent quartz crystal, a raw material that is difficult to flake, but can be used to produce stone tools. Surovell et al. (2003:83) confirm that the raw material is “of extremely low quality and occurs exclusively as debitage… The majority of that debitage is angular debris, with very few pieces showing clear flake morphology or concoidal fracture.” The raw material is classified by Surovell et al. (2003:82) as local, but they acknowledge that it could have been imported from more distant locations. No information is given to support the assertion that the quartz comes from a local source. East of South Park, Precambrian granitic rocks of the Pikes Peak batholith (Tweto 1979) produced a number of major source areas of quartz crystals known to gem collectors, including Crystal Peak, Crystal Park, and Devils Head (Pearl 1972:126-129, 168-170, 185-189). Quartz crystals outcropping from rocks of the Pikes Peak batholith are known to have been used by native people as a source of tool stone. For example, a quartz crystal procurement site located northwest of Chessman Reservoir on the South Platte River is recorded as 5JF3075. This source of crystals lies 120 km southeast of Locality B and suggests that if the tool stone at Locality B is indeed quartz crystal, this raw material may have been obtained from a distant source to the east of South Park. The fact that some stone in the assemblage was identified as Trout Creek jasper from a source west of South Park adds credence to the possibility that the quartz comes from a distant source to the southeast of Middle Park.
Four small flakes and one large flake are of a material described only as igneous rock that is said to be of local origin. Until more information is provided on exactly what this raw is and where it occurs, I will classify it as unsourced.

One core, one large flake, and 11 small flakes are described simply as Morrison quartzite which the site investigators state is local in origin, but again they provide no supporting information. The Morrison Formation does outcrop in the North and Middle Park geologic basin, but I am unaware of a source of Morrison orthoquartzite. The closest sources of this material with which I am familiar are the distant sources by Kalouse discussed in Chapter 7 which occur to the east-northeast of Locality B at a distance of 221 km.

The following eight tool stones are considered by the original site investigators to be from nonlocal sources outside of Middle Park. Though this may very well be true, they are identified in Table 12-11 as raw material from local or nonlocal sources because their source is unknown. Together, they comprise less that one percent of the assemblage.

The third most common non-Kremmling chert tool stone is described as a pink translucent chert which the site investigators believe comes from a nonlocal source. One artifact thought to be a fragment of an end scraper (Surovell et al. 2003:87-88) and 88 small flakes comprise the sample of this tool stone. The description of the tool stone conforms to that of Flat Top chalcedony.

The second most common non-Kremmling chert tool stone is described as an opaque, weakly banded, gray-to-brown chert. Included in the sample of this raw material are 143 small flakes, six channel flakes, one point, and one artifact classified as a flake tool.

A total of 15 small flakes and a point are classified simply as “other” tool stone (Waguespack et al. 2006:33-34, Table 3.3). The point is said to be made of a “dark yellow-orange mottled chert,” but it is not specified if the flakes are also of this material.

Other unsourced tool stones thought by the original site investigators to be from outside Middle Park include those that are represented solely by small flakes, flake tools, or
both. Included is a coarse brown chert that produced two flake tools and one small flake. A
pink dendritic chert and a red and yellow translucent chert are represented by one flake tool
each. Finally, 12 small flakes are of a speckled chert.

Nine artifacts classed as abrading stones are made of tabular pieces of a sandstone
that is not described in detail. Possible sources of the sandstone are not discussed.
Formations that produce durable slabs of sandstone, such as the Dakota Sandstone, do
outcrop in Middle Park, so a local source is possible.

One of the two definitely nonlocal tool stones identified as a named tool stone type
from a distant source is Trout Creek jasper. The source of this material is 136 km south of
Locality B in the relatively low mountain range separating South Park from the Upper
Arkansas Valley to the west. Trout Creek jasper is the most common non-Kremmling chert
tool stone in the collection, accounting for 246 small flakes, five flake tools, one biface, one
point preform, and three channel flakes. Surovell et al. (2003:82) identified the tool stone as
Trout Creek jasper through comparison with material from the source, which they visited. A
segment of the edge of the point preform is perpendicular to the faces and conjoins with a
break facet on a large, thin biface fragment, demonstrating that the preform was made from a
fragment of a large biface (Surovell et al. 2003:84-87, Figure 5.5). These conjoining artifacts
are noteworthy because they suggest that some large bifaces known from Clovis and Folsom
sites may be specialized bifaces intended for point manufacture, rather than bifacial cores. A
total of 21 of 55 Clovis bifacial blanks from the Anzick cache in Montana have break facets
perpendicular to both faces preserved along a segment of lateral edge, suggesting that they
too were made from fragments of larger bifaces (Wilke et al. 1991:Figures 7-11). One of the
three channel flake fragments of Trout Creek jasper refits to a flute on the preform. Surovell
et al. (2003:87) suggest that the other two channel flakes may indicate that another preform
from the large biface was fluted on the site, so apparently the channel flakes are of the same
color and texture as the biface fragment and point preform.
The other definite nonlocal tool stone in the assemblage that comes from a distant source is Dawson petrified wood, which is represented by a single informal retouched flake tool, specifically a spokeshave that was made on a secondary flake. The wood grain evident on the cortical surface suggests the petrified wood was obtained from a primary source, rather than from river gravels (Surovell et al. 2003:Figure 5.6). The center of the primary source area of Dawson petrified wood in the Palmer Divide area is located 164 km east-southeast of Locality B.

Crying Woman Site

Another Folsom site in the general area of the main source area for Kremmling chert is known as the Crying Woman site (Naze 1994). A minor outcrop of Kremmling chert occurs on-site, but was probably not the source for the hundreds of thousands of pieces of Kremmling chert debitage present on this large multicomponent site. A high-quality source of Kremmling chert is about 4 km from the site. Artifacts on the site occur around the rim of a topographic bowl that contains a spring at the head of an intermittent stream, as well as around the spring itself. Characteristics of the site’s location are conducive to camping, including the presence of drinking water from the spring and firewood from on-site stands of conifers present on the northward facing slopes of the bowl.

The site was reported by artifact collectors who found Folsom diagnostic artifacts on the ground surface in two areas on the site. Near the top of a gentle southeast slope of a northeast trending ridge flanking the rim of the bowl was found a fluted Folsom point preform of Kremmling chert. A two meter by two meter test pit, designated Excavation Unit 1 was dug at the spot where the preform was found (Naze 1994). On the ground surface, about six meters to the south was found a fire-cracked, basal fragment of a Folsom point. The raw material of the point is black chert with tan speckling and a red dot. Exposure to fire can darken the normally white Kremmling chert and even turn it completely black. This is
nicely illustrated by a photograph of an unfluted Folsom or “Goshen” point from another site in Middle Park. The point originally was made of white Kremmling chert. A basal fragment of the point conjoins to a distal fragment. The basal fragment had been exposed to fire and is now pitch black while the proximal fragment was evidently not exposed to fire and remains white (Kornfeld and Frison 2000:Figure 9). The fire-cracked fluted point fragment from the Crying Woman site has a red speck, which is not characteristic of Kremmling chert, but is a trait of the Sevenmile Ridge variety of Bridger chert from northwest Colorado. This variety of Bridger chert is normally very dark brown to black with tan speckling and sparse red specks and white or light blue ostracod fossils. Excavation of the test pit revealed that post-Folsom buried artifacts occur above a Folsom occupation layer that has been disturbed by the activities of burrowing animals, particularly badgers. The entrance to a badger hole was located in the northeast quarter of the excavation unit and the preform had been found on the ground surface of what was to later become the southwest quarter of the excavation unit. The digging activity of badgers is thought to have brought the Folsom preform to the ground surface. The areal extent of the Folsom occupation layer is unknown. At a location estimated to be 110 m southwest of Excavation Unit 1, an unusually small Folsom point of Table Mountain jasper was found in another area where the terrain slopes gently northward toward the rim of the bowl. Judging from the distance from the point to the area that was test excavated, the point may not relate to the same occupation represented in Excavation Unit 1. Therefore, the point is not included in the artifact assemblage discussed here. Included in the assemblage are artifacts from the defined occupation layer, as well as diagnostic Folsom artifacts that are thought to have been displaced to the ground surface and to a depth below the occupation layer by the activity of burrowing animals. The diagnostic artifacts include the point and preform from the ground surface and another preform found below the occupation layer.
The Folsom occupation layer appears to be emplaced just above the southward sloping contact between two soil strata. This stratigraphic contact may indicate that the ground surface in the vicinity of the excavation unit once sloped more steeply to the south toward a swale that flanks the low, broad ridge on which the surface artifacts were found. From top to bottom, three sedimentary strata were defined and numbered 1 to 3 (Naze 1994). The underlying bedrock is white tuff of the Troublesome Formation. The Folsom layer appears to be just above the contact between strata 1 and 2. Since the nature of sediment stratification was unknown prior to excavation, the test pit was excavated in 10 cm levels that did not follow the inclination of the strata. The test pit was excavated in four quarters measuring one square-meter each and designated the northwest, northeast, southwest, and southeast quarters. The Folsom occupation layer was defined primarily by peaks in the vertical depth of buried artifacts within each quarter. In the levels with relatively high densities of artifacts were diagnostic Folsom artifacts, including three channel flakes. Also present in a level defining the Folsom occupation layer was an end scraper with a spur on one end of the distal edge. Spurred end scrapers are common in Paleoindian assemblages (Rodgers 1986). Some artifacts that might be of Folsom manufacture were excluded from the assemblage considered herein. Included are tools of Kremmling chert from excavation levels close to those that define the occupation layer. Among these are a side scraper and a utilized large biface thinning flake. The distal fragment of an end scraper of the streaked variety of Bridger chert was found in the uppermost excavation level in the southwest quarter, which is where the Folsom preform was found on the ground surface. Because of its proximity to the Folsom preform and the relative rarity of Bridger chert artifacts on the site as a whole (Naze 1994:Table 6), it is possible that the end scraper fragment was brought to the ground surface along with the preform by the badger activity. However, this is not for certain, consequently the end scraper fragment was excluded from the Folsom assemblage considered here.
Although only a small area has been excavated, the artifact assemblage recovered permits a preliminary interpretation of the site to be offered. Interpretations are tentative because the nature of the assemblage is known from a relatively small sample of artifacts (n = 104) recovered from an excavation unit measuring only two meters by two meters. The test pit revealed that a buried cultural layer containing a fairly dense concentration of artifacts is present, but the size of the archaeological deposit is unknown.

The archaeological deposit exposed in Excavation Unit 1 is tentatively interpreted as a midden deposit where lithic debris produced elsewhere on the site was discarded, but some of the debitage present may be from knapping activity that actually took place at the location of the test pit. Ethnoarchaeological study of trash disposal among a group of Australian aborigines documented that items larger than five cm in maximum dimension were generally tossed onto a midden shortly after they were finished being used or produced in an activity, while smaller items were dropped in the activity area where they were produced (O’Connell 1987:82). Subsequent sweeping up of work areas, usually within a few days, would transport some of the smaller items to the midden. Of the 90 flakes from the excavation unit, 22 (or 24 percent) are microflakes that were recovered during wet screening samples of the excavation levels through 1/16 inch window screen. The sampled areas comprise only 1/25 or 4 percent of the total area excavated in each 10-centimeter-thick excavation level. The above information implies that a substantial amount of flakes present in the Folsom layer in the area of Excavation Unit 1 are so small that their presence suggests either that they were produced from knapping activity that occurred at the location of the test pit or that knapping activity performed elsewhere involved using a hide to catch debitage which was later discarded in the midden.

Evidence from the Crying Woman site can be cited to support an interpretation of the cultural layer in Excavation Unit 1 as the product of a group of people that had geared up at the site using the local Kremmling chert in preparation for communal hunting. The
alternative view acknowledges that small task groups would sometimes have visited lithic sources, but the point and end scraper associated with the cultural layer is more suggestive of a group camped at that site that was not only involved in stone tool manufacture, but was also concerned with on-going hunting and other activities. The end scraper cannot be said to provide evidence of hide processing because the distal edge of the specimen demonstrates mostly step flaking and edge crushing rather than a polished and rounded edge characteristic of hide working (Naze 1994:193). The kinds of artifacts in the Crying Woman site assemblage gives general support for the assertion that gearing up for large-scale hunting may be represented. From the kinds of flakes retrieved from the 1/4 inch screen, it can be suggested that the manufacture of both unifacial and bifacial tools occurred on-site (Table 12-12). The presence of two preforms and three channel flakes within the confines of a single two-meter by two-meter test pit suggests that a good amount of bifacial artifact manufacture may have been directed toward production of projectile points.

If indeed the archaeological deposit at Excavation Unit 1 was a midden representative of gearing up like those herein suggested to have existed at Locality B of the Barger Gulch site complex and the localities of the Hell Gap site complex, then one might reasonably expect to find some bone from animals hunted to feed a group amassed for a large-scale hunt, but none were present. Bone that is likely intrusive to the deposits was common, including numerous isolated bones of northern pocket gophers and Richardsons ground squirrels, as well as some coprolites comprised of bones of these animals that were likely produced by badgers (Naze 1994:187). Like the nearby Locality B, evidence from Excavation Unit 1 at the Crying Woman site suggests that Folsom cultural material may have been exposed on the ground surface for periods of time sufficient to cause bone representing food remains that was once present to completely disintegrate under the forces of weathering. Fire-cracked artifacts from the occupation layer suggest the Folsom cultural material was exposed on the ground surface for some time during which artifacts present were fractured by
Table 12-12. Tool Stone and Artifact Composition of Folsom Assemblage Associated with Excavation Unit 1 at the Crying Woman Site. \(^a\)

<table>
<thead>
<tr>
<th>Tool Stone Type</th>
<th>Manufacturing Debris</th>
<th>Stone Tools</th>
<th>Distance to Tool Stone Source Used in Analysis (km)</th>
<th>Relative Distance to Tool Stone Source</th>
<th>Percent of Assemblage Composed of Tool Stone Type, According to Artifact Count</th>
<th>Percent of Assemblage Composed of Local Versus Nonlocal Stone, According to Artifact Count</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flakes from 1/4 Screen</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kremmling Chert</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Definite Flakes from Bifaces</td>
<td>21</td>
<td>47</td>
<td>22</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>FLakes from Bifaces and Indefinite Flakes from Bifaces</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Micro-Flakes from 1/16 Inch Screen</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Point Preforms</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chancel Flakes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Utilized Flakes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Utilized Naturally Shaped Piece of Tool Stone</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Informal Retouched Flake Tool (Engraving or Boring Implement)</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>End Scraper</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Projectile Point</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total Number of Artifacts</td>
<td>21</td>
<td>47</td>
<td>22</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Percent of Assemblage</td>
<td>20.19</td>
<td>45.19</td>
<td>21.15</td>
<td>1.92</td>
<td>2.84</td>
</tr>
</tbody>
</table>

\(^a\) Data from Naze (1994).
natural fires before being buried. One of the channel flakes from the occupation layer and a few other flakes from the occupation layer were fire-cracked, as was the point fragment from the ground surface (Naze 1994:12, 186, 199). That the artifacts were likely burned by natural fires when exposed on the ground as opposed to having been burned in a hearth and later discarded is seen in evidence from the excavation unit indicating that fires repeatedly swept over the area. In reporting on Excavation Unit 1, I noted that:

“…naturally occurring chert pebbles, many of which display thermal fracturing, were collected from throughout the excavation unit and were particularly common in Strata 1 and 2. Thermally fractured chert pebbles occur in association with the Folsom occupation layer and overlying cultural deposits. A total of 28 thermally fractured chert pebbles occurred in the Folsom occupation layer and a sum of 133 were recovered from the entire excavation unit. Such pebbles were likely fractured as a result of natural phenomena, such as exposure to brush fires. Evidence of previous brush fires was encountered during excavation. A vertical exposure of a burned sagebrush root was evident on the south wall of the excavation unit, near the ground surface… Several small, circular charcoal stains, measuring a few to several centimeters in maximum dimension, were exposed on excavation level floors from 10 to 120 centimeters bpgs [below present ground surface]. These charcoal stains are interpreted as representing burned roots, probably sagebrush roots [Naze 1994:199-200].

The above suggests that any bone that may have been deposited by site occupants along with the artifacts may have completely weathered away during periods of exposure on the ground surface.

The local Kremmling chert and the Sevenmile Ridge variety of Bridger chert from a distant source area in the Yampa River drainage in northwest Colorado are the only two tool stones present in the Folsom assemblage. Kremmling chert was used to produce over 98 percent of the assemblage, according to artifact count (Table 12-12) and is the raw material of all of the flakes, point preforms, channel flakes, and informal tools. As elaborated in Chapter 7, the principal source of the variety of Bridger chert present in the defined Folsom layer is Sevenmile Ridge, which bounds the Sand Wash Basin on its east side. A recorded procurement site for the Sevenmile Ridge variety is 5MF2909 which is situated 186 km west-northwest of the Crying Woman site. The only formal tools definitely assigned to the Folsom assemblage (the point from the ground surface and the end scraper from the occupation layer)
are made from the Sevenmile Ridge variety of Bridger chert. Since the end scraper made of the streaked variety of Bridger chert might be of Folsom manufacture, it is relevant to note that this variety is common throughout the Sand Wash Basin and was quarried prehistorically from pits at sources in the central part of the basin.

**Jerry Craig Site**

A second site associated with communal bison hunting in western Middle Park is named after the artifact collector who discovered it in the 1970s. The site is located in the Troublesome Creek drainage in the vicinity of Little Wolford Mountain. Test excavation of a bonebed by the University of Wyoming in the 1990s determined that the site dates to early in the Cody time period, based on a radiocarbon date of 9310 ± 50 B.P. obtained on charcoal directly associated with the bone deposit (Kornfeld 1998:53-54). The area containing the bonebed is located at the northern base of a moderately sloping, eastward trending ridge. More specifically, the bonebed is in a topographic bowl that was formed in the side of the ridge and opens to the north. A small drainage in the bottom of the bowl flows to the north when transporting water during spring runoff and after downpours. From higher country to the west, an intermittent stream drains into the bowl, then bends northward and gradually turns northeastward to join a tributary of Troublesome Creek.

Dental ages of five bison mandibles exhumed during excavations range from $N + .3$ yr to $N + .5$ yr. If the middle dental age marks the time of the bison kill, then the event occurred around August or September.

The current environmental setting of the site is not very conducive to camping. The portion of the site with the bonebed is covered with sagebrush. East of the site, sagebrush carpets the basically flat terrain in the Troublesome Creek drainage. Today, the Troublesome Creek drainage is semi-arid country with water available only from the creek and scattered springs. Firewood is available from isolated stands of trees on the northern slopes of a series
of mountains along the drainage divide between Troublesome Creek and Muddy Creek, which is located to the west. From north to south, these mountains include Wolford, Little Wolford, and Twin mountains. Currently, the intermittent stream along which the site is located is dry in summer except after a downpour and trees are only present as small isolated stands on the north slope of the ridge, the closest of which is about 120 m from the bonebed.

Paleoenvironmental studies have revealed that during the Paleoindian occupation, the environment of the site was conducive to camping because drinking water and firewood was readily available. A study of the ancient soils at the site by Reider (1998:64-66) revealed that a paleosol, which formed in a wet meadow environment, is exposed 30 m northeast of the bonebed in the deepest sections of the drainage at the bottom of the bowl. Characteristics of the soil horizon indicate that running springs were formerly present. Furthermore, the stratum in which the bonebed was emplaced demonstrates qualities diagnostic of a forest soil and strongly suggests that trees were present on the site at the time of occupation. Analysis of pollen samples collected from the site further supports the idea that stands of timber were more extensive on the north slope of the ridge when the bonebed was produced (Scott Cummings and Moutoux 1998). Comparison of pollen samples from the cultural level with that collected from the modern ground surface demonstrates relatively less arboreal pollen in the modern pollen ran than that during Cody times. In Chapter 6, environmental conditions in the study area during Cody times were characterized as having been not drastically different from those of today. Although still basically true, the pollen data from Jerry Craig and other sites in Middle Park demonstrate an increased level of precipitation prevailed in the region early in the Cody time period. Increased precipitation would have depressed the elevation of the lower tree line in Middle Park and expanded isolated stands of trees, like those in the Little Wolford area.

The above information provides partial support for an interpretation of the Jerry Craig site as a temporary hunting camp. Given the environmental characteristics conducive
to camping, particularly the presence of drinking water and firewood, it is reasonable to suggest that during Cody times, an aggregated group of people surrounded and killed a herd of bison somewhere in the Troublesome drainage or adjacent parts of western Middle Park. Probably with the assistance of dogs, bison carcass segments were then transported to the wooded area by the spring at the Jerry Craig site where the meat was processed at a temporary hunting camp.

In contrast, an interpretation of the site in existing literature suggests that the bison were actually killed at the bonebed. Under this scenario, water from the spring and the wet meadow vegetation would have attracted bison and the topography and patches of forest would have served to impede their escape. Reider (1998:68) suggests that, “[t]he meadows may have been prime grazing areas for bison and other animals hunted by aboriginal groups. In the case of the Jerry Craig site, bison could have been run up the wet meadows to the forest at the head of the drainage. Blocked by the forest and the steep topography, the bison could have been prime targets for slaughter.”

However, based on the limited test excavations carried out to date, one might argue that the bonebed is a midden where trash was discarded at a temporary hunting camp. The areal extent of the bonebed is still poorly understood. The densest concentration of bone apparently was situated on the west side of the bowl within an area measuring a minimum of 4 m north-south by 4 m east-west where several excavation units measuring one meter by one meter were dug. Scattered bone was encountered and mapped within a row of three and one-half contiguous excavation units aligned east to west. Only half of the westernmost excavation unit was dug. Excavation of the row of units produced the pollen samples and pieces of charcoal used in radiocarbon dating. Scattered bison bone was also encountered in a one-meter by one-meter excavation unit situated two to three m north of the row of units. Within these five excavation units, bones from five bison were scattered, so the bones may have been discarded in a fairly concentrated area. Excavation units revealed that bone is also
distributed over a broader area measuring 17 m north-south by six m east-west, although its presence was apparently not as dense (Logan et al. 1998:20-22). The above facts suggest the current minimum number of bison will increase with future excavations, perhaps dramatically.

The fact that a large number of points are known from the site suggests the bonebed may have been produced following a comparatively large kill. Richings (1998:28) reports that a total of 64 points are known from the site. A total of 43 were picked up from the ground surface by artifact collectors and archaeologists. Surface points were distributed throughout the bowl within an area measuring about 145 m north-south by 125 m east-west (Logan et al. 1998:Figure 3.1).

Available information suggests that the dense concentration of bone uncovered at the site is a midden where bone, points, and debitage were discarded. Surface points were concentrated in the area where test excavation revealed bison bone to be the densest, as well as along the drainage in the bottom of the bowl. Test excavations produced 21 points and exposed an area totaling 12.5 m². Therefore, about 1.7 points were uncovered with every square meter excavated. A map showing the distribution of artifacts in the row of excavation units and the unit to the north indicates that 15 points or fragments were present in a total excavated area of 4½ m². In other words, about 3.3 points were recovered from each square meter excavated in the densest part of the bonebed. The site investigators also note that, “[t]he frequency of debitage is highest in association with the bone bed” (Logan et al. 1998:22).

The presence of a few non-bison bones in the bone deposit provides additional support for the thinking that a midden at a temporary hunting camp may be represented. Four unidentifiable bone fragments from a small-to-medium sized mammal were recovered along with the bone from the wing of an unidentified bird (Logan et al. 1998:13, Table 3.3).
Presence of some non-bison faunal material suggests the possibility that other kinds of animals were taken while the human group was camped at the site.

As with the other excavated Paleoindian sites in western Middle Park, it is important to note that the bonebed was exposed to weathering and fire before being buried. The bison bone was “highly fragmented” and was found in a condition “exhibiting extreme weathering and intense burning” (Logan et al. 1998:13). Artifacts in the bonebed and elsewhere were also burned. Cultural material excavated at Jerry Craig and other Middle Park Paleoindian sites seem to demonstrate a pattern where slow sediment deposition can leave bone and artifacts exposed on the ground surface for long periods during which time the bone becomes weathered and both bone and artifacts may be burned by natural fires.

Although most points from the site appear to be classifiable as Cody points, this type may have been recovered from the bone level in association with a number of Angostura points. In an appendix, three unnumbered pages of photographs of 37 different points from the site show 23 points with square bases, parallel lateral edges, or other characteristics diagnostic of Cody points, along with one Angostura point (Kornfeld 1998). Of the 11 complete points drawn in Richings’ (1998) discussion of the point collection, three are classifiable as Angostura points. One was collected from the ground surface and two were recovered during test excavations. The row of three and one-half excavation units in the densest part of the bone deposit produced three complete Late Paleoindian projectile points. Two are Cody points (specimens J100-5-33 and J101-8-49; Logan et al. 1998:Figure 4.1, first page, top row, right specimen and bottom row, middle specimen). Apparently specimen J101-8-49 is incorrectly labeled in the report as having come from J100-8, which refers to an excavation unit that has yet to be excavated (Logan et al. 1998:29). The third excavated point from the row of excavation units conforms to the Angostura type (specimen J101-8-67; Logan et al. 1998:Figure 4.1, first page, top row, left specimen). Another Angostura point
was found during excavation of unit N100-16, located 15 m north-northwest of the row of three and one-half excavation units. However, the point was not found *in situ*.

It is relevant to note that the soil profile of the south wall of the row of three and one-half excavation units indicates the stratigraphic position of the bonebed with associated projectile points, but also shows two points of unidentified type on the contact between two strata above a stratum radiocarbon dated to 3750 ± 50 B.P. (Kornfeld 1998:Figure 6.12; Logan et al. 1998:Figure 3.11; Reider 1998:65). If the radiocarbon date is accurate and the points are Paleoindian in age, they would necessarily have been eroded from a Paleoindian deposit originally located upslope of the excavation units and redeposited above the bone level. However, the report is silent on this chronological issue.

A radiocarbon date of 9310 ± 50 B.P. was obtained on charcoal from the stratum containing the bison bone (Hill and Kornfeld 1999:31; Kornfeld 1998:53) and provides the best date available for the activities that took place on the site during Late Paleoindian times. The charcoal was collected from the row of excavation units in the relatively dense portion of the bone deposit. A dark, irregularly shaped deposit containing charcoal flecks labeled as a possible cultural feature was mapped in the excavation unit located two to three meters north of the row of units producing the radiocarbon date (Logan et al. 1998:Figures 3.9, 3.13). This evidence for burning of undetermined origin (cultural or natural), combined with the previously discussed indication of bone and artifacts having been burned over by a probably natural burn event sometime after discard suggests the radiocarbon date on scattered charcoal is not necessarily a date on the occupation of the site. If bone from the site is found to contain sufficient organic material, it would be better to date the bone directly. Be that as it may, the date on charcoal falls early within the period during which Cody and Angostura points were in use.

The types of artifacts recovered during test excavations support the assessment of the bone deposit as representative of a midden at a temporary hunting camp. The assemblage
includes a limited range of artifact types consisting of points and debitage (Table 12-13). One end scraper is reported from the site (Logan et al. 1998:23-24), but the first part of its catalog number (5GA195-226) is the site number for the Barger Gulch site complex, so there is some confusion in regard to which site produced the artifact. Therefore, it is not included in Table 12-13. Judging from the three unnumbered pages of photographs of 37 different points from the site (Kornfeld 1998), this photographed collection of points includes six tips, 13 midsections, eight bases, nine complete points, and one fire-cracked fragment. The presence of a relatively high proportion of bases would not be expected at the actual site of the bison kill. Rather, it is expected that basal fragments would have been removed from the recovered foreshafts and discarded at a camp. Debitage from the site was simply classified as either flakes less than two cm in maximum dimension, pieces of shatter less than two cm, or debitage greater than two cm (Logan et al. 1998:20). Because the larger debitage was then classified according to what part of a flake is present (e.g. proximal or distal), the larger debitage is here assumed to be largely or entirely composed of flakes. Flakes smaller than two cm are of a size that might include most resharpening flakes removed from finished tools. Resharpening flakes are common at bison bonebeds that arguably are located at the actual site of the kill, such as the Casper site. However, they also may be present at temporary hunting camps, such at the Jurgens site. The larger flakes over two cm in maximum dimension and the pieces of shatter suggest that these flakes and other debitage may have been struck from blocky cores or bifaces during artifact manufacture and this activity is more likely to have been performed at a camp, rather than at the actual site of a bison kill.

Data on the tool stone composition of the assemblage are presented in Table 12-13. The table was constructed by combining data on the tool stone classification of debitage recovered during test excavations provided by Logan et al. (1998:20-24, Table 3.4) with available data on the raw materials represented in a small, non-representative sample of the
Table 12-13. Tool Stone and Artifact Composition of Assemblage from Cody and Angostura Occupation of Jerry Craig Site.\(^a\)

<table>
<thead>
<tr>
<th>Tool Stone Type</th>
<th>Manufacturing Debris</th>
<th>Flaked Stone Tools</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pieces of Shatter</td>
<td>Flakes</td>
<td>Flakes Greater than 2 cm in Maximum Dimension</td>
<td>Utilized Flakes</td>
<td>Projectile Points</td>
<td>Total Number of Artifacts</td>
<td>Distance to Tool Stone Source Used in Analysis (km)</td>
<td>Relative Distance to Tool Stone Source</td>
<td>Percent of Assemblage Composed of Tool Stone Type, According to Artifact Count</td>
<td>Percent of Assemblage Composed of Local Stone, According to Artifact Count</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kremmling Chert</td>
<td>106</td>
<td>119</td>
<td>25</td>
<td>3</td>
<td>12</td>
<td>265</td>
<td>11</td>
<td>Local</td>
<td>89.23</td>
<td>97.98</td>
<td>97.98</td>
<td>percent</td>
</tr>
<tr>
<td>Petrified Wood from Middle Park</td>
<td>3</td>
<td>12</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>16</td>
<td>?</td>
<td>Local</td>
<td>5.39</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Windy Ridge Orthoquartzite</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>32</td>
<td>Local</td>
<td>1.01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Table Mountain Jasper</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>7</td>
<td>39</td>
<td>Local</td>
<td>2.36</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Red Orthoquartzite</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>135 / 162</td>
<td>Distant</td>
<td>.34</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chert that Likely Derives from Mississippian or Pennsylvanian Limestones</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>145 / 282</td>
<td>Distant or Very Distant</td>
<td>.34</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yellow Translucent Chert with Black Dendrites</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>Distant or Very Distant</td>
<td>.34</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown Chert</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>Distant or Very Distant</td>
<td>.34</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhyolite</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>?</td>
<td>Distant or Very Distant</td>
<td>.34</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obsidian</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>?</td>
<td>Very Distant</td>
<td>.34</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>112</td>
<td>138</td>
<td>28</td>
<td>3</td>
<td>16</td>
<td>297</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
</tr>
<tr>
<td>Percent of Assemblage</td>
<td>37.71</td>
<td>46.46</td>
<td>9.43</td>
<td>1.01</td>
<td>5.39</td>
<td>100.00</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>100.00</td>
<td>100.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>

projectile points. Of the 64 points known from the site, the raw material of only 16 points was specified in the current literature at the time of writing. The 16 points include nine of the 21 points obtained during test excavations. The nine points were exhumed early in the excavations and classified into tool stone types for a report by Kornfeld and Frison (2000:139). Richings (1998) identifies the raw material of each of the 11 complete points she discusses in her typological consideration of points from the site. Four of the 11 points are from excavated contexts and may be among the nine tallied by Kornfeld and Frison (2000) and so are not included in Table 12-13. The remaining seven points in her sample were from the ground surface and thus the raw materials of these points were tallied and included in the table. Because the original site investigators did not emphasize the fact that both Cody and Angostura points are present in the assemblage, the raw materials of the two types cannot be quantified in Table 12-13, but are discussed in a general way in the text.

Based on artifact counts, a large majority of the assemblage (98 percent) is composed of local tool stones from Middle Park. Of this amount, Kremmling chert accounts for 89 percent with smaller percentages attributed to other Middle Park tool stones. The Kremmling chert source area is between 10 and 20 km from the site. A large majority of the Cody points can be said to have been made of Kremmling chert, but two are of nonlocal tool stones from outside the park and are discussed below. All three of the lanceolate points indentified here as Angostura points are made of Kremmling chert.

About five percent of the assemblage is comprised of pieces of debitage here identified as petrified wood from Middle Park. Literature on the geology of Middle Park mentions petrified wood from various sources, but this tool stone category is not described in any detail in published archaeological site reports. Formations that reportedly produce petrified wood in Middle Park include the Troublesome (Miocene), the Middle Park Formation (Paleocene), and the Morrison (Jurassic) (Naze 1994:149). To this list of possible local sources, Logan et al. (1998:22) suggest the petrified wood from the Jerry Craig site may
be from the Coalmont Formation, the North Park equivalent to the Middle Park Formation. Although the purported local sources remain unsubstantiated, I will accept this category of raw material as probably local in origin and classify it in Table 12-13 simply as petrified wood from Middle Park.

One percent of the assemblage is comprised of small flakes of orthoquartzite which Logan et al. (1998:22) imply may be from the Windy Ridge source along the northwestern boundary of Middle Park. Though they do not identify this tool stone type by name, they state that the orthoquartzite may be from the Gore Range, which is where the Windy Ridge orthoquartzite quarry site is located. This source is 32 km from the Jerry Craig site.

Several pieces of debitage and a projectile of unspecified type are here classified as Table Mountain jasper, which comprises about two percent of the assemblage. Logan et al. (1998:21-22) refer to the raw material of the pieces of debitage recovered during testing as variegated porcellanite and imply this material is distinct from Table Mountain jasper because they state that the later raw material is represented by only one piece of shatter. However, variegated porcellanite is the term used by the University of Wyoming tool stone specialist for the Middle Park Paleoindian Project (James Miller) to refer to an opaque orange or brown microcrystalline tool stone from exposures of the Grouse Mountain Basalt in the central portion of Middle Park north of the town of Parshall (Miller 1991a:2, 5; 1998:93). He acknowledges that the tool stone from the Grouse Mountain Basalt is similar to that from Table Mountain (Miller 1991b:471). I find that materials from the two sources are basically indistinguishable and combine them as Table Mountain jasper in Table 12-13. Kornfeld and Frison (2000:139) state that one of the points from the site is made of Table Mountain jasper. From the Jerry Craig site, the recorded sources of Table Mountain jasper north of Parshall mentioned in Chapter 7 are about 13 km from the site on average and the main source of the tool stone in eastern Middle Park is at a distance of 39 km.
A total of two percent of the Jerry Craig assemblage is composed of various tool stones believed to derive from nonlocal sources outside of Middle Park. The raw material of a point of unspecified type is simply described as red orthoquartzite (Kornfeld and Frison 2000:139). One of the Cody points was made from a yellow translucent chert with black dendrites and another was made from a possible nonlocal tool stone simply described as brown chert (Richings 1998:30). One of the excavation units in the row of units positioned in the densest part of the bone deposit produced two flakes here considered to be likely of nonlocal origin. The raw material of one flake is variously described by Logan et al. (1998:21-22) as Madison Formation chert or Mississippian chert is here classified as chert from Mississippian or Pennsylvanian limestones. The other flake is of rhyolite, which is suggested by Logan et al. (1998:22) to originate from exposures of Grouse Mountain Basalt. However, rhyolite is an extrusive igneous rock of felsic composition and so is unlikely to originate from exposures of basalt, which is an extrusive igneous rock of mafic composition (Sanders et al. 1976:140-144). Finally, a flake of obsidian is said to have been recovered from the bone deposit in an excavation unit located within a few meters northwest of the row of units mentioned above (Logan et al. 1998:21, Figure 3.13). Obsidian is available only from sources that are very distant from the Jerry Craig site.

High Front Range Cluster

Devils Thumb Game Drive

A Late Paleoindian occupation is evident at Area A of the Devils Thumb Valley Game Drive, an archaeological manifestation in the forest-tundra ecotone on the east side of the high Front Range that appears to me to be part of a larger game drive system that extends westward up to the crest of the range (see Benedict 2000b:Figure 2.7). The Devils Thumb Valley Game Drive refers to a diverse set of archaeological sites and features in the vicinity of the eastern part of the game drive system. Included are a number of lithic scatters,
campsites, and game drive features. From its eastern end, located 40 m west of Area A, the drive system extends southwestward along a ridge crest, all the way up to the crest of the Front Range at Devils Thumb Pass, which is actually positioned at a high point along the range. East of the pass, the range has been gouged by two glacial cirques that are drained by tributaries of Jasper Creek, which in turn feeds into Middle Boulder Creek. From the forest-tundra ecotone on the east slope, the drive system runs southwestward for a distance of about one kilometer along the ridge dividing the two branches of Jasper Creek until the crest of the range is reached. West of the range crest, the terrain slopes to the west down a flat peneplane surface toward the drainage of Ranch Creek, a tributary of the Fraser River. The game drive system also extends along the crest of the range in a north-south direction for a distance of about .6 km. Discontinuous, low rock walls or alignments of cairns, as well as primarily circular hunting blinds constructed of local rocks and boulders, comprise the game drive system. Benedict (2000b) believes two separate game drive systems are present. He refers to the eastern segment of the drive system as the Devils Thumb Valley Game Drive (5BL3440). A middle section of the drive system on the ridge dividing the branches of Jasper Creek (recorded as 5BL103) and the western portion on the crest of the range (recorded as 5GA20) are labeled by Benedict as the Devils Thumb Pass Game Drive.

Three uses of the Devils Thumb Pass area in prehistory may be suggested. As implied by the name, the Devils Thumb Valley Game Drive and adjoining parts of the drive system may have been the end destination for presumably aggregated groups of people intent on cooperating in large-scale big game hunts and processing of the acquired meat. The Pass itself offers a relatively easy travel route over the Front Range between Middle Park and the Boulder Creek drainage on the east slope and thus may arguably have been used at other times by people traveling across the range from one region to another. It is reasonable to speculate that not every stay in the Jasper Creek drainage was related to game driving operations and it may be suggested that some of the lithic scatters and campsites may result
from use of the area by family groups subsisting by hunting and gathering a wider range of food resources.

The question arises as to how the game drive system worked. Relatively few blinds are present in the portion of the drive system east of the range crest; most are along the north-south segment on the crest of the range (see Benedict 2000b:Figure 2.7). The drive system was likely used multiple times and it may have served to direct the movement of herds to the east or to the west depending on the circumstances of each instance of use. However, the above facts suggest to me that the main idea behind the construction of the game drive system was to move animals from the drainage of Jasper Creek westward up to the crest of the ridge where most of the hunters were waiting in blinds. The presence of relatively few blinds along the segment of the drive system along the dividing ridge between the branches of Jasper Creek suggests that some hunters would have been positioned along the route leading up to the crest. Observations on the possible manner in which the drive system functioned are relevant to evaluating the original interpretation of Area A as a kill site where animals driven to the east were killed and processed. As discussed in Chapter 5, little direct evidence exists regarding the species of animal hunted, but for various reasons, it is suggested that the Devils Thumb game drive and others along the Front Range were constructed to procure elk, bighorn sheep, or mule deer.

The Devils Thumb Valley Game Drive site complex is located in the forest-tundra ecotone on a broad east-northeast trending ridge separating the tributary drainages of Jasper Creek. The site is vegetated with open meadows, islands of trees, thickets of dwarfed spruce and fir “krummholz” vegetation, and patches of low-lying willow. Site dimensions are 655 m northeast-southwest by 280 m northwest-southeast. Three drive lines and four or five blinds are located on the site. Unlike the central and western portions of the game drive system, the eastern segment is conducive to camping, being presently situated in the forest-tundra ecotone where water and firewood are both available. A total of 12 areas included within the
general area encompassed by the Devils Thumb Valley Game Drive may be classified as campsites or lithic scatters. These were given letter designations. Areas A and B are in Benedict’s purported Late Paleoindian kill area and are discussed below. Of the remaining areas, six are here classified as lithic scatters and consist of debitage and utilized flakes, one is a lithic scatter with debitage and formal flaked stone tools, and three are campsites.

The campsites produced plant food grinding artifacts (manos and grinding slabs) or pottery. The ethnographic record of foraging peoples generally associates the processing of wild plant foods and the use of pottery with the subsistence activities of women. Assuming a similar division of labor in the prehistoric foragers who occupied the Devils Thumb Pass area, the presence of these artifacts implies that family groups camped at the Devils Thumb Game Drive. Whether these families were operating as individual social units or part of aggregated groups involved in communal hunting is presently not well understood. Area L produced two Archaic points, other flaked stone tools, and two manos of Lyons Sandstone. Two multicomponent campsites are situated by a pond at the head of the northern tributary of Jasper Creek. One site originally designated Area I by Benedict (2000b) was test excavated by Kindig (2000) and given a separate site number (5BL6904). The site produced evidence of repeated occupation throughout prehistory. Sherds of vessels assigned to the Dismal River type and to a Ute occupation were recovered. Archaic and Late Prehistoric points were also collected. A biface with undulating edges that appears to be a preform has parallel diagonal flaking and was suggested to be of Paleoindian affiliation. The second campsite, designated Area J, also produced evidence of repeated occupations. Thought to have functioned as a camp based on the presence of grinding slabs of Lyons Sandstone, the site produced points of the Late Prehistoric, Archaic, and Paleoindian periods. The basal fragment of a concave-base lanceolate point was collected from the site. Lateral edges of the specimen diverge rapidly in a distal direction from the basal edge. Basal ears are close together, being only .7 cm apart at
their apexes (Benedict 2009b:Figure 2.19, Specimen 1). These are attributes diagnostic of some Angostura points (Pitblado 2007:320-321, Table10.2, Figure10.4).

The middle segment of the game drive system (5BL103) is situated on a steep ridge that develops from the broad ridge and leads generally westward to Devils Thumb Pass. Site dimensions are 330 m northeast-southwest by 40 m northwest-southeast. Drive walls and cairn lines parallel the ridge. Three or four blinds are also present.

The western portion of the drive system (5GA20) consists of basically north-south aligned drive walls and cairn lines with associated blinds situated along the crest of the range. The arrangement of the drive lines suggests that they were designed to divert animals heading west up the ridge to the north or south where they would have to pass close to hunting blinds. In all, 21 blinds are present. Based on radiocarbon dating of single charcoal grains from three blinds at 5GA20 and one blind at 5BL103, Benedict (2000b:28) suggests the former features were used in the Late Prehistoric and the later was put to use in the middle Archaic. However, it would seem unlikely that hunters would build fires in structures intended to conceal them from game animals. Game animals would see and smell smoke produced by a fire or hear the crackling of the fire and flee the area. Rather, the source of the charcoal grains may have been from forest fires that can disperse charcoal to higher elevations in the tundra, a possibility that Benedict acknowledges.

At the other end of the game drive system, Benedict suggests a Late Paleoindian kill site exists in an open swale. The main drive line of the Devils Thumb Valley Game Drive (Line C) is about 280 m long, aligned northeast-southwest, and comprised of intermittent segments of low drive walls and cairn lines (Benedict 2000b:Figure 2.14). Its northeastern end terminates 40 m west of Area A, which is located in a swale aligned west-southwest by east-northeast (Benedict 2000b:Figure 2.26). A small creek heads at a patch of low-lying willows in the bottom of the swale where a spring may be and flows southwest out of the swale, past a pond, and then turns south and proceeds to a wetland. On the south side of the
swale, a fragment of a parallel diagonal flaked Late Paleoindian point was found on a gopher mound and eight flakes were scattered about on the ground surface. The site was designated Area A and an irregularly shaped excavation block covering 26 m² with maximum dimensions of 7 m north-south by 5 m east-west was dug at the location of the point fragment (Benedict 2000b:Figure 2.32). The total area excavated equates to an excavation area measuring 5.1 m by 5.1 m. Excavation revealed a scatter of flaked stone artifacts composed of debitage and utilized flakes buried about 30 cm below the ground surface. A large majority of the debitage is concentrated in a scatter within a four square-meter area at the south end of the excavation block where the ground is basically level. The debitage concentration was called a lithic workshop by Benedict (2000b:75) who suggests that it represents where, “a hunter, waiting for game to arrive from the west, killed time by making final adjustments to his tool kit.” At a distance of 23 m northwest of Area A, near the bottom of the swale is what Benedict refers to as Blind 3. Twelve meters northeast of Blind 3 is where an asymmetrical bifacial knife tip and a fragment of a drill or perforator were found on the ground surface. An excavation block totaling eight square meters was dug at this location and revealed a hearth that produced charcoal samples dated to late in the Archaic period: 2250 ± 70 B.P. and 2160 ± 60 B.P.

A critical evaluation of the characterization of the swale as a kill site finds a lack of supporting evidence. Blind 3 is in a crevice in a bedrock outcrop measuring 1.7 m wide with concentration of boulders at the ends of the crevice. The largest of the boulders range up to 1.1 m in maximum dimension and are of such a large size that one might reasonably question whether they would have been moved to their present position by people. From the map and photograph of Blind 3 the supposedly fallen boulder walls at each end of the crevice do not appear to be definitely man-made (Benedict 2000b:Figures 2.24-2.25). Seven charcoal grains from one of two charcoal stains in the purported feature are said to date the use of the blind to the late Archaic period. However, the stains are not definitely hearths and, as suggested in
discussion of the supposedly dated blinds above tree line, the presumption that a hunter would build a fire in a structure intended to conceal humans from game animals seems unlikely.

The idea that a scatter of flaked stone artifacts in Area A is a workshop of a hunter making final adjustments to his tool kit also seems unlikely if indeed the swale is where people would be waiting for big game animals being driven toward them. Instead, it is reasonable to suppose that the hunters would have had all necessary weaponry and initial butchering tools ready to be put to use before the drive. Hunters waiting for game animals must remain silent and avoid sudden movements. Percussion flintknapping involves sudden movements that make a cracking sound as flakes are detached from blocky cores or bifaces and pressure flaking also makes some noise, so these activities are unlikely to have been preformed by hunters awaiting the arrival of game animals.

Benedict correctly identifies the point from Area A as a Late Paleoindian type and I would suggest it may be assigned to the Angostura type. The point fragment consists of the midsection and tip and displays parallel diagonal flaking. The basal part of one lateral edge angles toward the base at a point that may be considered a slight shoulder. This attribute would suggest the fragment may be of an Angostura point. The discovery of a definite basal fragment of an Angostura point elsewhere on the site complex at Area J gives more credence to the suggestion.

The stratigraphic relationship between artifacts in the occupation layer to charred organic radiocarbon samples provides insight into the paleoenvironmental setting of the site. Stratigraphic study has revealed that artifacts are concentrated at the contact between underlying stratum IB and overlying stratum IIA. Seven radiocarbon dates in excess of 9000 B.P. obtained from charcoal and charred conifer needles were collected on or near the stratigraphic contact. The samples were not collected from hearths and do not provide a precise date for site occupation, but do approximate the time of site occupation. Two
radiocarbon samples of burned parts of trees and other material recovered via flotation of sediment collected for dating from the northern part of the excavation block demonstrate that at around the time of occupation, trees were growing in the part of the now-open swale where Area A is located. A sample of charcoal and charred spruce needles collected from the charcoal-stained contact was dated to 9390 ± 70 B.P. The charcoal-stained layer also contained slag-like vesicular material thought to be burned tree sap. Though charred needles may be blown by the wind, the pieces of vesicular material would be better evidence that trees grew in the swale at the time of occupation, if indeed they were originally tree sap. The charcoal layer is exposed in a soil profile and in one location appears to have been thrown back over on itself, as if produced by a falling tree, implying that trees also grew in the swale sometime after the forest fire associated with the date of 9390 ± 70 B.P. (Benedict 2000b:61-62, Figure 2.33). A second radiocarbon sample from the northern portion of the excavation block was composed of charred spruce needles collected at the contact of strata IB and IIA and dated to 9340 ± 50 B.P. Flotation of the organic layer producing the dated needles also recovered charred sclerotia, which are structures formed by fungi on tree roots. Their presence is further evidence that trees grew in the swale around the time of occupation.

Paleoenvironmental evidence regarding the presence of trees on the site is in agreement with fossil insect data discussed in Chapter 6 indicating that the upper tree line rose above its present position sometime in the Late Paleoindian period. If the swale was forested at the time of occupation rather than open as has been presumed, this would be yet another line of evidence to support the thinking that Area A is not located at the actual site of a big game kill.

A careful excavation procedure was followed to assess the temporal relationship between buried artifacts and dated grains of charcoal. A column of sediment in the artifact concentration in the southern part of the excavation block was removed in 5 cm increments which were water screened to recover microdebitage and charcoal. This procedure revealed
that a peak in the vertical distribution of microdebitage coincides with a peak in the
distribution of charcoal grains. Both peaks in frequency distribution correlate with the strata
IB/IIA contact. A total of 7 percent of the debitage of larger sizes recovered from throughout
the occupation layer during dry screening show evidence of having been exposed to fire.
From the above information, it may be concluded that some artifacts from the occupation lay
on the ground surface for a certain amount of time after site occupation, during which time
they were exposed to a forest fire. Most artifacts were shallowly buried and protected from
breakage or cracking by fire. Later, all artifacts were completely covered with sediment.
Soil mixing processes, particularly freeze-thaw cycles gradually mixed the artifacts and
charcoal grains together in the charcoal-stained layer. Three dates on single charcoal grains
recovered from sediment column are: 9410 ± 90, 9310 ± 60, and 9270 ± 40 B.P. Benedict
(2000b:68, Figure 2.38) used a computer program to average the calibrated date range
associated with each of the three dates and concluded that a forest fire swept over the site at
9325 ± 30 B.P.

Finally, two dates on single charcoal grains collected in association with the artifact
concentration are somewhat earlier. One charcoal grain at the strata IB/IIA contact dated to
9570 ± 80 and another from stratum IIA dated 9550 ± 80 B.P. The calibrated date ranges
associated with the two dates average 9560 ± 65 (Benedict 2000b:68).

Whether the dates are associated with charcoal produced during the occupation by
Paleoindians or yet an earlier forest fire is unknown. All that can be said for certain is that
occupation took place sometime before ca. 9300 B.P.

The environmental setting of the site is in line with the thinking that the swale was
not the location of a big game kill, but rather was used as a camp by Paleoindians. As
previously discussed, the distribution of genuine hunting blinds is such that relatively few are
scattered along the drive route leading up to the range crest where most are concentrated.
This suggests that inflicting wounds on big game animals during operation of the drive
system principally occurred far from Area A. Again, paleoenvironmental evidence from excavation of Area A indicates that the swale was forested, rather than open as it is today. Therefore, the wooded swale would not likely have served as a topographic feature that would serve to funnel the movements of game animals toward waiting hunters. On the other hand, the swale would offer the necessities for camping. Adequate amounts of firewood would likely be available and drinking water could be obtained from the stream that apparently begins at a spring situated 22 m west of the site (Benedict 2000b:Figure 2.26).

Consideration of the kinds of artifacts recovered from Area A supports the thinking that the area was a campsite that served as a base for some amount of hunting activity. The point fragment consists of the midsection and tip. One possible scenario accounting for the presence of the point on the site is that it broke in its haft during a hunt and subsequently was transported back to camp where the fragment was removed from the haft and discarded. Another possibility is that it may have been transported back to camp embedded in a carcass segment of a big game animal. Though the assemblage is small (n = 305 artifacts), the absence of end scrapers would be consistent with the thinking that non-bison game animals were killed for their meat, but their hides may not have been utilized. Evidence that both unifacial and bifacial artifacts were manufactured on-site tends to favor the interpretation that the site functioned as a camp, rather than the actual location of a communal kill. Benedict (2000b:Table 2.7) classified the 304 pieces of debitage from the site into tool resharpening flakes (41 percent), possible tool manufacture flakes (seven percent), pieces of shatter (29 percent), and flakes of uncertain origin (24 percent). Resharpening flakes were classified according to their parent object with some categorized as having come from bifaces, others as deriving from unifaces, and others being of uncertain origin. Of the 59 flakes classified by Benedict (2000b:Table 2.7) as coming from bifaces, eight are between two and three cm in length and eight are over three cm in length. The relatively large size of these flakes suggests they were removed from bifaces during manufacture, rather than when bifacial tools were
being resharpened. Similarly, of the 38 flakes classified as uniface sharpening flakes, six are between two and three cm in length and two are over 3 cm long. The comparatively large size of these flakes also suggests that they were removed from tools during manufacture. Of all debitage, seven percent are classed by Benedict as flakes from tool manufacture because they lacked edge damage at the juncture of the striking platform and the dorsal face. Whether these flakes may have been produced during blocky core reduction or biface thinning is not discussed. A total of 29 percent of the debitage is classified as shatter, which is more characteristic of blocky core reduction than biface thinning.

It may be suggested that the artifact scatter in Area A represents a midden area in which trash was discarded. As at the Crying Woman site, microflakes were found to be abundant in the artifact concentration at Area A. This suggests that the some flintknapping may have taken place at the concentration. Alternatively, if the concentration is entirely a secondary deposit of trash, then a hide ground cover may have been used to collect flakes of all size ranges produced in flintknapping which were subsequently discarded in the midden. From the available information, it may be suggested that the artifact composition of the assemblage from Area A represents trash generated during an episode of camping during which debris from unifacial and bifacial artifact manufacture and maintenance was either left in a concentration where it fell during actual flintknapping, or was discarded there during camp cleanup, or both. Furthermore, a point broken during use was discarded in the midden after a hunt.

Based on the available information, it is problematic as to whether the artifact concentration at Area A is best interpreted as a midden produced at a camp by people involved in large-scale hunting of big game or a trash disposal area at a camp of a group of band or sub-band size involved in generalized foraging that included some amount of hunting. One point was recovered from an excavation block that equates to an area measuring 5.1 m by 5.1 m. If the site was a camp of an aggregated group involved in large-
scale hunting of big game, one might expect a lot of broken points would have been discarded somewhere at the site. Since only one point was recovered, one possible interpretation is that the site was a camp of a group of people affiliated with the local Angostura band that was in the high country during the warmer months, subsisting by means of generalized foraging.

Were it not for the point, the surface assemblage from Area A would consist of only eight pieces of debitage of Kremmling chert or Table Mountain jasper (Benedict 2000b:70) and would not appear conspicuously different from the six unexcavated lithic scatters reported for the Devils Thumb Valley Game Drive site complex as a whole (Areas C-F, H, and K). In reference to the lithic scatters, Benedict (2000b:36) states that, “[f]lakes and tools were clustered in small areas (10 to 20 m²), often on slopes. Relatively few flakes, and only two lithic materials (both from Middle Park quarries), are represented.” Under the interpretation of Area A as a midden produced by a non-aggregated group, the game drive system located to the west may have been constructed sometime after the Paleoindian occupation evident at Area A.

On the other hand, one could also reason that the midden at Area A is at a camp that is associated with Paleoindian use of the game drive system and was therefore produced by a single or multi-band group involved in large-scale hunting of big game. This interpretation rests on the proximity of Area A to the game drive system. At least two periods of use are evident on the game drive structures, based on the amount of weathering on the igneous rocks used to construct the walls, cairns, or blinds when compared with that present on nearby outcrops (Benedict 2000b:28, 31). A wall at the middle segment of the game drive system (5BL103) exhibits a lesser amount of weathering, indicating a more recent time of construction. This wall could also be dated by means of lichenometric dating of its constituent boulders. Lichenometry is based on the fact that certain species of lichen grow in circular patches that increase in diameter with time. The lichenometric estimate of the date of construction is A.D. 1280. Boulders comprising particular drive walls at the segment of the
drive system along the crest of the range (5GA20) and at the lower segment (the Devils
Thumb Valley Game Drive; 5BL3440), including Drive Line C, are weathered to the same
degree as natural rock outcrops and are therefore assigned to an older period of use. The time
period represented is of an age that is not amenable to the more precise age determinations
possible with lichenometry. The period represented by the highly weathered drive walls is of
unknown duration and could include multiple episodes of use that extend back to Late
Paleoindian times. If people in the Late Paleoindian period used the game drive system, it is
presumed that the number of people required to operate the game drive and process meat
from the kill would have required that a group at least the size of a band would have been
present.

According to this interpretation, the lack of bones of big game animals among the
discarded artifacts of Area A might be explained by site formation processes unfavorable to
bone preservation. It is reasonable to suppose that relatively large numbers of game animals
were killed during a single use of a game drive system. Processing of the animal carcasses
should have produced bonebeds at camps associated with the more than 50 game drive sites
noted in the high Front Range by Benedict (1992a:4) and yet no such bonebeds are known.
Benedict (1992a:6) attributes the rarity of faunal remains at sites in the high Front Range to
environmental factors that promote bone destruction, such as slow sediment deposition which
results in long periods of bone exposure to forces of weathering on the ground surface. In the
case of Area A, the facts that seven percent of the debitage in the assemblage is burned and
that the flakes coincide stratigraphically with charcoal from a forest fire would suggest that at
least some cultural material was exposed on the ground surface for long enough after
occupation took place that a forest fire eventually burned over the site. From this, one might
reason that if any bone was discarded in the midden at Area A, it may have been completely
weathered away during long periods of exposure on the ground surface.
Finally, the presence of only one point at the site that arguably is associated with large-scale big game hunting might be attributed to sampling error. Because of the presence of bison bone from 15 animals at Upper Twin Mountain, the suggestion that the site may represent a camp associated with large-scale hunting of big game is not seen as an unreasonable interpretation. The site produced four points from excavation blocks equivalent to an area measuring 5.3 by 5.3 m. The excavation block at Area A of the Devils Thumb Valley Game Drive is equivalent to an area measuring 5.1 m by 5.1 m and it produced a single point, so the relative lack of points might plausibly be explained by sampling error if only a portion of the midden was excavated. Because the assemblage from Area A might plausibly be interpreted as the result of either occupation by a group at least the size of a band that was involved in operating a game drive system or by a band or smaller group of people subsisting by more generalized foraging, both of these interpretations will be evaluated when the tool stone composition of the assemblage is considered below.

The tool stone composition of the assemblage from Area A is given in Table 12-14. The assemblage is comprised solely of the three main tool stones of Middle Park. Table Mountain jasper comprises seven percent of the assemblage and is present in the form of various kinds of debitage. This tool stone is available from local sources, with the closest being 27 km to the northwest of the site. A total of 93 percent of the assemblage is composed of Kremmling chert, which is present in the form of various kinds of debitage. Kremmling chert also is available from local sources, with the main source area in the Barger Gulch drainage situated 54 km west of the site. Windy Ridge orthoquartzite is represented by the single point which accounts for .3 percent of the assemblage. The main source of this tool stone in Middle Park is the Windy Ridge quarry site which is situated 89 km west-northwest of the Devils Thumb Valley Game Drive. The quarry site would be considered a distant source under the classification generally endorsed herein. However, as explained more completely below, the source of Windy Ridge orthoquartzite is best considered a local source.
Table 12-14. Tool Stone and Artifact Composition of Assemblage from Area A at Devils Thumb Valley Game Drive.

<table>
<thead>
<tr>
<th>Tool Stone Type</th>
<th>Waste Flakes (54 %), Utilized Flakes (17.4 %), and Pieces of Shatter (28.6 %)</th>
<th>Projectile Points</th>
<th>Total Number of Artifacts</th>
<th>Distance to Tool Stone Source Used in Analysis (km)</th>
<th>Relative Distance to Tool Stone Source</th>
<th>Percent of Assemblage Composed of Tool Stone Type, According to Artifact Count</th>
<th>Percent of Assemblage Composed of Local Versus Nonlocal Stone, According to Artifact Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table Mountain Jasper</td>
<td>21</td>
<td>0</td>
<td>21</td>
<td>27</td>
<td>Local</td>
<td>6.88</td>
<td>99.67 percent Local</td>
</tr>
<tr>
<td>Kremmling Chert</td>
<td>283</td>
<td>0</td>
<td>283</td>
<td>54</td>
<td>Local</td>
<td>92.79</td>
<td></td>
</tr>
<tr>
<td>Windy Ridge Orthoquartzite</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>89</td>
<td>Distant</td>
<td>0.33</td>
<td>0.33 percent Nonlocal</td>
</tr>
<tr>
<td>Total</td>
<td>304</td>
<td>1</td>
<td>305</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of Assemblage</td>
<td>99.67</td>
<td>0.33</td>
<td>100.00</td>
<td></td>
<td></td>
<td>100.00</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Data from Benedict (2000b:53-54, 70, Table 2.7). Above table excludes “microdebitage” recovered from sampled areas of excavation block.
because a local band of mountain people would have normally operated within a range that included the Front Range, Middle Park, and lower elevations to the west.

Caribou Lake Site

The Caribou Lake site (5GA22) is situated along a travel route over the Front Range that is also known to have been used in prehistory for game drives above tree line. More specifically, the site is located at Caribou Lake, which is located along timberline at the head of Arapaho Creek. The stream flows northwest and originally joined the Colorado River in eastern Middle Park at what is now Lake Granby. South of the site is a short east-west segment of the crest of the Front Range. A saddle along the ridge located a kilometer south of the site is known as Arapaho Pass and affords access to the headwaters of Middle Boulder Creek. According to Ives (1942:461), the pass, “…is the easiest route for a man traveling afoot from the eastern foothills to Middle Park.” Benedict (2000a:160) cites a historic account indicating that the pass was along an Indian trail from Grand Lake in eastern Middle Park to the Plains in the vicinity of Boulder. The trail was used by the Arapaho to cross the crest of the Front Range, apparently on horseback. Pitblado (2000:127, Figure 4.2) notes that an old trail that she labels as “prehistoric” runs through the site. Writing in the early 1940s, Ives (1942:461) also mentions an Indian trail leading over Arapaho Pass and states that, “[s]hort sections of the old trail can still be found in timber in the upper part of the Arapaho Creek Valley, and along them are many chips and fragments of worked artifact material.” At the pass is a game drive site recorded as 5BL114 (Benedict 1981:8). Game drive lines are also found above and below Lake Dorothy, a small lake perched above tree line west of the pass (Benedict 1981:8).

Caribou Lake provides a good location for camping and was the scene of multiple prehistoric occupations. Area A of the site is located on a bench on a moraine that formed the lake and saw occupation during Late Paleoindian and later prehistoric times. Currently the
environment in the immediate vicinity of Area A is largely open with scattered conifers present. Areas B and C were occupied during post-Paleoindian times and are situated to the northeast. Lake water is available 22 m south of Area A and running water from Arapaho Creek is available 41 m to the east-southeast. Firewood is currently available at the site.

Evidence from the study of fossil pollen and insects demonstrates that during Late Paleoindian times, upper tree line rose to the elevation of current tree line and continued to rise thereafter on into Altithermal times. From the above information, it is reasonable to hypothesize that tree line may have been higher during the Late Paleoindian occupation of the Caribou Lake site and thus the site may have been more wooded.

The history of site investigations and the basic cultural stratigraphy is here summarized to provide background information for the discussion to follow. Early excavations at the site were directed by Benedict (1974, 1985) and occurred in the early 1970s and the early 1980s. Later excavations in the mid-1990s were under the direction of Pitblado (2000). To date, an irregular excavation block measuring a maximum of 12 m northeast-southwest by 6 m northwest-southeast has been dug. The total area excavated equates to an area measuring 7.1 m by 7.1 m. Archaeological material at the site occurs in two layers. Six sedimentary strata were encountered during excavation and numbered 1 through 6 consecutively from bottom to top. The Late Paleoindian level is present at the contact between strata 3 and 4 which is present at an average depth of around 20 cm below ground surface. Stratum 3 is a till deposited during the Satanta Peak advance, a minor glacial resurgence of early Paleoindian times associated with the Younger Dryas climatic episode. Stratum 4 is redeposited loess and gravel. Archaic and Late Preshistoric cultural material occurs from the contact of strata 5 and 6 and continues up through stratum 6 to the ground surface.

The Paleoindian points from Area A at Caribou Lake conform to the Frederick type. Initially, the Late Paleoindian occupation of the site was thought to be of Cody affiliation,
based on the discovery of a point base with a parallel lateral edges and a slightly concave basal edge (Benedict 1974). The point base displays parallel diagonal flaking, however, an attribute not characteristic of the Cody type (Pitblado 2000:Figure 4.5). This, in conjunction with the fact that three other points recovered in the later excavations conform to the Frederick type leads to the conclusion that during terminal Paleoindian times, the site was occupied by people of the western plains.

Upon consideration of purported hearths in the Late Paleoindian level and the radiocarbon dates obtained from them, Pitblado concludes that multiple occupations of the site took place. The early excavations at the site uncovered Feature A-1 in the southwestern portion of the excavation block, which was dated to 8460 ± 140 B.P. Later excavations in the northeastern portion of the excavation block revealed Feature A-4. An anomalously early date of 9080 ± 75 was obtained from charcoal originating from the suspected hearth. Two other dates of 7985 ± 75 and 7940 ± 70 were also obtained on charcoal from the feature. From the above information, Pitblado (2000:140) concludes that two or three occupations of the Caribou Lake site during the Late Paleoindian period are indicated.

Pitblado uses the widely varying radiocarbon dates from the two features as the basis for arguing that at least two separate occupations took place during which activities were centered about hearths. She cites the distribution of artifacts of various tool stone types in support of this interpretation. As pointed out by Pitblado, artifacts of Kremmling chert are most concentrated around Feature A-1 in the southwestern portion of the excavation block and artifacts of red orthoquartzite are most prevalent near Feature A-4 in the northeastern part of the excavations. Based on this, Pitblado suggests that activities during a relatively early occupation of the site were centered at Feature A-1, where Kremmling chert debitage and tools were deposited. In a later occupation of the site, debitage and tools of red orthoquartzite were deposited around Feature A-4. The concentrations of artifacts of the various tool stone types present do seem to vary across the excavation block, but the division is not as absolute
as suggested by Pitblado. Some flakes of Kremmling chert do occur by the northeastern feature (A-4) and a point base of red orthoquartzite was recovered in the southwestern feature (A-1) (Pitblado 2000:Figure 4.11, Table 4.2). Also, a flake of tan orthoquartzite with a high luster was found in the northeastern feature (A-4) and a complete point of similar raw material was found by the southwestern feature (A-1).

A review of the descriptions of the purported hearths leads me to question whether they in fact are manmade features. Benedict never claimed that his Feature A-1 was a hearth. Occupation is recorded by the stem of a probable Scottsbluff projectile point, a bifacial knife, and chipping debris, all found in direct association with a charcoal concentration at the southwest margin of the excavation area. The charcoal, with a maximum thickness of less than 4 cm. and a horizontal extent of less than 1m², lay in shallow natural depressions on the surface of the till. Lack of oxidation at its base suggests that the charcoal washed from a nearby hearth, and did not burn in place. The radiocarbon age of the charcoal is 8460 ± 140 years B.P. (I-5449); the date applies to Plano [Late Paleoindian] occupation of the site… [Benedict 1974:2].

Contrary to Benedict, the charcoal concentration of Feature A-1 may not have washed in from a nearby hearth. Rather, considering the forested nature of the site’s setting, it would seem to me that a more probable explanation for the presence of the charcoal concentration is that it resulted from a forest fire that swept over the site. The feature uncovered in the later excavations (A-4) may also be of natural origin. The feature is described as a pronouncedly reddish black stain that is irregular in shape, with a maximum diameter of 80 cm and a maximum thickness of 7 cm. It is situated at the same stratigraphic position as Feature A-1. No photograph, planview map, or profile is presented in the report to substantiate the assessment that the charcoal stain is cultural in origin. Pitblado (2000:138) states that “[h]earth A-4 fill was densely packed with charcoal… it had a distinctly oxidized appearance even at its surface… The apparent oxidation of all of the hearth fill, rather than oxidation of only the hearth’s perimeter — as was the case with younger fire features at 5GA22 (A-5, A-6, and A-7) — is puzzling.” It may be that the reddish oxidation of the sediment enveloping the
charcoal resulted from natural burning of a tree root or a similar scenario associated with a forest fire.

Since there is cause to suspect that the purported fire features at Caribou Lake actually result from natural burns, the radiocarbon dates on charcoal obtained do not provide precise dates for occupation of the site, but likely date forest fires that occurred in the general time range when Paleoindians camped at the site. If so, this would explain the puzzling wide range in the radiocarbon dates thought to be associated with occupation of the site.

If indeed Pitblado’s interpretation of multiple Late Paleoindian occupations is in error, this would have an important repercussion for how the site should be interpreted. Lacking any information to the contrary, the occurrence of a scatter of artifacts at the same stratigraphic position throughout the excavation block would argue for the presence of a single Frederick occupation of the Caribou Lake site.

Pitblado interprets the artifacts present in the Paleoindian level as primary refuse that was discarded by site occupants sitting around hearths, but the condition of projectile points suggests some of the assemblage may represent secondary refuse that was discarded in a trash disposal area. To counter the possibility that some of the Paleoindian artifacts may have become mixed with later prehistoric artifacts from the occupation layer that is positioned only about 10 cm above, the debitage from only the lower portion of stratum 4 was combined with that from stratum 3 to produce a sample of 63 flakes or pieces of shatter attributed to the Paleoindian component. Excavated fill was screened through 1/8 inch hardware cloth. A large majority of the recovered debitage consists of small flakes or pieces of shatter, with the average maximum dimension of the 63 pieces of debitage being only .87 cm. in maximum dimension. The small size of most debitage suggests that some of the artifacts may be primary debitage produced during episodes of flintknapping that took place in Area A. If not, the presence of such small debitage would likely have to be explained less parsimoniously by suggesting that site occupants used a hide to cover the ground during flint knapping episodes.
conducted elsewhere and subsequently discarded the debris in Area A. The condition of the points suggests that at least some of the artifacts present were discarded in Area A as secondary refuse. The sample of points includes two basal fragments, a tip, and a complete point. As discussed previously in relation to the Jurgens site and elsewhere, one possible explanation for the presence of complete, functional points and tips in middens of temporary hunting camps may be that points and fragments encountered while stripping muscle from bone were discarded in the midden along with the bone following a successful large-scale kill. If this is a reasonable expectation, the presence of a complete point and a tip would suggest that at least some of the artifacts may be indicative of secondary refuse having been disposed of in Area A.

If the above scenario is valid, one might reasonably ask where the bone is that supposedly was discarded. As with other high mountain sites, the complete absence of bone from the Paleoindian level at Area A might result from forces that discourage bone preservation. If bone was exposed on the ground surface for long periods of time, it is entirely possible that bone was once present but subsequently was completely weathered away. Benedict considers the soil contact on which the Paleoindian artifacts occur to represent an erosion surface. In reference to the contact between strata 3 and 4, Benedict (1992b:349) states that “…Paleoindian … artifacts occurred on the… erosion surface, which was patterned by frost sorting; rocks that protruded above the erosion surface were differentially weathered, suggesting exposure to surficial processes for a considerable time prior to burial.”

If the Paleoindian level represents a single occupation, it may be argued that artifacts present were part of a midden produced by a large group of people. Operating on the assumption that the features are hearths of different ages and that artifacts distributed around the features are primary refuse related to activities carried out around the hearths, Pitblado suggests that small groups of Paleoindians occupied the site during at least two occupations.
of the site. According to Pitblado (2000:151), “[c]haracteristics of the debitage and tools reveal the precise nature of the activities undertaken as people sat around Hearths A-4 and A-1. At the north end of the site, site occupants — limited to a very small group or even just an individual or two…”. Pitblado (2000:152) goes on to suggest that, “[a]ctivities centered around Hearth A-1 at the south end of Area A were probably quite similar to those inferred for Hearth A-4, although based on the number and variety of raw materials a slightly larger (but still small) group may have been involved.” On the other hand, if the artifacts recovered from Area A are best interpreted as resulting from a single component, it is important to note that the areal extent of the Paleoindian cultural material has not yet been determined for areas northeast, northwest, and southwest of the excavation block (see Pitblado 2000:Figure 4.11, Table 4.2). From this observation, it follows that if a single occupation is represented by the Paleoindian assemblage, then the total area covered by the midden could be large, which would in turn imply that a large group was camped out at the site.

The kinds of artifacts present in the Paleoindian assemblage support the supposition that the site served as a temporary hunting camp (Table 12-15). One artifact labeled as a bifacial knife by both Benedict and Pitblado is better classified as a point preform. The biface has irregular edges and a straight basal edge. A photograph of the artifact provided by Benedict (1974:Figure 2 b) suggests that it has been shaped by soft-hammer percussion which resulted in a number of deep flake scars that terminate in step fractures. The artifact is made of Kremmling chert. An apparent crack emanating from the distal end of the biface (Benedict 1974:Figure 2 b; Pitblado 2000:Figure 4.6 a) may in fact be an internal structural plane, a raw material flaw common in Kremmling chert (Naze 1994:74-76). Presence of a possible fatal flaw in the raw material would suggest why a point preform would have been discarded at the site without having been finished. According to Pitblado (2000:131), edges of the biface “show use wear consistent with cutting” but Benedict states that “edges are ground and battered by use…” (1974:3). To me, a ground and battered edge would be more suggestive
of abrasion of the biface edges to prevent crushing of striking platforms during manufacture (Sheets 1973). In combination with the four points found during excavation of Area A, the point preform makes a total of 5 points or point-related artifacts deposited within an area equivalent to an area measuring 7.1 m by 7.1 m during what may have been a single occupation. In comparison, at the Allen Site, nine points were deposited in a one-meter-thick midden deposit within an area equivalent in size to an area measuring 10.9 m by 10.9 m by what arguably were small groups of Paleoindians engaged in generalized foraging (Bamforth 2007). The comparison supports the inference that big game hunting was an important activity pursued by occupants of the Caribou Lake site. Of the three points recovered during the later excavations, two were subjected to blood residue analysis and one reacted positively to elk antibody (Pitblado 2000:144).

One end scraper was found, but microscopic examination did not reveal use wear indicative of use on hide, nor did residue analysis produce any evidence for blood as might be expected if the artifact was used on hide. Adjacent to the end scraper bit on the artifact is a concave retouched “spokeshave” edge suggesting that the tool may have been intended to assist in the production of wooden shafts for hunting weapons, however, no use wear of any kind was found on either the spokeshave edge or the end scraper bit. Lack of end scrapers with use wear indicative of hide processing suggests that the intent of game drive operations may have been to acquire meat from a non-bison game animal, but not to process the hides.

Of the kinds of debitage present, some are consistent with the supposition that manufacture of finished of tools occurred prior to large-scale hunting while others are in line with the thinking that maintenance of worn tools took place at the site after a successful hunt. Pitblado classified the debitage into functional categories including tool production, final finishing, and tool rejuvenation (i.e. resharpening). Of the 63 pieces of debitage from the later excavations, one flake of Kremmling chert possessed cortex indicative of blocky core reduction. Apparently, the most recent investigation of the site did not re-examine the
debitage from the early excavations, but Benedict (1974:3) also notes that some decortication
flakes of Kremmling chert were found, suggesting that some tools were manufactured on-site.
Another flake of Kremmling chert recovered during the later excavations exhibited attributes
demonstrative of soft-hammer biface thinning (Pitblado 2000:151). From the above, it can be
suggested that at least a minor amount of the initial stages of manufacture of unifacial tools
from blocky cores may have taken place on-site, as did thinning of bifacial artifacts. The
presence of the point preform suggests that bifacial artifact manufacture included the
finishing of projectile points from preforms.

Pitblado emphasizes that the debitage collection from the later excavations is
primarily demonstrative of the final finishing of bifacial artifacts. Data on the attributes of
the debitage recovered reiterates, however, that some amount of unifacial artifact production
also occurred. For example, catalog # 889 is a flake of Kremmling chert that measures .73
cm long, has an unworn platform and a flake angle of 91 - 100°, and displays a curving
longitudinal profile (Pitblado 2000:Table 4.2). (The flake angle is that formed by the
intersection of the striking platform and the dorsal face of the flake). The above
characteristics are most suggestive of a flake removed during production of a unifacial tool as
opposed to a bifacial one.

Some debitage with platform edges considered to be “worn” were classified by
Pitblado as rejuvenation (i.e. resharpening) flakes. A number of flakes of dark red
orthoquartzite were classed as resharpening flakes. Benedict classifies some of these flakes
as deriving from unifacial tools, while others are said to come from bifacial tools, but
Pitblado (2000:150) contends that only bifacial tool resharpening flakes are present. Data on
the flake angles of the two red orthoquartzite flakes with worn platforms, however, suggests
resharpening of unifacial tools (Pitblado 2000:Table 4.2). The flakes (catalog # 364 and 365)
are said to have flake angles of between 81 and 90°, which is more suggestive of removal of
flakes from a unifacial tool edge. Regardless of whether the resharpening flakes derive from
the maintenance of unifacial tools or bifacial ones, or both, their presence in the Paleoindian assemblage suggests that tool refurbishing may have taken place on-site following use of the tools in activities that typically follow a successful hunt, particularly butchering.

The tool stone composition of the assemblage is given in Table 12-15. The table was constructed by combining data on the collections recovered during early and later excavations given in Pitblado (2000:129, 131, 141-147, Table 4.2). The raw material of some of the debitage recovered during the early excavations was not specified, but considering that these artifacts comprise only four percent of the combined assemblage, this missing information should not seriously affect the conclusions reached.

The majority of the assemblage (68 percent) is composed of artifacts of Kremmling chert. As mentioned, the point preform, biface thinning flake, and decortication flakes demonstrate that some of this raw material was brought to the site in unfinished form. This is in contrast to most all other tool stones which occur either as points or small flakes. An exception is tan orthoquartzite, which occurred not only in the form of points and small flakes, but as a relatively large flake measuring 2.2 cm in maximum dimension that is classed as a tool production flake (Pitblado 2000:Table 4.2).

Much of the assemblage is composed of orthoquartzites suspected of originating from distant sources in northeast Colorado, with a red variety being an important tool stone, accounting for 18 percent of the collection. The tool stone is described by Pitblado as light red or dark red with black specks. I happened to see the original point base from the early excavations when it was in the possession of Dr. Douglas Bamforth of the University of Colorado for use wear analysis and would describe its color as dark maroon. Pitblado (2000:143, 146, 156) refers to this and other varieties of orthoquartzite from the site as Dakota quartzite and suggests they derive from Pleistocene terraces on the Pawnee National Grasslands of northeast Colorado. These scattered tracts of public lands are located in an east-west band situated between the Wyoming state line and the South Platte River. The
Table 12.-15. Tool Stone and Artifact Composition of Late Paleoindian Assemblage from the Caribou Lake Site. a

<table>
<thead>
<tr>
<th>Tool Stone Type</th>
<th>Flaked Stone Tools</th>
<th>Tool Manufacturing and Maintenance Debris</th>
<th>Flaked Stone Tools</th>
<th>Flaked Stone Tools</th>
<th>Total Number of Artifacts</th>
<th>Distance to Tool Stone Source Used in Analysis (km)</th>
<th>Relative Distance to Tool Stone Source</th>
<th>Percent of Assemblage Composed of Local Versus Nonlocal Stone, According to Artifact Count</th>
<th>Percentage of Assemblage Composed of Local Versus Nonlocal Stone, According to Artifact Count</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Flakes</td>
<td>Point Preform</td>
<td>Utilized Flakes</td>
<td>Informal Retouched Flake Tool (Graver)</td>
<td>End Scraper with Spokeshave Edge</td>
<td>Projectile Points</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kremmling Chert</td>
<td>89</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>96</td>
<td>53</td>
<td>Local</td>
</tr>
<tr>
<td>Unspecified Tool Stone Type(s)</td>
<td>6</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>6</td>
<td>?</td>
<td></td>
</tr>
<tr>
<td>Light and Dark Red Orthoquartzite, possibly from Northeast Colorado</td>
<td>23</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>25</td>
<td>102/171</td>
<td>Distant</td>
</tr>
<tr>
<td>Tan Orthoquartzite with High Luster, Possibly from White River Group Gravels</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>171?</td>
<td>Distant</td>
</tr>
<tr>
<td>Gray Quartzite, possibly from Northeast Colorado</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>171?</td>
<td>Distant</td>
</tr>
<tr>
<td>Cream-Colored Medium-Grained Quartzite</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>171?</td>
<td>Distant</td>
</tr>
<tr>
<td>Brown Chert</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>?</td>
<td>Distant or Very Distant</td>
</tr>
<tr>
<td>White Chert with Inclusions</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>?</td>
<td>Distant or Very Distant</td>
</tr>
<tr>
<td>Peach Chert</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>?</td>
<td>Distant or Very Distant</td>
</tr>
<tr>
<td>Hartville Uplift Chert</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>274</td>
<td>Very Distant</td>
</tr>
<tr>
<td>Total</td>
<td>1.31</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>4</td>
<td>142</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Percent of Assemblage</td>
<td>92.25</td>
<td>.70</td>
<td>2.82</td>
<td>.70</td>
<td>2.82</td>
<td>100.00</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

a Data from Pitblado (2000:129, 131, 141-147, Table 4.2).
information given on the suspected sources of the orthoquartzite suggests to me that they may be equivalent to what I have defined herein as various kinds of orthoquartzites from White River Group gravels (WRGG), which are of Oligocene age, not Pleistocene. With the exception of Morrison orthoquartzite that ultimately derives from the Morrison formation, many of the varieties of orthoquartzite found in the White River Group gravels can not be attributed emphatically to a particular formation, such as the Dakota Sandstone. A characteristic of artifacts of red orthoquartzite from Caribou Lake that supports Pitblado’s assertion that a likely source area is northeast Colorado is the fact that the orthoquartzite artifacts from the site and select hand samples of some varieties of orthoquartzite from the White River Group gravels have no color response under longwave UV light and fluoresce green under shortwave radiation. Of 10 hand samples of very-rough textured orthoquartzite collected from the three procurement sites in the Kalouse area discussed in Chapter 7, a total of 30 percent (n = 3) displayed a none / green color response under long and shortwave light, respectively. Furthermore, of the 265 artifacts from the Jurgens site made of very rough-textured orthoquartzite, 5 percent (n = 13) exhibited a none / green color response (Table A-2). Sources of WRGG occur throughout a broad east-west orientated band, nevertheless, to give some idea of the distance and direction to the source area, it may be noted that the lithic procurement sites in the Kalouse area are 171 km east-northeast of Caribou Lake.

Based on its color in normal light, another possible source of the red orthoquartzite is the poorly known source rumored to exist in the Big Hole area of the Boxelder Creek drainage in the foothills east of the Lindenmeier site at the Colorado-Wyoming state line. Benedict (1985) suggests the red orthoquartzite artifacts from Caribou Lake may have originated from near the Lindenmeier site. However, the maroon quartzite at the two small sources discussed in Chapter 7 does not have black specks, nor do hand samples fluoresce under either long or shortwave UV light. Four hand samples from the primary source in T 12 N, R 69 W, Section 32 did not show a fluorescent color response and neither did two hand
samples from the secondary source in T 12 N, R 69 W, Section 35. Big Hole is situated 102 km north-northeast of Caribou Lake.

Sources of a red to purple orthoquartzite also occur in northwest Colorado, but for a number of reasons, this region is not thought to be the source of the stone used to make the Caribou Lake artifacts. The raw material is known as Uinta orthoquartzite and originates in exposures of the Uinta Mountain Group (Naze 1994). Compared to the Caribou Lake artifacts, however, this tool stone can be coarser grained with more angular grains. It also lacks the black specks and hand samples from three sources were found to not fluoresce under either long or shortwave UV light.

The raw material of three flakes and the complete point from the Caribou Lake site is a tan orthoquartzite. The point and at least one of the flakes were specifically noted to have a high luster, a characteristic shared with the very rough-textured orthoquartzite variety of WRGG. The UV color response of the point was none/green, further bolstering the likelihood that the raw material originated from a source of WRGG in northeast Colorado.

Finally, other colors of orthoquartzite from the Caribou Lake site are classified in Table 12-15 as likely deriving from distant sources in northeast Colorado. Included is a gray orthoquartzite referred to as Dakota quartzite by Pitblado, thus implying a likely source in northeast Colorado. Also included is a tan medium-grained orthoquartzite.

Two artifacts in the assemblage are made of a tool stone that is here classified as Hartville Uplift chert. One is a flake of cream-colored chert with dendrites (Pitblado 2000:Table 4.2). The raw material of the end scraper is described as a butterscotch-colored chert with black dendrites that are arranged in arcs. The UV fluorescent color response of the artifact is green under shortwave light (Pitblado 2000:146) and apparently there is no fluorescent color response under longwave radiation. No color response under longwave UV light with a green response under shortwave is common to artifacts of Hartville Uplift chert in the Jurgens collection where it occurs in 129 out of 302 artifacts or 43 percent of the cases.
recorded (Table A-16). As the table shows, the none / green color response is also common among hand samples of Hartville Uplift chert in three comparative tool stone collections examined. In relation to the Caribou Lake site, the closest source of Hartville Uplift chert is located in very distant lands, occurring 274 km north-northeast of the site.

A variety of chert available in northwest Colorado is often identical to Hartville Uplift chert. The tool stone is known as Morgan-Madison chert because it outcrops from the Morgan Formation (Pennsylvanian) as well as the underlying Madison Limestone (Mississippian). One variety of Morgan-Madison chert is called pumpkin chert because it often is colored brownish orange or brownish yellow. Pumpkin chert has black dendrites and is identical to the yellow-to-orange-to-brown dendritic chert from the Hartville Uplift. Under UV light, pumpkin chert is not distinct from Hartville Uplift chert because it also commonly has a none / green color response under long and shortwave light, respectively. Pumpkin chert is available from a number of source areas in northwest Colorado (Naze 1994), with a source on Cross Mountain (5MF3461) lying 226 km west-northwest of the Caribou Lake site. This distance is actually closer to the Caribou Lake site than the closest Hartville Uplift sources.

However, considering that characteristics of the orthoquartzite artifacts in the collection best compare to stone from northeast Colorado rather than to the Uinta orthoquartzite from northwest Colorado, the artifacts of dendritic chert in the assemblage are here considered to derive from sources in southeast Wyoming located north and east of the site in the Hartville Uplift. This suspicion is bolstered by the above review of the assemblages from the Jurgens, Frazier, and Lindenmeier assemblages which demonstrates that Hartville Uplift chert was commonly transported to sites in the South Platte drainage of northeast Colorado.

A few artifacts in the assemblage are made of tool stone types from unknown sources. The artifacts comprise a small proportion of the assemblage, so the inability to
identify the sources of the raw materials will not affect interpretation of the tool stone composition of the assemblage. Since the main tool stones available in Middle Park are known and there is little chance the unidentified stone originates from sources in the igneous and metamorphic core of the Front Range, the raw materials of these few artifacts are considered nonlocal in origin. The artifacts include four flakes of brown chert, one flake of white chert with inclusions that is not Kremmling chert, and one flake of peach-colored chert.

Fourth of July Valley Site

Like the Caribou Lake site, the Fourth of July Valley site is located near game drives along the crest of the Front Range and in proximity to Arapaho Pass, only this site is located on the east side. The site is in a high mountain valley that is within the watershed of Middle Boulder Creek. One kilometer north of the site lies Arapaho Pass with game drive site 5BL114 situated just south of the pass. The game drive lines above and below Lake Dorothy are one and one-half km to the west-northwest of the site.

The environmental setting of the site is favorable for camping. The site is located on the top and inside, or western, slope of a terminal moraine formed during the Satanta Peak advance, a relatively minor glacial resurgence associated with the Younger Dryas climatic cooling during Folsom times. By the time of the Late Paleoindian occupation of the site, soil formation had leveled the rocky surface of the moraine (Benedict 1981:75). Water is available immediately north of the site from a permanent creek and several springs are situated 20 to 70 m east of the site (Benedict 1981:Figure 7). The site is in the forest-tundra ecotone with scattered stands of spruce and fir occurring in the vicinity along with patches of dwarfed conifers known as krummholz vegetation. Currently, trees are not present on the site. As discussed in Chapter 6, evidence from pollen and fossil insect studies demonstrate that upper tree line had risen to its modern day level from depressed elevations in the terminal Wisconsin times by approximately 9200 B.P. Charcoal from forest fires recovered during
site excavation provide evidence suggesting that the site vicinity was wooded at the time of forest fires that occurred around 9170 ± 40 B.P., and again at ca. 8920 ± 50 B.P. This information in turn suggests that firewood would not have been far for the Late Paleoindian occupants of the site. A series of eight radiocarbon assays ranging between 6470 ± 50 B.P. and 6240 ± 40 B.P. date a forest fire that occurred in Altithermal times. Oxidation of sediment underlying some patches of charcoal dating to this period indicates that wood burned on-site and suggests that trees grew on the moraine crest during the Altithermal. (Originally, two patches of charcoal dating to the Altithermal were interpreted as hearths denoting an early Archaic occupation of the site, but they have since been re-interpreted as having been natural in origin (Benedict 1981:75; 2005).

The density of points recovered during excavation and surface collection of the site suggests that hunting was an important activity performed by the people who occupied the site. An irregularly shaped excavation block measuring a maximum of 14 m northeast-southwest by 6 m northwest-southeast was aligned along the moraine crest and extended down the inside slope. The total area excavated in 1971 was 41 m², which equates to an area measuring 6.4 m by 6.4 m. Most of the 18 points or point fragments recovered from the site were within the excavation grid, but two were found on the ground surface to the west (Benedict 1981:80-82). In comparison, nine points were collected during excavations at the Allen site which in total equate to an area measuring 10.9 m by 10.9 m. Excavations there were carried out in thick midden deposits representing essentially the entire Paleoindian period. Groups occupying the site are thought to have been involved in generalized foraging of the Medicine Creek drainage in Nebraska. Methods of assessing the number of occupations, such as refitting studies or minimum analytical nodule analysis, had not been developed during the time that the Fourth of July site was excavated and its contents reported upon, however, lacking evidence to the contrary, the site is here interpreted to represent a single occupation. If this assumption is valid, the density of points at the Fourth of July
Valley site strongly implies that people camped at or near the site were engaged in large-scale hunting of big game animals. The proximity of the site to game drive sites suggests the animals may have been taken in a communal drive.

Artifacts in the assemblage may represent both primary and secondary refuse. Most of 1,392 flakes from the site are small, averaging around one centimeter in maximum dimension (Benedict 1981:84). As discussed previously, enthoarchaeological study by O’Connell (1987) suggests that artifacts larger than five cm in maximum dimension are most likely to be cleaned up from a work area and deposited in a secondary refuse deposit. Smaller items sometimes were eventually swept to the edge of midden deposits peripheral to work areas, but some also remained in work areas. Artifact density is relatively sparse on the moraine crest where there are at most more than ten flakes per m². Two concentrations of artifacts occur lower on the inside slope of the moraine and contain substantially higher flake densities of over 100 flakes per m² (Benedict 1981:Figure 56 b). These concentrations are here hypothesized to be trash middens. This possibility seems especially likely for the westernmost of the two concentrations. It occurs in a natural depression measuring about 1.8 m northwest-southeast by 1.1 m northeast-southwest (Benedict 1981:Figure 66). Included within the depression was a high density of flakes and a number of worked artifacts, including seven points, one possible point preform, an unfinished biface, and two informal retouched flake tools (see below and Benedict 1981:82, Figure 56 b).

A consideration of the formation processes that affected the site suggests that if bones of game animals were once present in the cultural deposit, they may have completely weathered away. Some of the artifacts in the assemblage, especially those in the northeastern portion of the excavation block were discolored from exposure to fire (Benedict 1981:84-85, Figure 71 c). This suggests that cultural material may have been exposed on the ground surface for a considerable period of time during which one or more forest fires swept over the
site. If bone was exposed on the ground surface for a long period of time, it is possible that it completely weathered away and was never buried.

The sedimentary stratum in which the cultural material is believed to have been originally deposited is referred to as Unit 2, a layer of reworked glacial outwash which overlies the till. Stratigraphy at the site is complex, but soil profiles presented in Benedict (2005:Figures 10, 15a) demonstrate that Unit 2 varies in depth to about 20 or 30 cm below ground surface.

Points recovered from the site are mostly classifiable as belonging to the Angostura type, but one is best typed as a Frederick point. As discussed in Chapter 8, the Angostura point is a type attributable to Late Paleoindian people of the Southern Rocky Mountains and the Frederick point is a type made by Paleoindian people of the western portion of the Central Plains. No definite hearths were uncovered in the excavations and, as argued in Chapter 8, the poor degree of association between the bioturbated artifacts and the scattered charcoal from forest fires does not permit the site to be precisely dated. Attributes that diagnose the points from the site as belong to the Angostura and Frederick types were reviewed in Chapter 8. In particular, it should be emphasized that Frederick points have a demonstrably wider basal width. In a sample of 65 Angostura points examined by Pitblado (2007:Table 10.2, Figure 10.4) basal width averaged only 1.409 cm. Basal width in a sample of 49 Frederick or Allen points averaged 2.135 cm. The Frederick point base from the Fourth of July Valley has a basal width of 2.3 cm (Benedict 1981:Figure 67 a) and the Angostura point fragments from the site are noticeably narrower.

There appears to be a difference between the raw material of the Angostura points and that of the Frederick point. A color photograph of the points shows that the points typed here as Angostura are all made of light gray Windy Ridge orthoquartzite (Benedict 2005:Figure 5). Included are two stemmed points thought to be reworked distal fragments. The photograph also shows the raw material of the Frederick point as being a medium
yellowish brown orthoquartzite. Benedict (2005:Figure 5 caption) suggests that the point is made of Windy Ridge orthoquartzite that was discolored from exposure to a forest fire. However, the artifact does not display pot lids or thermal crazing indicative of rapid heating. Also, in my experience, the color of the orthoquartzite is outside the range for both unaltered and thermally altered Windy Ridge orthoquartzite. A large majority of pieces of Windy Ridge orthoquartzite at the source in northwest Middle Park range from off-white to medium gray with most being light gray. A minor color variety is light to medium brown. When exposed to fire, Windy Ridge quartzite may turn reddish or dark gray. For the above reasons, I suspect that the Frederick point pictured from the site may be made of another type of orthoquartzite besides that from the Windy Ridge source in Middle Park or the similar source in North Park.

A final observation regarding the Frederick point is that it was found by itself in the northeast part of the excavation block which also had most of the artifacts of microcrystalline tool stone. The excavated Angostura points from the site are all from the southwest part of the excavation block where the two artifact concentrations were located. From this one might argue that the site was occupied twice: once by people who made Angostura points and emphasized the use of Windy Ridge orthoquartzite and also on a separate occasion by makers of the Frederick point who possessed quantities of microcrystalline stone. However, it should be recalled that some Paleoindian middens that evidently resulted from a single occupation related to a large-scale bison hunt have artifacts of differing tool stones separated into identifiable concentrations which are interpreted as representing different episodes of trash disposal. The Jurgens and Frazier sites would be examples. Thus, the separation of the Frederick point and artifacts of microcrystalline stone primarily in one part of the site is not necessarily an indication of multiple occupations. The site will therefore be interpreted as the product of one occupation during which points of both the Angostura and Frederick types were discarded.
The artifact composition of the assemblage from the Fourth of July Valley site is comparable to that of assemblages from sites interpreted above as temporary hunting camps of people engaged in large-scale hunting of big game. Artifacts in the collection include the 18 points, one fragmentary biface that appears to me to be a possible point preform (Benedict 1981:Figure 68 a), and two biface fragments that display irregular edges and are here classified as unfinished bifaces of unknown manufacturing stage (Benedict 1981:Figure 68 c-d) (Table 12-16). Another biface fragment appears to have fairly regularized edges (Benedict 1981:Figure 68 b) and is here classified as a finished (Stage 4) biface that may have served as a knife. Also present in the assemblage are 10 tools lumped together here as informal retouched flake tools. According to Benedict’s (1981:82-84) classification, these tools included one edge-retouched flake, two edge-retouched flake knives, one prismatic blade, one chopper or scraper, two flake perforators, one tool with a chisel bit, and two gravers.

As was the case with the other two sites in the high Front Range, no end scrapers are among the tools recovered from the Fourth of July Valley site. This would tend to support the suggestion that the non-bison big game animals taken in game drives above tree line may have been exploited as a source of food, but there is no evidence to suggest that their hides were processed.

Among the debitage, there is evidence that some amount of blocky core reduction took place as seen in the recovery of a blocky core made of milky white chalcedony that is here considered to be Kremmling chert, along with several large unmodified flakes of Windy Ridge orthoquartzite (Benedict 1981:84). Photographs of the ventral faces of two complete specimens of these flakes appear to show striking platforms suggesting the flakes were struck from a blocky core as opposed to having been detached from a biface (Benedict 1981:Figure 68 p-q). Maximum dimensions of the flakes are 3.9 cm and 4.9 cm.

A majority of flakes are small with maximum dimensions averaging around one cm. Benedict (1981:84) notes that most flakes have edge angles that cluster between 55° and 85°.
Table 12-16. Tool Stone and Artifact Composition of the Assemblage from the Fourth of July Valley Site. a

<table>
<thead>
<tr>
<th>Tool Stone Type</th>
<th>Excavated Flakes</th>
<th>Blocky Core</th>
<th>Unfinished Block</th>
<th>Unknown Stage</th>
<th>Possible Projectile Point Preforms</th>
<th>Informal Retouched Flake Tools</th>
<th>Flaked Stone Tools</th>
<th>Unfinished Point Type or Stage</th>
<th>Finished (Stage 4) Biface</th>
<th>Frederick Points</th>
<th>Angostura Points</th>
<th>Possible Projectile Point Preforms</th>
<th>Informal Retouched Flake Tools</th>
<th>Total Number of Artifacts</th>
<th>Distances to Tool Stone Source Used in Analysis (km)</th>
<th>Relative Distance to Tool Stone Source (percent)</th>
<th>Percent of Assemblage Composed of Local Versus Nonlocal Stone, According to Artifact Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kremmling Chert</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>Middle Park</td>
<td>54</td>
<td>0.40</td>
<td>.40 percent Local</td>
<td>Middle Park</td>
<td>1.076</td>
<td>86.56</td>
<td>.88 percent Local or Nonlocal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unspecified Tool Stone Type(s)</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>11</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>?</td>
<td>11</td>
<td>?</td>
<td>.88 percent Local or Nonlocal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Windy Ridge Orthoquartzite</td>
<td>1,053</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>13</td>
<td>4</td>
<td>Middle Park</td>
<td>88</td>
<td>86.56</td>
<td>86.56</td>
<td>2.90 White River Group Gravel</td>
<td>98.71</td>
<td>98.71 percent Nonlocal</td>
<td>98.71 percent Nonlocal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium Yellowish Brown Orthoquartzite (Possibly from White River Group Gravels [WRGG])</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>Plains</td>
<td>170</td>
<td>Distant</td>
<td>Distant or Very Distant</td>
<td>White River Group Gravel</td>
<td>.88</td>
<td>.88 Local</td>
<td>.88 percent Local or Nonlocal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light Brown to Light Reddish Brown Orthoquartzite with High Luster (Possibly from WRGG)</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>11</td>
<td>Plains</td>
<td>170</td>
<td>Distant</td>
<td>Distant or Very Distant</td>
<td>White River Group Gravel</td>
<td>.88</td>
<td>.88 Local</td>
<td>.88 percent Local or Nonlocal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brown to Reddish Brown Orthoquartzite with White Silica Matrix (Possibly from WRGG)</td>
<td>24</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>24</td>
<td>Plains</td>
<td>170</td>
<td>Distant</td>
<td>Distant or Very Distant</td>
<td>White River Group Gravel</td>
<td>.88</td>
<td>.88 Local</td>
<td>.88 percent Local or Nonlocal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purplish Pink Chert</td>
<td>32</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>32</td>
<td>?</td>
<td>?</td>
<td>Distant or Very Distant</td>
<td>2.57</td>
<td>3.78 Hartville Uplift Chert</td>
<td>100.00</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Conglomeratic Chert</td>
<td>22</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>22</td>
<td>?</td>
<td>?</td>
<td>Distant or Very Distant</td>
<td>1.77</td>
<td>3.78 Hartville Uplift Chert</td>
<td>100.00</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Dull Brown Chert</td>
<td>14</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>14</td>
<td>?</td>
<td>?</td>
<td>Distant or Very Distant</td>
<td>1.13</td>
<td>3.78 Hartville Uplift Chert</td>
<td>100.00</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Fossiliferous Brown Chert with Black Dendrites (Hartville Uplift Chert)</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>17</td>
<td>Plains</td>
<td>278</td>
<td>Very Distant</td>
<td>Very Distant</td>
<td>Hartville Uplift Chert</td>
<td>.88</td>
<td>.88 Local</td>
<td>.88 percent Local or Nonlocal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Five Tool Stone Types That Are Possibly Varieties of Hartville Uplift Chert (See Text for Full Description)</td>
<td>28</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>30</td>
<td>Plains</td>
<td>278</td>
<td>Very Distant</td>
<td>Very Distant</td>
<td>Hartville Uplift Chert</td>
<td>.88</td>
<td>.88 Local</td>
<td>.88 percent Local or Nonlocal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1,210</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>10</td>
<td>1</td>
<td>13</td>
<td>4</td>
<td>1,243</td>
<td></td>
<td></td>
<td></td>
<td>100.00</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Percent of Assemblage</td>
<td>97.35</td>
<td>.08</td>
<td>.16</td>
<td>.08</td>
<td>.80</td>
<td>.80</td>
<td>1.45</td>
<td>.80</td>
<td>100.00</td>
<td>-</td>
<td>-</td>
<td></td>
<td>100.00</td>
<td>-</td>
<td>-</td>
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<td></td>
</tr>
</tbody>
</table>

and from this observation he suggests that the flakes may have been detached from tools used in hide scraping in order to resharpen them. No end scrapers were discarded on the site, however. Lacking more convincing evidence for resharpening of hide working tools, it is best to simply consider the majority of the flakes to be small pieces of debitage that are consistent with the hypothesis that principally the later stages of stone tool production and possibly some tool resharpening took place at the site.

A large majority of the assemblage from the Fourth of July Valley site is made of Windy Ridge orthoquartzite from Middle Park that should be considered of local origin. A total of 87 percent of the assemblage is made of Windy Ridge orthoquartzite. The closest source of this tool stone is in the northwest corner of Middle Park, near Rabbit Ears Pass. The Windy Ridge orthoquartzite quarry is 88 km from the site and would generally be categorized as a distant tool stone source under the classification used in this study. The classification of Windy Ridge orthoquartzite as a tool stone from a distant source is retained in the data on the tool stone composition of the assemblage presented in Table 12-16. However, as will be explained in a following section on interpretation of the geographic extent of land use from the tool stone composition of the high Front Range sites, the Windy Ridge orthoquartzite quarry is best considered to be a local source for mountain people who would have wintered in mountain valleys northwest and southwest of Middle Park.

Of the two other main tool stones of Middle Park, one is present only in miniscule amounts and the other is completely absent. One blocky core, one informal retouched flake tool, and three waste flakes are of Kremmling chert, which together comprise less than one percent of the collection. No artifacts whatsoever of Table Mountain jasper are present.

The assemblage contains three kinds of orthoquartzite possessing characteristics suggesting that they may derive from distant sources of White River Group gravel within the South Platte River drainage on the plains of northeast Colorado. To give a general idea of the distance and direction of the broad source area of WRGG, it may be noted that the cluster of
three WRGG procurement sites in the Kalouse area discussed in Chapter 7 is situated 170 km northeast of the site. If re-examination of the Frederick point determines that it is not made of Windy Ridge orthoquartzite, a possibility would exist that the medium yellowish brown orthoquartzite may derive from sources of White River Group gravels. A total of 11 flakes are made from a light brown to light reddish brown orthoquartzite with a luster described by Benedict (1981:121) as adamantine, meaning that have a high luster, like a diamond. This quality is shared by very rough-textured orthoquartzite, a variety of WRGG and the similarity suggests northeast Colorado as the region from which the orthoquartzite derives. A third kind of orthoquartzite is brown to reddish brown and composed of sand grains embedded in a white silica matrix. The white silica matrix is again a quality of a small percentage of the orthoquartzites thought to originate from WRGG sources. For example, a minimum analytical nodule from the Jurgens site composed of a point midsection and two interior flakes were made from a light red, very rough textured orthoquartzite with the matrix between the sand grains of the raw material appearing to have patinated to a white color (Table B-2, minimum analytical nodule # 9). In total, artifacts made of orthoquartzite that display characteristics suggestive of having originated in exposures of WRGG from northeast Colorado make up three percent of the collection.

Several tool stone types in the assemblage seem to be probably or possibly varieties of Hartville Uplift chert, based on the detailed descriptions of the principal raw materials and color photographs provided by Benedict (1981:121-122; 2005:Figure 6). A brown chert containing black dendrites and invertebrate fossils of Pennsylvanian age matches the description of a common variety of Hartville Uplift chert and is here considered to probably originate from the source area in southeast Wyoming. Two other tool stones possess black dendrites, including a clear to brownish yellow chert and a dark red chalcedony and therefore are considered to possibly be Hartville Uplift chert. Some artifacts in the Jurgens collection thought to be made of Hartville Uplift chert are brecciated, meaning that the chert appears to
have formed fractures that subsequently were filled with silica (e.g. Figure 7-14 Specimen I). Based on this observation, the raw material of an informal retouched flake tool from the Fourth of July Valley site described as a brecciated tan, brown, and pink chert is thought to possibly be Hartville Uplift chert. Hues of red, yellow, and brown are common in Hartville Uplift chert and therefore the raw material of artifacts from the site described by Benedict as being made of chert or chalcedony of these colors were also classified as possibly being Hartville Uplift chert. Included are a dark yellowish brown chalcedony and a pink chalcedony that is finely flecked with red. All together, varieties of microcrystalline tool stones attributed to Hartville Uplift chert comprise four percent of the assemblage. The closest sources of Hartville Uplift chert are situated 278 km north-northeast of the site.

A few tool stone types are from undetermined sources and their presence at low levels should not seriously affect the interpretation of the tool stone composition of the assemblage. Flakes of a purplish pink chert, a conglomeratic chert, and a dull brown chert are classified in Table 12-16 as deriving from distant or very distant sources, based on the reasoning that the local tool stones of Middle Park are fairly well known and the descriptions of the raw materials suggest they do not originate within the park. Also, 11 flakes are made of tool stones that are uncommon in the collection and were not described by Benedict.

EVALUATION OF CONTRASTING VIEWS

The tool stone composition of the study assemblages favors the alternative view over traditional thinking as a better theoretical framework for interpreting land use. Data on the tool stone composition of assemblages was found to conform to theoretical expectations developed under the alternative view. The following discussion will first consider assemblages from sites related to communal kills located in environments lacking a high-quality source of stone. For various reasons, the tool stone composition of assemblages from
sites in this category favor the alternative view over traditional thought. Next, assemblages from sites associated with large-scale kills situated in environments with a local high-quality source of stone are discussed. In a number of cases, the tool stone composition of these sites are not at all in conformity with expectations of the traditional view and allow the theoretical perspective to be rejected outright. Then, the tool stone composition of the only site that is definitely classifiable as a site not associated with communal hunting is discussed and found to favor the alternative view. Finally, the tool stone composition of assemblages from sites at high-quality sources of stone are considered. The tool stone composition of assemblages from some of these sites is completely different from the expectations of the traditional view and therefore permits the theoretical perspective to be rejected in favor of alternative thinking. Because the alternative view was determined to be a superior theoretical construct, it will be used in the following section to interpret the relevance of each site for providing an improved understanding of Paleoindian land use.

The tool stone composition of the sites related to communal kills located in environments without a high-quality source of stone favors the alternative view over traditional thinking. Under the traditional view, nonlocal stone is expected to dominate the assemblages and if indeed Paleoindians operated in single bands that moved about within ranges of the size envisioned, there should be some sites in this category with substantial amounts of stone from very distant sources. Instead, of the five assemblages definitely in this category, four have only miniscule amounts of stone from very distant sources (Casper, Jones-Miller, Jurgens, and Powars). Only the Frazier site has what might be considered an appreciable amount of stone from a very distant source (13 percent of the assemblage is Alibates agate, according to artifact count). Nevertheless, the tool stone still accounts for only a small minority of the assemblage.

The tool stone composition of assemblages from sites related to communal hunting in environments lacking high-quality sources of local stone better conforms to the alternative
view for a number of reasons. First, since the assemblages are dominated by distant and local stone (if available), this observation is more in line with the expectation that people from bands in neighboring ranges brought stone with them to a communal hunt with local people. Alternatively, for some sites assemblages, it may be argued that members of the local band that were planning a communal hunt may have procured the stone from distant sources in order to gear up. Secondly, for some sites, the positioning of the distant sources on the landscape would support the idea of bands coalescing for a communal hunt. This is the case with the Jones-Miller site where the distant sources of two tool stones that together comprise 78 percent of the assemblage occur in opposite directions from the site. Also, the fact that the distant sources of the two tool stones that together account for 94 percent of the Casper assemblage are situated on opposite sides of the Laramie Mountains, with one situated in an upriver direction and one located downriver, would support the notion of aggregation of cooperating bands.

The tool stone composition of assemblages from sites related to large kills located in environments with local high-quality sources of stone refutes the traditional view in favor of the alternative. Because Paleoindians are traditionally thought to have always had some high-quality tool stone from nonlocal sources in their tool supply as part of their frugal lithic technology, assemblages from sites in this category should be dominated by nonlocal raw materials (if the band had yet to visit a local source) or else contain at least an appreciable amount of nonlocal stone (if a local source had been visited). Under no circumstances should assemblages be totally dominated by local tool stone, or nearly so, as is the case with both of the sites in Middle Park (Jerry Craig and Upper Twin Mountain) and one of the three sites in the high Front Range (Devils Thumb Game Drive). According to the alternative view, however, sites with assemblages that are very dominated by local stone are produced when members of a local band cooperate in communal hunt or when a multi-band aggregation gears up with local stone after aggregating for large-scale hunting. All of the above-
mentioned sites produced tool stones in varying amounts from all three sources in Middle Park. Even though the groups of people who produced these sites would not have wintered in Middle Park or the high Front Range, the presence of all three Middle Park sources implies the sites were produced in part or in whole by persons from a band that could be considered local in that they occupied the regions during at least part of the year and made use of stone from all three of the main Middle Park sources. Presence of two coeval point types at the Jerry Craig site, coupled with the prevalence of Kremmling chert from a nearby source in the point collection, supports an alternative interpretation of this site as the product of a multi-band aggregation composed of culturally distinct groups that geared up with local stone.

Tool stone composition of the only site that is definitely not associated with communal hunting and located in an environment with local high-quality sources of tool stone supports the alternative view over traditional thinking. The tool stone composition of the Allen site is nearly completely dominated with local stone with only miniscule amounts of non-local stone present in the form of points and flakes removed from bifacial artifacts. This situation is more in keeping with the thinking that Paleoindians had land use patterns that were more comparable to that of ethnographically known people and less in line with the thinking that Paleoindians made use of a frugal technology to operate within huge ranges.

Finally, the tool stone composition of assemblages from sites at sources rejects the traditional view which maintains that relatively large amounts of nonlocal tool stone should be present in the collection of discarded tools as tools in disrepair are replaced with others made from the local stone. Of the seven site assemblages in this category, none comply with the expectations of the traditional view; all contained collections of tools dominated by the local stone.

The alternative view asserts that sites by sources may have been produced through occupation by groups of varying size with differing purposes (e.g. gearing up versus a more general resupply of tool stone) and that much needs to be done to improve methods of
analysis. For example, developing methods of differentiating single versus multi-band occupations of sites at sources is important but may prove challenging, particularly in the situation where there is only one kind of local stone and no differing tools stones from distant sources. With this in mind, however, it is relevant to note that sources of tool stone represented in the assemblage from Locality V at the Hell Gap site cluster do support the view that a local band occupied the site for purposes of gearing up for communal hunting using stone from the local sources of Hartville Uplift chert. Present in the assemblage are multiple types of tool stones from local and distant sources. The assemblage from Locality V of Hell Gap contains a large amount of Hartville Uplift chert from nearby sources (71 percent), three other types of local tool stone that together total 27 percent, and two tool stones from distant sources that account for only two percent. The tool stone composition of Locality V therefore supports the alternative expectation that some sites at sources may represent a single band camped at a lithic source to gear up for communal hunting.

ALTERNATIVE INTERPRETATION OF GEOGRAPHIC SCALE OF LAND USE

Sites Related to Communal Kills in Environments Lacking High-Quality Source of Stone

Casper Site

The substantial and roughly equal amounts of quartzite from the Shirley Basin and microcrystalline stone from the Hartville Uplift support an interpretation contending that multiple bands aggregated for a communal bison hunt at the Casper site. The source of the two varieties of quartzite is estimated to be 80 km south-southeast of the site and the source area of the dendritic jaspers and other microcrystalline tool stones is roughly 144 km to the east-southeast of the site. Because sources of both the orthoquartzites and the microcrystalline tool stones are situated to the south and east of the site, one might wonder if both source areas were visited by constituents of a single band. However, consideration of
the geographical setting of the source areas tends to favor the thinking that separate bands are represented. First of all, the source areas are separated by the Laramie Mountains and although the range is low and not expected to have been a real barrier to movement by human groups, the position of the Laramie Mountains and the North Platte River may have very well influenced the location of band ranges on the landscape. Secondly, the orthoquartzite source area is situated in the drainage of the North Platte upriver or basically south of Casper and the microcrystalline source area is located in the watershed of the river in a downstream direction, to the east-southeast. For a human group intent on traveling up the river after gearing up, the sources in the Hartville Uplift would be conveniently close to the river. The cluster of sources of dendritic jasper immediately west of the Hell Gap site complex (to which the distance from the Casper site was measured) are only 15 km north of the river. Two lithic sources at Glendo Reservoir mapped by Saul (1969:Figure 1) are right at the river and situated closer to the Casper site, but it is not known if they produce the dendritic jasper common in the assemblage. Judging from Frison’s description of the location of the orthoquartzite source in the Shirley Basin, it is apparently not far west of the western base of the Laramie Mountains and about 75 km east of the North Platte River. In light of the differing geographic settings of the quartzite and microcrystalline source areas, the tool stone composition of the Casper site point collection is thought to conform to expectations of the alternative view for an assemblage produced by a multi-band aggregation

Under the alternative view, the small number of points of Ft. Union porcellanite and Knife River flint in the Casper collection are best explained as having arrived at the site not via one of the participating bands actually having visited the sources of these tool stones, but rather by means of one of the forms of social interaction thought to have moved small quantities of raw material great distances. Considering the evidence that Knife River flint is a high-quality stone that sometimes was transported far from its very distant source area via an exchange network, it is reasonable to suggest that the three points and one informal retouched
flake tool of KRF arrived at the Casper site through trade. The positioning of the Knife River flint source area to the north-northeast of the site suggests that the tool stone more likely would have been transported to the site by members of the hypothetical downriver band, represented by the artifacts of Hartville Uplift chert. Under the alternative view, the single point of Ft. Union porcellanite, thought to derive from either a distant or very distant source within a broad area north of the site, might reasonably be suggested to represent either trade or participation in the communal hunt by an individual or small group of hunters from a band that had its habitual range somewhere in the Powder River Basin.

Some support for the thinking that the Casper assemblage represents aggregation of more than one band comes from a preliminary consideration of possible projectile point styles present at the Casper site and other Hell Gap sites located upriver and downriver. Frison (1974:Table 1.4, Figures 1.35 – 1.43) provides excellent illustrations of points found at the Casper site in 1971 and classifies each illustrated artifact according to raw material. Four Hell Gap points of quartzite display an elongated outline that is arguably characteristic of a particular style of Hell Gap point (Frison 1974:Figures 1.35 a, b; 1.43 a, b). A Hell Gap occupation of another site along the North Platte River is evident at the Seminoe Beach site, situated south-southwest of the Casper site at Seminoe Reservoir. The site is located about 106 km further up the North Platte River, as measured along the route of the river. Here, 21 quartzite bifaces thought to represent manufacture of Hell Gap points were found in one area of the site. A nearly complete preform broken during the final stage of manufacture also demonstrates the unusually elongated style (Miller 1986:Figure 2a). Other points from the Casper site display a unique flaking pattern that might be characteristic of another regional style. The points possess large adjacent flake scars produced by soft-hammer percussion that extend from a lateral edge to the long axis of the point or beyond, sometimes extending across the entire face (e.g. Frison 1974:Figures 1.36 a; 1.38 e, f; 1.42 c). The raw materials of these four points are classified as jasper (n = 2), orthoquartzite (n = 1), and Knife River flint.

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(n = 1). The likely source of the jasper is in the Hartville Uplift and, as suggested above, the Knife River flint in the Casper assemblage more likely arrived at the site via the hypothetical downriver band, rather than from an upriver band normally residing south of Casper. The above information suggests that most points displaying the knapping style were made from stone brought to the site from downriver. About 159 km downriver at the Hell Gap site complex, a highly comparable flaking pattern can be seen on Hell Gap points from Localities I and II (Hashizume 2009:Figure 18.1). From the above, it may be stated that possible regional styles of Hell Gap points that occur together at the Casper site occur separately at other sites located in different segments of the North Platte River valley, with one segment located upriver from the site and the other being situated downriver. Thus, evidence from the possible point styles present at Casper serves to bolster the suggestion based on the tool stone composition of the assemblage that a band from upriver aggregated with another from downriver to cooperate in a communal bison kill.

**Jones-Miller Site**

Interpretations of the Jones-Miller assemblage developed from the alternative view again support the thinking that the geographic extent of Paleoindian land use did not necessarily involve movement within anomalously large ranges. Two reasonable hypotheses may be proposed under the alternative view to account for the tool stone composition of the assemblage. As far as is known, the local environment of the site lacks a high-quality source of tool stone, so raw material from one or more distant sources would necessarily have been acquired in order to gear up for large-scale bison hunting. It is reasonable to hypothesize that the stone from local or distant gravels (which account for 18 percent of the assemblage) were produced by members of a local band with a habitual range in the Arikaree River drainage and that lots of stone from the two high-quality distant sources (Flat Top Butte and a source of Smoky Hill jasper) were also acquired to gear up with points.
Another possible hypothesis produced from the alternative perspective would propose that a local band and another visiting from distant lands aggregated to cooperate in communal hunting. The local band would be expected to gear up with stone from the nearest distant source. This would be Flat Top chalcedony, which accounts for 50 percent of the assemblage and derives from a source situated 148 km northwest of the site. The other tool stone from a distant source is said to be Smoky Hill jasper from Trego county, which accounts for 28 percent of the assemblage and originates from a source located about 218 km southeast of the site, in the opposite direction from Flat Top Butte. Under the alternative view, the Smoky Hill jasper portion of the assemblage might reasonably be suggested to have been brought to the site by a visiting band. If this hypothesis has merit, it could be supported if stylistic attributes of points of Flat Top chalcedony are demonstrated to differ significantly from those of Smoky Hill jasper points. Considering that over 100 points were recovered from the site, testing the hypothesis of band aggregation with an independent line of evidence from the study of point styles seems to be a real possibility.

Finally, the tool stones from very distant source in the Jones-Miller collection are best interpreted with the alternative model of land use and social interaction. Only 1.5 percent of the assemblage is composed of chert from the Hartville Uplift and agate from the Alibates source area in the Texas panhandle comprises a mere 2.0 percent of the assemblage. If for the sake of illustration it is assumed that the assemblage numbers exactly 130 artifacts, then there would be only 2 or 3 artifacts of each of the two tool stones from very distant sources. If Paleoindian band ranges were comparable in size to the largest ethnographically recorded band ranges, then transportation of Hartville Uplift chert to the site from its source area would involve crossing about three band ranges and movement of Alibates agate to the site would entail crossing approximately four band ranges. In light of the small amounts of these two tool stones, their presence in the assemblage is best interpreted as being the result
of a series of exchanges, or the result of long-distance travel by individuals or small groups intent on participating in communal bison hunting.

**Kersey Cluster**

The tool stone composition of assemblages from sites related to large-scale bison hunting in the Kersey cluster permits interpretations of the geographic extent of land use patterns to be interpreted from the alternative view. As discussed in Chapter 10, there is reason to suspect that a high-quality source of orthoquartzite may occur in the local environment, but such a source has yet to be identified among the many exposures of White River Group gravel where various kinds of orthoquartzite and microcrystalline tool stones are available. Given currently available information, the Kersey cluster sites are best considered as being situated in an environment lacking a readily available high-quality source. This situation should have required members of a local band gearing up for a communal hunt to somehow acquire stone from distant high-quality sources. In the case of a communal hunt involving multiple bands, stone from distant high-quality sources would have been brought into the site by a visiting band. Though the local stone may or may not have included a high-quality source, it was at least of useable quality as seen in its presence in the Jurgens and Frazier assemblages and possibly in the Powars collection as well. The above understanding of the tool stone situation was used to interpret land use from the Kersey cluster assemblages. The Jurgens site is interpreted as resulting from occupation by multiple bands. On the other hand, the Frazier and possibly the Powars sites are interpreted as having been produced by occupations of a single local band.

**Jurgens Site.** The interpretation of the Jurgens assemblage in terms of its meaning to Paleoindian land use is briefly reviewed here for comparison with interpretations of neighboring sites in the Kersey cluster to follow. It may be argued that the Jurgens site
resulted from aggregation of local and visiting bands from distant areas in order to cooperate in a communal bison kill. People participating in the event geared up principally with a variety of orthoquartzite from local exposures of White River Group gravel and tool stone from three distant sources that may represent neighboring bands bringing raw material from their homelands. Tool stones from distant lands were transported to the site from their sources located to the east, down the South Platte drainage (Flat Top chalcedony), to the south in the Palmer Divide (Dawson petrified wood), and to the north in the Hartville Uplift (Hartville Uplift chert). Alternatively, some of the tool stones from distant sources may have been acquired through direct procurement by local people sending out task groups or through an exchange network. Miniscule amounts of artifacts of tool stone from very distant sources from throughout the Plains and Wyoming Basin are best explained as representing the acquisition of some artifacts through trade or by participation in the communal hunt of individuals or small groups visiting from very distant lands.

Frazier Site. Interpretation of the tool stone composition of the Frazier assemblage from the alternative view produces a scenario of Paleoindian land use within the context of communal bison hunting that complies with the understanding that bands would not necessarily have operated within anomalously large ranges. Comparing the Frazier assemblage to that recovered from Jurgens highlights differences in tool stone composition which may reflect differences in the scale of aggregation and the methods used to gear up. At Jurgens, the preponderance of tool stone from distant sources formed the basis for suggesting that one or more bands from distant areas aggregated with a local band for communal hunting. The assemblage is composed of 17 percent local tool stone (WRGG) and 81 percent is stone from three distant sources. In contrast, the Frazier site is composed of 67 percent local stone (presumed to be mostly WRGG) and 16 percent stone from distant sources. The greater amount of local stone in the Frazier collection may reflect differences in group size.
While Jurgens was argued to represent a multi-band aggregation, the Frazier assemblage may have been produced by a group of people comprised solely or predominantly of the local band.

One of the two tool stones from distant sources in the Frazier assemblage might possibly reflect participation of a visiting band in the communal hunt or else acquisition of stone from a distant high-quality source by the local band. In contrast to Jurgens, Flat Top chalcedony from a distant source comprises a mere 2 percent of the Frazier assemblage. The artifacts of Flat Top chalcedony in the Frazier collection are not likely representative of a band from downriver bringing stone from their home range to a bison hunt or any other cultural mechanism intended to gear up with Flat Top chalcedony. Among artifacts of this tool stone, none are points, none are bifaces, and only one of the 23 end scrapers is of Flat Top chalcedony. Conversely, the amount of Hartville Uplift in the Frazier assemblage and the kinds of artifacts produced from it suggest that a band from distant lands to the north may have participated in the bison hunt. The raw material comprises 14 percent of the assemblage and is disproportionately represented among the kinds of artifacts needed to kill and butcher bison and process their hides. Hartville Uplift chert comprises six of the nine points, three of the 10 bifaces, and 11 of the 23 end scrapers. Another possibility is that a task group from the local band directly procured Hartville Uplift chert to gear up with needed tools since the local area is not definitely known to contain a high-quality source. Because a comparable amount of the assemblage is comprised of stone from a very distant source that likely was traded into the area, a third possibility is that stone from the Hartville Uplift may have been acquired by the local band through an exchange network.

The tool stone from a very distant source that occurs in the assemblage in an unusually high frequency for being from such a great distance is Alibates agate. Normally, stone from very distant sources occurs in the study area assemblages only in miniscule amounts, if it is present at all. Alibates agate accounts for 13 percent of the collection. The
raw material may have been acquired by people in the local band to gear up for a communal bison hunt. The raw material accounts for six of the 23 end scrapers, one of the nine points, and one of the 10 bifaces. It is suggested that Alibates agate arrived at the site via an exchange network. Under the alternative view, the situation of the source of Alibates agate so far away from the site makes it highly unlikely that the stone was brought in by a visiting band or through direct procurement at the source by a task group send out from the local band. To put the distance to the source in perspective, it is helpful to note that if Alibates agate arrived at the site through a series of exchanges from one band to another, and if Plains Paleoindian ranges were comparable in size to the largest ethnographic example, then the stone would have changed hands four times.

**Powars Site.** Based on a consideration of currently available evidence, an interpretation of Paleoindian land use from the tool stone composition of points and related manufacturing debris from the Powars site does not require acceptance of the premise that bands operated within huge ranges. The unidentified tool stone in the sample of 269 points, preforms, or channel flakes comprises roughly half of the collection and if future study proves the stone to be of local origin, participation of a local band in communal bison hunting would be suggested. Tool stones from four distant sources also account for approximately half of the collection. One of the tool stones from distant sources is identified as Kremmling chert from a source in Middle Park. This raw material accounts for only 5 artifacts (or 1.8 percent) of the collection. As mentioned, Kremmling chert can be very similar in appearance to Holiday Springs chalcedony, which is one of the varieties of locally occurring tool stones from the White River Group. Some possibility therefore exists that the artifacts identified as Kremmling chert are actually made of local stone. All three of the remaining tool stones from distant sources are the same Plains sources that are present in varying amounts in the other Kersey cluster sites. Dawson petrified wood is the raw material of only two artifacts (or
.7 percent) and can not be definitely said to have been exploited in bulk to gear up. Flat Top chalcedony accounts for 11 artifacts (or 4 percent) and it too can not be said to have been procured in bulk as part of gearing up. On the other hand, Hartville Uplift chert arguably was procured by occupants of the Powars site in quantities sufficient to gear up for communal hunting. Hartville Uplift chert is the raw material of 116 artifacts (or 43 percent) of the collection.

A number of cultural mechanisms may be proposed to explain the relatively large amount of Hartville Uplift chert in the Powars collection, but one is supported by multiple lines of evidence and is therefore preferred over the others. The stone could have been brought to the site by a neighboring band to the north that participated in communal hunting. Alternatively, members of a local band could have procured the stone to gear up by sending a task group to go and get it or perhaps the stone was acquired through an exchange network. As argued in Chapter 8, the apparent presence of only fluted points in this Folsom-age collection that is arguably related to communal bison hunting would tend to favor the interpretation that multiple bands were actually present.

No matter what the actual cultural mechanism was that brought stone from the Hartville Uplift to the Powars site, the presence of an ample quantity of stone from a distant source is not unexpected. Under the alternative view, Plains foragers of any time period who are preparing for a communal hunt in an area lacking a local high-quality source of stone would be expected to acquire stone from a nonlocal high-quality source by some means in order to gear up for the event. On the other hand, the alternative view can also explain the presence of a lot of Hartville Uplift chert in the Powars collection as having been brought in by a visiting band, if the communal hunt was carried out by multiple bands.
Lindenmeier Site

Information on the Lindenmeier site in existing literature may be cited to support differing interpretations of site function. These interpretations include the view that Folsom occupations of the site were related to communal bison hunting by relatively large groups of people, the opinion that the site saw occupations by comparatively small groups of people not engaged in large-scale hunting, and the perspective that both kinds of site occupations may have occurred. Because of this uncertainty, the meaning of the tool stone composition of the Folsom assemblage will be interpreted from both the view that communal hunting by large groups produced the assemblage as well as from the view that the site results from occupation of smaller groups not involved in large-scale hunting.

Given that a high-quality source of stone is not definitely present in the local environment, the two contrasting interpretations of site function are both expected to produce a tool assemblage containing large amounts of stone from high-quality nonlocal sources. If the Lindenmeier Folsom occupations were produced by groups involved in communal hunting that were composed of either the entire local band or multiple bands, tools of local material will have been brought to the site by the local people. If communal hunting was carried out by the local band, tool stones from distant high-quality sources will have been acquired by sending out task groups or through exchange. On the other hand, if the communal hunting was a joint effort by local and visiting bands, tool stones from distant high-quality sources may have been acquired by visiting bands bringing quality stone with them from their home range. Under the alternative interpretation of site function, if the Folsom occupations were produced by the local band or smaller subunits of the band when not involved in communal hunting, it is expected that in this situation, people would still have acquired stone from high-quality distant sources through direct procurement by task groups or via exchange. Tool stones from distant sources should therefore occur in large amounts among tools.
Data on the tool stone composition of worked pieces in the Coffin collection support the theoretical expectation that large amounts of stone from nonlocal high-quality sources should be present among tools. A total of 63 percent of the collection is comprised of stone that derives from one of two distant high-quality sources, including 39 percent Hartville Uplift chert and 24 percent Flat Top chalcedony. Tool stone categories of unidentified quartzite and unidentified chalcedony are here interpreted to likely derive from local sources and together comprise eight percent of the collection of worked stone. Tool stones that cannot be confidently categorized as originating from local or distant sources comprise 28 percent. The main constituent of tool stones unidentified to source is the category of unidentified chert (26 percent), which may contain chert from more than one source. Also included is petrified wood, which accounts for two percent.

Data on the prevalence of local materials in debitage present in the Smithsonian collection are pertinent to correctly interpret the tool stone composition of the assemblage. Orthoquartzite is the most common raw material in the sample of debitage from the site, accounting for 552 of 1,048 flakes or 52.7 percent (Wilmsen and Roberts 1978:Table 49). The next most common raw material in the debitage is chalcedony, which accounts for 23.2 percent (243 of 1,048 flakes). The category of chalcedony is probably comprised of both the local chalcedony and Flat Top chalcedony. Jasper accounts for 197 of 1,048 flakes or 18.8 percent.

Taken together, the above percentages strongly suggest that most tool stone knapped on-site was from local sources. This observation is in agreement with the idea that local people with local stone in the raw material supplies were on the site during occupations unrelated to large-scale bison hunting. The observation is also in line with the thinking that stone from local sources was brought to a camp occupied by people intent on communal hunting, regardless of whether the group was comprised of solely the local band or multiple bands. Even though the local stone would be less than ideal for making points and end
scrapers, a supply of local stone would be useful to satisfy daily tool needs. This interpretation is supported by the tool stone composition of the Frazier assemblage. The Frazier site is interpreted as a site related to a communal hunt located in an environment lacking a definite high-quality source of stone. At the Frazier site, stone that is believed to derive from local White River Group gravels accounts for a majority of the assemblage. It is also relevant to note that in the Jurgens assemblage, which comes from a site related to communal hunting that is interpreted as having been produced by multiple bands, the locally available WRGG is disproportionately represented in the artifact category comprised of cores, tested cobbles or pebbles, pieces of shatter, and flakes with cortex (Table 10-8). This further supports the assertion that local stone of less than optimum quality would have been brought to hunting camps established by people involved in communal hunting to satisfy general tool needs.

The tool stone composition of the Coffin collection demonstrates that the proportional representation of local orthoquartzite among worked pieces is much less than among the debitage. Orthoquartzite comprises 17 of 309 tools in the Coffin collection, or five percent (Table 12-3). Data on the Coffin collection presented in the table primarily relates to retouched and formal tools, but also includes some point manufacturing debris (preforms and channel flakes) and may include some unfinished tools (e.g. bifaces broken in manufacture). These data indicate that local orthoquartzite was used to make minor amounts of the bifaces and points in the assemblage. A total of six of 17 orthoquartzite tools are bifaces (35 percent). One point or preform is of quartzite (six percent). The much larger sample of tools in the Smithsonian collection dissuades concerns that the above percentage may not be accurate do to sampling error because 27 (or five percent) of the 537 points or performs tabulated by Wilmsen according to raw material are made of orthoquartzite (Wilmsen and Roberts 1978:Table 44). No channel flakes of orthoquartzite are in the Coffin collection, however (Table 12-3). Apparently, the local orthoquartzite was of adequate
quality for point manufacture. No orthoquartzite end scrapers are present in the Coffin collection, however. The larger sample of tools in the Smithsonian collection again confirms the dearth of end scrapers made of orthoquartzite. In the part of the Smithsonian collection that includes flakes, informal tools, and formal tools, but excludes points and preforms, there are 845 artifacts of orthoquartzite and only two (or .2 percent) are end scrapers or “distal end tools” to use the term employed by Wilmsen (Wilmsen and Roberts 1978:Table 49). As suggested during discussion of the lack of orthoquartzite end scrapers at the Jurgens site, there may have been some raw material-based reason for why orthoquartzite was evidently avoided for end scraper manufacture in favor of microcrystalline stone.

For the remaining tool stones in the Coffin collection, consideration of the kinds of artifacts made of these materials usually observes that points and end scrapers are common. If the Lindenmeier occupations were related to communal hunting, it is expected that the above kinds of artifacts would be transported to the site from nonlocal sources to gear up for hunting. On the other hand, Bamforth and Becker (2007a:176-178) successfully argue that points and point preforms made of stone from very distant sources were transported to the Allen site during times of the year when Plains Paleoindians were operating in small groups not involved in communal hunting. Therefore, it must be kept in mind that the small amounts of stone from nonlocal sources listed below do not by themselves refute an interpretation of the Lindenmeier site as a camp site produce by small groups involved in generalized foraging.

It is suggested that the unidentified chalcedony in the Coffin collection is the local material and that some evidence exists to suggest that this local stone was used to a minor degree to gear up. Only nine worked pieces of the presumably local chalcedony are present, accounting for three percent of the collection. However, two artifacts (or 22 percent of the items of unidentified chalcedony) are bifaces, none are points, and six (or 66 percent) are channel flakes (Table 12-3). As with orthoquartzite, there are no end scrapers of the
unidentified chalcedony. The above figures constitute a small sample and so must be treated with caution. Nevertheless, they do suggest the possibility that local chalcedony was used in gearing up by manufacturing bifaces and projectile points.

Petrified wood in the Coffin collection may be a grab bag of local and distant tool stone that in aggregate gives some support to the notion that this raw material was also used to a minor degree by site occupants to gear up. Only seven petrified wood tools are present in the Coffin collection and account for two percent. Two were positively identified as Dawson petrified wood and may derive from distant sources in the Palmer Divide area. The sole projectile point was made of Dawson petrified wood (Ambler 1999:80, 156, Figure 24, catalog # 398), as was one of the three petrified wood end scrapers (Ambler 1999: 135, 153, Figure 11, catalog # 466). Ambler does not comment on the possible source of the remaining artifacts of petrified wood, but Coffin (1937:10) states that, “[t]he petrified wood used could have been secured from the nearby basal Dakota sandstone…” Caution must be exercised when interpreting the petrified wood sample because the total of seven artifacts does not constitute a representative sample. With this in mind, it is still worth noting that the point comprises 14 percent of petrified wood artifacts and the three end scrapers comprise another 43 percent (Table 12-3). Therefore, petrified wood may have been used to help gear up for large-scale bison hunting.

Unidentified chert is a tool stone category that comprises much of the collection (26 percent) and was used to produce particular classes of artifacts that occur in frequencies suggestive of gearing up. It is unclear if the category includes tool stone from one or multiple sources, but it is here suspected that a number of tool stone types from different sources are represented, considering that a large sample of 80 artifacts is made of unidentified chert. Use of unidentified chert for gearing up through the manufacture of bifacial artifacts is suggested by the presence of nine bifaces (11 percent of artifacts of the raw material), nine points or preforms (11 percent), and 23 channel flakes (29 percent) (Table 12-3). Production of
unifacial tools, specifically end scrapers, is also suggested by the occurrence of 13 end scrapers which comprise 16 percent of the raw material.

A large sample of 75 worked pieces are made of Flat Top chalcedony from its distant source and the kinds and frequencies of artifacts present support the notion of gearing up with this raw material. Artifacts of Flat Top chalcedony comprise 24 percent of the assemblage. The source of the stone lies 147 km east of the site in the South Platte drainage. A total of seven points or preforms are present, accounting for nine percent of all worked pieces of the tool stone (Table 12-3). Furthermore, 23 (or 29 percent) of the artifacts of Flat Top chalcedony are channel flakes. Thus, manufacture of points of Flat Top chalcedony occurred on-site. No artifacts classed more generally as bifaces are present in the collection, however. A total of 26 end scrapers of Flat Top chalcedony are present, comprising 35 percent of all artifacts of this raw material. In sum, the collection provides evidence for the transportation of Flat Top chalcedony to the site to gear up for a bison hunt with projectile points and numerous end scrapers.

An even larger sample of worked pieces originated from one or more distant sources of Hartville Uplift chert and the kinds and amounts of artifacts of this raw material again support the idea of gearing up. Artifacts of Hartville Uplift chert account for 39 percent of the Coffin collection. Hartville Uplift chert derives from the North Platte drainage with the closest source being 161 km from the site in a north-northeast direction. Only three bifaces are of Hartville Uplift chert and together they comprise a mere two percent of all artifacts of this material (Table 12-3). Somewhat surprising is the presence of only two points of Hartville Uplift chert, which together account for another two percent of the Hartville Uplift chert sample. Ambler (1999:76, 80, 85, Figure 26) notes that the relative frequency of points in the Coffin collection is 4.8 percent less than in the Smithsonian collection and suggests the difference may be due to the heirs of Coffin keeping some of the nicer points. A total of 15 channel flakes of Hartville Uplift chert are present in the collection, accounting for 12 percent
of all artifacts of this material. This demonstrates that finishing preforms of Hartville Uplift chert took place on-site. Finally, a relatively large number of end scrapers (n = 54) of the chert are present and comprise 45 percent of all artifacts of this raw material. To summarize, chert from one or more distant sources in the Hartville Uplift was transported to the Lindenmeier site and may have been used to gear up for bison hunting by manufacturing many of the end scrapers recovered and some of the bifacial artifacts, specifically a number of the projectile points.

Finally, the artifacts from nine very distant sources are best interpreted as representing the arrival of presumably small amounts of stone via cultural mechanisms such as a long-distance exchange network or visitation by small groups or individuals. The artifacts from very distant sources arrived at the site from virtually all directions, an observation that would perhaps favor the explanation that an extensive exchange network was the responsible cultural mechanism. Of the nine tool stones from very distant sources, the six listed by Jodry (1999:Tables 48, 51) are present in the large sample of points, preforms, and channel flakes in the Smithsonian collection. The artifact of Alibates agate in the Coffin collection is an end scraper and the types of artifacts made of Wamsutter oölitic chert and Yellowstone obsidian are unspecified. In sum, the above data support the assertion that projectile points in particular were transported over great distances in extensive exchange networks.

Sites Related to Communal Kills in Environments with High-Quality Sources of Stone

Western Middle Park Cluster

The tool stone composition of sites containing bonebeds associated with communal bison hunting in western Middle Park allows interpretation of the geographic extent of land use to be developed from the alternative view. Both bonebed sites are located in an environment with three locally available high quality sources of tool stone. Of these sources,
the two bonebed sites are closest to the Kremmling chert source area. The availability of local tool stone would have permitted members of a local band to gear up for a communal hunt at one or more of the three locally available sources. If a local band was dispersed throughout the park into family groups that geared up prior to aggregating, all three sources of stone may be represented. On the other hand, if aggregation of the band for a communal hunt planned in a particular area preceded gearing up, stone from the source closest the bonebed may be expected to dominate the assemblage. Middle Park would have been used seasonally by at least one local band that wintered in lower elevations situated generally west of the park as well as by a minimum of one local band that wintered in lower elevations east of the Front Range. In the case of a communal hunt involving multiple bands that included visiting bands from distant lands, visitors could bring stone from their home ranges in distant lands, if available. Alternatively, since the high-quality source of Kremmling chert is centrally located in western Middle Park, visiting bands from distant lands could chose to gear up with Kremmling chert after arriving in Middle Park if the communal hunt was to be carried out nearby. The theoretical predictability of bison herds in western Middle Park and the fact that the bonebed interpreted as the product of multiple bands is close to the Kremmling chert source area give support to the thinking that visiting bands could have exercised the option of waiting to gear up in western Middle Park before engaging in communal bison hunting nearby. With the above understanding of tool stone availability and bison herd predictability in mind, the tool stone composition of the bonebeds was used, along with other evidence, to interpret the geographic extent of Paleoindian land use patterns. The Upper Twin Mountain site is interpreted as resulting from a communal hunt carried out by a local band during the Folsom period. In contrast, the Jerry Craig site is interpreted as reflecting cooperation of multiple bands, with one contingent being comprised of mountain people using Angostura points and other consisting of Plains people equipped with Cody points.
Upper Twin Mountain Site. The tool stone composition of the Upper Twin Mountain site supports the alternative view that the geographic extent of land use is best explained using a theoretical model wherein bands operated in ranges comparable in size to those documented in the ethnographic literature. In an environment with local high-quality sources of tool stone, the general expectation for the alternative view is that a single-band aggregation will produce an assemblage dominated by local stone. The rationale supporting this expectation is that a local band will use the stone in its habitual range to gear up for a large-scale bison hunt to be carried out in its own range. In the case of Middle Park, bands considered local would inhabit the park only during part of the year. During the height of the cold season, a local band would be found wintering in lowlands of the surrounding regions. Local stone does dominate the Upper Twin Mountain assemblage, so the general expectation is met. Not apparent in the general expectation is that there could be variations on this theme. For example, a band could plan to first aggregate and then gear-up as a group at one particular tool stone source that could be but one of multiple sources within the band’s range. In this scenario, the aggregated group would produce an assemblage dominated by just one of the local tool stones. On the other hand, dispersed families belonging to a band could gear up on their own using stone from the closest source to them and then aggregate with the other family groups. That this possible scenario may apply to the Upper Twin Mountain site is supported by all three of the main tool stones being present in the assemblage in the form of projectile points and flakes, rather than the assemblage being completely dominated by just stone from the nearest source (Kremmling chert) (Table 12-10). As discussed below, evidence suggests use of Kremmling chert was emphasized over other tool stones in one aspect of gearing up; that being the production of flake tools from blocky cores. However, the presence of all the main tool stones from sources throughout the park nevertheless supports the assertion that some gearing up was accomplished by dispersed elements of a local band prior to aggregating for a communal hunt.
Evidence from the artifactual and tool stone composition of the assemblage suggests that stone from the nearby source of Kremmling chert was used much more than other Middle Park tool stones in one particular aspect of gearing up; that being the need for flake tools. Most of the assemblage is comprised of both Kremmling chert (47 percent) and Windy Ridge orthoquartzite (37 percent), as measured by artifact count. However, debitage of Windy Ridge orthoquartzite is present solely in the form of very small flakes produced by retouching or resharpening bifacial tools. Flakes of Windy Ridge orthoquartzite measure at most only a few millimeters in maximum dimension. According to Kornfeld and Frison (2000:146-147), the Kremmling chert debitage is present in the form of one blocky core, pieces of shatter, and primarily flakes struck from blocky cores. Some of the Kremmling chert artifacts are large, with the blocky core measuring 8.6 cm in maximum dimension and the largest illustrated flake being 5.4 cm in maximum dimension (Kornfeld et al. 1999:Figure 9). Because very small flakes of Windy Ridge orthoquartzite are relatively abundant, the prevalence of Kremmling chert in the assemblage does not appear great when the relative amount of tool stones is considered by artifact count. Considering the much larger size of the Kremmling chert debitage, it is reasonable to assume that Kremmling chert accounts for a large majority of the flaked stone assemblage according to total tool stone weight. A total of six informal retouched flake tools were recovered, all of which are made from Kremmling chert (Table 12-10). In sum, the above information suggests that the Kremmling chert source area in Barger Gulch was visited to gear up for the hunt and in particular, raw material was procured in a form suitable for making informal retouched flake tools that may have been intended for use in processing bison.

Finally, it should be noted that the unfluted character of the projectile points from the site may provide support for the assertion, based on the tool stone composition of the assemblage, that the Upper Twin Mountain site represents occupation by an aggregation of a single local band operating within a home range that included Middle Park during part of the
year. In Chapter 8, I developed a preliminary theoretical model asserting that during Folsom times, assemblages from sites associated with large-scale bison kills conducted by smaller, possibly single-band aggregations tend to be dominated by collateral flaked, unfluted points whereas collections from sites related to communal hunting operated by larger, possibly multi-band aggregations produce primarily fluted points. Although the total area excavated at the Upper Twin Mountain site is equivalent to an area measuring only 5.3 m by 5.3 m and only four points have been recovered from the site to-date, the fact they are all unfluted, collateral flaked points (Kornfeld and Frison 2000:Figure 13) provides limited support for the thinking that the site represents occupation by a local band.

**Jerry Craig Site.** The predominance of a tool stone from a local high-quality source among both Angostura and Cody points in the sample of 11 complete points from the Jerry Craig site supports the hypothesis that makers of both types were actually present at the bison kill. All three Angostura points and six of the eight Cody points are made of Kremmling chert. High-quality sources of the tool stone are located between about 10 and 20 km from the site. The predominance of Kremmling chert among both Angostura and Cody points may be best explained as a result of people from both cultural groups gearing up at a source of Kremmling chert in preparation for a communal bison kill nearby in which both groups participated. Because good evidence exists to support the view that both mountain people and people from the western plains were present on-site, it follows that people from at least two bands were among the group that had coalesced for communal hunting.

The tool stone composition of the Jerry Craig site is congruent with the understanding that neighboring bands would sometimes coalesce to cooperate in communal bison hunting. Situated in Middle Park, the site is located within an area that would have been within a region that arguably was used on a seasonal basis by a local band of mountain people who wintered in regions generally west of the park, as well as by a local band of
Plains people who spent the winter somewhere east of the high Front Range in the general vicinity of Boulder, Colorado. Both mountain and plains peoples would likely have known that bison herd location in the tract of sagebrush grassland in western Middle Park was fairly predictable. Furthermore, both peoples would probably have been aware that the high-quality source of Kremmling chert was centrally located within western Middle Park. Because a high-quality source of tool stone was present close to the hunting area, both peoples would have the option of not bringing much stone with them to the communal hunt. Rather, both mountain and plains peoples could plan on gearing up at the Kremmling chert source area before proceeding to go elsewhere in western Middle Park for the communal hunt. The above hypothetical scenario is supported by the preponderance of Kremmling chert in the assemblage in general as well as in the sample of 11 complete points of both Cody and Angostura types.

Because both groups evidently waited to gear up in the area to be hunted, very little stone from distant sources is present, so it is not possible to determine specifically from which regions surrounding Middle Park the mountain and plains groups arrived. However, the descriptions provided of three tool stones that may derive from distant sources are suggestive of two general areas. One point was made of red orthoquartzite and another was made of yellow translucent chert with black dendrites. Also, a flake is said to be made of a chert that likely originated from Mississippian or Pennsylvanian limestones. The description of the above tool stones suggests that they may originate from sources on the Plains in the Platte River drainage. A red orthoquartzite occurs at distant sources in the Boxelder Creek drainage west of Lindenmeier that are estimated to lie 162 km from the site. Hartville Uplift chert originates from Mississippian and Pennsylvanian limestones lying in very distant lands, with the closest source being 282 km from the site. The translucent yellow chert with black dendrites in some respects is like Hartville Uplift chert, but the later is opaque. Red orthoquartzite and chert from Mississippian and Pennsylvanian limestones, some of which is
dendritic, also occur in distant lands along the southern edge of the Wyoming Basin, in the lower reaches of the Yampa River drainage in northwest Colorado. A distant source of red orthoquartzite, recorded as 5MF2942, is situated 135 km from the site. Chert from Mississippian and Pennsylvanian limestones, some of which is dendritic, is also available in northwest Colorado. The closest source is recorded as 5MF3461 and is located 145 km from the site.

Tool stones from distant and very distant sources occur only as single points or flakes. A flake of obsidian is noteworthy because it is the only artifact that can be said to definitely derive from a very distant source. Because the nonlocal stones occur only in the form of points or flakes and never in quantities greater than one, acquisition of points or preforms by local bands through exchange or participation of individual hunters from nonlocal lands are better possible explanations for the presence of the nonlocal stone than is the suggestion that a visiting band from distant lands participated in the communal hunt.

A final characteristic of the Jerry Craig assemblage that may relate to the geographic extent of land use is the presence of small amounts of non-Kremmling chert tool stones from Middle Park. Debitage of petrified wood that may derive from sources in Middle Park accounts for five percent of the collection. Flakes of Windy Ridge orthoquartzite from northwestern Middle Park may also be present and comprise one percent of the assemblage. Finally, flakes and a projectile point are classified as Table Mountain jasper from sources in central or eastern Middle Park and account for two percent of the collection. Presence of small quantities of non-Kremmling chert suggests that family groups belonging to one or more of the participating bands were dispersed throughout Middle Park in the weeks prior to the communal bison hunt that took place in western Middle Park in August or September. Evidently, dispersed groups may have brought some tool stone form various parts of the park with them to the communal hunt.
High Front Range Cluster

Some discussion is in order before the geographic extent of Paleoindian land use may be interpreted from the tool stone composition of assemblages of sites in the high Front Range. The analytical units of local, distant, and very distant sources of stone were developed to interpret the tool stone composition of assemblages in the relatively straightforward situation where sites related to large-scale hunting were produced by people affiliated with one or more bands of the same cultural group coming together on the flat expanse of the Great Plains. In the case of the sites in the high Front Range, the situation is more complex because sites in the high mountains were produced by groups of people affiliated with bands from two cultural groups: a so-called mountain people and a western plains people. Furthermore, the Front Range and Middle Park would have been used by both cultural groups and seasonally abandoned by both groups during the height of the cold-season. Also, high-quality sources of tool stone are locally available only to the west of the Front Range in Middle Park. All of these factors would have affected the land use of local bands of mountain and western plains peoples and must be conceptualized in at least a rudimentary way before the tool stone composition of assemblages may be interpreted.

Based on point typology, the three sites of the high Front Range cluster demonstrate use of the alpine tundra for communal hunting by both mountain and western plains peoples during the Late Paleoindian period. Use of the high Front Range by mountain people is represented by the presence of sites producing Angostura points. Exploitation of the alpine tundra by western plains people is demonstrated at sites producing Cody points (e.g. Benedict 2000a) and sites yielding points of the generally later Frederick points. Included in the high Front Range cluster is a site that demonstrates use by just mountain people, another that is indicative of use by only western plains people, and a third that arguably was occupied jointly by both cultural groups. Occupation of the high Front Range by mountain people is believed to be represented at Area A of the Devils Thumb game drive, based partly on the presence of
a single projectile point that arguably may be classified as an Angostura point. Use of the alpine tundra by plains peoples is evident at the Caribou Lake site where four points conforming to the Frederick type were found. Joint occupation of the Fourth of July Valley site by both mountain and western plains peoples is arguably in evidence, based partly on the presence of 13 Angostura points and one point that conforms to the Frederick type.

To interpret what the tool stone composition of assemblages from the three sites in the high Front Range cluster may mean in terms of the size of the ranges used by Paleoindians, it is necessary to develop an understanding of the hypothetical ranges that would have been used by local mountain and western plains bands and the area of overlap in their ranges, based on a consideration of the physical geography. Based on evidence from the Jerry Craig site, it may be asserted that mountain and plains people occasionally cooperated for bison hunting in Middle Park. The three high Front Range sites demonstrate that both mountain and plains people operated game drives there. Middle Park and the high Front Range were evidently within the area that was used on a seasonal basis by both mountain and plains bands. During the height of the cold-season, both Middle Park and the high Front Range would have been abandoned by people of both cultural groups. A local band of mountain people who seasonally use the regions would have wintered somewhere west of Middle Park. A mountain band may have wintered further down the Colorado River drainage, to the southwest. Excavation of the Yarmony Pithouse site of Archaic age demonstrates that lands suitable for winter habitation were not far down the Colorado River drainage from Middle Park (Metcalf and Black 1991). Middle Park and the high Front Range may have also been used seasonally by a mountain band that wintered in the Yampa River drainage, located northwest of Middle Park. Excavation of an Archaic pithouse in the Red Army Rockshelter near Hayden, Colorado (Pool 1997) demonstrates that lands suitable for winter habitation occurred not far down the Yampa River drainage. A local band of western
plains people would have wintered along the eastern base of the Front Range or further east, out on the Plains.

From the above information and the knowledge that the maximum dimension of an ethnographically documented band range is about 150 km, a vague conception of the ranges used by local bands of mountain people may be obtained. For the sake of illustration, the eastern base of the Front Range may be taken as the eastern edge of the hypothetical range of a local mountain band. Measuring along a straight line from Boulder, Colorado in a south-southwesterly direction across the Front Range and Middle Park and then down the Colorado River drainage would place the western edge of the habitual range of a local band of mountain people that wintered in the Colorado River drainage close to the town of Eagle, Colorado. The western part of the area delimited would include suitable wintering grounds for Archaic people as demonstrated at the Yarmony Pithouse site. Measuring along a straight line from Boulder, Colorado in a west-northwest direction across the Front Range and Middle Park and then down the Yampa River drainage would place the western edge of the home range of a local mountain band that wintered in the Yampa River drainage about 45 km further downriver from the Red Army Rockshelter. The western portion of the area delineated would be within country that was suitable for overwintering by Archaic people. The above discussion suggests that it is reasonable to hypothesize that the high Front Range east of Middle Park could have been used by local bands of mountain people who wintered in lower country to the west, in the Colorado and Yampa River drainages.

A vague conception of the range used by a local band of western plains people may also be acquired using the same method. Measuring along a straight line from the western edge of Middle Park eastward across the park and the Front Range and then out onto the Plains would place the eastern edge of the hypothetical range of a plains band east of the South Platte River, somewhere around the city of Brighton.
Having developed an understanding of where local band ranges of mountain and plains peoples may have been on the landscape, it is necessary to also consider the placement of high-quality tool stone sources within those ranges to then be able to properly interpret the tool stone composition of assemblages from the high Front Range. From the standpoint of the local mountain bands, the Middle Park tool stone sources would be within the central portion of their hypothetical ranges. Local bands that eventually moved east into the high Front Range for communal hunting would be expected to have geared up with the local Middle Park tool stones. In relation to the high Front Range sites, the Windy Ridge orthoquartzite quarry is situated beyond the 75 km distance used herein to define local tool stone. From the above discussion, however, it is reasonable to assume that the quarry would have been within the ranges of local mountain bands and therefore is considered to be local stone in the interpretations to follow.

A plains band planning a communal hunt in the high Front Range could conceivably first gear up with stone from Middle Park. From the perspective of the local band of plains people when living on the plains, the Middle Park tool stones would be the closest high-quality sources, even though they are situated on the opposite side of the Front Range. On The local plains band could send out a task group to go and get a supply of stone from a Middle Park source. Another possibility would be for the entire band to first spend time in Middle Park carrying out communal bison hunts and gearing up at high-quality tool stone sources before traveling back east for communal hunting of what were likely non-bison big game herds in the high Front Range. Plains peoples of Cody times engaged in communal bison hunts in Middle Park, as demonstrated by the Cody occupation of the Jerry Craig site. That plains people during terminal Paleoindian times also conducted large-scale bison kills in Middle Park is suggested by the Phillips Williams Fork Reservoir site (Kornfeld and Frison 2000:135-136). Here, a total of 28 Allen points were found along the shore of Williams Fork Reservoir in a relatively confined area where fluctuating reservoir levels are eroding away
site matrix and exposing artifacts. The quantity of points recovered and the location of the site in western Middle Park suggests the possibility that the terminal Paleoindian occupation was associated with large-scale bison hunting. In consideration of the above, a local plains band planning to operate a game drive in the high Front Range could have geared up with stone from Middle Park even though it would require traveling over the mountains because the closest available high-quality sources are those in the park.

Alternatively, a local plains band could plan to gear up with stone from the Plains before entering the mountains, but this option would require obtaining stone from high-quality sources in distant or very distant lands. The plains in the area east of Boulder to Brighton are devoid of high-quality sources of tool stone. Stone from nonlocal Plains sources could have been directly procured by task groups from the local plains band when it was occupying the Plains in order to gear up before traveling west up into the high Front Range. Tool stone from three Plains sources that are closest to the Boulder-Brighton area would be the most likely to be present in some quantity at sites in the high Front Range. These include the primary sources of Dawson petrified wood in the Palmer Divide area to the south and sources of White River Group gravel and the Boxelder Creek materials to the north.

A final comment on the tool stone situation relevant to interpreting the tool stone composition of sites in the high Front Range concerns the relative desirability of the three Middle Park sources. Though all three may be considered high-quality sources, the western Middle Park tool stones (Kremmling chert and Windy Ridge orthoquartzite) are superior to the eastern Middle Park source of Table Mountain jasper for the purpose of gearing up because tool stone is available in larger pieces at the western sources. Tool stone is available in thick seams at the western Middle Park sources and prehistoric quarry pits were dug at both sources to acquire large pieces of tool stone. In contrast, at the Table Mountain source, pieces of jasper occur as float on the ground surface and pieces range in size up to about 15 cm in maximum dimension. Since thick seams of Table Mountain jasper do not occur, quarry
pits dug to obtain large pieces of raw material are unknown at the sources of jasper. The smaller size of the pieces of Table Mountain jasper may have imposed limits on the kind and size of artifact that could be made of this raw material. If so, Table Mountain and nearby sources in eastern Middle Park would have been less desirable as a high-quality source at which to gear up for communal hunts. Given the above information, it is expected that even though sources of Table Mountain jasper in eastern Middle Park are the closest to the high Front Range, stone from the western sources may be more common at sites related to communal hunting largely because of the superiority of larger pieces of tool stone for gearing up.

**Devils Thumb Game Drive.** The tool stone composition of the assemblage from Area A of the Devils Thumb game drive conforms to the view that Paleoindian bands would not necessarily have always operated within ranges that were much larger than those known for ethnographic peoples. The assemblage is composed solely of stone from the three main Middle Park high-quality sources. A single point from the site may be compared to the Angostura type. Based on these pieces of information, occupation by a group of mountain people is suggested. The best way to classify the site into a functional category is not clear, but two possibilities are plausible. Based in part on the proximity of the site to a game drive system, one might argue that the site is related to communal hunting and this is the interpretation favored here. Because only the three tool stones that arguably could have been within the range of a local band of mountain people are present in the assemblage, one might reason that occupation by a single local band is represented. On the other hand, only one point is present and based on available information, the general character of the assemblage is not definitely indicative of a site associated with large-scale hunting. For these and other reasons discussed above, one might reasonably interpret the site as a camp not associated with communal hunting that was occupied by the local band or family group subsisting by
means of more generalized foraging. If the assemblage from Area A represents occupation of a campsite by the local band or smaller group subsisting by means of generalized foraging, the tool stone composition conforms to the alternative view’s expectation that large amounts of local stone will be present in the assemblage, having been procured by band members at local sources within their home range. If the Area A assemblage was instead discarded by the local band engaged in large-scale hunting of big game using the adjacent game drive system, the tool stone composition also conforms to expectations of the alternative view. According to this theoretical perspective, assemblages from sites associated with large-scale kills of big game produced by single bands in environments with local high-quality sources of tool stone should be dominated by local stone.

The superiority of the western Middle Park tool stones in terms of the size of pieces of raw material available is reflected in the Area A assemblage. The single point from the site is the only formal tool in the assemblage, all other artifacts are either debitage or utilized flakes. Sources of Table Mountain jasper in eastern Middle Park are the closest to the site, but comprise only seven percent of the assemblage. In contrast, 93 percent of the assemblage is Kremmling chert. The single point is of Windy Ridge orthoquartzite, which comprises a negligible amount. The above information confirms the idea that among the local tool stones, the western Middle Park sources were favored because of the larger sized pieces available there. If members of a local band involved in communal hunting produced the assemblage from Area A, they evidently geared up primarily with Kremmling chert.

Caribou Lake Site. The tool stone composition of the Frederick occupation at the Caribou Lake site may be interpreted as resulting from a communal game drive conducted by an aggregated group of people comprised of multiple bands that operated within ranges comparable in size to ethnographic foragers. If the aggregation of people was composed largely of members of the local band that had geared up with stone from a high-quality source
within its habitual range, one would expect that local tool stone would comprise a majority of
the assemblage and be represented by a wide array of artifact types. Such is the case with the
Kremmling chert artifacts in the Caribou Lake collection, which account for 68 percent of the
assemblage and comprise a total of 142 artifacts (Table 12-15.) The local band could have
directly procured the Kremmling chert by sending a task group to the source in Middle Park
in order to acquire a supply of stone with which to gear up before returning back east to the
band. Alternatively, the entire band may have spent time in Middle Park and procured
Kremmling chert to gear up for a game drive in the high Front Range on its return trip to the
Plains. Even though Table Mountain jasper may be considered to be a tool stone from a
high-quality source in eastern Middle Park that is closest to the site, it is not present in the
collection at all. This is best explained by the superiority of the western Middle Park sources
for gearing up in that larger pieces of raw material are available there. Of the two tool stones
outcropping in western Middle Park, Kremmling chert would have been the closest for a
plains people arriving from the east and following the Colorado River downstream. The
orthoquartzites in the assemblage suspected of deriving from distant sources in northeast
Colorado comprise a substantial 22 percent of the assemblage. From this, it may be
suggested that some people from the local plains band acquired stone from nonlocal sources
on the Plains to gear up before moving west into the mountains. Alternatively, a neighboring
band with a home range in distant lands on the plains of northeast Colorado may have
participated in the game drive and geared up beforehand with stone from sources in their own
home range and from sources in the Hartville Uplift. A single end scraper with a spokeshave
edge was made of Hartville Uplift chert. This raw material was commonly acquired through
various means by people native to the South Platte drainage and gives support to the
reasoning that a local band or a band from distant lands in northeast Colorado participated in
a game drive in the high Front Range.
Since there is a lack of high-quality sources of tool stone for flaked stone artifacts in the high Front Range, one would expect that participating groups would have brought not only finished tools, but also supplies of tool stone in unfinished form from their home range to make informal flake tools and to replace formal tools as the need arose. Of the 63 flakes recovered during the later excavations, 59 (or 94 percent) are relatively small flakes that are classified by Pitblado (2000:Table 4.2) as either final finishing flakes, tool resharpening flakes, or flakes that are thought to represent either final finishing or resharpening. Under the interpretation suggested here, the local band would have brought Kremmling chert to the planned game drive. Benedict (1974:3) noted the presence of some decortication flakes of Kremmling chert among the debitage of this material recovered during the early excavations. Pitblado (2000) quantified the debitage recovered during later excavations into various types of flakes. Artifacts indicating that a supply of Kremmling chert in unfinished form was on-site include two conjoining fragments of a secondary flake (catalog # 352 and 355) and one soft-hammer biface thinning flake measuring 2.7 cm in maximum dimension (catalog # 669) (Pitblado 2000:151, Figure 4.2). Since Benedict did not quantify the kinds of flakes recovered in the early excavations, the two flakes noted by Pitblado, along with the possible point preform, may greatly underestimate the amount of unfinished artifacts of Kremmling chert present. Nevertheless, the three artifacts represent three percent of all Kremmling chert artifacts (3 ÷ 96 = 3.1 percent) (Table 12-15). Some of the orthoquartzite also appears to have been brought to the site in the form of unfinished artifacts. One flake of orthoquartzite of the tan variety (catalog # 443) was classified as a tool production flake (Pitblado 2000:Table 4.2). The flake represents three percent of all orthoquartzite artifacts (1 ÷ 32 = 3.1 percent) (Table 12-15).

In conclusion, the tool stone composition of the assemblage from the Frederick component at the Caribou Lake site may be best explained under the alternative view. A plausible scenario developed under this theoretical perspective maintains that the site is the
result of a communal game drive in the vicinity of Arapaho Pass that involved aggregation of
the local band with members of another band whose range was situated in the South Platte
drainage of northeast Colorado. The local band geared up with Kremmling chert and the
visiting band principally geared up with orthoquartzites from sources in the South Platte
drainage.

Fourth of July Valley Site. An interpretation of the tool stone composition of the
Fourth of July Valley site from the alternative perspective suggests that Paleoindian bands
operated in ranges that were not necessarily much larger than those of later foragers.
Presence of 13 Angostura points of a Middle Park tool stone and one Frederick point of an
orthoquartzite thought to originate on the plains or northeast Colorado is the basis for
interpreting the assemblage as the product of an aggregated group composed of mostly
mountain people with a minority of people from the western plains. The tool stone
composition of the assemblage further supports this interpretation. A total of 87 percent of
the assemblage is composed of Middle Park tool stones and 12 percent is made of various
tool stones suspected of originating on the Plains within the drainages of the South and North
Platte rivers. As explained above, all Middle Park tool stones are best considered as local in
origin. The Middle Park tool stones are dominated by Windy Ridge orthoquartzite, which is
thought to have been procured by a local band of mountain people to gear up for a communal
game drive. Within the hypothetical home range of a local plains band wintering in the
Boulder area and seasonally occupying Middle Park, the only high-quality tool stone sources
would be those present in the park. No high-quality sources of raw material are available in
the plains east of Boulder to around the city of Brighton, so a local band of plains people
intent on gearing up for a communal hunt using sources on the plains would have to acquire
stone from distant or very distant sources. Tool stones in the Fourth of July Valley
assemblage suspected of being from plains sources are believed to originate from distant
sources in the South Platte drainage and from a very distant source area in the watershed of
the North Platte. The distant tool stones are orthoquartzites that are thought to originate from
exposures of White River Group gravel (three percent of the assemblage). A variety of
microcrystalline tool stones in the assemblage are described as chert or chalcedony colored
brown, yellow, or red that sometimes contains black dendrites. These raw materials are
suspected of being varieties of Hartville Uplift chert from very distant sources and account
for four percent of the assemblage. Whether the tool stones from Plains sources represent the
gearing up activities of a local plains band or participation of a band from distant lands is
problematic. In either case, the above information supports an interpretation of the tool stone
composition of the assemblage from the Fourth of July Valley site as demonstrating
aggregation of people from both mountain and plains bands that operated within ranges
comparable in size to ethnographic foragers.

The predominance of Windy Ridge orthoquartzite in the Fourth of July Valley
assemblage in conjunction with the high percentage of Kremmling chert in the collection
from the Devils Thumb game drive gives support to the model of Late Paleoindian land use
outlined above. In part, the model contends that bands of mountain people wintering in
valleys to the northwest and southwest of Middle Park made their way eastward for
communal game drives in the high Front Range and geared up with Middle Park tool stones.
It was suggested that larger pieces of raw material available at the sources of Kremmling
chert and Windy Ridge orthoquartzite in western Middle Park would have served to make
these sources more attractive for gearing up in comparison to the source of Table Mountain
jasper in the eastern part of the park. The assemblage from Area A at the Devils Thumb
game drive was dominated by Kremmling chert (93 percent) with a minor amount of Table
Mountain jasper present (7 percent) and a single artifact of Windy Ridge orthoquartzite.
Since the source areas of both Kremmling chert and Table Mountain jasper are basically
along the Colorado river, the tool stone composition would support an interpretation of a
band of mountain people wintering in the lower Colorado River drainage southwest of Middle Park, then moving east into the park, gearing up primarily at the Kremmling chert source, and moving up into the high Front Range for communal hunting. In contrast, the assemblage from the Fourth of July Valley site was dominated by Windy Ridge orthoquartzite (87 percent), a miniscule amount of Kremmling chert (.4 percent), and no Table Mountain jasper whatsoever. This tool stone composition would support an interpretation suggesting that a band of mountain people wintered in the Yampa River valley to the northwest of Middle Park, crossed the Gore Range over Rabbit Ears Pass, and geared up almost exclusively at the Windy Ridge orthoquartzite source in the northwest corner of the park before traveling to a game drive in the high Front Range.

It is relevant to note that the Plains tool stones represented in the Frederick components at both the Fourth of July Valley site and the Caribou Lake site are not from the high-quality Plains source that is closest to the site. From the mouth of the canyon of Middle Boulder Creek at the city of Boulder, the primary source area of Dawson petrified wood is the nearest high-quality source of tool stone. Lithic procurement sites at the northern end of the source area lie 66 km to the southeast. The source area of exposures of White River Group gravels is the next closest place that might possibly classify as a high-quality source of tool stone. Sources of WRGG occur in a broad, east-west aligned band between the South Platte River and the Wyoming state line. A recorded lithic procurement site in the western end of the band of sources (5WL1445) is situated 104 km to the northeast.

Considering that drainage patterns on the Plains would have had some effect on the land use patterns of prehistoric foragers, the somewhat unexpected absence of Dawson petrified wood in the Fourth of July Valley and Caribou Lake assemblages might be explained by the arrangement of watercourses on the Colorado piedmont. On the plains east of Boulder, the drainage pattern consists of a series of permanent streams that issue from the mountains and flow generally to the northeast to join with the South Platter River. From the
mouth of Boulder Canyon, direct travel to the lithic procurement sites at the north end of the Dawson petrified wood source area requires cutting across the drainage pattern by moving from one stream to another. The travel route involves a few segments where water would be unavailable, including two stretches of about 10 kilometers. In contrast, the route from Boulder to the area in the vicinity of WRGG sources would entail following watercourses all of the way. The above information supports the view that the drainage pattern on the Colorado Piedmont section of the Central Plains exerted some influence on the land use patterns of Plains Paleoindians. The drainage pattern may have to some extent influenced how band ranges were positioned on the plains and how stone was transported across the plains.

In summary, the tool stone composition of the assemblage from Fourth of July Valley site meets the expectations of the alternative view for a collection of artifacts deposited by an aggregation of people from multiple bands that operated in ranges that were comparable in size to those of ethnographic foragers. Both mountain and plains peoples participated in a communal game drive, with the former group comprising the majority of participants. Most tool stone brought to the site was acquired from the source of Windy Ridge orthoquartzite in Middle Park which was arguably situated within the range of the local band of mountain people. Participants in the communal drive from the Plains geared up for the event by acquiring stone from distant and very distant sources on the Plains to the north and northeast of the Fourth of July Valley.

Campsite Not Related to Communal Kill in Environment with High-Quality Stone

Allen Site

The tool stone composition of the assemblage from the Allen site conforms to what would be expected if Paleoindian bands operated within ranges that were of sizes comparable to ethnographic foragers. Under the alternative view, campsites not associated with large-
scale hunting that are located in environments with a local high-quality source of tool stone should be dominated by the local stone. Predominance of the local raw material will of course apply to the debitage, but also should be evident in the collection of discarded tools. This is indeed the situation with the Allen site assemblage which is best thought of as an amalgamation of many campsite assemblages. It should be noted that with the exception of other sources of Smoky Hill jasper located to the south and east of the site, there are no other high-quality sources of stone located in distant areas that would have been occupied by other bands. Therefore, rather than being an accumulation of camp debris from just one or more local bands that had Medicine Creek in their habitual ranges, the Allen site may also include cultural material discarded by task groups send out from neighboring bands in distant lands to acquire jasper from Medicine Creek to replenish their supply of tool stone. In any case, the tool stone composition of the Allen assemblage is in keeping with the view of Paleoindian bands operating in ranges of ethnographic size.

The artifacts of tool stone from very distant sources in the Allen assemblage may therefore be best thought of as evidence of the long-distance connections between the local and neighboring bands, on the one hand, and bands native to very distant lands, on the other. The only types of artifacts made of tool stone from nonlocal sources are projectile points, flakes, and a pot lid from a biface. Included among the artifacts of stone from very distant sources is one point of Alibates agate and two points of chalcedony, chert, or unknown material from unidentified sources (Table 12-5). The pot lid is said to have possibly come from a biface, so it may be from a point of Flint Hills chert. Of the 79 nonjasper flakes in the collection, 68 are specifically identified as flakes from bifacial reduction (Bamforth and Becker 2007a:Table 10.15). Thus, many of the nonjasper flakes may be by-products of manufacturing projectile points from preforms of stone from very distant sources. In light of the above information, a plausible interpretation of the artifacts of stone from very distant sources is that they represent trade or long-distance travel by individuals or small groups. In
sum, the artifacts are demonstrative of long-distance connections between people of the Medicine Creek vicinity and the Flint Hills or the lower Platte drainage (as demonstrated by the artifact of Flint Hills chert or Nehawka chert, respectively), the North Platte drainage (Hartville Uplift chert and possible Table Mountain chert), the South Platte drainage (possible Flat Top chalcedony), and the Llano Estacado section of the Southern Plains (Alibates agate).

Understanding the geographic extent of Paleoindian land use patterns will require more than just assessing if the ranges used by bands were comparable in size to ethnographic foragers. Future research should be directed toward defining the location of homelands of Paleoindian cultural groups and the areas within which neighboring cultural groups would have interacted. A step toward achieving this goal was made in the above discussion of the theoretical boundary zone of Late Paleoindian times between mountain people and culturally distinct people of the western Central Plains. Interpretation of sites in Middle Park and the high Front Range was based on the understanding that both regions were within what may be considered a boundary zone that was used seasonally by mountain people who wintered in mountain valleys to the west and by people of the west Central Plains who wintered east of the Front Range. Cultural differentiation on the Central Plains is less understood, but as discussed in Chapter 8, differences exist between the types of points and hide scrapers found on the western plains and those common in the eastern portion.

To hypothesize how the people who repeatedly occupied the Allen site fit into the above cultural distribution, one might consider the kinds of hide scrapers present. A total of 23 beveled tools were found throughout the meter-thick cultural deposits, but no end scrapers were recovered. If beveled tools prove to be diagnostic of people of the eastern Central Plains, there is cause to hypothesize that the small groups of men, women, and children that repeatedly occupied the sites were affiliated with the eastern cultural group.

When the kinds of points found at the Allen site are considered, the cultural affiliation of local people is less clear, but this class of artifact nevertheless provides some
possible insight into the distribution of cultural groups. The interpretive value of points is hampered by the small sample size of points attributable to eastern or western types with exact provenience information. Only two concave-based lanceolate points that are potentially attributable to eastern people have precise provenience and only two points of western types (an Agate Basin point and a possible Hell Gap point) have exact provenience. The concave-based lanceolate points are from the lowest and intermediate portions of the cultural deposit (Occupation Level 1 and the Intermediate Zone). The Agate Basin and possible Hell Gap point are from Occupation Level 1. As theorized in Chapter 8, a broad, north-south aligned boundary zone between eastern and western peoples may have existed west of Medicine Creek. Within this zone, interaction between the cultural groups in the social context of communal bison hunts may have occurred. It was further suggested that evidence from Medicine Creek supports the view that western plains peoples occasionally visited the area to procure tool stone from high-quality sources, at least during Late Paleoindian (specifically Cody) times. A consideration of the raw materials of the earlier Late Paleoindian points of western types from the Allen site supports the thinking that western plains people may have occasionally camped at the Allen site in pre-Cody times. One Agate Basin point is made of stone from an unknown source and could represent a point obtained by local people through exchange. A second relevant artifact is actually a beveled tool made by reworking a fragmentary Agate Basin point of unspecified raw material (Bamforth and Becker 2007a:160). This artifact arguably is a point of a western type that was acquired indirectly by local people and reworked into a hide scraping tool of the type attributable to the eastern plains people. Finally, a possible Hell Gap point is arguably of a western type and was made of Smoky Hill jasper. This point thus constitutes limited evidence that makers of western point types occasionally were present in the Medicine Creek drainage in pre-Cody times. In conclusion, consideration of the kinds of points and hide scrapers in the Allen assemblage forms the basis for hypothesizing that Medicine Creek was within the homelands of people
affiliated with the eastern cultural group, but the drainage was also visited by people of the western cultural group.

Sites near High-Quality Lithic Sources

Hell Gap Cluster, Locality V

The tool stone composition of the Locality V assemblage conforms to the expectations for an assemblage produced by a band visiting a high-quality source of tool stone. The expectations state that stone from the nearby source will account for a large amount of debitage. Furthermore, expectations state that as tool kits are rejuvenated with stone from the nearby source, finished tools discarded on the site will be comprised of large amounts of local stone. Contrary to the later statement, the tools of local raw materials discarded at Locality V probably do not in this case represent tools that band members discarded because new tools had been made to replace worn out tools. Rather, as argued above, the bison bone, broken points, discarded end scrapers, and other aspects of the faunal and artifact collection from Locality V suggest that many tools had been recently made and discarded after being used to kill and process bison.

Examination of data in Table 12-8 serves to further illustrate the interpretation that a local band of Cody people aggregated at Hell Gap for large-scale bison hunting. Three local tool stones, including Hartville Uplift chert, Arikaree chert, and Spanish Diggings orthoquartzite account for a large percentage (98 percent) and occur in the form of all (or almost all) of the kinds of flaked stone artifacts present in the assemblage. The kinds of artifacts can be broadly grouped as either manufacturing debris or tools. Data in Table 12-8 support the assertion that blocky cores and unfinished bifaces, including point preforms, of these three local raw materials were knapped on-site as part of gearing up. Hartville Uplift chert makes up a majority of the assemblage (71 percent). Considering that eight sources of this tool stone are known to occur within several kilometers of Locality V, it is possible that
much of this raw material was procured after segments of the band had aggregated and were camped at Locality V. The two other types of tool stone were apparently brought to Locality V in unfinished form and worked into tools needed for killing and processing numbers of bison. The absence of end scrapers of Spanish Diggings orthoquartzite continues the trend demonstrated previously at sites such as Jurgens, Frazier, and Lindenmeier where orthoquartzite was apparently avoided in the manufacture of end scrapers. It is noteworthy that artifacts of Arikaree chert from a source area reportedly lying 30 to 45 km east of the Hartville Uplift on the plains is over five times as common as artifacts of Spanish Diggings orthoquartzite from the source area situated elsewhere in the Hartville Uplift at a distance of 27 km to the northwest. This would suggest that the habitual range of the band may have encompassed parts or all of the Hartville Uplift as well as areas situated in the grasslands to the east.

The limited amount of nonlocal stone and the restricted kinds of artifacts in which it occurs also tends to favor the conclusion that the aggregation at Locality V was composed primarily of segments of the local Cody band, rather than a multi-band aggregation of Cody people. For the presence of nonlocal artifacts of Table Mountain chert to represent participation of a neighboring band from down the North Platte drainage in communal hunting planned for the Hartville Uplift area, more of the assemblage would be expected to be comprised of this raw material. Instead, only one end scraper and 10 flakes of the tool stone are present and together comprise only .3 percent of the collection. The source of the material is situated at 76 km from the site and just barely classifies as a distant source. Artifacts of Table Mountain chert may therefore represent aggregation of segments of the local band. The exact source of artifacts of Tongue River silicified sediment is not known, although the material is believed to derive from a nonlocal source somewhere in the Powder River Basin. Nevertheless, TRSS artifacts also support the view that the social gathering at Locality V did not involve multiple bands. If an entire band from the Powder River Basin
joined with the local band of the Hartville Uplift area, it is reasonable to expect that more TRSS would be in the assemblage and would occur in a broader range of artifact types. Manufacturing debris of TRSS includes 47 flakes, one blocky core, and one Cody point preform. In total, artifacts of TRSS comprise one percent of the assemblage. Flaked stone tools of the raw material include three utilized flakes, one informal retouched flake tool, and four Cody points. This collection of TRSS artifacts contains a high proportion of points and preforms. The presence of TRSS artifacts in the Locality V assemblage may be interpreted as representing trade between a local band and another situated to the northwest in the Powder River Basin. Alternatively, participation of some hunters from a band in the Powder River Basin may reasonably be suggested.

The case that a single-band aggregation is represented at Locality V is bolstered by comparing the assemblage to that of the Jurgens site, where it was argued that multiple Cody bands aggregated. In the Locality V collection, artifacts of TRSS from nonlocal sources in the Powder River Basin and Table Mountain chert from a distant source located farther down the North Platte drainage comprise at total of less than two percent of the assemblage, according to artifact count. In comparison, three tool stones from distant sources in the Jurgens assemblage (Dawson petrified wood, Flat Top chalcedony, and Hartville Uplift chert) together total 81 percent of the assemblage according to artifact count and 53 percent of the collection based on total weight of the tool stones from distant sources (Table 10.3).

The thinking that the Jurgens artifact assemblage represents a larger social gathering than that represented by the Locality V artifacts is further supported by the observation that a wide variety of tool stone from very distant sources is present in the Jurgens collection, but not in the Locality V assemblage. In relation to the Jurgens site, the very distant sources of tool stone are situated in various directions from the site. Tool stone from six very distant sources occur in the Jurgens assemblage. Together, the sources of the tool stones are spread throughout a huge area that includes the Wyoming Basin (Wamsutter oolitic chert), the
Northwest Plains (Ft. Union porcellanite), the Northern Plains (Knife River flint), the Central Plains (Smoky Hill jasper) and the Southern Plains (Alibates agate and Edwards chert).

Projectile points in the Jurgens assemblage occur in a significantly higher proportion in the combined sample of tool stones from very distant sources in comparison to artifacts from distant sources. This observation suggests that participating bands acquired primarily points and preforms from nonlocal sources through an exchange network prior to aggregating with other bands for communal hunting. In contrast, no tool stone from Locality V can be said to definitely derive from a very distant source. A possible exception is TRSS. As discussed previously, the existing published literature indicates that sources occur in the Powder River Basin, but specific sources are not discussed. Based on the location of the Powder River Basin in relation to Hell Gap, the TRSS present in the Locality V assemblage is believed to derive from either distant or very distant sources.

**Western Middle Park Cluster**

*Barger Gulch Site Complex, Locality B.* To assist in evaluating competing potential explanations for the tool stone composition of Locality B as formulated from the alternative perspective, the raw material availability and potential for winter occupation in that portion of the Plains and in those intermontane basins and valleys that neighbor Middle Park will be briefly reviewed. For heuristic purposes, this discussion will assume that Folsom bands had ranges similar in size to the largest known ethnographic example.

A band that had Middle Park in its range, as well as lower reaches of the Colorado River drainage to around the city of Glenwood Springs, would have the Middle Park sources in the eastern part of its range. The western part would be in land conducive to winter occupation, as seen in the fact that later Archaic peoples wintered here at the Yarmony Pithouse site.
The next band downriver would operate within a range that may have extended to about the Utah state line. No high-quality lithic sources are known within this area. That later peoples wintered in this area is seen at the Kewclaw site, where an Archaic pithouse was excavated near the town of Parachute (Cassells 1997:104-105).

To the northwest of Middle Park lies the Yampa River valley which is accessible over Rabbit Ears Pass. By following the Yampa River drainage downstream for about 150 km, one arrives at the source area of Bridger chert in the Sand Wash Basin. Therefore, if the group camped at Locality B included people from a band in the Yampa River drainage, there may be some Bridger chert in the assemblage. That later foragers wintered in this area is seen at a number of sites, including the Red Army Rockshelter near Hayden, Colorado, which contained an Archaic pithouse (Pool 1997).

A band with its range in North Park and further north-northwest down the North Platte drainage to around Rawlins, Wyoming may have had access to the source of Windy Ridge quartzite known from the northeast portion of North Park. Stone from this source would be difficult to differentiate from the main source of this tool stone in the northwest part of the Middle Park drainage. That later Archaic people wintered in the lower portion of this area is seen at two pithouse sites near Seminole Reservoir known as the Shoreline site and the Medicine House site (Miller and McGuire 1997; Walker et al. 1997).

Another band may have operated in a range situated east of the Front Range. Primary sources of Dawson petrified wood are in the southern part of this area. Whether a band in this area would incorporate Middle Park in the habitual range that it used on an annual basis is uncertain because this would require annual treks over the high Front Range. Participation of people from a band situated east of the Front Range in large-scale bison kills planned in Middle Park does not seem out of the question, however. Wedel (1964) remarks on the suitability of the foothills region around Boulder, Colorado for winter habitation.
South of Middle Park lie South Park and the Upper Arkansas Valley. These regions would not be conducive to overwintering, but could have been used by bands that wintered to the east or west. For example, a band that wintered on the Plains within the Arkansas River drainage around Cañon City would be close to the sources of Dawson petrified wood in the Palmer Divide area and upon moving west into the mountains, would have access to the sources of quartz crystal east of South Park as well as the Trout Creek jasper quarry, located west of the park.

With the above understanding of the tool stone availability in regions surrounding Middle Park, a number of possible explanations of the tool stone composition of Locality B developed under the alternative view may be considered. Being able to assess which explanation is best is hampered by the fact that of the 16 tool stones comprising the collection, 11 have not been positively identified to a specific source. Nevertheless, possible explanatory scenarios are presented along with mention of their pros and cons when appropriate in an effort to develop the alternative view of land use.

In contemplating possible land use scenarios, it is relevant to note that tool stone brought to Locality B from outside Middle Park arrived there in a limited range of artifact types. The kinds of artifacts made of the most common tool stones from outside the park will be considered first. These tool stones include Trout Creek jasper, opaque, weakly banded gray-to-brown chert, pink translucent chalcedony, and quartz crystal. The sample of Trout Creek jasper demonstrates that this tool stone was disproportionally used in the manufacture of hunting weaponry. The sample is composed of the fragment of a biface that arguably was intended to be used for point manufacture, a point preform, three channel flakes, and 246 small flakes. The small flakes from the site were not analyzed to determine if they derive from the reduction of blocky cores or bifaces, but considering the types of artifacts made of this material, the possibility that many of the flakes derive from bifacial reduction of point preforms seems likely. Also, five artifacts of Trout Creek jasper are generally classified as
“flake tools.” The next most common non-Kremmling Chert tool stone is the gray-to-brown chert. Judging from the kinds of artifacts made of this material, it can be said that a lot of this stone present on the site was in the form of point preforms which were finished into points at the site. The sample of this tool stone includes one point base, 6 channel flakes (2 of which refit to flutes on both faces of the point base), 143 small flakes, and one flake tool. The third most common non-Kremmling chert tool stone is the pink translucent chert which may be Flat Top chalcedony. The sample of this material includes 88 small flakes and one end scraper. It is relevant to note that the tool is of a type that is needed at bison kills where hides were to be processed. Also, from the above review of other Paleoindian assemblages in the study area, the end-scraper is a tool type that, like points and preforms, was sometimes transported considerable distances. Finally, the fourth most prevalent non-Kremmling chert tool stone is the material that may be quartz crystal. The sample of this material includes only debitage. Because most of the 72 artifacts are pieces of shatter, it seems doubtful that the finishing of projectile points is represented.

Other tool stones that may be from outside Middle Park may show the same pattern of being primarily represented by points, preforms, and small flakes possibly resulting from the finishing of points. The tool stone designated as “other” includes a point made of stone described as “dark yellow-orange mottled chert” as well as 15 small flakes, but it is not specified if the flakes are of the same material or are a grab bag of various tool stones. A tool stone described simply as speckled chert is represented by 15 small flakes.

Finally, some of the tool stones that are possibly from nonlocal sources outside Middle Park are represented wholly or principally by flake tools. Included are the pink dendritic chert and a red and yellow translucent chert, both of which are represented by a single flake tool. A coarse brown chert is the raw material of two flake tools and one small flake.
One hypothetical scenario developed under the alternative view to explain the tool stone composition of Locality B envisions the site as the result of bands that may be considered local in so far that they operated in habitual ranges that included occupying Middle Park for part of the year and making use of Kremmling chert. This model is somewhat analogous to the historic Ute coming into Middle Park from the lowlands to the west where they spent the winter and occupying the park at the same time that the Arapaho made seasonal use of the park from their wintering bases in lowlands to the east. Prior to aggregating for a large-scale hunt in Middle Park, dispersed elements of a local band that wintered west of the park may have obtained artifacts of Trout Creek jasper and quartz crystal in trade with people to the south who made seasonal use of the South Park area. The presence of artifacts of Dawson petrified wood, Morrison quartzite, and pink translucent chalcedony could have arrived from the site if a band that wintered east of the Front Range similarly obtained tool stone through an exchange network in anticipation of participating in a communal hunt planned in Middle Park.

An observation that does not conform to the suggestion that local bands that normally made use of Middle Park on a seasonal basis jointly occupied Locality B is the near total lack of the other two main tool stones of Middle Park. If Middle Park was occupied by dispersed units of one or more bands that then coalesced to participate in a communal hunt, one would expect that there would be appreciable amounts of artifacts of Windy Ridge quartzite from family units arriving from the northern part of western Middle Park or North Park. Also, one might expect to see at least some artifacts of Table Mountain jasper from people arriving from the eastern part of Middle Park. Instead, only one small flake is identified as Windy Ridge orthoquartzite and no artifacts of Table Mountain jasper are reported. This nearly total lack of the other main Middle Park tool stones suggests that a local band may not have participated in the communal hunt or that the aggregation was so large that any artifacts of
Middle Park tool stone brought in by local people were swamped by the artifacts of Kremmling chert newly made during gearing up operations.

Another model that is rooted in alternative thinking might instead propose that the small amounts of nonlocal tool stones represent hunters from neighboring bands arriving in Middle Park to participate in a planned communal hunt. As theorized by MacDonald (1999), their motivation may have been to attend a large social gathering to socialize with prospective spouses. Upon initial consideration, the fact that small amounts of hunting weaponry made of a variety of nonlocal tool stones are present would seem to be congruent with McDonald’s hypothesis. If indeed the nonlocal tool stones reflect socialization and courtship activities common to all adult hunters at some time in their lives, it is expected that the points and related artifacts of nonlocal stone would demonstrate a wide range of flint knapping skill levels, with most being of average workmanship. In Chapter 8, it was suggested that fluting of Folsom points may require excellent flintknapping skills. If true, the fact that a preform of Trout Creek jasper and a preform of presumably nonlocal gray-to-brown chert were fluted on-site would strongly suggest that the preforms of stone from distant lands were worked by an expert flintknapper, not a hunter of average skill. The artifacts of Trout Creek jasper in particular possess qualities demonstrative of a skilled flintknapper. The fragment of a large biface is extremely thin. It has a width-to-thickness ratio of 8.4 to 1 and considering that it was once part of an even wider biface, Surovell et al. (2003:85-86) suggest that the original biface may have had a width-to-thickness ratio of over 10 to 1. The artifacts of Trout Creek jasper, then, are more indicative of having been worked by an expert flintknapper, rather than an ordinary hunter visiting from the South Park area.

A final hypothetical scenario that conceivably could explain the kinds and amounts of nonlocal tool stones in the Locality B assemblage is that entire bands that normally operated in habitual ranges lying in distant lands traveled to Middle Park to participate in a communal hunt. The expectation developed under the alternative view for the tool stone
composition of assemblages created by multiple bands aggregated at a tool stone source is that, “[t]ools discarded on-site will be made of a substantial amount of local stone procured by the local band along with substantial amounts of nonlocal stone procured within the home range of one or more visiting bands” (Table 8-5). The Locality B assemblage does not conform to this expectation because there are only very small amounts of nonlocal tool stones. As argued in Chapter 5, however, the situation in Middle Park may have been such that bison herd locations would have been more predictable that on the Plains. This, coupled with the fact that the main Kremmling chert source area happens to be centrally situated within the expanse of sagebrush grasslands in western Middle Park where bison herds would likely be found during much of the year, would suggest that a visiting band could plan on not taking much stone from their home range and instead gear up at the Kremmling chert source area prior to the hunt.

The stone from nonlocal sources mentioned above would suggest that if indeed entire bands were camped near Locality B, they may have arrived from at least two different directions. One possible explanation of the presence of artifacts of Dawson petrified wood, quartz crystal, and Trout Creek jasper in the assemblage is that a band that wintered along the Front Range in the Arkansas valley and had access to the above materials within its habitual range was among the bands at Locality B. One might also argue that the artifacts of Dawson petrified wood, Morrison orthoquartzite, and pink translucent chert (assuming it is Flat Top chalcedony) would support the thinking that another band that normally wintered along the eastern base of the Front Range in the drainage of the South Platte River east-northeast of Middle Park came over one of the passes in the high Front Range to participate in a bison kill in western Middle Park. Artifacts of the gray-to-brown chert, which include a point and channel flakes, may have originated from a source in another region surrounding Middle Park and represent the participation of yet another band.
Some support for the notion that entire bands from distant lands had assembled at Locality B comes from a consideration of possible point styles evident in the collection. Different styles of Folsom points are arguably present in the assemblage, which would support the thinking that multiple expert flintknappers were present. Four points in particular are demonstrative of a highly unusual, possibly idiosyncratic or regional style of manufacture. From the basal edge, lateral edges of the points diverge rapidly from one another (Surovell et al. 2003:Figure 5.25 b, d, f; Waguespack et al. 2006:3.3 f). Three are made of the local Kremmling chert, suggesting that the knapper possessing excellent flintknapping skill who made the points did so in Middle Park using the local chert. The same unusual attribute is seen on two points from the Mountaineer site in the Gunnison Basin (Stiger 2006:Figure 12, middle row, second and third from the right), implying that the same idiosyncratic or regional point style was also present in that intermontane basin. The Gunnison basin is situated south and west of Middle Park, adding to the evidence in support of the interpretation that a band that wintered east or west of the mountains had access to tool stones in the South Park and Upper Arkansas Valley was one of the groups that were gathered together at Locality B. (See Figure 5-1 to review the geographical position of the above regions in the Southern Rocky Mountains).

**Crying Woman Site.** When interpreted as a site near a source that is representative of occupation by a group intent on gearing up for communal hunting, the tool stone composition of the Crying Woman site supports the view that the geographic extent of band ranges was not necessarily greater than that known for ethnographic foragers. Because the assemblage is small and derives from a single two-meter by two-meter excavation unit, interpretation of land use from the tool stone composition must necessarily be preliminary. Nevertheless, if the presence of only fluted points of Folsom age at the site is more likely to indicate a multi-band group rather than a single band, it is noteworthy that the tool stone composition of the
assemblage may be interpreted as supporting the view that more than one band was present. Under the alternative view, discarded tools in assemblages from sites at sources that were produced by multi-band aggregations may sometimes contain substantial numbers of not only the local stone, but also stone from a nonlocal source that represents tools brought in by a visiting band. No formal tools of Kremmling chert were recovered, however, but this could simply be a result of the small sample from the occupation layer obtained through excavation.

Other Folsom sites in western Middle Park producing points made of Bridger chert provide supporting evidence that some form of recurring contact took place between the park and the Yampa River drainage. Three sites located in the general vicinity of the Upper Twin Mountain site each produced a fluted Folsom point of the Sevenmile Ridge variety of Bridger chert. One point was found at the Lower Twin Mountain site (Kornfeld and Frison 2000:139-143:Figure 8 c; Naze 1986:27, Figure 4 g). Another was reportedly found on a lithic scatter by a nearby spring (Naze 1986:10, Figure 3 a, b). A third point was found on the Jerry Craig site, away from the bonebed area that produced Cody and Angostura points. Finally, the tiger chert variety of Bridger chert is the raw material of a distal point fragment from Middle Park that has an accentuated tip comparable to those noted on so-called Goshen points from the Upper Twin Mountain and Mill Iron sites. The artifact was found at a lithic scatter in the Barger Gulch site complex designated Locality I (as in the letter “I”) (Waguespack et al. 2006:5-6, Figure 1.3 a).

It may be significant to note that no formal tools or even waste flakes of the two other main Middle Park tool stones besides Kremmling chert were recovered from the Folsom occupation layer in Excavation Unit 1. The reader will recall that at the nearby site of Locality B, only one flake of Windy Ridge orthoquartzite is mentioned. Perhaps the lack of other Middle Park stone besides Kremmling chert may mean that if a local band was part of an aggregated group that hypothetically geared up at the Crying Woman site, the plan was for participating bands to first gear up as an aggregated group at the Kremmling chert source area.
because this was a high-quality source centrally located in the tract of open grassland in western Middle Park where communal bison hunts took place. This possibility is supported by the proximity of the known Paleoindian bison bonebeds to the Kremmling chert source area. The Jerry Craig site is only about 11 km from the source area and the Upper Twin Mountain site is about 16 km distant.

**Medicine Creek Cluster**

**Red Smoke Site, Zone V.** The tool stone composition of the Zone V collection supports the view that Paleoindian bands operated within ranges that were not necessarily tremendously larger than ethnographically documented foragers. If Zone V is the product of one or more occupations by a single local band involved in gearing up for large-scale bison hunting, it is expected that local stone will dominate the assemblage because Smoky Hill jasper is available in the local environment from high-quality sources. In the situation where neighboring bands are planning to cooperate in a communal hunt and have high-quality sources of stone in their home ranges, the bands would have the option of gearing up with those tool stones before aggregating with the others. Distant areas to the northwest and northeast of the Medicine Creek Paleoindian sites lie within the drainage of the Platte River and distant areas to the southwest are within the upper reaches of the Kansas River drainage. These areas are conducive to habitation by foraging peoples, but have no known high-quality sources of tool stone. Therefore, if bands whose home ranges were in these distant areas planned to get together for a bison hunt, they would not be able to gear up in their home ranges. Rather, they might meet and gear up at one of the high-quality sources of jasper in the Medicine Creek drainage. Distant lands to the southeast of the Red Smoke site lie in the Kansas River drainage. The main source area for Smoky Hill jasper mapped by Holen (1991:401, Figure 23.1) occurs in the distant lands southeast of Medicine Creek, so a band whose home range lies in this area would have the option of gearing up before traveling to
Medicine Creek. Considering that high-quality sources of the same tool stone are available in Medicine Creek, the band may have chosen to gear up using Medicine Creek stone along with any other participating bands, rather than to carry stone with them. In light of the above, the near complete dominance of Smoky Hill jasper in the assemblage from Zone V is what would be expected under the alternative view for either a single-band or a multi-band group of people gearing up for a communal hunt.

Comparison of the tool stones from very distant sources present in both the Zone V point collection from Red Smoke and the Allen site reveals that essentially the same set of sources occur in these two sites that produced similar kinds of projectile points. Occupations of the Allen site were suggested to be principally the product of small groups associated with one or more local bands of an eastern plains people that made beveled tools and concave-based lanceolate points. Throughout two millennia of site reuse, bifaces and points of the following tool stones from very distant sources were transported to the site: Flint Hills chert or Nehawka chert, Table Mountain chert or Flat Top chalcedony, Hartville Uplift chert, and Alibates agate. Occupation of Zone V at Red Smoke is here preliminarily attributed to a potentially large group of people who were involved in communal bison hunting. The occupants of the site made concave-based lanceolate points during a time period when Cody points were in use on the western plains. Points of tool stone from essentially the same very distant sources listed above are present in the point collection from Zone V (Table 12-6). If indeed the two sites were produced by people of the eastern plains cultural group, it would not be unexpected that assemblages from those sites would produce evidence of interaction with the same very distant lands. However, while the tool stones from very distant sources in the Allen site accumulated over the course of two millennia, what is essentially the same set of tool stones in the Zone V point collection at Red Smoke may have be deposited during a single episode of site use.
Two cultural mechanisms may be proposed to explain the presence of the relatively few points of raw materials from very distant sources in the Zone V point collection. Though reasons may be offered to suggest why one particular mechanism may be more or less likely than the other, it is not yet possible to determine definitely which explanation for the presence of the points from very distant sources is best.

Though it may be possible that a single band acquired points and preforms through trade with people in very distant lands, the fact that essentially all the tool stones from very distant sources are present would tend to favor the view that Zone V may have been produced by a multi-band group that included neighboring bands from distant lands that brought stone they had acquired from sources in lands that were in turn very distant in relation to their homelands. As discussed in Chapter 8, a distant band affiliated with the eastern plains cultural group that inhabited a range to the northeast of Medicine Creek in the lower Platte drainage would have been in an area where Nehawka chert was available for use in the context of bison hunting as seen at the Meserve site. Furthermore, evidence from the Clary Ranch and Scottsbluff sites, as well as the Hell Gap site complex, suggests that a distant band of the eastern plains culture inhabiting the lower reaches of the North Platte drainage to the northwest of Medicine Creek would have been in an area where Flat Top chalcedony or Table Mountain chert was available for use during bison hunts, as were Hartville Uplift materials, which would have been brought into the area by Cody peoples. Finally, a distant band of the eastern plains cultural group living to the south of Medicine Creek in the Kansas River drainage would have been in an area where at least some Alibates agate was evidently available for use in bison hunts, as seen at the Norton site (Hofman et al. 1995). Trading for points and preforms with a neighboring cultural group may best explain the presence of Cody points made of stone from very distant sources in the Hartville Uplift (Spanish Diggings orthoquartzite) and on the Southern Plains (Alibates agate).
A final possible cultural mechanism that might be proposed to explain the presence in Zone V of points made of stone from very distant sources is that they were brought in by a few hunters from very distant bands who were seeking spouses from surrounding social units. In support of this view, MacDonald (1999:Table 1) presents ethnographic data on the average distance between the birthplaces of spouses for a sample of six cultural groups, a statistic referred to as the mean mating distance. For example, data on the !Kung Bushmen shows the mean mating distance to be 66 km. The maximum dimension of the !Kung band at the Dobe waterhole is 22 km (Table 8-1). Thus, the average mating distance is three times the size of a band range, based on a truly meager amount of data. Armed with this observation alone, one might suggest that if a source of very distant stone is within three range diameters of the Red Smoke site, then support would be garnered for MacDonald’s thinking. Indeed, using the range diameters used here for Plains Paleoindians, the Hartville Uplift sources are about three range diameters away from Red Smoke, the Nehawka source area is two range diameters away, and the Alibates source area is three range diameters away from Red Smoke. My concern with MacDonald’s idea lies in the observation that points of stone from very distant sources all appear to be made by expert flintknappers (Knudsen 2002:Table 7.3, Figure 7.10 a, c, e, f, 7.11 a-d). If points of very distant stone were brought in by hunters in general, one would expect to see a range of flintknapping skill levels evident in the points. The observation that the points appear to be made by expert craftsmen would instead tend to favor the idea that they are items that arrived at the site in an exchange network.

Lime Creek Site, Zone I. The tool stone composition of the Zone I worked pieces best conforms to the view that Paleoindian bands operated within ranges that were not necessarily much larger than those known for ethnographic foragers. One or more bands that could be considered local in that their home range included the Medicine Creek drainage may not have been affiliated with the western plains cultural group that made Cody points.
Rather, a local band inhabiting the Medicine Creek drainage may have been affiliated with the eastern plains cultural group that made beveled tools and concave-based lanceolate points. A group composed of one or more Cody bands camped out at a lithic source in Medicine Creek may have come from one or more habitual ranges situated in distant lands off to the northwest, west, or southwest. These ranges would have been situated in areas that are completely lacking of high-quality sources of stone. Cody bands inhabiting these ranges would have to somehow procure stone from nonlocal sources and the closest sources available to them may have included the Smoky Hill jasper outcrops in Medicine Creek or the sources of WRGS on Flat Top Butte or Table Mountain. Whether the Cody occupation of Zone V would have been produced by a group of one or more bands is problematic. Nevertheless, the fact that the discarded tools in the Zone I assemblage are primarily of the local jasper is in keeping with the alternative view’s position that the scale of Paleoindian land use may have been comparable to that of ethnographically known peoples. If sources of Smoky Hill jasper in the Medicine Creek drainage were the closest high-quality source of stone available to the Cody band or bands that produced Zone I, then discarded tools in the collection should be mostly made of the local jasper. Evaluation of this expectation is hindered by the relatively few numbers of discarded formal tools. Informal tools, including flake tools, wedges, and hammerstones are indeed either completely or mostly made of Smoky Hill jasper, but these artifacts may not have been in use for very long before being discarded (Table 12-7). Among the formal tools, the two end scrapers examined by Hicks can not be said to be mostly made of the local jasper — only one is. However, the four end scrapers and two end-and-side scrapers illustrated by Davis (1962:Figure 13 a-b, e-h) in a black-and-white photograph may be of the local jasper, especially three that appear to retain a chalky cortex on their dorsal faces. In the small sample of points in the assemblage, a slight majority was made of the local jasper (three of five points, see Table 12-7). Though providing less than resounding support for the alternative view, the above information on the
tool stone composition of the worked pieces of flaked stone from Zone I best agrees with the alternative model of land use.

An observation worth noting in regard to land use patterns related to large-scale bison hunting is that the Medicine Creek source area may have been somewhat differentially located with respect to the bison hunting area of the eastern plains cultural group in comparison to that used by the western plains people. Sites with bison bonebeds that contain concave-based lanceolate points occur both to the east and to the west of an imaginary north-south line through the Medicine Creek drainage. Sometimes the bonebeds west of the line also contain Cody points. Conversely, currently known bonebeds containing Cody points only occur to the west of the north-south line through the Medicine Creek drainage. From this, one might theorize that the Medicine Creek source area was situated somewhere in the eastern end of the area normally used by people of the western plains cultural group for large-scale bison hunts.

Support for the above thinking comes from the distribution of the very distant sources of stone represented in the Zone I artifact collection. If the above supposition is true, a Cody group in an area west of Medicine Creek would travel generally eastward if the people planned to gear up with Smoky Hill jasper prior to bison hunting. In this situation, one would expect that the few artifacts of stone from very distant sources that may be in a Cody assemblage at Medicine Creek to be from western sources. It is these western sources that a Cody band living in distant lands west of Medicine Creek would have most access to via direct procurement by a task group or exchange with other groups. The fact that only one point of Hartville Uplift chert and one end scraper of Flat Top chalcedony or Table Mountain chert are present in the collection is more in line with the thinking that these artifacts were acquired by the Cody group through exchange, rather than through an actual visit to a very distant lithic source by a task group or an entire band. The interpretation presented above for the presence of artifacts of stone from very distant sources in the Red Smoke assemblage
suggests that cultural groups of the eastern and western plains did engage in some exchange of artifacts, particularly points, so it is not beyond the realm of possibility that there could be some Nehawka chert, for example, in a Cody site at Medicine Creek. The point to be made, however, is that if the proposed positioning of eastern and western plains cultural groups on the landscape is accurate and if a Cody group traveled east to gear up at Medicine Creek, then western sources of very distant stone would most likely be present in the assemblage instead of eastern sources.

Although the numbers of artifacts of stone from very distant sources in the Zone I assemblage is small and therefore precludes making any definitive statements, the fact that only western sources are represented does provide some support for the above ideas on Cody land use and exchange. The end scraper could derive from either Flat Top Butte in the lower South Platte drainage, or Table Mountain in the lower North Platte watershed. Indurated Cretaceous sandstone is available in the lower North Platte drainage in an area north of Scottsbluff, Nebraska (Lawrence Conyers, cited in Bamforth 2007:186) and could have been the source of the ground stone artifacts in the assemblage. The sources of the point of Hartville Uplift chert would have been further west up the North Platte drainage.

A final artifact from the Lime Creek site made of the tiger chert variety of Bridger chert is deserving of mention because if it came from Zone I, it would strengthen the case presented above in support of the idea that tool stones from very distant sources are from lands to the west that were inhabited by people who made Cody points. The artifact is a large flake with retouched edges (Hicks 2002:Appendices C-D, catalog #8269). Bamforth (2007:239) suggests the artifact was a blank for a point. The artifact lacks specific provenience information and can not be definitely attributed to Zone I, but it is worth noting that this cultural level produced far more worked pieces (n = 128) in comparison to Zone II (n = 2) or Zone III (n = 32) (Davis 1962:Table I). The closest source of tiger chert that I am aware of are two adjacent quarries (5MF2677 and 5MF4325) in the Sand Wash Basin of
northwest Colorado, located west of the Lime Creek site at a straight-line distance of 680 km. The great distance from the site to the source suggests that the artifact may have arrived at the site by means of a series of exchanges. Alternating bands of light and dark brown give the tool stone a striking appearance. One might think that this would have enhanced the artifact’s value as an exchange item outside of the Wyoming Basin. However, the striking contrast between the light and dark colored bands on prehistoric artifacts of tiger chert develops only after a considerable period of weathering. As pointed out by Love (1977:23), “[m]ost freshly flaked chert is dark brown and only subtly banded… Most of the tools made from tiger chert cores would not have had much apparent aesthetic appeal until long after they had been used and discarded. Therefore, the excellent flaking qualities and usability of the chert was its prime attraction.” Cody peoples are known to have occupied the Wyoming Basin, but so did contemporary people who made Angostura points. Therefore, if the artifact is from Zone I, its presence at the Lime Creek site may be interpreted as resulting from a long-distance exchange network between Cody peoples of the Central Plains and other people in the Wyoming Basin of either Cody or Angostura affiliation.

INTERPRETATION OF LAND USE REGULARITY FROM THE ALTERNATIVE PERSPECTIVE

Kersey Cluster

The proximity of the Kersey cluster sites to one another may have bearing on the question of the degree of regularity involved in Paleoindian land use related to large-scale bison hunting. The traditional view promotes an image of Paleoindian land use as having been shaped by the unpredictable distribution of bison herds which could have been found virtually anywhere within a large area. The fact that the Kersey cluster consists of three sites definitely or arguably associated with large-scale hunting that are all within a few kilometers
of one another does not conform to the traditional view that bison bonebeds essentially mark
the location of where Paleoindians happened to find and kill a herd of bison.

Rather, the proximity of the three sites is more compatible with the view of the sites as
temporary hunting camps that may be close together in the Kersey area for reasons having
to do with large-scale bison hunting as envisioned by alternative thinkers. As argued in
Chapter 4, the amount of work represented by the number of bison remains present in
bonebeds produced during warm weather strongly suggests that some communal kills would
have required the labor of an entire band to process the procured animals before the meat
would spoil, while the larger kills would necessarily have involved multiple bands. From
this, one might theorize that once plans for a bison hunt were finalized, individuals would
have to inform dispersed groups of the plan to meet at a certain time and place. It may be
relevant to note that the Kersey cluster is situated close to a major river confluence which
could have served as a known, easy-to-find location on the landscape at which people could
meet for bison hunting. From the Frazier site, the confluence of the South Platte and Cache la
Poudre rivers is only about two km to the northwest. An alternative interpretation of the
Kersey cluster would have Paleoindians aggregating near the confluence, establishing
temporary hunting camps, surrounding and killing bison herds in the surrounding
countryside, and transporting carcass segments back to camp for further processing. This
basic hypothetical scenario was supported by data from the Jurgens artifact assemblage and
future study of the Frazier and Powars collections from this theoretical understanding may
provide further support.

An alternative view of Paleoindian land use would expect a certain amount of
similarity to exist in the tool stone composition of assemblages from the Kersey cluster and
currently available data support this idea. Under the alternative view, the landscape in post-
Clovis times would have been populated with neighboring bands. During much of the year,
various forms of social interaction among bands, such as individuals and small groups
visiting friends, relatives, and prospective spouses in neighboring bands, would normally result in at least small amounts of tool stones from distant sources on the Plains to occur in assemblages of neighboring bands. At the Kersey cluster where local stone is available, assemblages from all sites arguably contain some amounts of local tool stone from the White River Group as well as stone from distant Plains sources. For the Powars site, it must be assumed that local stone is likely present among the more than 130 points, preforms, or channel flakes comprising the half of the sample that could not be sourced. All three assemblages contain some amount of stone from the three distant sources on the Plains. These include Flat Top chalcedony from a source downriver to the east, Dawson petrified wood from the Palmer Divide to the south, and dendritic chert form the Hartville Uplift to the north. All three of the sites are arguably the products of communal bison hunting. In regard to the Powars site, this assessment is based on the recovery of a lot of points and related manufacturing debris, rather than the presence of a bonebed because the site was deflated and bone scraps recovered were not identifiable to species. For assemblages produced as a result of communal hunting, the relative amount of stone from local and distant sources can vary greatly according to the particular circumstances surrounding each bison hunt. Circumstances include how many bands were involved, which particular bands cooperated, and which of the three tool stones from distant high-quality sources were acquired to gear up for the hunt. The amount of variability that can occur in assemblages that were all produced during communal hunts is illustrated by the three collections from the Kersey cluster.

The Jurgens site contained 17 percent local stone (WRGG), as well as 81 percent from the three distant sources and is interpreted as having been produced by multiple bands. Most stone from distant sources comes from the Flat Top Butte source, located to the east, down the South Platte drainage (60 percent of the assemblage). Lesser amounts of stone from the other two distant sources are present (14 percent Hartville Uplift chert and six percent Dawson petrified wood).
In contrast, the Frazier assemblage may prove to contain as much as 67 percent local stone (WRGG) along with 29 percent nonlocal stone and may be interpreted as having been produced by the local band. In the category of nonlocal stone, a total of 14 percent of the assemblage is stone from the distant source in the Hartville Uplift and 13 percent is stone from a very distant source on the Southern Plains (Alibates agate). From the above data, one possible interpretation of the Frazier assemblage is that it is the product of a communal hunt by the local band that had acquired stone from distant and very distant high-quality sources to gear up. Only small amounts of stone from the two other distant sources (Flat Top chalcedony and Dawson petrified wood) occur in the assemblage but, as explained above, are to be expected in small amounts under the alternative view.

The more limited data available on the tool stone composition of the Powars site may, with further study, prove to support an interpretation of the site as having been produced through aggregation of bands with local and distant home ranges for the purpose of communal bison hunting. Data on the tool stone composition consists solely of a sample of 269 fluted Folsom points, point preforms, or channel flakes, about half of which were assigned to tool stone types from known sources. According to the alternative view, in an environment without a local high-quality source of stone, a sample of points may contain a higher proportion of nonlocal stone in comparison to entire assemblages because points are the kind of artifact that would tend to have been made of stone from distant high-quality sources. With this precaution in mind, it is noteworthy that about half of the points and related manufacturing debris could not be identified to a source. If further study of the artifacts determines that the unidentified specimens were made from local stone, this would support an interpretation of the site as being the product of a communal hunt involving the local band. A total of 43 percent of the artifact sample is made of stone from the distant source of Hartville Uplift chert. Among the possible interpretations of the high amount of Hartville Uplift chert in the assemblage are that the local band may have acquired the stone to
gear up through direct procurement of the stone by task groups or through an exchange network. As elaborated in Chapter 8, sites related to communal hunting that are of Folsom-age and contain fluted points, rather than unfluted points, are more likely to have been produced by a multi-band aggregation. For this reason, the interpretation that the Powars assemblage represents cooperation between a local band and a visiting band from the north for the purpose of communal bison hunting is favored. Artifacts of stone from the other two distant sources (Flat Top chalcedony and Dawson petrified wood) also occur in the sample in small amounts, but this is not unexpected under the alternative view.

In light of the above, the tool stone composition of the assemblages from the Kersey cluster sites supports the contention that Paleoindian land use was characterized by a certain amount of regularity. This is seen in evidence supporting the view that during certain times of year, bands of the South Platte drainage would camp near the confluence of the South Platte and Cache la Poudre rivers where they would engage in communal bison hunting. To prepare for the hunting season, people would exploit the locally available gravels for tool stone, as well as gear up with stone from distant high-quality sources. In some instances, members of a single band would cooperate to conduct a communal bison kill. In other instances, people from multiple bands with neighboring home ranges would aggregate for communal bison hunting.

Hell Gap Cluster

Evidence from the Hell Gap site complex supports the view that Paleoindian land use involved a certain amount of regularity, at least in one respect. It was argued above that most of the occupations of the Hell Gap site cluster were by groups of people involved in gearing up and otherwise preparing for large-scale bison hunting. Four Paleoindian sites in the cluster are located along a .75 kilometer-long stretch of Hell Gap Creek. As presented here, Locality I contains six cultural levels, Locality II is a location that originally had five
Paleoindian cultural levels (most of which were subsequently affected by alluvial erosion and redeposition), Area III has two definite cultural levels, and one definite cultural level is present at Area V. Weak spring activity is reported at Localities I, II, and V and the open woodland in which the sites are located would have provided a source of firewood, therefore, the sites evidently offered an attractive place to camp. It was suggested that a major reason the sites comprising the cluster were chosen for occupation was the presence of nearby high-quality chert sources where tool stone for gearing up could be obtained. In sum, the above information suggests that in one respect, Paleoindian land use related to preparing for large-scale bison hunting was regular in so far that it involved repetitive use of this area, which was conducive to habitation and near a major source area.

However, use of the Hell Gap area during the large-scale bison hunting season was not regular in the sense that the area was reused frequently. To the contrary, reoccupation of the area was infrequent because the time between deposition of cultural levels at the same site is best measured in terms of centuries. From this, it should not be immediately concluded that large-scale bison hunts took place on such an infrequent time schedule. A recurring theme throughout this dissertation is that communal hunting occurred during a time of year that arguably permitted meat to be stored for a relatively lean time of year. If a main purpose of communal hunting was to assist in surviving a lean time of year, this would in turn imply that communal hunting would have been an annual occurrence. Duguid (2009:315) reports that multiple Paleoindian sites besides those at Hell Gap are present at water sources in canyons along the eastern edge of the Hartville Uplift. This would suggest that gearing up for communal bison hunting in the Hartville Uplift area may have occurred in a number of places besides Hell Gap. Still, given the available evidence, the matter of whether aggregation of Paleoindians for large-scale hunting would have occurred on an annual basis or much less frequently is still an open question.
One aspect of Paleoindian land use that does appear to have involved a high degree of regularity as supported by evidence from the Hell Gap site cluster is the time of year during which people aggregated for large-scale bison hunting. As demonstrated by the discussion in Chapter 8, the seasonal timing of large-scale bison hunting during Paleoindian times on the Plains in general occurred within a time frame that comprised only a minor part of the year. Data on stages of tooth eruption and wear evident on specimens of bison dentition analyzed for six of the occupations at the Hell Gap site cluster indicates that five occupations took place during the usual large-scale bison hunting season for the particular Paleoindian time period represented. These include the Folsom, Agate Basin, and Frederick occupations of Locality I, the Hell Gap occupation at Locality III, and the Cody occupation of Locality V. The data from bison dentition also support the conclusion that the Agate Basin occupation of Locality II, which arguably was associated with large-scale bison hunting, took place outside of the normal bison hunting season for Agate Basin times on the Northwestern and Central Plains. The reason that this particular bison kill occurred at an abnormal time of year is unknown.

Medicine Creek Cluster

The tool stone composition of the Allen collection is not only pertinent to the issue of the geographic extent of band movement, but also the matter of the regularity with which bands or subunits thereof used the landscape. Situated along the lower reach of the main stem of Medicine Creek, the Allen site is arguably positioned in an ideal location to exploit not only the food resources of the gallery forest and neighboring uplands, but also the high-quality sources of jasper that are present within a few kilometers. The site was used throughout a period spanning a minimum of 2,000 radiocarbon years and refitting of flakes from the meter-thick cultural deposit demonstrates that the site was reoccupied many times during this period. The Allen site is indicative of a high level of regularity in Paleoindian
land use in so far that evidence from the site paints a picture of local groups of men, women, and children repeatedly occupying the site throughout the Paleoindian period. During the many occupations of the Allen site, this spot along Medicine Creek was used as a residential hub for use of the surrounding area for essentially the same kinds of activities throughout all of Paleoindian time, namely general foraging activities and procurement of stone from locally available high-quality sources for tool manufacture on-site. Though artifacts deposited during individual site occupations can not be differentiated, the tool stone composition of the assemblage as a whole demonstrates that locally available Smoky Hill jasper was the raw material used to manufacture a very large majority of the stone tools used during each occupation of the site. Miniscule amounts of tool stone from very distant sources in the form of points and mostly biface thinning flakes are present in the assemblage. These tool stones demonstrate that throughout the two millennia during which the site was reoccupied, the people occupying the site interacted with others in surrounding regions to the extent that occasionally they received points or bifaces of tool stone originating from very distant sources that are spread throughout a very large area. Sources represented are distributed from the lower Platte drainage or other regions to the east (Nehawka chert or Flint Hills chert), all the way up the North Platte valley to the Hartville Uplift (Hartville Uplift chert), and south as far as the Llano Estacado (Alibates agate).

The regularity of Paleoindian land use patterns is more than the degree to which sites were reoccupied by local people through time. The possibility that culturally distinct groups inhabited various environments must be better understood if the social aspects of land use are to be theorized. As elaborated in Chapter 8, different kinds of points and hide scrapers in the eastern and western portions of the Central Plains give cause to hypothesize that culturally distinct groups existed. Though it is beyond the scope of the dissertation to fully theorize possible causes of cultural differentiation on the Central Plains, it should be reiterated that on the Great Plains, increasing precipitation in the more easterly portions produces
corresponding changes in vegetation and available animal food resources. Chapters 5 and 6 demonstrate that latitudinal variation in climate on the Plains today was in effect during Paleoindian times as well. From this, it may be hypothesized that environmental differences between the eastern and western Plains observable today may have been in effect during Paleoindian times as well. If environmental differences between the eastern and western plains encouraged differing subsistence economies to develop among Plains foragers, this and other cultural differences may be expressed in differing material culture, including distinct types of points and hide scrapers. If beveled tools prove to be diagnostic of the theoretical eastern cultural group, the presence of this tool type throughout the entire history of occupation documented at the Allen site, along with the corresponding lack of end scrapers, would support the hypothesis that Medicine Creek was within the homelands of the eastern cultural group for a majority of the Paleoindian period (back to at least 10,600 B.P.). It would then follow that cultural differentiation across the Central Plains may have been a regular feature of forager land use and social interaction throughout much of the Paleoindian period. Further study of the degree to which Paleoindian groups on the Central Plains varied from east to west is therefore needed to begin the difficult task of better understanding the degree to which Paleoindian land use involved regular, on-going interaction between long-standing contemporary cultural groups.

The Lime Creek and Red Smoke sites also demonstrate repetitive, though less frequent, occupation of a tributary stream in the Medicine Creek drainage. When compared to the Allen site, the two sites along Lime Creek are closer to sources of Smoky Hill jasper, with both sites situated within a few hundred meters of an outcrop. Though perhaps not as conducive to habitation as the main stem of Medicine Creek, the tributary drainage is amenable to camping, with drinking water and firewood available along Lime Creek. Occupation of the sites along Lime Creek was more episodic than at the Allen site. Eight cultural levels were defined at Red Smoke. Of these, six are Paleoindian in age, occur
throughout a horizontal depth of 3.7 m of the stratigraphic column, and represent 1,850 radiocarbon years of the Paleoindian period (9820 ± 80 B.P. to 7970 ± 210 B.P.) (Knudsen 2002:Figure 7.6; May 2007). At the Lime Creek site, three Paleoindian cultural levels occur throughout a horizontal depth of 2.7 m of the stratigraphic column, and represent a period extending from the Cody occupation in Zone I (dating to ca. 9120 ± 510 B.P.) to a possible terminal Paleoindian occupation evident in Zone III.

Based on available information, at least some of the levels at the Lime Creek sites arguably may represent occupation by potentially large groups of people for purposes related to gearing up for large-scale bison hunting. As argued above, such may have been the case at Zone V of Red Smoke and Zone I at the Lime Creek site. Though by no means definitive, the information available on the other levels at the Lime Creek sites suggest that different episodes of site use might also relate to occupation by groups involved in gearing up for large-scale bison hunting. Zone III at the Lime Creek site may prove to be an example. In an excavated area equivalent to an area measuring 6.8 m by 6.8 m, two possible middens were uncovered. The possible middens contain hearths and, “[t]he surrounding soil zone, up to six feet away, was heavily carbon-stained and full of bone and flint [jasper] fragments, many of which were burned” (Davis 1962:69). All animal bones from Zone III are of bison, with several individuals represented. The level is not radiocarbon dated, but three points were recovered that may generally be classified as Late Paleoindian (Davis 1962:70-71). One specimen in particular appears to be an almost complete preform that is most comparable to the Frederick type, at least in its outline form, but lacks the typical parallel diagonal flaking (Davis 1962:Figures 20a, 30). As discussed in Chapter 8, the presence of evidence for production or use of powdered ochre may prove to be an activity associated with large-scale bison hunting. With this in mind, it is noteworthy that ochre stains were uncovered during excavation of the uppermost Paleoindian level at Red Smoke site (zone VI), as well as the two overlying post-Paleoindian levels at the site (Knudson 2002:99, Table 7.2)
Pending the results of on-going and future studies, the Lime Creek sites may prove to demonstrate that Paleoindian use of the Medicine Creek drainage may be considered regular, at least in that jasper outcrops of the area were visited by people of both eastern and western plains cultural groups to gear up for communal bison hunting. In particular, future refitting studies should be conducted to assess the number of occupations represented in cultural levels at both the Red Smoke and Lime Creek sites. Based on currently available information, however, it may be argued that a potentially large group of people affiliated with the eastern plains cultural group geared up with local jasper at the Red Smoke site where they left primarily concave-based lanceolate points in Zone V. The fact that the points in the Zone V collection that are made of tool stones from very distant sources define essentially the same very large area of the Central Plains as do the nonlocal tool stones in the Allen site assemblage supports the thinking that the same eastern plains cultural group with similar long-distance connections was responsible for both the Zone V assemblage and much of the Allen site assemblage. A similar line of reasoning may be used to hypothesize that a large group of people affiliated with the western plains cultural group geared up at the Lime Creek site and left Cody points in Zone I. Presence in the Zone I assemblage of tools made from a very distant source in the lower reaches of the South Platte or North Platte watersheds (Flat Top chalcedony or Table Mountain chert) and from a source area further west up the North Platte drainage (Hartville Uplift chert) bolsters the possibility that Zone I was occupied by a group from western lands.

Western Middle Park Cluster

A certain amount of regularity in Paleoindian land use is suggested by evidence from the cluster of sites in the central portion of the large tract of open sagebrush grassland in western Middle Park. It is suggested that prior knowledge of the presence of high-quality sources of Kremmling chert in the area, coupled with knowledge that herds of bison would
also likely be available in the vicinity, could have enabled Paleoindians to plan their activities accordingly with the result that a certain amount of similarity in pre-hunt and post-hunt activities is observable in the archaeological record of different Paleoindian occupations. Although the degree to which the local high-quality tool stone was used to gear up for the hunt varied somewhat depending upon whether the aggregated group consisted of a formerly dispersed local band or a multi-band aggregation, each of the four assemblages provide evidence to support the view that gearing up using the Kremmling chert sources in Barger Gulch proceeded the hunt. The two bonebed sites in the Troublesome Creek drainage suggest that bison herds killed nearby in a neighboring area of flat, open grasslands to the north were transported to temporary hunting camps at water sources with isolated stands of timber for further processing. To review, three of the sites are of Folsom age. The Upper Twin Mountain site in the Troublesome Creek drainage produced unfluted points of Folsom age in association with a bonebed interpreted as a bone midden from processing of bison procured in a large-scale bison kill by an aggregation of members of a local band. Locality B is located in the Kremmling chert source area in Barger Gulch and the Crying Woman site is nearby. Both sites produced fluted Folsom points and are thought to represent occupation by multi-band aggregated groups. The Jerry Craig site is a bison bonebed in the Troublesome Creek drainage that is interpreted as representing an occupation by a multi-band aggregation composed of people affiliated with mountain and western plains peoples who made Angostura and Cody points, respectively.

The tool stone and artifact composition of the Upper Twin Mountain site supports the interpretation that a local Folsom-age band involved in the large-scale bison kill aggregated from throughout the park and primarily geared up with Kremmling chert from the nearby source in Barger Gulch. It was argued above that the tool stone composition of the assemblage supports the contention that family units of a local band dispersed throughout Middle Park later coalesced in western Middle Park for a large-scale bison hunt around
October or November. Projectile points and flakes from all three of the main Middle Park tool stone sources are present in the assemblage, including Table Mountain jasper from the eastern part of the park as well as Windy Ridge orthoquartzite and Kremmling chert from the western portion. This would suggest that participating family groups dispersed throughout the park may have contributed toward gearing up operations by procuring stone from a nearby source before aggregating for hunting in western Middle Park. If measured by tool stone weigh, however, Kremmling chert probably accounts for a large majority of the assemblage. In large part, Kremmling chert was used to gear up by making flake tools from blocky cores.

It is relevant to note that of the two high-quality sources of tool stone in western Middle Park, the Kremmling chert source is the closer to the Upper Twin Mountain bonebed. From the bonebed, the source of Windy Ridge orthoquartzite at the northern end of western Middle Park is 29 km away, but the closest high-quality source of Kremmling chert in the Barger Gulch drainage is at a distance of only 15 km. It may be relevant to also note that Barger Gulch drains north into the Colorado River and that directly across the river from the gulch is the Troublesome Creek drainage. Because it may be asserted that the bulk of the assemblage was made from tool stone acquired from the source area of Kremmling chert in Barger Gulch in order to gear up for a large-scale bison hunt, the fact that the source of Kremmling chert is also the closest to the bonebed in turn supports the hypothesis that participants in the bison hunt knew that the distribution of bison in western Middle Park was such that a herd could likely be killed relatively close to the source of Kremmling chert.

The tool stone composition of the assemblages from Locality B at Barger Gulch and the Crying Woman site was interpreted as resulting from multiple bands that were aggregated at the Kremmling chert source area to gear up for large-scale bison hunting. As argued above, presence of fluted Folsom points and preforms at both sites is in keeping with the interpretation that the sites were occupied by aggregated groups consisting of multiple bands.
The argument for occupation by multiple bands is strongest at Locality B where extensive excavation has taken place and less secure for the Crying Woman site where limited test excavation has been carried out.

At Locality B, the presence of artifacts of Trout Creek jasper and quartz crystal suggests the participation of people who arrived from the South Park and Upper Arkansas Valley area and the occurrence of artifacts of a pink chalcedony and Morrison orthoquartzite is in keeping with the possibility that people from the Plains of northeast Colorado may have been present. Nonlocal tool stones from unidentified sources suggest that participants from still other surrounding regions may have been present. The tool stone composition of the Locality B assemblage is dominated by Kremmling chert with very few artifacts from other Middle Park sources present. Kremmling chert accounts for 98.8 percent of the assemblage. Of the 50,697 artifacts in the assemblage, only one flake might be Windy Ridge orthoquartzite and the raw material of another flake is possibly petrified wood from Middle Park (Table 12-13). If the two flakes are indeed from Middle Park sources, their presence would suggest that if a local Folsom band was a participating group, then gearing up at other Middle Park sources did not occur. Considering the small number of artifacts of possible Middle Park stone and the tentative manner in which I have assigned them to Middle Park sources, another possibility is that the multi-band group occupying the site did not include a local band.

The assemblage from the Crying Woman site is much smaller (n = 104), but similarities with the Locality B assemblage support the possibility that an occupation by multiple bands may be represented. First, Kremmling chert dominates the assemblage, accounting for 98.1 percent. Secondly, non-Kremmling chert tool stones from sources in other parts of Middle Park are lacking in the assemblage. In fact, no Middle Park tool stones besides Kremmling chert are present in the collection. Artifacts of the Sevenmile Ridge
variety of Bridger chert in the assemblage are interpreted as evidence for participation of a band from the Yampa River drainage of northwest Colorado.

While camped in the Kremmling chert source area, aggregated Folsom bands at Locality B and the Crying Woman site not only geared up with tool stone, but did some big game hunting (possibly to feed a large group of people present) and processed hides from the animals killed. As far as I am aware, no dense bonebeds of Paleoindian or later periods are known from sites actually located at a lithic source. In light of this, the 21 points and 21 end scrapers from Locality B apparently are indicative of on-going hunting to feed a large group and processing of the hides. Though only limited excavations have been accomplished at the Crying Woman site, the point base found on the surface near Excavation Unit 1 may also be evidence of on-going hunting. Evidence that bone at Locality B was exposed to weathering on the ground surface for long periods of time prior to burial may in part explain why only a single bison is represented in the faunal collection.

Apart from the availability of a high-quality source of tool stone, the predictability of bison herd distribution in western Middle Park would have also allowed multi-band groups to plan on gearing up with Kremmling chert in anticipation of then being able to conduct a successful large-scale bison hunt in the general vicinity. Knowing that a high-quality source of chert was available in Barger Gulch near the hunting area would have given bands from distant home ranges the option of not having to transport unfinished tool stone and a lot of tools with them on their journey to Middle Park. Rather, they could wait to gear up almost exclusively with stone at the Kremmling chert source area, knowing that bison herds would likely be located nearby. Following a successful hunt, carcass segments would be transported to a temporary hunting camp where a dense bone midden would be produced that contained a lithic assemblage dominated by Kremmling chert. Unfortunately, there is simply no way to verify or refute the above model of land use by examining assemblages from the sites at the Kremmling chert source area itself.
However, support for the model comes from the nearby Troublesome Creek watershed, where the Jerry Craig site provides evidence of having been a hunting camp occupied by a multi-band group that geared up with Kremmling chert in Barger Gulch. The site may be considered to be the product of a multi-band aggregation because points made by different cultural groups were present in the bonebed. Considering that all three of the complete Angostura points were made of Kremmling chert, as were six of eight complete Cody points, a strong case may be made in support of the thinking that people from both cultural groups had actually been on-site and geared up at the nearby chert source. The dominance of Kremmling chert in the Jerry Craig assemblage in general provides further support for the model contending that multi-band aggregations would normally gear up at the Kremmling chert source area after arriving in Middle Park.

The prevalence of Kremmling chert in the Jerry Craig assemblage (89 percent of the assemblage) is not as great as at the Barger Gulch site (99 percent) or the Crying Woman site (98 percent). This does not diminish the confidence with which all may be considered to be the product of multi-band groups that geared up in Barger Gulch. The lower percentage of Kremmling chert at Jerry Craig is explained by the fact that nine percent of the assemblage is comprised of three non-Kremmling chert tool stones from sources throughout Middle Park. A scenario that would explain the presence of small amounts of Middle Park tool stones is if one of the participating bands had been dispersed into family groups in the weeks prior to the communal hunt and brought tool stone from various parts of Middle Park with them when they aggregated for gearing up. If the suggestion that a band was dispersed into family groups is valid, the seasonal timing of the communal bison hunt in late summer (August or September) would in turn suggest that the band was dispersed earlier in the summer.

Finally, the two sites with bonebeds in the Troublesome Creek drainage suggest that a certain amount of regularity in land use patterns also pertained once a bison herd had been killed. Both the Jerry Craig and Upper Twin Mountain sites are located along the western
edge of the Troublesome Creek drainage. Although it is not possible to know precisely where the kills associated with the sites took place, it is reasonable to speculate that in both cases, herds of bison were surrounded and killed somewhere in the Troublesome Creek drainage. Afterwards, bison carcass segments were transported with the assistance of dogs to springs at one of the isolated wooded areas on lone mountains along the west side of the drainage where people established temporary hunting camps to further process the bison meat.

High Front Range Cluster

Late Paleoindian land use as viewed from the high Front Range site cluster may be considered regular in that it involved people conducting game drives at predetermined places on the landscape. Big game movements into the high Front Range are expected to have been regular to the extent that herds would return to the same general grazing areas year after year. One might suggest that scouts could be used to locate the specific location of herds and report back to those responsible with planning the communal game drive. Left unmolested, the herds would have no motivation to move far from an area offering adequate grazing. The point to be stressed here is that the limited extent of the alpine tundra, the somewhat confining nature of the high valleys in which big game herds are often found, and the disinclination of herds to move far if left unmolested would suggest the land use pattern revealed by Late Paleoindian sites is one where bands moved to a specific valley where game were known to exist with the intention of operating a pre-existing game drive system. This suggests a certain amount of regularity in the Late Paleoindian use of the high Front Range.

The observation that all three sites are at passes along travel routes over the mountains may be relevant to the question of land use regularity. The travel routes to passes would have provided the easiest way for both mountain people and western plains people to access grazing areas in the alpine tundra where game drives could be set up. Planning to hold
a game drive at the easiest pass over the Front Range (Arapaho Pass) could assist in carrying out a game drive where a group of mountain people was to meet up with a group from the western plains, as is suggested for the Fourth of July Valley site. Holding a game drive at Arapaho Pass would also assist in the situations where a local band of the western plains group had to first cross over the mountains to gear up with stone from a source in Middle Park and then meet with a band arriving from distant lands on the Plains, as is suggested for the Caribou Lake site. All of the above implies that both mountain and western plains peoples had intimate knowledge of the mountain terrain, game animal movements, the location of the closest tool stone sources, and the existence of people on the other side of the mountains with whom they could sometimes cooperate. In those cases where a group of people arriving from the west was to meet in the high Front Range with a group from the east, the game drive was held in a location that was most easily accessed by both groups. From the above, it may be argued that sites in the high Front Range cluster suggest that the prehistoric people who left those sites had an intimate knowledge of the land, its resources, and their neighbors. From this, it follows that land use may have been patterned in the sense that it involved recurring subsistence activities and interactions with surrounding social groups.

What is still an open question in regard to land use regularity in the high Front Range is the degree to which game drive sites were reused. An observation worth noting is that the construction of permanent game drives and hunting blinds suggests that such labor intensive structures may have been intended to be used multiple times. At the very least, one might suggest that the commotion involved in constructing the rock features would likely spook game animals out of the area and thus construction would have to proceed actual use of the game drive by a certain period of time.
Regularity in Seasonal Timing of Regional Abandonment and Communal Hunting

Finally, it is appropriate to reiterate here that the review of existing literature on the seasonal timing of communal bison hunting in Chapter 8 indicates a certain amount of regularity in Paleoindian land use patterns. On the Plains where Paleoindian habitation was year-round, review of existing literature showed that communal hunting occurred only during a minority of the year and that for each time period considered, this activity normally took place in the same season each year that it occurred. In those parts of the Plains where temperatures were low enough to assist in short-term preservation of meat, communal kills were carried out during the height of the cold-season. In areas that were insufficiently cold, hunts were planned for the months prior to the height of the cold-season when meat could be preserved by drying. The fact that hunts were held prior to the height of the cold-season, and not after, implies that the intent of communal hunting was to put up stores of food for the lean time of year. If communal hunting was a necessary part of surviving the cold-season on the Plains, it stands to reason that the activity would have been an annual event.

Limited data from the high Front Range and Middle Park support the thinking that seasonal abandonment and communal hunting within these regions normally occurred at the same time each year. Review of data on modern and Paleoindian climatic conditions supports the assertion that the high Front Range was normally uninhabitable from about November to May and that Middle Park would have been abandoned for at least the height of the cold-season. Since people would have had to abandon these regions during the height of the cold-season, communal hunting would have occurred in the months preceding this time of year in order to put up stores of food. Seasonality data from two bison bonebeds in Middle Park provide limited support for the above proposed schedule of regional abandonment and communal hunting in the high Front Range and Middle Park.
CHAPTER SUMMARY AND CONCLUDING REMARKS

Data on the tool stone composition of assemblages from sites in the study area and other evidence from existing literature was reviewed to assess the relative validity of contrasting views on Paleoindian land use. The tool stone composition of each assemblage was compared to theoretical expectations concerning the proportion of local to nonlocal stone that should be present according to the contrasting models on the geographic extent of land use. The alternative perspective was found to be superior. The alternative view was then used to interpret the tool stone composition of assemblages from sites in the study area in regard to the geographic extent of land use. Data on the tool stone composition of assemblages from clustered sites in the study area and other information from existing literature was then interpreted from the alternative view to assess the degree of regularity inherent in land use patterns. The review found support for the assessment that Paleoindian land use within the study area involved a certain degree of regularity.

Expectations developed under the alternative view were supported by data on the tool stone composition of assemblages from all kinds of sites in the study area. The only site in the study area that may be classified definitely as a camp not associated with communal hunting is the Allen site, which is located in an environment where high-quality tool stone sources are locally available. Under the traditional view, the collection of tools discarded at the Allen site should be comprised of at least substantial amounts of nonlocal stone, but it is dominated by local stone, as expected under the alternative view. Five assemblages from the study area derive from sites associated with communal kills of big game animals in environments with local sources of high-quality tool stone. The traditional view expects that in assemblages from these sites, there should be substantial or at least appreciable amounts of nonlocal stone. Instead, assemblages from three of the five sites are dominated by local stone, which is in keeping with the alternative view. The remaining two sites are in the high
Front Range and consideration of the tool stone availability in conjunction with theoretical use of the high Front Range by groups that wintered both east and west of the mountains was found to provide a plausible alternative interpretation of the land use represented by assemblages from these sites, as explained below. Several sites in the study area are associated with large-scale bison kills and are situated in environments with no known high-quality source of tool stone. Though the tool stone composition of assemblages from these sites conform to the general expectations of both views, a more detailed consideration of the distance to sources favors the alternative perspective. With one exception, the tool stone composition of assemblages from these sites contains only miniscule amounts of stone from very distant sources, which is not in agreement with the size of band ranges envisioned under the traditional view. The exception is the assemblage of the Frazier site which has a substantial amount of stone from a very distant source as the result of stone having been acquired through long-distance exchange. The assemblages from sites associated with large-scale bison kills in environments lacking local high-quality sources of tool stone are either dominated by stone from distant sources or have variable amounts of stone from distant sources along with some stone from local sources that can not be said to have definitely derived from a high-quality source. Under the alternative view, the substantial to large amounts of stone from distant lands is in agreement with the thinking that Plains foragers in areas lacking high-quality sources geared up for communal hunting through direct procurement of stone from neighboring ranges or through aggregating bands bringing stone from their home ranges. Local stone that is not from a known high-quality source will account for some of the artifacts in the assemblage, if available. Finally, the traditional view expects that tools discarded at sites at high-quality sources should contain large amounts of nonlocal stone, but discarded tools in the five assemblages from sites at sources are dominated by local stone.
Having determined that the alternative view offers a better explanatory model, the geographic extent of Paleoindian land use as represented in the tool stone composition of the assemblages from each kind of site in the study area was interpreted from the alternative perspective. The tool stone composition of assemblages from sites related to communal bison kills in environments lacking a high-quality tool stone source was interpreted. A case for aggregation of neighboring bands was made for the Jones-Miller site, based on the fact that the assemblage is primarily comprised of Smoky Hill jasper from a distant source, as well as Flat Top chalcedony from its distant source lying in the opposite direction from the site. Another case for aggregation of neighboring bands was presented based on the assemblage from the Casper site, which is located along the North Platte River. A large majority of the assemblage is comprised of either orthoquartzite from a distant source in an upriver direction or microcrystalline stone from distant downriver sources in the Hartville Uplift. A majority of the assemblage from the Jurgens site is composed of tool stones from distant sources in the Hartville Uplift, the Palmer Divide, and further down the South Platte drainage, with some local stone also present. This observation forms the basis for interpreting the site as the product of multiple bands aggregating for a communal hunt. Small amounts of seven tool stones from very distant sources situated in various directions from the site are also present. This phenomenon is interpreted as participating bands bringing points and other artifacts made of stone acquired in an exchange network to the communal hunt.

The tool stone composition of other collections of artifacts from sites related to large-scale bison kills located in environments lacking local high-quality sources is more suggestive of communal hunts carried out by single local bands. The tool stone composition of the Frazier site is thought to be comprised principally of local materials that do not necessarily derive from high-quality sources, along with substantial amounts of stone from both a distant source in the Hartville Uplift and a very distant source on the Southern Plains.
Tentatively, the Frazier site is interpreted as having been produced by a local band that geared up with stone from distant and very distant high-quality sources.

Finally, a definitive interpretation of the Lindenmeier collection is hampered by uncertainty regarding whether the site is the product of multiple occupations by large groups involved in communal hunting, or small groups subsisting by means of more generalized foraging, or both. Nevertheless, a tentative interpretation of the Lindenmeier assemblage was presented in light of this uncertainty.

Plausible land use scenarios were also produced from the alternative perspective when interpreting the tool stone composition of assemblages from sites related to communal bison kills in western Middle Park, where high-quality sources of tool stone occur locally and sources of Kremmling chert in particular are less than 20 km from the sites. The tool stone composition of the Upper Twin Mountain assemblage is interpreted as being representative of gearing up for a communal hunt where subunits of a local band visited the local high-quality sources of all three Middle Park tool stones, especially the nearby source of Kremmling chert. The presence of only unfluted points at this bonebed of Folsom age supports the thinking that the work of a single band may be represented. A bison bonebed at the Jerry Craig site is interpreted as representing the work of an aggregation of people from bands affiliated with cultural groups of both the mountains and the western plains. Recovery of Angostura and Cody points made of Kremmling chert from the nearby high-quality source bolsters the thinking that people of both cultural groups were actually present on-site. The tool stone composition of the assemblage is dominated by stone from a nearby Kremmling chert source (89 percent), but also includes an appreciable amount (9 percent) of three other tool stones from Middle Park. This suggests that a portion of the group that participated in the communal kill aggregated for the event from throughout the Middle Park drainage. The participation of western plains people is bolstered by a small percentage of the assemblage...
composed of tool stones from nonlocal sources, including raw materials suspected of originating on the plains of northeast Colorado and southeast Wyoming.

Sites in the high Front Range thought to be related to communal kills of non-bison big game animals at game drive structures in the alpine tundra may also be interpreted under the alternative view as sites associated with large-scale hunting in an environment with locally available high-quality sources of tool stone. Plausible interpretations of the tool stone composition of the high Front Range sites were produced with the theoretical understanding that the high Front Range and Middle Park were occupied seasonally by people from local bands of both mountain and western plains peoples who had access to local high-quality sources of tool stone in Middle Park. Even though the source of Windy Ridge orthoquartzite classifies as a distant source under the general system of analytical units proposed here, the source would have been within the range of local bands of mountain people and should be considered local when analyzing assemblages from the high Front Range. The assemblage from Area A at the Devils Thumb game drive may be interpreted as representative of communal hunting by a group of mountain people. A point from the site is arguably assignable to the Angostura type. The tool stone composition of the assemblage suggests that site occupants geared up exclusively with Middle Park sources, especially Kremmling chert. Excavation of Area A at the Caribou Lake site, located on the west side of Arapaho Pass, produced evidence of communal hunting by western plains people who made Frederick points. The tool stone composition of the assemblage suggests that one of the nearby game drive systems was operated by a group composed of a local band that geared up with Kremmling chert as well as people from a band with access to tool stones suspected of originating on the plains of northeast Colorado and southeast Wyoming. On the other side of the pass lies the Fourth of July Valley site, which also produced evidence of having been occupied by a group of people involved in operating a nearby game drive system. The group operating the game drive is believed to have been composed primarily of mountain people.
with a smaller group from the western plains also present. A total of 13 Angostura points and one point here assigned to the Frederick type are in the collection. The assemblage is dominated by orthoquartzite from the Windy Ridge source with a substantial amount composed of various tool stones believed to derive from sources on the plains of northeast Colorado and southeast Wyoming.

One site in the study area definitely may be classified as a campsite occupied by relatively small groups of people that were not involved in communal bison hunting, but rather subsisted by means of more generalized foraging. A meter-thick cultural deposit at the Allen site in the Medicine Creek drainage of Nebraska documents repeated occupation from about 10,600 to 8700 B.P. Recovery of 23 beveled tools from various depths in the cultural deposit is the basis for hypothesizing that the many occupations of the site are primarily associated with a cultural group of the eastern plains. This possibility is bolstered by the recovery of a few concave-based lanceolate points, but the possibility that the site was also visited by people from the western plains is suggested by the excavation of a few points assignable to western types, one of which was made of locally available jasper. High-quality sources of Smoky Hill jasper are locally available in the Medicine Creek drainage and are mapped in distant areas to the south and east. Given the distribution of tool stone sources, the dominance of Smoky Hill jasper among the tools discarded at the Allen site is in keeping with a scenario of repeated occupation of the site by small local groups of people exploiting local high-quality tool stone sources. Miniscule amounts of tool stones from various very distant sources occur in the collection principally in the form of points and biface thinning flakes and are suggestive of long-distance contact between the local people and groups inhabiting a broad area. The nonlocal artifacts are demonstrative of connections with very distant lands in the lower Platte drainage or elsewhere to the east, as well as the area of the lower North or South Platte drainages, and further west up the North Platte drainage as far as the Hartville Uplift. Finally, connections with the Southern Plains are also evident.
Interpretation of the tool stone composition of assemblages from sites at high-quality tool stone sources permits an alternative view of land use to be further developed. Consideration of the artifact and faunal assemblages recovered from sites at sources in the study area supports the assessment that occupation was by a potentially large group that was gearing up for communal bison hunting. Two sites at sources of Smoky Hill jasper in the Medicine Creek drainage demonstrate less frequent reoccupation than at the Allen site and may tentatively be interpreted as sites related to gearing up for communal hunting.

Excavation of a probable midden deposit containing large amounts of flaking debris in Zone V at the Red Smoke site produced a minimum of 36 discarded points and evidence for bison hunting. Points and bison bones may be evidence for hunting activities intended to feed a large group of people gearing up for communal hunting. Most points are concave-based lanceolate specimens affiliated with an eastern plains cultural group, but two are Cody points attributable to a contemporary cultural group of the western plains. Dominance of Smoky Hill jasper among the worked pieces of flaked stone is consistent with the interpretation that the group that geared up at the site was composed of a local band or multiple neighboring bands. A minority of concave-based lanceolate points are made from stone originating at very distant sources. These points define essentially the same large area as artifacts of nonlocal stone at the Allen site. The points from Red Smoke are interpreted to have been obtained in advance of a communal hunt via a geographically extensive exchange network existing among bands of the eastern plains cultural group and contemporary people of the western plains.

Zone I at the Lime Creek site may have resulted from occupation by a large group of people affiliated with a western plains culture that came to the Medicine Creek drainage to gear up for communal hunting. Three points from the cultural level are here assigned to the Cody type and two others share attributes with Cody points, but can not be confidently assigned to the type. Recovery of 15 discarded Cody point preforms provides evidence that
site occupants were gearing up and a faunal assemblage consisting of the remains of a variety of big and small game animals is suggestive of on-going subsistence activities to feed the group of people present. Dominance of the local jasper in the collection of worked pieces of flaked stone artifacts would be expected for an assemblage produced by a potentially large group composed of one or more bands intent on gearing up, given the local availability of tool stone. Presence of a point and an end scraper from very distant sources in the Platte River drainage northwest of Medicine Creek supports identification of the site occupants as having been affiliated with a western plains cultural group.

A stronger case that many excavated sites at sources provide evidence of gearing up by a group involved in communal bison hunting was made for the cultural levels at the four Paleoindian sites of the Hell Gap site cluster, especially the Cody occupation evident at Locality V. Through comparison with the faunal assemblage from the Allen site, higher levels of bison hunting are suggested for the occupations of Hell Gap. Demonstration that the bison represented in the Hell Gap levels were primarily killed during the normal bison hunting season provides strong support that occupations were related to large-scale hunting. Occurrence of ochre in many of the levels is seen as further support that occupations of Hell Gap may be related to communal bison hunting. On-going hunting necessary to feed a potentially large group of people is one possible explanation for evidence of bison hunting at Hell Gap. Gearing up and bison hunting is particularly evident from the Cody level excavated at Locality V. A total of 19 Cody point preforms suggest that gearing up took place on-site and 21 discarded Cody points, 19 end scrapers, and remains of seven bison are evidence of on-going hunting and hide processing. Some possibility exists that a point base reported from the excavations could be an Angostura point and if found in association with the Cody level, would be potential evidence for some form of social interaction between a western plains cultural group and contemporary mountain people.
The raw material composition of the assemblage from the Cody level is dominated by stone from a number of local sources and is interpreted as indicative of gearing up by a local band. Hartville Uplift chert from nearby sources comprise a majority (71 percent) of the assemblage, but other tool stones from local sources in the uplift and on the plains to the east comprise another 27 percent. Furthermore, ochre reported during excavations and present on two artifacts might be from the local source of Sunrise red ochre. Small percentages of the assemblage are comprised of artifacts made of a tool stone from a known distant source and another raw material suspected of originating from an unknown nonlocal source. In sum, the tool stone composition of the Locality V assemblage provides a good example of a collection that arguably was produced by a single local Cody band. The site thus provides a good basis of comparison to the aggregated Cody group composed of multiple bands evident in the tool stone composition of the Jurgens assemblage.

Finally, Folsom sites at the Kremmling chert source area in Middle Park may be interpreted as representative of gearing up by multi-band groups involved in communal bison hunting. The 25 discarded Folsom point preforms and 147 channel flakes recovered from Locality B of the Barger Gulch site complex are indicative of gearing up primarily with stone available from nearby sources of chert. A total of 21 discarded points, one of which was made from a preform fluted on-site, as well as 21 end scrapers, are demonstrative of some amount of on-going hunting and hide processing. Ochre and abrading stones used to pulverize the mineral were recovered and support the thinking that site occupants were involved in large-scale hunting of bison. Bone is highly fragmented and scattered and much is burned, as are many of the artifacts. The condition of the bone and artifacts suggests plentiful bone may have once been present, but was destroyed during long periods of exposure during which time the archaeological material was exposed to range fires. The scatter of artifacts varies in density but in general is relatively high, which is suggestive of a midden where trash was dumped, possibly during occupation by a large group. The
assemblage, including the discarded tools, is almost completely dominated by the local chert. Miniscule amounts of a variety of nonlocal tool stones occur, most of which was not identified to specific sources. Some artifacts of nonlocal stone demonstrate or suggest connections with neighboring South Park and the Upper Arkansas Valley area, as well as the plains of northeast Colorado. Connections with other regions surrounding Middle Park may someday be demonstrable in the remaining unsourced artifacts of nonlocal stone.

The tool stone composition of Locality B may be interpreted as the product of multiple bands converging on western Middle Park. Because of the presence of a high-quality tool stone source in this relatively confined intermontane basin where bison herds could be predictably located, visiting bands could plan to gear up at the source after aggregating with other incoming bands, rather than having to bring a lot of stone with them as was necessary on much of the Plains. The thinking that a multi-band group is represented at Locality B is supported by the fluted condition of all of the points.

The Crying Woman site is another Folsom site at the Kremmling chert source area which may prove to also be the product of a potentially large group gearing up for communal hunting, though only limited test excavation has been completed. Recovery of two preforms and three channel flakes among a collection of 104 artifacts from a Folsom level in a test pit measuring only 2 m by 2m is suggestive of a trash midden where point preforms broken in manufacture during gearing up were discarded. A point base found on the ground surface near the test pit may be evidence of on-going hunting and an end scraper was recovered from the Folsom level, but does not have use wear indicative of hide processing. Kremmling chert dominates the artifact collection. The point and end scraper are of Bridger chert and suggest that members of a band from the Yampa River drainage were present on-site.

Analysis of individual sites and their assemblages proved to be helpful for elucidating the geographic extent of land use, but consideration of evidence from clusters of sites provided insight into the degree to which Paleoindian land use patterns involved a
certain amount of regularity. The three sites of the Kersey cluster date to various time
periods, but are all arguably camps related to communal bison hunting situated close to one
another near a major river confluence that may have served as an easy-to-find place at which
dispersed groups could rendezvous. It may be suggested that bison bone was once present in
quantity at the Powars site, but wind deflation left only the sparse, shallowly buried bone
scraps encountered during test excavation. If so, the evidence from all sites supports the view
that at various times in the Paleoindian period, single local bands or multi-band groups
established hunting camps near a major river confluence, made points and tools as part of
gearing up, successfully killed a herd of bison in the surrounding country, and brought
carcass segments back to camp for further processing.

At Hell Gap, a series of springs along a creek in an area with available firewood were
occupied at various times throughout the Paleoindian period by groups of people involved in
communal bison hunting. Nearby sources of Hartville Uplift chert were exploited to gear up.
Some bison hunting, presumably to feed relatively large groups of people amassed for
communal hunting, as well as hide processing occurred. Seasonality data from bison
dentition recovered from many of the cultural levels confirm that the bison were primarily
killed during the normal large-scale bison hunting season.

Sites in the Medicine Creek drainage also present a picture of a regular land use
pattern involving repetitive use of the landscape and available food and lithic resources.
Regularity in land use is demonstrated at the Allen site where a meter-thick cultural deposit
documents many episodes of camping primarily by a cultural group of the eastern plains that
used beveled tools and concave-based lanceolate points. Paleoindians occupied the site
during the warm-season when operating in small groups subsisting by means of a relatively
generalized subsistence strategy. Exploitation of local food resources and high-quality
sources of jasper for stone tool manufacture were two aspects of land use in the Medicine
Creek drainage that attracted repeated occupation of the Allen site. Sites at jasper sources
along Lime Creek were occupied less frequently and may have been used to gear up for
communal bison hunting by larger groups of people affiliated with both eastern and western
plains cultural groups. With further investigation, Zone V at the Red Smoke site may prove
to have been occupied by a relatively large group of people affiliated with the eastern plains
cultural group that discarded primarily concave-based lanceolate points at the site. Zone I of
the Lime Creek site may have been occupied by a comparatively large group of people from
the western plains, as denoted by the Cody points and preforms recovered.

Sites at the Kremmling chert source area and nearby bison bonebeds in western
Middle Park together are demonstrative of a land use pattern that involved gearing up at a
high-quality source in preparation for communal bison hunting in adjacent areas of the park.
During Folsom times, large groups of people that may have formed through the aggregation
of multiple bands occupied Locality B at the Barger Gulch site and the Crying Woman site to
gear up with Kremmling chert. In doing so, they produced assemblages dominated by the
local chert that also contain small amounts of nonlocal tool stones originating in surrounding
regions. At the sites in the Kremmling chert source area, excellent flintknappers produced
fluted points for use by participating hunters. Less than 20 km away at the Upper Twin
Mountain site, a group of people encamped in a wooded area during the Folsom period
processed bison carcass segments obtained in a communal kill. Much of the artifact
assemblage left at the site is of Kremmling chert, but the other main tool stone of western
Middle Park is also present in a substantial amount, and the jasper from a source in the
central or eastern portion of the park is present in a small amount. The tool stone
composition of the assemblage suggests that elements of a local band dispersed throughout
the park had geared up with stone from various Middle Park sources and aggregated to
cooperate in a communal hunt. Points used in the kill and discarded at the camp are unfluted,
but display well executed collateral flaking that is demonstrative of the work of flintknappers
in the local band who were of above average skill. Not far away at the Jerry Craig site, a
group of people camped at a spring during Late Paleoindian times processed bison carcasses procured in a communal kill. Multiple points of the Angostura and Cody types made of Kremmling chert indicate that the kill was carried out by a multi-band group composed of people affiliated with distinct cultural groups of the mountains and of the western plains. Dominance of Kremmling chert in the Jerry Craig assemblage strongly implies that during Late Paleoindian times, both mountain and plains peoples were aware that they could plan to gear up at the Kremmling chert source area and subsequently cooperate in a communal bison kill nearby.

Evidence from sites in the high Front Range suggests a certain amount of regularity in Paleoindian use of the alpine tundra for communal hunting of non-bison game animals. The location of all three sites at passes leading over the range suggests the game drives were planned for certain areas where the high Front Range could be easily accessed and crossed by game animals as well as people from both sides of the mountains. Sometimes game drive systems were operated by mountain people who would have wintered west of Middle Park, as seen at the Devils Thumb game drive. At other times, communal game drives in the alpine tundra were carried out by western plains people who would have wintered east of the Front Range, as demonstrated at the Caribou Lake site. On still other occasions, people of the two cultural groups cooperated to operate a game drive, as was the case at the Fourth of July Valley site. Finally, it is notable that construction of stone game drive structures in particular locations for later use implies that Paleoindians were aware that game animal movements were regular to the extent that people could expend effort in planning and making a game drive system with some assurance that they would then be able to return at a later date with others to conduct a successful game drive.

Finally, review of data in existing literature on the season during which communal bison kills were held provides further support for the idea of regularity in Paleoindian land use because large-scale hunting normally occurred only during a minor part of the year and
this subsistence activity may have been annually recurring. In those latitudes on the Plains where freezing temperatures could help preserve meat, kills were held during the height of the cold-season, while in more southerly latitudes, communal hunts were necessarily planned during a warmer time of year when meat could be preserved by drying. The fact that communal hunts were held in the months prior to the height of the cold-season (which would be the leanest time of year for foraging peoples) strongly implies that communal hunts were an important subsistence activity for ensuring survival on the Great Plains. If true, then large-scale big game hunting would have been an annual occurrence. In the study area, climatic conditions would force people to abandon the high Front Range and Middle Park during the height of the cold-season. Thus, communal big game hunts would necessarily have been held during the preceding months. Some support for this idea is provided by data from the two bison bonebeds in Middle Park which indicate that the large-scale kills took place in months well in advance of the coldest time of year.

If the above extensive review of existing literature may be likened to a long journey, we have finally arrived at our destination and it is now time to summarize what has been learned from the entire project. From an intensive analysis of the Jurgens collection, we took the first steps toward developing an ability to recognize how social aggregation and other cultural mechanisms that transported stone raw materials and artifacts across the landscape may be reflected in the tool stone composition of assemblages. With this knowledge, we proceeded to visit other sites in the South Platte drainage and then traveled east to stop at sites in the Kansas River drainage, including those at the Medicine Creek source area. From there, we headed back west up the North Platte River, stopping at the sites in the Hartville Uplift source area. In doing so, we thoroughly surveyed the available evidence on the land use patterns of the Central Plains by considering the tool stone composition of assemblages from all the categories of sites, as well as from sites in environments both with and without high-quality sources of stone. Following the North Platte into the Southern Rocky Mountains, we
visited sites in western Middle Park in the general vicinity of the main source for one of the major tool stones of the region. From the sagebrush grasslands of Middle Park, we climbed high into the Front Range to visit sites where tool stone had to be brought in from Middle Park or nonlocal sources out on the Central Plains. For each site visited along the way, it was necessary to review the kinds of artifacts and tool stones making up the assemblage to assess site function and interpret the relevance of the site to Paleoindian land use patterns. Because most of the sites in the study area are related to large-scale hunting of big game, the process proved repetitious, and may have made for a monotonous journey. However, the process in the end was insightful because it revealed that many of the sites at lithic sources are indeed related to large-scale bison hunting, a realization that currently is not fully appreciated by many Paleoindian archaeologists. When all was said and done, review of the 17 sites and their assemblages proved to be a demanding journey. So, in consideration of the intrepid reader who has followed every step of my reasoning throughout Chapter 12, I will now turn to summarizing the project as a whole so that we might then rest and reflect on what has been learned.
CHAPTER 13
SUMMARY AND CONCLUDING REMARKS

This dissertation has provided a thorough consideration of traditional and alternative views on Paleoindian land use and has determined the later to be a much more capable theoretical approach for producing accurate models of this topic. A review of both approaches identified shortcomings with traditional thinking as well as aspects of the alternative view in need of theoretical and methodological development. To evaluate the explanatory potential of both views, a program of research that involved in-depth reanalysis of the Jurgens site collection and use of data from existing literature on the tool stone composition of assemblages from 16 other sites in the study area was developed and carried out. Toward this end, a method of analyzing collections was developed that permits the archaeologist to examine affects of raw material availability and aggregation of bands on the tool stone composition of assemblages. Clusters of sites were incorporated into the sample of sites examined in order to study the regularity of land use patterns over time. Results of this study demonstrate the superiority of the alternative view as an explanatory theoretical perspective and suggest ways that the approach may produce further insights into the true nature of Paleoindian land use and social organization.

The rationale behind the inception of the traditional view in the 1930s and its development into the 21st century were outlined. At the beginning of Paleoindian archaeology, excavation of sites focused substantially on bison bonebeds. The widespread distribution of these sites and of the types of points recovered from them likely served to foster the thinking that Paleoindians were nomads who moved about within vast areas. As
archaeologists became more knowledgeable about the major tool stone quarries of the Plains beginning in the 1950s, points from bonebeds made of stone acquired from very distant sources seemed to confirm the idea that Paleoindian bands operated within huge ranges. This belief was incorporated into cultural evolutionary theorizing of the 1950s which proposed that unrestricted wandering of early Paleoindians gave rise to restricted wandering of late Paleoindians, which in turn led to central-based wandering of Archaic times, and ultimately to sedentary agricultural villages. Apparently, the understanding that Paleoindian land use involved irregular movements began at this time as well, based on the belief that movement of these early foragers in essence entailed following herds of game animals which in turn were assumed to involve unstructured wandering across the Great Plains. Dependence on big game for subsistence was therefore thought to be a main cause of large ranges and irregular movements. The relative rarity of Paleoindian sites may have been the root of the thinking that low population density would have prevailed in the earliest period of human habitation and therefore would have permitted high mobility of bands for the simple reason that the land was relatively unpopulated. In the 1980s, an attempt was made to explain the large ranges and irregular movements of Paleoindian bands as land use strategies that were adaptive to ecological conditions unique to the Pleistocene. These environmental conditions were said to include equable climates, mosaic vegetation distributions, and disharmonious faunal associations. By combining one set of assumptions with another, an elegant and internally consistent (yet wholly unsupported) model of Paleoindian land use had been constructed by the 1990s and formed the basis for archaeological interpretation on into the 21st century.

Many of the proponents of traditional theory working in the 1960s and 1970s were intent on providing empirical support for the land use model, but the state of knowledge regarding the tool stone sources available to Paleoindians was in many cases still incomplete. It was in this intellectual setting that the concept of a frugal Paleoindian lithic technology was born and presented as the cultural means through which Paleoindians facilitated their highly
mobile lifestyle through conservative consumption of tool stone. Purported aspects of a frugal technology included use of microcrystalline stone over granular raw material (including orthoquartzite), emphasis on the use of bifacial tools and cores over the production of unifacial tools from blocky cores, and use of tools especially designed to permit numerous episodes of resharpening. Traditionally minded archaeologists sought to provide some support for the notion of a frugal technology by citing examples in early Paleoindian assemblages of large bifaces, or flakes struck from large bifaces.

In the 1970s and continuing into the 1990s, archaeologists working with the remains of hunter-gatherers began to grapple with developing methods to illuminate aspects of prehistoric forager land use patterns by means of tool stone sourcing and these early efforts were seemingly adopted as guiding principles in the work of some Paleoindian specialists working from a traditional perspective. In the minds of many traditional thinkers, the notion of embedded procurement, where tool stone is obtained as a secondary activity during trips primarily directed toward food getting, seems to have prevailed over the concept of direct procurement of stone via trips to sources. Posing the question of tool stone procurement as having been either embedded or direct creates a false dichotomy, but of importance here is the observation that by siding with the concept of embedded procurement, traditionally minded archaeologists were able to maintain the view that Paleoindian society and land use involved individual bands operating in huge ranges. Though not specifically developed to advance the traditional view, proponents of this approach also have embraced the concept of a segmented reduction strategy, which argues that stone obtained at a source was transformed from unfinished tool stone into tools of various types over a period of time. Implicit in this view is the understanding that a source visited recently by a band in its travels will account for more tool stone and be in less finished form than a source visited earlier. Based on the above theoretical concepts, some traditional thinkers implicitly propose to be able to reconstruct a band’s movements by “connecting the dots” from the source producing the least
prevalent tool stone to the source accounting for the most stone in the assemblage. Drawing a line around the dots is believed to provide a rough idea of the range exploited by the band.

In the 1980s, some Paleoindian archaeologists were beginning to seriously question the theoretical foundations of the traditional view. The notion that Paleoindians lived in an environment that was so unique in comparison to modern conditions that any attempt to understand their world and cultural responses to it can not be facilitated by applying ecological principles to paleoenvironmental data was found to be simply wrong. Furthermore, a thorough consideration of information on Paleoindian subsistence economy in the Plains and Rocky Mountains demonstrates a certain amount of variability due to the differing mix of plants and animals available in various environments. Finally, geoarchaeological studies have demonstrated that the relative rarity of Paleoindian sites is in large part due to the workings of geological processes that resulted in lower preservation and exposure of Paleoindian sites. Consequently, the traditional contention that Paleoindian land use patterns differed from those of later periods partly because of low human population density is not necessarily true for the entire period.

Evaluation of the strength of the evidence put forward by traditional thinkers to give some empirical support to the theoretical foundations of the school of thought has also led to misgivings about the veracity of conventional thought. In particular, the argument that Paleoindian lithic technology emphasized the use of bifacial cores over blocky cores and the production of bifacial tools over unifacial ones struck from blocky cores was found to be untrue. As a whole, Paleoindian assemblages were not distinct from those of later foragers in so far that they lack blocky cores. Large bifacial cores and flakes struck from them are known from early Paleoindian assemblages but it was here suggested that these may be evidence of the use of large bifacial cores for making large, flat flakes to be used in point manufacture.
Charged with offering a better method of investigating Paleoindian land use, advocates of the alternative view recognize the need to build theory that adequately deals with the wide array of factors that would have affected land use. Also, in light of the biased site sample consisting of sites primarily related to large-scale hunting, archaeologists are well advised to develop methods of studying land use from these kinds of sites while being cognizant of the need to direct future field work and theorizing toward other kinds of sites in order to correct this bias. As with traditional theory, the affect of environmental conditions on land use patterns needs to be considered, but the ecological relationships between climate, vegetation, and fauna, all need to be understood to identify potential environmental affects on land use in a particular physiographic region. The affects of terrain, precipitation, and forage distribution on the distribution of game animals must be understood to in turn theorize the affect of game animal distribution on land use patterns. Also, a good understanding of environmental changes throughout the Paleoindian period is necessary to then theorize the manner in which changing environmental conditions have affected land use. Furthermore, when theorizing the relationships between the environment and land use, it is imperative to consider the affects of tool stone availability. Finally, the affects of social interaction on land use patterns must be incorporated into theory building. This should include recognition of the fact that forager land use involves not only the movements of groups (such as bands within ranges), but also the potentially greater area covered by task groups and individuals intent on various activities. Development of theory on land use of Paleoindians of the Plains and Rocky Mountains should especially recognize the need to theorize the aggregation of single and multi-band groups for communal hunting.

Alternative minded archaeologists have also begun to theorize the various cultural mechanisms by which tool stone and completed tools were obtained by Paleoindians and to contemplate potential analytical methods of identifying the differing mechanisms. This may be properly categorized as middle-range theory because it seeks to understand the ways that
certain kinds of behavior may be identified in the archaeological record. As such, it is distinct from general theory, and its development is necessary for more general-level theory to progress. The motivation behind middle-range theory building is the realization that knowledge of tool stone sources has reached a point where it now should be possible to identify the sources comprising the majority of each excavated assemblage from throughout the Plains and Rocky Mountains. Therefore, developing means by which the various ways that raw material and finished artifacts were obtained would seem to be the next step toward an improved understanding of prehistoric land use. To contribute toward middle-range theory development, it was suggested that Paleoindian tool stone acquisition may have variously involved embedded and direct procurement. Moreover, groups involved in procuring tool stone from a source may have varied in size from task groups, to individual bands, to aggregations composed of multiple bands. The thinking that people participating in communal hunts would gear up at high-quality sources of stone where quality stone is available in abundant, large pieces was found to be useful in identifying assemblages produced by groups involved in large-scale hunting. Finally, the likelihood that tool stone and artifacts were transported across the Plains in exchange networks needs further study to develop methods of distinguishing it from other cultural mechanisms responsible for transporting stone across the landscape.

To evaluate the relative validity of the two views, a program of research involving three basic steps was implemented. First, the traditional view’s idea that Paleoindian lithic technology was specially designed to allow for frugal consumption of tool stone was tested using data collected from the assemblage of the Jurgens site, which contains bonebeds associated with a large-scale bison kill. Next, the crucial issue of whether Paleoindian social organization involved aggregation of the population for communal hunting was addressed with data from the Jurgens collection. Toward this end, an analytical method was developed that involved ranking sources of tool stones present in the assemblage into categories of local,
distant, and very distant with the distances used to define each rank based on the size of the largest range of ethnographically documented pedestrian foragers. The thinking behind the units of analysis chosen was that if the assemblage was dominated by tool stones from local and distant sources, this would not only support the idea that in some cases local and neighboring bands coalesced for communal bison hunting, but would also bolster the thinking that the geographic extent of Paleoindian land use patterns was on a scale of order comparable to that of ethnographically known foragers. Finally, a study area was chosen to evaluate if the tool stone composition of assemblages from sites within the area better conforms to expectations developed under the traditional view or those promulgated under alternative thinking. To test the alternative view’s predictions on the affect of raw material availability on tool stone composition, the study area was chosen to include areas with local high-quality sources of stone and areas without. In order to examine the expectations of the alternative view regarding population dispersion with periodic aggregation for large-scale hunting, the sample of sites included those related to large-scale hunting as well as sites at sources which, prior to in-depth analysis, were thought to be not necessarily related to large-scale hunting. Analysis demonstrated that many of the sites at lithic sources arguably were indeed produced by aggregated groups intent on large-scale hunting. Only one site is definitely the product of repeated occupation by smaller, non-aggregated groups of people.

Having defined a study area, environmental conditions that would arguably affect land use, according to the alternative view, were defined. Occupants of sites in the study area were subjected to conditions prevailing in basically three environments: the short-grass and mixed-grass prairie of the Central Plains, sagebrush grasslands of Middle Park, and the alpine tundra and subalpine forest of the high Front Range. Aspects of the modern environment, including topography, climate, vegetation, as well as game animal and tool stone distributions were considered along with the relevant ecological relationships between them to identify environmental conditions that would have affected land use patterns of not only historic
foragers, but also Paleoindians. Paleoenvironmental evidence from the study area was reviewed to identify how changing environmental conditions would have differentially affected foraging peoples throughout the Paleoindian period.

Climatic conditions would have influenced human use of the various environments in a general way as well as in the timing and location of communal hunting. Deep accumulations of snow in the high Front Range would have obviously restricted use of this environment to a certain period of the year for both game animals and humans. Not so obvious in the absence of temperature data is the likelihood that temperature inversions characteristic of mountain basins during the height of the cold-season dictated that Middle Park be abandoned at this time of year. On the Great Plains, modern temperatures at the height of the cold-season vary according to latitude and suggest that while short-term storage of meat in freezing weather is possible in the more northerly portions, such is not the case in the more southerly climes. Foragers living under a modern-like climate on the Southern Plains would have to go through the additional effort of drying bison meat acquired in large-scale kills conducted prior to the height of the cold-season if they intended to put up stores of food for this relatively lean time of year. Review of paleoclimatic data from the Plains supports the conclusion that as the relatively colder temperatures prevailing during the height of the cold-season during Folsom times warmed to temperatures in late Paleoindian times comparable to those of today, the imaginary line north of which meat storage via freezing was possible would have shifted northward.

Consideration of variation in the predictability of bison herd location was found to be helpful in further defining the environmental factors that would have affected land use related to large-scale hunting. Under modern conditions, annual variation in rainfall patterns on the Plains affect the distribution of quality forage, particularly in the more arid westerly portions in the rain shadow of the Rocky Mountains. Correspondingly, this variation in forage quality would have affected the distribution of bison and other herbivores to the extent the herd
location would be expected to be relatively unpredictable. Furthermore, the comparatively
flat topography of the Central Plains would not serve to restrict herd movements. In contrast,
seasonal variation in the greening of forage with the coming of spring-like weather strongly
influences the timing of movements of bison and other herbivores up into the mountains and
the annual descent is related to the coming of deep snows. Historical information on bison
distributions in the intermontane parks of Colorado coupled with modern studies of
Yellowstone bison movements and a consideration of the relatively small size of the Middle
Park portion of the study area support the conclusion that bison herd movements in this
mountain-rimmed basin would have been relatively predictable compared to the Great Plains.

Finally, the distribution of tool stone resources varies throughout the study area and
would have differentially affected raw material procurement practices of prehistoric peoples
living in the different regions. At risk of oversimplifying, it may be stated that high-quality
sources of tool stone are widely distributed within the Central Plains portion of the study
area. This generality does not apply to the extensive source areas of Smoky Hill jasper in
Nebraska and Kansas and the source area of the Hartville Uplift. In comparison, high-quality
sources of tool stone are clustered in Middle Park and are non-existent in the high Front
Range.

With potential environmental effects on land use identified, a rudimentary model of
Paleoindian subsistence economy and social organization in the study area was developed
under the alternative view in order to produce expectations regarding how aggregation of
social groups for cooperation in large-scale hunting should be reflected in the tool stone
composition of assemblages and by other evidence. It was suggested that for much of the
year, Paleoindians would have been dispersed into relatively small groups subsisting by
hunting and gathering a variety of food resources within a habitual range. The small groups
are perhaps best conceptualized as family groups or sub-band units. During a minority of the
year, people would have aggregated into larger groups to cooperate in large-scale hunting of big game.

Due to the emphasis on excavation and study of bison bonebeds, much is known in a relative sense about the large-scale bison hunting aspect of Paleoindian subsistence economy in the study area and the implications of this subsistence activity for the dynamics of social organization were theorized under the alternative view. Most Paleoindian bison bonebeds represent middens at temporary hunting camps produced as a result of processing segments of carcasses of bison killed in a single event that likely involved use of the surround hunting technique. Dogs equipped with travois likely were used on the Plains and perhaps in other regions of low topographic relief to transport carcass segments to a campsite. Variation in the numbers of bison killed during a single large-scale hunt suggests that some kills could represent the work of an aggregation of people from a single band of average ethnographic size, while larger kills would necessarily have been carried out by an aggregation from multiple bands. Comparison of the characteristics of Paleoindian and Late Prehistoric bison bonebeds was found to support the contention that the intensity of bison hunting had increased by the later period because bison were being hunted not only for subsistence, but also for production of commodities such as pemmican and hides to be used as trade goods. The less intensive hunting indicated for Paleoindian times would therefore suggest a subsistence-level of hunting.

Variation in the seasonal timing of Paleoindian bison kills also proved helpful for placing large-scale hunts in the study area into the larger context of annual changes in subsistence activities and social organization. Based on the reasoning that most Paleoindian bison bonebeds represent single events, the available data on the time of year during which bison were killed indicate that the large-scale bison hunting season lasted only a minor part of the year. Analysis of the seasonal timing of Paleoindian bison kills on the Plains demonstrated that in northerly latitudes, large-scale kills occurred during the height of the
cold-season. In regard to food resources other than big game, this would have been a relatively lean time of year for foraging people, and may have been a major motivation for cooperating in large-scale hunts. Also, temperatures during the coldest time of year in northerly latitudes were sufficiently low to assist in the short-term preservation of meat by allowing people to take advantage of periods of freezing temperatures. To the contrary, on the more southerly portions of the Plains, existing data indicate that large-scale kills during the Paleoindian period occurred in months prior to the coldest time of year. In the southerly portions of the Plains, the coldest time of the year would also be a comparatively lean period for hunter-gatherers in regard to the availability of food resources other than big game. Prevailing temperatures on the Southern Plains would have been insufficiently cold throughout the Paleoindian period to permit short-term shortage of meat by freezing, so people would have to go through the extra effort of drying meat if they intended to preserve some of the food procured in communal hunts. Modern daytime temperatures during the height of the cold-season on the Southern Plains are less than ideal for drying meat. Paleoenvironmental data suggest that cold-season temperatures on the Southern Plains during Late Paleoindian times were comparable to those of modern times and perhaps during the preceding Folsom period as well. In light of the above information, the fact that Paleoindians on the Southern Plains held large-scale bison kills in the months preceding the coldest time of year supports the interpretation that such events were planned for a time when temperatures would allow meat to be preserved via drying in order to put up stores of food for a relatively lean time of year.

Knowledge of the variability in seasonal timing of Paleoindian large-scale bison kills across the Plains was used to model the time of year when communal bison hunts would have been carried out in the various environments of the study area. In response to the general warming of the climate throughout the post-Clovis Paleoindian period, people living on the Plains portion of the study area early in the period normally aggregated for large-scale
hunting during the height of the cold-season while later Paleoindian people would have done so during the months preceding the coldest time of year. The timing of large-scale bison hunts differed under the climatic regime prevailing in the Middle Park environment. Study of modern temperature data from Middle Park, coupled with a review of the archaeological literature suggests that throughout prehistory, even during the early Archaic when temperatures were warmer than today, foragers abandoned Middle Park during the height of the cold-season to avoid bouts of extremely frigid temperature brought on by temperature inversions. Paleoenvironmental data from the adjacent Front Range support the inference that temperatures were comparable to those of today sometime during the Cody period and colder in earlier Paleoindian times. From the above, it is concluded that large-scale bison hunting in Middle Park throughout the Paleoindian period would have been conducted by aggregated groups in the months prior to the coldest time of year, when people would have abandoned the park. Evidence supporting this conclusion comes in the form of seasonality data from the study of bison dentition excavated at two bonebeds in Middle Park, one dating to early Paleoindian times, the other to the Late Paleoindian period.

Information relating to three late Paleoindian sites in the high Front Range permitted the dynamics of social organization relating to another aspect of subsistence economy in the study area to be modeled — specifically that related to large-scale hunting of what were probably non-bison game animals using game drive systems set up in the alpine tundra. More than 50 game drive sites are known in the high Front Range east of Middle Park. Available evidence suggests their use continued from Late Paleoindian to Late Prehistoric times. Poor bone preservation frustrates attempts to identify the target species. Modern game animal behavior coupled with limited faunal remains from non-Paleoindian sites suggest that elk, bighorn sheep, and mule deer may have been taken. Blood residue analysis of one Late Paleoindian point of the Frederick type from the Caribou Lake site indicates that the point was used on an elk. Again due to poor bone preservation, data on the numbers of
animals killed are lacking and therefore evidence relating to the size of the human groups involved is not as convincing as is the case with bison bonebeds. Nevertheless, it was theorized that groups of people from one or more bands would have been required to conduct a game drive. Bands with wintering grounds in lower country east and west of the high Front Range would both be expected to use the highlands for communal hunting in the months prior to the height of the cold-season, at which time the region would have been abandoned.

A final topic relevant to producing a rudimentary model of Paleoindian subsistence, social aggregation, and land use in the study area is the occurrence of contemporaneous Paleoindian point types with differing distributions. Paleoindian point types of the intermountain basins and western Plains portion of the study area that follow Clovis include Folsom, Agate Basin, and Hell Gap points. These types occur in association with end scrapers — a type of hide scraping tool made by retouching the distal end of a flake. Furthermore, these earlier Paleoindian point types are known from sites associated with large-scale bison kills in the intermontane basins and western Plains portion of the study area. Current evidence suggests that the makers of these Paleoindian point types did not engage in large-scale hunting of non-bison big game in the high Front Range. In the deciduous woodlands east of the study area, concave-based lanceolate points occur in association with beveled tools and are dated as early as 10,530 ± 650 B.P. and therefore may be contemporaneous with Folsom, Agate Basin, and Hell Gap points. In the eastern Plains portion of the study area, Occupation Level 1 at the Allen site produced points assignable to Hell Gap and Agate Basin types along with a concave-base lanceolate point. Also present were beveled tools which, as a class, were shown to have been used for scraping hides at the Allen site. Occupation Level 1 has been dated to 10,600 ± 620 and 10,270 ± 360 B.P. The above suggests a certain amount of differentiation in the material culture of the earlier Paleoindian inhabitants of the study area, but the nature of any interaction between the two cultural groups is largely unknown.
In contrast, by Late Paleoindian times, material culture of the inhabitants of the study area is more clearly separable into distinct, contemporaneous point types that tend to have different distributions. The distribution of distinct types of hide scraping tools also supports the notion of the existence of culturally distinct groups at this time. An apparent correlation between Late Paleoindian point types and differing environments of the study area suggests that makers of contemporaneous point types may have also differed to some extent in their subsistence economies.

Late Paleoindian cultural groups that may have wintered in the valleys of the Southern Rocky Mountains west of the study area seasonally occupied Middle Park and the high Front Range where first they left Angostura points and then Pryor Stemmed points. Evidence from rockshelters in the Middle Rocky Mountains of Wyoming suggests that these people subsisted on a range of big game species, including bighorn sheep, as well as small game and plant foods.

People who wintered on the western Plains portion of the study area also made seasonal use of Middle Park and the high Front Range where their passing is marked by a series of point types. From earliest to latest, these include Cody, Frederick, and Allen points. Previous research into the Late Paleoindian use of the intermontane basins, the high Front Range, and the western Plains portion of the study area has emphasized investigation of sites associated with large-scale bison kills. The nature of the subsistence economy during that portion of the year outside of the communal hunting season has yet to be investigated. Cooperation of mountain and western plains peoples in large-scale hunts for bison in Middle Park as well as in game drives in the high Front Range for what were probably non-bison big game animals is documented at the Jerry Craig and Fourth of July Valley sites, respectively.

In the more easterly Plains portion of the study area, a more mesic grassland environment than that on the short-grass prairie to the west is present and Late Paleoindian habitation is marked by poorly understood concave-based lanceolate points as well as beveled
tools. Whether there was a simple correlation between concave-based lanceolate points and the beveled tool hide-scaper with both kinds of artifacts made by the same cultural group is as yet unclear from available information. Many of the occupations of the Allen site during Late Paleoindian times may be attributed to small human groups that left beveled tools. Concave-based lanceolate points also derive from the Late Paleoindian occupations at the Allen site. Evidence from the site therefore suggests that when operating in small groups, people who made concave-based lanceolate points possessed a fairly generalized subsistence economy based on the utilization of plants, a variety of small and large game animals, and other food resources. That makers of these points also engaged in large-scale bison hunts is suggested by evidence from Zone V of the Red Smoke site and is more definitively demonstrated at other sites within the more easterly Plains portion of the study area. Several sites associated with large-scale bison kills contain both Cody and concave-based lanceolate points. These sites occur within a broad east-to-west band and suggest that culturally distinct Late Paleoindian groups lived on the Plains portion of the study area and sometimes aggregated to cooperate in large-scale bison hunts.

Having completed a lengthy but necessary consideration of the expected environmental and social effects on land use patterns in the study area, the stage was set to compare the relative explanatory value of both views with existing literature. However, before that could occur, assessment of whether or not aggregation is demonstrable in artifact assemblages through an in-depth analysis of data from the Jurgens collection was necessary, as was evaluating traditional claims for a frugal Paleoindian technology.

The three aspects of the concept of a frugal Paleoindian technology were tested with data collected from the Jurgens assemblage and all were refuted by evidence from the site. Use of a granular tool stone (here referred to as the very rough-textured orthoquartzite variety of White River Group gravel) to gear up for large-scale bison hunting is evident in the assemblage and is at odds with the traditional view that Paleoindians preferentially used
microcrystalline stone. An assessment of the relative amounts of the assemblage that are indicative of production of artifacts through bifacial reduction versus knapping of blocky cores was not in conformity with the assertion that Paleoindian lithic technology emphasized use of bifacial cores and tools. To the contrary, the activities related to large-scale bison hunting that took place at the Jurgens site required the production and use of both unifacial and bifacial tools in order to kill and process a large number of bison. Data from the Jurgens site also refute the contention of the traditional view that Paleoindian tools were designed to permit a high number of episodes of resharpening to extend tool use-life. Based on the traditional view, it was reasoned that points and end scrapers of tool stone from very distant sources will have been in the possession of the band longer and therefore should have been subjected to a greater amount of resharpening and consequently be shorter than comparable artifacts made of stone from local and distant sources. However, this comparison found no difference in the lengths of points and end scrapers made of very distant stone versus those made of raw materials from closer sources. In sum, data from the Jurgens site refute all three aspects of the concept of a frugal Paleoindian lithic technology designed to enable a highly mobile lifestyle.

Data from the Jurgens site are also important for permitting development of the alternative view, primarily by addressing the question of whether Paleoindian bands aggregated for large-scale hunting of big game in a manner analogous to ethnographic foragers. The assemblage was found to be dominated by stone from local and distant sources and to demonstrate a dramatic falloff in the amount of stone from very distant sources. This was interpreted as reflecting the aggregation of multiple bands for communal bison hunting. Furthermore, analysis of the assemblage was found to support the alternative view by providing evidence in support of the existence of a long-distance exchange network among Plains Paleoindians that emphasized transport of projectile points and preforms. This conclusion is founded on the fact that the sample of artifacts made of tool stone from very
distant sources contains a significantly high proportion of points and preforms. Moreover, simply mapping the very distant sources represented in the assemblage demonstrated that small amounts of tool stone had arrived at the site from all regions of the Great Plains, as well as from the Wyoming Basin. To summarize, it may be stated that analysis of the Jurgens collection demonstrated that various cultural mechanisms, such as exchange, which theoretically could have transported stone great distances, must be considered when interpreting the meaning of variation in the tool stone composition of assemblages. Analysis also validated the thinking that band aggregation can be the main factor effecting the tool stone composition of sites associated with large-scale kills. This conclusion was particularly important in light of the fact that the sample of sites from the study area to be evaluated using information available in existing literature is dominated by sites related to communal hunting.

Evaluating the two theoretical views on the geographic extent of land use with data from existing literature favored the alternative view over the traditional school of thought. The Allen site was determined to be the only campsite in the sample that is wholly not associated with large-scale hunting. Although the distribution of tool stone sources in the site vicinity is less than ideal for defining the location of the range used by members of the local band, the tool stone composition of the assemblage was found to favor the alternative view. Review of the tool stone composition of assemblages from sites related to large-scale hunting also supported the alternative view. In portions of the study area without quality sources of stone, the alternative view was favored because the presence of stone from distant sources in site assemblages is best explained by aggregation of neighboring bands rather than a single band operating within a huge range. In parts of the study area with local stone, the near exclusive use of local sources is definitely not reconcilable with the traditional view. Sites related to gearing up for large-scale hunting at high-quality sources of stone also supported the alternative view. This was particularly evident at Locality V of the Hell Gap site cluster where a case was made that a local band exploited multiple local sources in order to gear up.
Sites associated with large-scale hunting at lithic sources were recognized as such through a careful consideration of the artifact types present and this in itself improved knowledge of Paleoindian archaeology because the presence of such sites at sources is not generally acknowledged. The model developed on the seasonal timing of large-scale bison hunts proved to be of value in verifying that a large majority of occupations of the Hell Gap site cluster at the Hartville Uplift source area took place during the large-scale bison hunting season.

Analysis of data from existing literature also provided insight into the regularity of Paleoindian land use patterns. The thick cultural deposit at the Allen site demonstrates a surprising amount of repetitive use of this campsite, which is not associated with large-scale hunting. With only one such site, it is difficult to say if other camps not related to communal hunting in the study area would be expected to display such regularity in land use patterns, but it does illustrate the potential bias in the existing sample of excavated sites associated with large-scale hunts and illustrates the need to look at other kinds of site in the future.

However, a certain amount of regularity in land use is indeed evident at clusters of sites related to communal bison hunting. Analysis of the site cluster in western Middle Park was found to support the interpretation that knowledge of the presence of a high-quality chert source, coupled with the relative predictability of bison herds in this area, fostered a fairly regular land use pattern that involved gearing up at the chert source in Barger Gulch followed by cooperating in a large-scale bison kill somewhere in neighboring areas. At the Kersey site cluster on the Plains of northeast Colorado, where the location of bison herds would arguably have been less predictable and a quality source of stone is not as close at hand, a certain amount of regularity during the large-scale bison hunting season is nevertheless in evidence. At various times throughout the Paleoindian period, aggregated groups of people cooperating in communal bison hunts occupied these three camps, which arguably were located near a
major river confluence that could have served as a known geographic location at which participating groups could meet.

Repetitive use of lithic sources by aggregated groups of people gearing up for bison hunting at high-quality lithic sources was found to be not as extreme as that demonstrated at the Allen site. If Paleoindians engaged in large-scale bison hunts on a yearly basis, it is expected that aggregated groups would revisit camps at sources much more frequently than is apparent in existing literature. This observation points to the need for future work to address the question of the frequency with which large-scale bison hunts occurred.

Lastly, a certain amount of regularity in land use relating to large-scale hunting was noted at the cluster of sites in the high Front Range where non-bison game animals were apparently killed *en masse* at game drive sites during Late Paleoindian times. The alpine tundra is normally amenable to habitation by game animals and humans sometime between May through November. This aspect of land use in the study area implies a certain amount of regularity in land use, at least in so far that operating a game drive at a predetermined time and place implies a certain amount of knowledge of the land and herd movements in order to be able to plan and prepare for the event with other participants. The game drive systems likely had to be constructed at some time prior to use. The two sites at Arapaho Pass, where groups arriving from east and west of the range arguably met to cooperate in a game drive, are along a travel route providing the easiest access between Middle Park and the Central Plains, a fact that would have facilitated coordination of the rendezvous between groups. If as suggested, non-bison big game would have returned to the same alpine grazing areas on a yearly basis, one might expect that more than two Late Paleoindian occupations of the Arapaho Pass area for the purpose of operating a game drive would be in evidence. This again raises the question of the frequency with which large-scale big game hunts were organized.
Review of existing literature provided insights into the nature of social interaction between Late Paleoindian cultural groups that made differing types of points. Consideration of the Late Paleoindian assemblages reported from in and around the study area provided information on the contemporaneity of cultural groups whose homelands were in differing parts of the study area. The Angostura point was found to be coeval with the Cody type as demonstrated at the Jerry Craig site where mountain and western plains peoples cooperated in a large-scale bison hunt in western Middle Park. With further excavation at the Hell Gap site cluster, an enigmatic point that might be of the Angostura type reported from the Cody level at Locality V may also prove to be evidence of some form of interaction between contemporaneous cultural groups of the mountains and western plains. Contemporaneity of the Angostura type and the Frederick point of post-Cody age is suggested at the Fourth of July Valley site where it was argued that mountain and western plains people cooperated in a game drive in the high Front Range that likely involved hunting a non-bison game animal. Finally, the possible contemporaneity of concave-based lanceolate points of the eastern plains and Cody points of the western plains was suggested based on evidence from Zone V at the Red Smoke site. The collection of projectile points from the level includes many concave-based lanceolate points of the local jasper, several points of this kind made of tool stones from very distant sources lying in essentially all directions from the site, and two Cody points made of tool stone from very distant sources to the northwest and south-southwest. This, coupled with other lines of evidence, formed the basis for the interpretation that gearing up for a large-scale bison hunt by makers of concave-based lanceolate points involved acquiring well made points of stone from very distant sources, including some made by members of the neighboring cultural group who made a different type of projectile point.

Review of existing literature also required addressing previous claims made for the existence of multiple contemporaneous point types in Early Paleoindian times (specifically during the Folsom period) and in the early part of the Late Paleoindian period (in Agate Basin
times). Such claims apply to those portions of the study area encompassing the western plains and the intermontane basins. In order to properly interpret early Paleoindian sites in Middle Park, the long-standing idea that Folsom, Plainview, Goshen, and Midland points are types of early Paleoindian points used by culturally distinct, contemporaneous people was reviewed and determined to be unsubstantiated. Rather, Plainview, Goshen, and Midland points may prove to be best considered as unfluted Folsom points. Data were presented to support the hypothesis that unfluted Folsom points tend to have been made and used for large-scale bison hunts by single-band aggregations of people while fluted Folsom points tend to be found in sites associated with larger bison kills conducted by multi-band aggregations. In order to properly interpret the occupations at the Hell Gap site cluster, the recently popular idea that evidence from Locality I indicates that fluted Folsom points, “Goshen” points, and Agate Basin points were coeval early Paleoindian point types made by culturally distinct groups was reviewed using stratigraphic and other information presented in the site report and found to be in error. Instead, available evidence indicates a Folsom occupation of Locality I took place during the large-scale bison hunting season and this was followed at a later time by an Agate Basin occupation that also occurred during the large-scale bison hunting season.

In conclusion, this study has demonstrated that the weight of the currently available evidence indicates that the traditional view is no longer an empirically defensible model of Paleoindian land use and should be abandoned. The alternative view offers better potential for developing accurate models of land use and social organization. The research reported here has helped to resolve a long standing debate regarding a topic in American prehistory of interest to professional and avocational archaeologists alike.

The real contribution of this study to the archaeology of hunting and gathering peoples, however, may lie in the development of needed methods of investigating the land use and social organization of prehistoric foragers in a more holistic and accurate manner. As
with many previous studies, the research reported here benefited from a careful consideration of the environmental factors that in part shaped prehistoric land use patterns, including the nature of the terrain, climate, and available food resources. Where this study stands out from others in a manner that I believe has allowed it to produce a more accurate model of land use is in its recognition of the importance of considering the effects of tool stone availability and social interaction when constructing theory and methods related to the study of prehistoric land use patterns. Sadly, despite repeated calls for archaeologists studying prehistoric hunter-gatherers to account for the effects of raw material availability in their interpretations of land use, this advice has rarely been heeded. In part, this may be the result of conventional studies which analyze particular sites and their contents. This study has demonstrated the magnitude of the geographical scale of analysis necessary to examine the effects of raw material availability on land use patterns. Equally imperative is the need to consider the effects of social interaction on land use patterns, including population aggregation for communal subsistence activities and long-distance travel by individuals or small groups intent on resource procurement, exchange, and so forth. As with the need to consider the effects of raw material availability, previous calls for archaeologists to incorporate social interaction into development of theoretical models and analytical methods of studying land use patterns of prehistoric hunter-gatherers have been in vain. These deficiencies simply must be corrected, for it is only then that archaeologists can seriously hope to accurately portray prehistoric hunter-gatherers as the once dynamic societies that they were.
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APPENDIX A

ULTRAVIOLET COLOR RESPONSES OF ARTIFACTS FROM THE JURGENS SITE AND HAND SAMPLES FROM LITHIC SOURCES

Appendix A presents data on the fluorescent color response of artifacts from the Jurgens site and hand samples from lithic sources to longwave and shortwave ultraviolet (UV) light. The data are presented here to assist future researchers in sourcing tool stones from sites in northeast Colorado. Data were collected on the UV color responses of over half of the artifacts in the Jurgens collection. To expedite analysis, these data were not collected for the 1,548 items excavated from Area 1 which are primarily flakes, as discussed in Chapter 9. The following narrative provides a summary of the data presented in Tables A-1 through A-23.

Main Tool Stones

**WRGG: Very Rough-Textured Orthoquartzite.** The color responses of 265 Jurgens artifacts of very rough-textured orthoquartzite from the White River Group gravels were recorded (Table A-1). A majority of artifacts (77.7 percent) have no fluorescent color response under both longwave and shortwave UV light. For brevity, a UV color response in this narrative will be stated as the longwave color response followed by the shortwave response. Using this system of reporting, the above color response is: none / none. Other color responses are much less common and include: none / green (4.9 percent of cases); white / none (6.4 percent); and white / white (5.3 percent).

Color responses of 10 hand samples collected by the author from lithic procurement sites recorded in the Kalouse area of northeast Colorado are presented in Table A-2. The set of hand samples is too small to form a representative sample (n = 10). Nevertheless, it is noteworthy that a majority (70 percent) of the hand samples also had a color response of none / none. Three hand samples had a color response of none / green.

**WRGG: Morrison Orthoquartzite.** Color responses of 26 Jurgens artifacts were compared to the responses of six hand samples collected from three lithic procurement sites in the Kalouse area (Table A-3). The color responses of all artifacts and hand samples were: none / none.

**WRGG: Light-to-Medium Red, Very Fine-Grained Orthoquartzite.** A total of seven artifacts of this variety of tool stone from the White River Group gravels present in the Jurgens collection were exposed to UV light (Table A-4). The color response of five artifacts (71.4 percent) was: none / none. Two artifacts (28.6 percent) fluoresced white / white. No hand samples of this presumably uncommon variety of WRGG were seen at the lithic procurement sites visited.
Table A-1. UV Color Responses of Jurgens Artifacts Made from Very Rough-Textured Orthoquartzite from White River Group Gravels.

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<th>Longwave UV Color Response</th>
<th>Shortwave UV Color Response</th>
<th>Total</th>
</tr>
</thead>
<tbody>
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<td>None</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Count</td>
<td>206</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>77.7%</td>
</tr>
<tr>
<td></td>
<td>Green</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>4.9%</td>
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<tr>
<td></td>
<td>Orange</td>
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</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>.4%</td>
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<tr>
<td></td>
<td>White</td>
<td>14</td>
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<tr>
<td></td>
<td>% of Total</td>
<td>5.3%</td>
</tr>
<tr>
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<td>Green and Orange</td>
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</tr>
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<td></td>
<td>% of Total</td>
<td>.4%</td>
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<tr>
<td></td>
<td>Green and White</td>
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<tr>
<td></td>
<td>Green, Orange, and White</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>.4%</td>
</tr>
<tr>
<td></td>
<td>Orange and White</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>1.1%</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>224</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>84.5%</td>
</tr>
</tbody>
</table>
Table A-2. UV Color Response Comparison Between Jurgens Artifacts of Very Rough-Textured Orthoquartzite from White River Group Gravels and Similar Tool Stone Collected from Procurement Sites.

<table>
<thead>
<tr>
<th>UV Color Response</th>
<th>Jurgens Artifacts</th>
<th>Hand Samples from Tool Stone Procurement Sites&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>Percentage</td>
</tr>
<tr>
<td>Longwave = None</td>
<td>206</td>
<td>77.7%</td>
</tr>
<tr>
<td>Shortwave = None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = None</td>
<td>13</td>
<td>4.9%</td>
</tr>
<tr>
<td>Shortwave = Green</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = White</td>
<td>17</td>
<td>6.4%</td>
</tr>
<tr>
<td>Shortwave = None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = White</td>
<td>14</td>
<td>5.3%</td>
</tr>
<tr>
<td>Shortwave = White</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other UV Color Responses that Individually Total Less than 5 Percent</td>
<td>15</td>
<td>5.7%</td>
</tr>
<tr>
<td>Total</td>
<td>265</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

<sup>a</sup> Hand samples collected from 5WL5, 5WL5180, and 5WL5182.
Table A-3. UV Color Response Comparison Between Jurgens Artifacts of Morrison Orthoquartzite from White River Group Gravels and Similar Tool Stone Collected from Procurement Sites.

<table>
<thead>
<tr>
<th>UV Color Response</th>
<th>Jurgens Artifacts</th>
<th>Hand Samples from Tool Stone Procurement Sites&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>Percentage</td>
</tr>
<tr>
<td>Longwave = None</td>
<td>26</td>
<td>100%</td>
</tr>
<tr>
<td>Shortwave = None</td>
<td>26</td>
<td>100%</td>
</tr>
<tr>
<td>Total</td>
<td>26</td>
<td>100%</td>
</tr>
</tbody>
</table>

<sup>a</sup> Hand samples collected from 5WL5, 5WL5181, and 5WL5182.

<table>
<thead>
<tr>
<th>Longwave UV Color Response</th>
<th>Shortwave UV Color Response</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>None</td>
<td>White</td>
</tr>
<tr>
<td>None</td>
<td>Count</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>71.4%</td>
</tr>
<tr>
<td>White</td>
<td>Count</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>71.4%</td>
</tr>
</tbody>
</table>
WRGG: Other Orthoquartzite. Small samples of Jurgens artifacts and hand specimens of tool stone from lithic procurement sites in the Kalouse area were classified as “Other orthoquartzite” from the White River Group gravel and tested for their color response. In normal light, the tool stone is an opaque, fine-grained orthoquartzite that occurs in shades of brown and red and has black speckles or dendritic inclusions. Because of small sample sizes, this exercise failed to firmly establish even the most common UV color response. All eight hand samples collected from three lithic procurement sites produced a none / none color response. In contrast, of the four artifacts of this tool stone from the Jurgens site that were exposed to UV light, only one had a none / none response; each of the remaining artifacts produced a different response (Table A-5).

WRGG: Holiday Springs Chalcedony. The color response of 40 Jurgens artifacts (Table A-6) as well as hand samples in two comparative tool stone collections were recorded and are compared in Table A-7. A total of 30 hand specimens of the tool stone from a larger set in the comparative tool stone collection of Joe Ben Wheat in the CU Museum were tested for their UV color response. The hand specimens were presumably collected near Holiday Springs. Also, seven hand samples collected from two lithic procurement sites I recorded near Holiday Springs were exposed to UV light. Color responses of the Jurgens artifacts was the most varied, possibly because they form the largest sample of the tool stone. The most common color response was orange / green which accounted for 52.5 percent of the cases. Six other color responses each account for 5 to 7.5 percent of the sample (Table A-7). The most common color response of the hand samples from the source area also was orange / green. This response was obtained for 56.7 percent of Wheat’s sample and 42.9 percent of the hand samples I collected.

WRGG: Kalouse Jasper. Ultraviolet color responses of six artifacts in the Jurgens collection were compared to those of hand samples in two comparative tool stone collections from separate sources of White River Group gravel in northeast Colorado. The comparative collections included a sample of 30 hand specimens collected from two lithic procurement sites I recorded in the Kalouse area and a sample of 14 specimens stored at UNC that were collected from a source elsewhere in Weld County (T 8 N, R 57 W, Section 15, SE ¼) (Table A-8). Of the artifacts from Jurgens, a majority of cases (66.7 percent) had a response of none / none as did a majority of (53.3 percent) of cases from the Kalouse sources and 100 percent of the hand samples from the other source in Weld County collected by UNC.

WRGG: Brown-to-Orange or Yellow Chert. Small samples of Jurgens artifacts and hand samples from the Kalouse area together produced highly varied color responses to UV light. Of the 12 artifacts from Jurgens, the most common color response was none / green, which accounted for 33.3 percent of the cases (Table A-9). I collected only two hand samples of this tool stone from a lithic procurement site in the Kalouse area (5WL5) and another one from a nearby procurement site (5WL5182). To add to the known variability in color responses for this tool stone, the response of all hand samples I collected was orange / orange, which did not match any of those from Jurgens.

WRGG: Dark-to-Medium Brown Petrified Wood. A small sample of nine artifacts from Jurgens and a single hand sample from a lithic procurement site together produced a highly variable color response, as seen in Table A-10. I collected only one hand sample of this tool stone when I recorded a lithic procurement site in the Kalouse area (5WL5182) and its color response (orange / orange) duplicated only one of the eight different responses produced by the Jurgens artifacts.
Table A-5. UV Color Response Comparison Between Jurgens Artifacts of “Other Orthoquartzite”\textsuperscript{a} from White River Group Gravels and Similar Tool Stone Collected from Procurement Sites.

<table>
<thead>
<tr>
<th>UV Color Response</th>
<th>Jurgens Artifacts</th>
<th>Hand Samples from Tool Stone Procurement Sites\textsuperscript{b}</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>Percentage</td>
</tr>
<tr>
<td>Longwave = None</td>
<td>1</td>
<td>25%</td>
</tr>
<tr>
<td>Shortwave = None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = None</td>
<td>1</td>
<td>25%</td>
</tr>
<tr>
<td>Shortwave = Green</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = Orange</td>
<td>1</td>
<td>25%</td>
</tr>
<tr>
<td>Shortwave = Green</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = White</td>
<td>1</td>
<td>25%</td>
</tr>
<tr>
<td>Shortwave = Green</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>4</td>
<td>100%</td>
</tr>
</tbody>
</table>

\textsuperscript{a} “Other orthoquartzite” is very fine-grained and sometimes has black dendrites.  
\textsuperscript{b} Hand samples collected from 5WL5, 5WL5181, and 5WL5182.
Table A-6. UV Color Responses of Jurgens Artifacts Made of Holiday Springs Chalcedony from White River Group Gravels.

<table>
<thead>
<tr>
<th>Longwave UV Color Response</th>
<th>Shortwave UV Color Response</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>None</td>
<td>Green</td>
</tr>
<tr>
<td>Green</td>
<td>Count</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>-</td>
</tr>
<tr>
<td>Orange</td>
<td>Count</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>2.5%</td>
</tr>
<tr>
<td>White</td>
<td>Count</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>-</td>
</tr>
<tr>
<td>Green and Orange</td>
<td>Count</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>2.5%</td>
</tr>
<tr>
<td>Green, Orange, and White</td>
<td>Count</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>-</td>
</tr>
<tr>
<td>Orange and White</td>
<td>Count</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>5.0%</td>
</tr>
</tbody>
</table>
Table A-7. UV Color Response Comparison Between Jurgens Artifacts of Holiday Springs Chalcedony from White River Group Gravels and Similar Tool Stone Collected from Procurement Sites.

<table>
<thead>
<tr>
<th>UV Color Response</th>
<th>Jurgens Artifacts</th>
<th>Hand Samples from Tool Stone Procurement Sites (^a)</th>
<th>Hand Samples from Tool Stone Procurement Area (^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>Percentage</td>
<td>Count</td>
</tr>
<tr>
<td>Longwave = Orange</td>
<td>21</td>
<td>52.5%</td>
<td>3</td>
</tr>
<tr>
<td>Shortwave = Green</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = Orange</td>
<td>3</td>
<td>7.5%</td>
<td>-</td>
</tr>
<tr>
<td>Shortwave = Green and Orange</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = White</td>
<td>2</td>
<td>5.0%</td>
<td>-</td>
</tr>
<tr>
<td>Shortwave = Green</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = Green and Orange</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shortwave = Green</td>
<td>2</td>
<td>5.0%</td>
<td>2</td>
</tr>
<tr>
<td>Longwave = Green and Orange</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shortwave = Green and Orange</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = Green, Orange, and White</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shortwave = Green</td>
<td>2</td>
<td>5.0%</td>
<td>-</td>
</tr>
<tr>
<td>Longwave = Orange and White</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shortwave = Green</td>
<td>3</td>
<td>7.5%</td>
<td>-</td>
</tr>
<tr>
<td>Other UV Color Responses that Individually Total Less than 5 Percent</td>
<td>7</td>
<td>17.5%</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>100.0%</td>
<td>7</td>
</tr>
</tbody>
</table>

\(^a\) Hand samples collected from 5WL5179 and 5WL5180.

\(^b\) Set of hand samples includes 30 pieces of Holiday Springs chalcedony selected from a larger group present in Joe Ben Wheat’s comparative tool stone collection at the University of Colorado Museum.
Table A-8. UV Color Response Comparison Between Jurgens Artifacts of Kalouse Jasper from White River Group Gravels and Similar Tool Stone Collected from Procurement Sites.

<table>
<thead>
<tr>
<th>UV Color Response</th>
<th>Jurgens Artifacts</th>
<th>Hand Samples from Tool Stone Procurement Sites (^a)</th>
<th>Hand Samples from Tool Stone Procurement Area (^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>Percentage</td>
<td>Count</td>
</tr>
<tr>
<td>Longwave = None</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shortwave = None</td>
<td>4</td>
<td>66.7%</td>
<td>16</td>
</tr>
<tr>
<td>Longwave = None</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shortwave = Green</td>
<td>-</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>Longwave = Orange</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shortwave = Orange</td>
<td>-</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>Longwave = Orange</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shortwave = Green and Orange</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Longwave = Orange</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shortwave = Orange and White</td>
<td>1</td>
<td>16.7%</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = White</td>
<td>1</td>
<td>16.7%</td>
<td>-</td>
</tr>
<tr>
<td>Shortwave = None</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>100.0%</td>
<td>30</td>
</tr>
</tbody>
</table>

\(^a\) Hand samples collected from 5WL5181 and 5WL5182.

\(^b\) Hand samples in comparative tool stone collection of Dr. Robert Brunswig at University of Northern Colorado, Anthropology Department, Archaeology and Paleoenvironment Research Laboratory. Collected from Weld County, Colorado; T 8 N, R 57 W, Section 15, SE ¼.
Table A-9. UV Color Responses of Jurgens Artifacts Made of Brown-to-Orange or Yellow Chert from White River Group Gravels.

<table>
<thead>
<tr>
<th>Longwave UV Color Response</th>
<th>Shortwave UV Color Response</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>None</td>
<td>Green</td>
</tr>
<tr>
<td>None</td>
<td>Count</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>8.3%</td>
</tr>
<tr>
<td>Green</td>
<td>Count</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>-</td>
</tr>
<tr>
<td>Orange</td>
<td>Count</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>8.3%</td>
</tr>
<tr>
<td>White</td>
<td>Count</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>16.7%</td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>33.3%</td>
</tr>
</tbody>
</table>
Table A-10. UV Color Responses of Jurgens Artifacts Made of Dark-to-Medium Brown Petrified Wood from White River Group Gravels.

<table>
<thead>
<tr>
<th>Longwave UV Color Response</th>
<th>Shortwave UV Color Response</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>None</td>
<td>Green</td>
</tr>
<tr>
<td>None</td>
<td>Count</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>11.1%</td>
</tr>
<tr>
<td>Orange</td>
<td>Count</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>-</td>
</tr>
<tr>
<td>White</td>
<td>Count</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>-</td>
</tr>
<tr>
<td>Green and Orange</td>
<td>Count</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>-</td>
</tr>
<tr>
<td>Orange and White</td>
<td>Count</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>11.1%</td>
</tr>
</tbody>
</table>
Flat Top Chalcedony. A sample of artifacts of this tool stone in the Jurgens collection was compared to a sample of hand samples produced by combining those present in three comparative tool stone collections. A total of 283 Jurgens artifacts classified as Flat Top chalcedony based on examination in normal light were exposed to UV light, producing eight color responses (Table A-11). By far the most common response was orange / green. Ten hand samples in the UNC comparative collection were combined with 10 in the possession of Dr. Douglas Bamforth and 16 in my possession to create a sample of 36 pieces of chalcedony collected from the source at Flat Top Butte (Table A-12). The four color responses produced by the hand samples duplicate those of the Jurgens artifacts, with the most common response again being orange / green.

Dawson Petrified Wood. A large sample of artifacts of this tool stone were exposed to UV light as were two small samples of hand specimens in the UNC comparative collection. A total of 128 artifacts from the Jurgens site produced nine different color combinations (Table A-13). The most common response was none / none (77.3 percent) with the next most frequent response being none / green (10.9 percent). Each of the other responses accounted for less than three percent of the total. A good comparative sample of the tool stone from primary sources was not available, but two small samples in the UNC collection were exposed to UV light (Table A-14). A total of 11 pieces of modern flintknapping debitage from an unknown number of cores procured from a primary source in the Palmer Divide area near Parker, Colorado were found to have a none / none response. Three pieces of Dawson petrified wood from a secondary deposit on a river terrace along the South Platte near the town of Platteville also had a none / none response.

Hartville Uplift Chert. A large sample of artifacts from the Jurgens site assigned to this tool stone were exposed to UV light and the color responses were compared to those of hand samples collected from sources in the Hartville Uplift. A total of 302 Jurgens artifacts produced 18 different color responses with the most common being none / green (42.7 percent) (Table A-15). Three collections of hand samples of Hartville Uplift chert from non-specified sources were exposed to UV light and the none / green color response was found to be the most common in two of the three collections (Table A-16). A small collection of 22 hand samples in the possession of Dr. Douglas Bamforth produced several color response combinations with none / green being the most frequent at 45.4 percent. A larger sample of 103 pieces in the collection of Dr. Joe Ben Wheat in the CU Museum produced several color responses with none / green again being most prevalent at 75.7 percent. Finally, a collection of 29 pieces in the UNC collection displayed a number of color responses with none / green accounting for the second largest number of responses at 31.0 percent. The most common color response in the comparative collection was none / none (37.9 percent).

Minor Tool Stones from Very Distant Sources and South Platte River Gravels

Knife River Flint. The UV color responses of artifacts from the Jurgens site believed to be Knife River flint (KRF) based on examination in normal light were varied and did not match a sample from the source area (Table A-17). Seven different color combinations were recorded for the 15 artifacts from Jurgens classified as KRF that were exposed to UV light. The most frequent color response was orange / orange, which occurred in 46.7 percent of the cases. The hand samples of KRF from the source area were less than ideal for comparative purposes. Together they comprise 12 flakes struck from a piece of tool stone with a white cortex and may all be from the same core. The stone was collected by Dr. Matthew Root.
Table A-11. UV Color Responses of Jurgens Artifacts Made of Flat Top Chalcedony.

<table>
<thead>
<tr>
<th>Longwave UV Color Response</th>
<th>Shortwave UV Color Response</th>
<th>None</th>
<th>Green</th>
<th>Orange</th>
<th>White</th>
<th>Green and Orange</th>
<th>Green and White</th>
<th>Green, Orange, and White</th>
<th>Orange and White</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>Count</td>
<td>1</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>.4%</td>
<td>1.1%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.4%</td>
</tr>
<tr>
<td>Green</td>
<td>Count</td>
<td>-</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>-</td>
<td>1.4%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.4%</td>
</tr>
<tr>
<td>Orange</td>
<td>Count</td>
<td>-</td>
<td>117</td>
<td>1</td>
<td>-</td>
<td>5</td>
<td>-</td>
<td>-</td>
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<td>-</td>
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<td>-</td>
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<td>.7%</td>
<td>13.1%</td>
<td>5.3%</td>
<td>2.8%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>21.9%</td>
</tr>
<tr>
<td>Green and Orange</td>
<td>Count</td>
<td>-</td>
<td>12</td>
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<td>-</td>
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<td>-</td>
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<td>-</td>
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<td>-</td>
<td>.4%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.6%</td>
</tr>
<tr>
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<td>Count</td>
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<td>-</td>
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<td>5</td>
</tr>
<tr>
<td></td>
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<td>-</td>
<td>1.8%</td>
<td>-</td>
<td>.4%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.8%</td>
</tr>
<tr>
<td>Green, Orange, and White</td>
<td>Count</td>
<td>-</td>
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<td>-</td>
<td>-</td>
<td>2</td>
<td>-</td>
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<td>-</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>-</td>
<td>1.4%</td>
<td>-</td>
<td>.7%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.1%</td>
</tr>
<tr>
<td>Orange and White</td>
<td>Count</td>
<td>-</td>
<td>49</td>
<td>-</td>
<td>-</td>
<td>10</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>62</td>
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<tr>
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<td>% of Total</td>
<td>-</td>
<td>17.3%</td>
<td>-</td>
<td>3.5%</td>
<td>.4%</td>
<td>.7%</td>
<td></td>
<td></td>
<td>21.9%</td>
</tr>
<tr>
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<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>-</td>
<td>.4%</td>
<td>-</td>
<td>-</td>
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<td></td>
<td></td>
<td></td>
<td>.4%</td>
</tr>
<tr>
<td>Reddish Orange</td>
<td>Count</td>
<td>-</td>
<td>1</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>-</td>
<td>.4%</td>
<td>-</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.4%</td>
</tr>
<tr>
<td>Yellow and White</td>
<td>Count</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>-</td>
<td>.4%</td>
<td>-</td>
<td>.4%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.4%</td>
</tr>
<tr>
<td>Orange, White, and Orange</td>
<td>Count</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>% of Total</td>
<td>-</td>
<td>.4%</td>
<td>-</td>
<td>.4%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.4%</td>
</tr>
<tr>
<td>Total</td>
<td>Count</td>
<td>5</td>
<td>234</td>
<td>1</td>
<td>16</td>
<td>8</td>
<td>18</td>
<td>1</td>
<td>2</td>
<td>283</td>
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<tr>
<td></td>
<td>% of Total</td>
<td>1.1%</td>
<td>82.7%</td>
<td>.4%</td>
<td>5.7%</td>
<td>2.8%</td>
<td>6.4%</td>
<td>.4%</td>
<td>.7%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>
Table A-12. Comparison of UV Color Responses of Jurgens Artifacts of Flat Top Chalcedony with Hand Samples of the Tool Stone Collected from the Procurement Site.

<table>
<thead>
<tr>
<th>UV Color Response</th>
<th>Jurgens Artifacts</th>
<th>Hand Samples from Tool Stone Procurement Site (^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>Percentage</td>
</tr>
<tr>
<td>Longwave = None</td>
<td>3</td>
<td>1.1%</td>
</tr>
<tr>
<td>Shortwave = Green</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = Green</td>
<td>4</td>
<td>1.4%</td>
</tr>
<tr>
<td>Shortwave = Green</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = Orange</td>
<td>117</td>
<td>41.3%</td>
</tr>
<tr>
<td>Shortwave = Green</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = White</td>
<td>37</td>
<td>13.1%</td>
</tr>
<tr>
<td>Shortwave = Green</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = White</td>
<td>15</td>
<td>5.3%</td>
</tr>
<tr>
<td>Shortwave = White</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = Green and Orange</td>
<td>12</td>
<td>4.2%</td>
</tr>
<tr>
<td>Shortwave = Green</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = Orange and White</td>
<td>49</td>
<td>17.3%</td>
</tr>
<tr>
<td>Shortwave = Green</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other UV Color Responses that Individually Total Less than 5 Percent</td>
<td>46</td>
<td>16.3%</td>
</tr>
<tr>
<td>Total</td>
<td>283</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

\(^a\) Hand samples from the procurement site at Flat Top Butte (5LO34) present in three comparative collections were examined, including 10 pieces of Dr. Robert Brunswig at the University of Northern Colorado, 10 pieces of Dr. Douglas Bamforth at the University of Colorado at Boulder, and 16 pieces in possession of the author.

<table>
<thead>
<tr>
<th>Longwave UV Color Response</th>
<th>Shortwave UV Color Response</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>None</td>
<td>Green</td>
</tr>
<tr>
<td>None Count</td>
<td>99</td>
<td>14</td>
</tr>
<tr>
<td>% of Total</td>
<td>77.3%</td>
<td>10.9%</td>
</tr>
<tr>
<td>Green Count</td>
<td>-</td>
<td>3</td>
</tr>
<tr>
<td>% of Total</td>
<td>-</td>
<td>2.3%</td>
</tr>
<tr>
<td>Orange Count</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>% of Total</td>
<td>.8%</td>
<td>1.6%</td>
</tr>
<tr>
<td>White Count</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>% of Total</td>
<td>1.6%</td>
<td>1.6%</td>
</tr>
<tr>
<td>Total Count</td>
<td>102</td>
<td>21</td>
</tr>
<tr>
<td>% of Total</td>
<td>79.7%</td>
<td>16.4%</td>
</tr>
</tbody>
</table>
Table A-14. UV Color Response Comparison Between Jurgens Artifacts of Dawson Petrified Wood and Hand Samples of the Tool Stone Collected from Procurement Sites.

<table>
<thead>
<tr>
<th>UV Color Response</th>
<th>Jurgens Artifacts</th>
<th>Hand Samples from Tool Stone Procurement Site a</th>
<th>Hand Samples from Tool Stone Procurement Site b</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>Percentage</td>
<td>Count</td>
</tr>
<tr>
<td>Longwave = None</td>
<td>99</td>
<td>77.3%</td>
<td>See footnote a</td>
</tr>
<tr>
<td>Shortwave = None</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = None</td>
<td>14</td>
<td>10.9%</td>
<td>-</td>
</tr>
<tr>
<td>Shortwave = Green</td>
<td>15</td>
<td>11.8%</td>
<td>-</td>
</tr>
<tr>
<td>Other UV Color Responses that Individually Total Less than 5 Percent</td>
<td>15</td>
<td>11.8%</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>128</td>
<td>100.0%</td>
<td>-</td>
</tr>
</tbody>
</table>

a Sample of Dawson petrified wood is from a lithic source near Parker, Colorado and is in Dr. Robert Brunswig's comparative collection at the University of Northern Colorado. A total of 11 pieces of modern flintknapping debitage from an unknown number of cores were exposed to UV light.

b Sample of Dawson petrified wood is from a tool stone source on a river terrace along the South Platte River near Plateville, Colorado and is in Dr. Robert Brunswig's comparative collection at the University of Northern Colorado. A total of 3 pieces of debitage from an unknown number of cores were exposed to UV light.
Table A-15. UV Color Responses of Jurgens Artifacts Made of Hartville Uplift Chert.

<table>
<thead>
<tr>
<th>Shortwave UV Color Response</th>
<th>None</th>
<th>Green</th>
<th>Orange</th>
<th>White</th>
<th>Green and White</th>
<th>Orange and White</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>46</td>
<td>129</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>175</td>
</tr>
<tr>
<td>% of Total</td>
<td>15.2%</td>
<td>42.7%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>57.9%</td>
</tr>
<tr>
<td>Green</td>
<td>1</td>
<td>15</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>16</td>
</tr>
<tr>
<td>% of Total</td>
<td>.3%</td>
<td>5.0%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5.3%</td>
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<tr>
<td>Orange</td>
<td>-</td>
<td>36</td>
<td>3</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>40</td>
</tr>
<tr>
<td>% of Total</td>
<td>-</td>
<td>11.9%</td>
<td>1.0%</td>
<td>-</td>
<td>.3%</td>
<td></td>
<td>13.2%</td>
</tr>
<tr>
<td>White</td>
<td>3</td>
<td>46</td>
<td>-</td>
<td>11</td>
<td>3</td>
<td>-</td>
<td>63</td>
</tr>
<tr>
<td>% of Total</td>
<td>1.0%</td>
<td>15.2%</td>
<td>-</td>
<td>3.6%</td>
<td>1.0%</td>
<td>-</td>
<td>20.9%</td>
</tr>
<tr>
<td>Green and Orange</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>% of Total</td>
<td>-</td>
<td>.3%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>.3%</td>
</tr>
<tr>
<td>Green and White</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>% of Total</td>
<td>-</td>
<td>-</td>
<td>.3%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>.3%</td>
</tr>
<tr>
<td>Orange and White</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>1.0%</td>
</tr>
<tr>
<td>% of Total</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>.7%</td>
<td>.3%</td>
<td></td>
<td>1.7%</td>
</tr>
<tr>
<td>Light Yellow</td>
<td>-</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>% of Total</td>
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<td>.3%</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>.3%</td>
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<tr>
<td>% of Total</td>
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<td>.3%</td>
<td>-</td>
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<tr>
<td>% of Total</td>
<td>16.6%</td>
<td>76.2%</td>
<td>1.0%</td>
<td>4.0%</td>
<td>1.7%</td>
<td>.7%</td>
<td>100.0%</td>
</tr>
<tr>
<td>UV Color Response</td>
<td>Jurgens Artifacts</td>
<td>Hand Samples from Tool Stone Source Area</td>
<td>Hand Samples from Tool Stone Source Area</td>
<td>Hand Samples from Tool Stone Source Area</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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</tr>
<tr>
<td></td>
<td>Count</td>
<td>Percentage</td>
<td>Count</td>
<td>Percentage</td>
<td>Count</td>
<td>Percentage</td>
<td>Count</td>
</tr>
<tr>
<td>Longwave = None</td>
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<td>15.2%</td>
<td>3</td>
<td>13.6%</td>
<td>10</td>
<td>9.7%</td>
<td>11</td>
</tr>
<tr>
<td>Shortwave = None</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>42.7%</td>
<td>10</td>
<td>45.4%</td>
<td>78</td>
<td>75.7%</td>
<td>9</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = Green</td>
<td>15</td>
<td>5.0%</td>
<td>6</td>
<td>27.3%</td>
<td>12</td>
<td>11.6%</td>
<td>3</td>
</tr>
<tr>
<td>Shortwave = Green</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = Orange</td>
<td>36</td>
<td>11.9%</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1.0%</td>
<td>1</td>
</tr>
<tr>
<td>Shortwave = Green</td>
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<td></td>
</tr>
<tr>
<td>Longwave = White</td>
<td>46</td>
<td>15.2%</td>
<td>2</td>
<td>9.1%</td>
<td>1</td>
<td>1.0%</td>
<td>-</td>
</tr>
<tr>
<td>Shortwave = Green</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other UV Color</td>
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<td>9.7%</td>
<td>1</td>
<td>4.5%</td>
<td>1</td>
<td>1.0%</td>
<td>5</td>
</tr>
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<td></td>
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</tr>
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<td>Individually Total</td>
<td>Less than 5 Percent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>302</td>
<td>100.0%</td>
<td>22</td>
<td>100.0%</td>
<td>103</td>
<td>100.0%</td>
<td>29</td>
</tr>
</tbody>
</table>

*a* Includes hand samples from non-specified source(s) in the Hartville Uplift in the comparative collection of Dr. Douglas Bamforth of the University of Colorado at Boulder.

*b* Includes hand samples from non-specified source(s) in the Hartville Uplift in the comparative collection of the late Dr. Joe Ben Wheat at the University of Colorado Museum, Boulder.

*c* Includes hand samples from non-specified source(s) in the Hartville Uplift in the comparative collection of Dr. Robert Brunswig at the University of Northern Colorado.
Table A-17. UV Color Response Comparison Between Jurgens Artifacts of Knife River Flint and Hand Sample of the Tool Stone Collected from a Procurement Site.

<table>
<thead>
<tr>
<th>UV Color Response</th>
<th>Jurgens Artifacts</th>
<th>Hand Sample from Tool Stone Procurement Site&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>Percentage</td>
</tr>
<tr>
<td>Longwave = Green</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Shortwave = Green</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = Orange</td>
<td>7</td>
<td>46.7%</td>
</tr>
<tr>
<td>Shortwave = Orange</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = Orange</td>
<td>1</td>
<td>6.7%</td>
</tr>
<tr>
<td>Shortwave = Green and Orange</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = White</td>
<td>1</td>
<td>6.7%</td>
</tr>
<tr>
<td>Shortwave = White</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = Green and Orange</td>
<td>1</td>
<td>6.7%</td>
</tr>
<tr>
<td>Shortwave = Orange and White</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = Light Yellow</td>
<td>3</td>
<td>20.0%</td>
</tr>
<tr>
<td>Shortwave = Light Yellow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = Reddish Orange</td>
<td>1</td>
<td>6.7%</td>
</tr>
<tr>
<td>Shortwave = Reddish Orange</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>15</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

<sup>a</sup> Hand sample in possession of author consists of 12 modern flakes struck from an unknown number cores. Collected by Matthew Root from site 32DU955A in North Dakota. Cortex of hand sample is white in normal light and fluoresces orange under longwave and shortwave UV light.
from site 32DU955A in North Dakota. All of the flakes fluoresced green / green and the cortex present on some of them had an orange/ orange color response.

**Smoky Hill Jasper.** The color response of the utilized flake classified as Smoky Hill jasper matched those of most of several hand samples from the source area (Table A-18). As the utilized flake did not fluoresce, its color response is none / none. This was also the response of a single hand sample from the Medicine Creek drainage in Nebraska. The color response of seven of eight hand samples from a source in Trego County, Kansas was none / none. The remaining piece of jasper had a none / green response.

**Wamsutter Oölitic Chert.** The UV color response of the point tip of Wamsutter oölitic chert was the same as that recorded for the exterior of two hand samples from the closest known source on Delaney Rim (Table A-18). The point tip fluoresced orange / orange. Under normal light, the artifact is off-white. This is the color of the patination layer that evidently forms on ancient artifacts of Wamsutter oölitic chert. The two hand samples were flaked to remove the patination layer. The color response of the patinated exterior of the hand samples was orange / orange. Under normal light, the interior of the hand samples exposed by flaking appears medium brown and has no color response when exposed to either long or shortwave UV light.

**Fort Union Porcellanite.** The UV color response of the point from the Jurgen site made of light gray Fort Union porcellanite was different from that of a light purple hand sample of the tool stone from Campbell County, Wyoming (Table A-18). The artifact had no color response under longwave and shortwave UV light, but the hand sample fluoresced none / white.

**Tool Stones from South Platte River Gravels.** Artifacts made from two varieties of tool stone from the South Platte River gravels were exposed to UV light to record their color response (Table A-18), but hand samples from a gravel source were not available for comparison. River cobbles of white-to-light gray metaquartzite were the raw material selected for 10 of the artifacts in the Jurgen collection. Included are flaked stone artifacts and hammerstones. Two cobbles of this stone were transported to the site as manuports without apparent modification. None of the artifacts or manuports produced a color response. An off-white-to-light brown tuff was the raw material of three flaked stone artifacts. This rock type also produced no UV color response.

**Alibates Agate.** The color responses of artifacts of Alibates agate from the Jurgen site and hand samples from the source area in Texas were both varied, but particular colors were found to be predominant under long and shortwave light. Five kinds of color responses were observed for the eight artifacts from Jurgen that were exposed to UV light (Table A-19). Three color responses were obtained from five hand samples collected in the source area (Table A-20). To generalize, it can be said that the most common color response under longwave radiation is white, occurring either by itself or with another color. Among the artifacts, white was the longwave color response in 62.5 percent of the cases. In the collection of the hand samples, white was also the most prevalent longwave response, occurring either by itself or with another color in 60 percent of the cases. Under shortwave UV light, green is the most common color, occurring alone or with one or two other colors. Green occurred in 50 percent of the shortwave color responses of the artifacts and in 100 percent of the responses from the hand samples.
Table A-18. UV Color Responses of Jurgens Artifacts Made of Minor Flaked Stone Raw Materials from Known Sources.

<table>
<thead>
<tr>
<th>Tool Stone Type</th>
<th>Artifact Count</th>
<th>UV Longwave Color Response</th>
<th>UV Shortwave Color Response</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smoky Hill Jasper</td>
<td>1</td>
<td>None</td>
<td>None</td>
<td>Color response of comparative tool stone samples in collection of Dr. Douglas Bamforth, University of Colorado, Boulder: one piece from Medicine Creek, Nebraska: longwave = none, shortwave = none. Eight pieces from Trego County, Kansas; T 11 S, R 25 W, Section 6: Seven pieces: longwave = none, shortwave = none, one piece: longwave = none, shortwave = green.</td>
</tr>
<tr>
<td>Wamsutter Öölitic Chert</td>
<td>1</td>
<td>Orange</td>
<td>Orange</td>
<td>Color response of comparative tool stone sample in possession of author: two pieces from Delaney Rim, Sweetwater County Wyoming: on patinated flaked surfaces: longwave = orange, shortwave = orange; on newly flaked surfaces: longwave = none, shortwave = none.</td>
</tr>
<tr>
<td>Ft. Union Porcellanite</td>
<td>1</td>
<td>None</td>
<td>None</td>
<td>Color response of comparative tool stone sample in possession of author: one piece from Campbell County, Wyoming: longwave = none, shortwave = white.</td>
</tr>
<tr>
<td>South Platte River Gravel, White-to-Light Gray Metaquartzite</td>
<td>10 artifacts, 2 manuports</td>
<td>None</td>
<td>None</td>
<td>No comparative tool stone sample available.</td>
</tr>
<tr>
<td>South Platte River Gravel, Off-White-to-Light-Brown Tuff</td>
<td>3</td>
<td>None</td>
<td>None</td>
<td>No comparative tool stone sample is available.</td>
</tr>
</tbody>
</table>
Table A-19. UV Color Responses of Jurgens Artifacts Made of Alibates Agate.

<table>
<thead>
<tr>
<th>Longwave UV Color Response</th>
<th>None</th>
<th>Green</th>
<th>White</th>
<th>Green and White</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shortwave UV Color Response</td>
<td>Count</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>1</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>% of Total</td>
<td>12.5%</td>
<td>12.5%</td>
<td>-</td>
<td>-</td>
<td>25.0%</td>
</tr>
<tr>
<td>Green</td>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>% of Total</td>
<td>-</td>
<td>12.5%</td>
<td>-</td>
<td>-</td>
<td>12.5%</td>
</tr>
<tr>
<td>White</td>
<td>-</td>
<td>-</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>% of Total</td>
<td>-</td>
<td>-</td>
<td>37.5%</td>
<td>25.0%</td>
<td>62.5%</td>
</tr>
<tr>
<td>Total</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>% of Total</td>
<td>12.5%</td>
<td>25.0%</td>
<td>37.5%</td>
<td>25.0%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>
Table A-20. UV Color Response Comparison Between Jurgens Artifacts of Alibates Agate and Hand Samples of the Tool Stone Collected from Procurement Site.

<table>
<thead>
<tr>
<th>UV Color Response</th>
<th>Jurgens Artifacts</th>
<th>Hand Samples from Tool Stone Procurement Site a</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>Percentage</td>
</tr>
<tr>
<td>Longwave = None</td>
<td>1</td>
<td>12.5%</td>
</tr>
<tr>
<td>Shortwave = None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = None</td>
<td>1</td>
<td>12.5%</td>
</tr>
<tr>
<td>Shortwave = Green</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = Green</td>
<td>1</td>
<td>12.5%</td>
</tr>
<tr>
<td>Shortwave = Green</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = White</td>
<td>3</td>
<td>37.5%</td>
</tr>
<tr>
<td>Shortwave = White</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = White</td>
<td>2</td>
<td>25.0%</td>
</tr>
<tr>
<td>Shortwave = Green and White</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = White and Yellow</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Shortwave = White, Yellow, and Green</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

a Hand samples in comparative tool stone collection of Dr. Douglas Bamforth, University of Colorado, Boulder. Collected from Alibates Flint Quarries National Monument, Potter County, Texas with permission of park officials.
Edwards Chert. The UV color responses of 12 artifacts in the Jurgens collection believed to be made of Edwards chert were compared with those of 21 hand samples of the tool stone known to have been obtained from sources in Texas. The 12 Jurgens artifacts produced four kinds of color responses under UV light (Table A-21) and irradiation of the 21 hand samples resulted in six different color responses (Table A-22). The items of Edwards chert in the sample of hand specimens included pieces of stone collected from sources as well as experimental stone tools used in use wear studies of Dr. Douglas Bamforth. Under longwave radiation, light yellow was a common color response, occurring in 75 percent of the artifacts and 80.9 percent of the hand samples. Light yellow was also a common color response under shortwave UV light. Among the artifacts from Jurgens, light yellow was a common shortwave color response, occurring by itself in 75 percent of the cases and, less frequently, in combination with green (8.3 percent). In the set of hand samples, light yellow was the shortwave color response in 33.3 percent of the cases and light yellow appeared along with green in another 33.3 percent.

Unsourced Tool Stones

Table A-23 describes the tool stones in the Jurgens collection from unknown sources when viewed under normal light and it also gives their color responses to longwave and shortwave UV radiation. It is suspected that some or all of these tool stones derive from very distant sources. The information is presented here in hopes that it may someday help archaeologists working in other parts of the Plains or surrounding regions to identify the sources of the tool stones.

<table>
<thead>
<tr>
<th>Longwave UV Color Response</th>
<th>Orange</th>
<th>Light Yellow</th>
<th>Reddish Orange</th>
<th>Light Yellow and Green</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orange</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>% of Total</td>
<td>8.3%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light Yellow</td>
<td></td>
<td>-</td>
<td>9</td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>% of Total</td>
<td>-</td>
<td>75.0%</td>
<td>75.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reddish Orange</td>
<td></td>
<td>-</td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>% of Total</td>
<td>-</td>
<td>-</td>
<td></td>
<td>8.3%</td>
<td>8.3%</td>
</tr>
<tr>
<td>Light Yellow and Green</td>
<td></td>
<td>-</td>
<td></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>% of Total</td>
<td>-</td>
<td>-</td>
<td></td>
<td>8.3%</td>
<td>8.3%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1</td>
<td>9</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>% of Total</td>
<td>8.3%</td>
<td>75.0%</td>
<td>8.3%</td>
<td>8.3%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>
Table A-22. UV Color Response Comparison Between Jurgens Artifacts of Edwards Chert and Hand Samples of the Tool Stone Collected from the Source Area.

<table>
<thead>
<tr>
<th>UV Color Response</th>
<th>Jurgens Artifacts</th>
<th>Hand Samples from Tool Stone Source Area&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Count</td>
<td>Percentage</td>
</tr>
<tr>
<td>Longwave = None</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Shortwave = None</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = Orange</td>
<td>1</td>
<td>8.3%</td>
</tr>
<tr>
<td>Shortwave = Orange</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = Light Yellow</td>
<td>9</td>
<td>75.0%</td>
</tr>
<tr>
<td>Shortwave = Light Yellow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = Light Yellow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shortwave = Light Yellow and Green</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Longwave = Light Yellow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shortwave = Green</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = Light Yellow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shortwave = Light Brown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = Light Yellow and Green</td>
<td>1</td>
<td>8.3%</td>
</tr>
<tr>
<td>Shortwave = Light Yellow and Green</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longwave = Reddish Orange</td>
<td>1</td>
<td>8.3%</td>
</tr>
<tr>
<td>Shortwave = Reddish Orange</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

<sup>a</sup> A total of 21 artifacts or hand samples of Edwards chert that originates from the source area in Texas were examined. The items are in the possession of Dr. Douglas Bamforth of the University of Colorado at Boulder and include 10 experimental stone tools used in use wear studies.
**Table A-23. UV Color Responses of Jurgens Artifacts Made of Flaked Stone Raw Materials from Unknown Sources.**

<table>
<thead>
<tr>
<th>Tool Stone Type</th>
<th>Artifact Count</th>
<th>UV Longwave Color Response</th>
<th>UV Shortwave Color Response</th>
<th>Artifact and Tool Stone Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsourced Tool Stone A</td>
<td>1</td>
<td>Red</td>
<td>Red</td>
<td>End scraper of opaque black chert with equidistant light brown splottes.</td>
</tr>
<tr>
<td>Unsourced Tool Stone B</td>
<td>1</td>
<td>Green, Orange, and White</td>
<td>Green</td>
<td>Beveled tool of translucent, rough-textured, light bluish gray chert with frequent smoky splottes, sparse white mottling, and sparse blue-to-black specks.</td>
</tr>
<tr>
<td>Unsourced Tool Stone C</td>
<td>1</td>
<td>None</td>
<td>Green</td>
<td>Utilized interior flake of dark brown chert</td>
</tr>
<tr>
<td>Unsourced Tool Stone D</td>
<td>1</td>
<td>None</td>
<td>None</td>
<td>Interior flake of opaque black chert</td>
</tr>
<tr>
<td>Unsourced Tool Stone E</td>
<td>1</td>
<td>Not Recorded</td>
<td>Not Recorded</td>
<td>Interior flake of translucent white petrified wood</td>
</tr>
<tr>
<td>Unsourced Tool Stone F</td>
<td>1</td>
<td>None</td>
<td>None</td>
<td>Interior flake of medium gray chert with numerous microscopic off-white spherical inclusions that weather into tiny pits when cut by a flake scar</td>
</tr>
</tbody>
</table>
APPENDIX B

TABLES DEMONSTRATING CONTEMPORANEOITY OF AREAS AT THE JURGENS SITE THROUGH IDENTIFICATION OF SETS OF CONJOINING OR REFITTING ARTIFACTS AND MINIMUM ANALYTICAL NODULES IN THE ARTIFACT ASSEMBLAGE

Appendix B consists of two tables exhibiting the results of analyses demonstrating contemporaneity of three areas at the Jurgens site by establishing connections among artifacts found in the separate areas. Table B-1 presents information on the sets of conjoining or refitting artifacts from the site. Table B-2 provides information on sets of artifacts determined to derive from the same nodule, piece, or batch of tool stone based on shared raw material characteristics.
Table B-1. Conjoining and Refitting Artifacts from the Jurgens Site (Page 1 of 5).

<table>
<thead>
<tr>
<th>Designation of Set of Conjoining or Refitting Artifacts</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Tool Stone Description</th>
<th>Provenience</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cat. # 23083</td>
<td>end scraper</td>
<td>Flat Top chalcedony</td>
<td>Area 1, Excavation Unit 14H90</td>
<td>The flake is not utilized and refits onto the dorsal face of the end scraper.</td>
</tr>
<tr>
<td></td>
<td>Cat. # 23094</td>
<td>interior flake</td>
<td></td>
<td>Area 2, Excavation Unit 10F59</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Cat. # 30193</td>
<td>bifacial core</td>
<td>South Platte River gravel: white-to-light gray metaquartzite</td>
<td>Area 2, ground surface</td>
<td>The artifact is from the western cluster of the concentration in Area 2.</td>
</tr>
<tr>
<td></td>
<td>Cat. # 23095, Field Specimen F69</td>
<td>secondary flake</td>
<td></td>
<td>Area 2, Excavation Unit 10F60</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cat. # 30171</td>
<td>informal retouched flake tool (graver)</td>
<td></td>
<td>Area 1, ground surface</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Cat. # 30089</td>
<td>end scraper</td>
<td>Flat Top chalcedony</td>
<td>Area 1, ground surface</td>
<td>When the pot lid came off of the end scraper, it removed a layer of patina, indicating the thermal damage did not occur in Cody times. After coming off of the end scraper, the pot lid was evidently moved to the Fill Area by an earth moving machine when the site area was leveled for farmland.</td>
</tr>
<tr>
<td></td>
<td>Cat. # 30199, Item 15</td>
<td>pot lid</td>
<td></td>
<td>Fill Area, ground surface</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Cat. # 30201g</td>
<td>grinding slab (fragment)</td>
<td>Lyons sandstone</td>
<td>Area 1, ground surface</td>
<td>A large scratch running across a matching face of both fragments suggests they were once part of a larger fragment that was broken by farm equipment.</td>
</tr>
<tr>
<td></td>
<td>Cat. # 30201i</td>
<td>grinding slab (fragment)</td>
<td></td>
<td>Area 1, ground surface</td>
<td></td>
</tr>
<tr>
<td>Designation of Set of Conjoining or Refitting Artifacts</td>
<td>Artifact Catalog Number and Any Other Identifiers</td>
<td>Artifact Type</td>
<td>Tool Stone Description</td>
<td>Provenience</td>
<td>Comments</td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
<td>-------------------------------------------------</td>
<td>--------------</td>
<td>------------------------</td>
<td>------------</td>
<td>---------</td>
</tr>
<tr>
<td>5</td>
<td>Cat. # 23116, Field Specimen F125</td>
<td>interior flake (fragment of biface thinning flake)</td>
<td>Flat Top chalcedony</td>
<td>Area 1, Excavation Unit 15I2</td>
<td>The break facets on these flake fragments are not as dirty as elsewhere, suggesting breakage occurred recently, perhaps during excavation.</td>
</tr>
<tr>
<td></td>
<td>Cat. # 23116, Field Specimen F126</td>
<td>interior flake (fragment of biface thinning flake)</td>
<td>Area 1, Excavation Unit 15I2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Cat. # 23116, Field Specimen F468</td>
<td>interior flake (fragment of biface thinning flake)</td>
<td>Flat Top chalcedony</td>
<td>Area 1, Excavation Unit 15I2</td>
<td>The fact that these conjoined flake fragments were assigned sequential field specimen numbers suggests the fragments were recovered close together and that the flake may have been broken during excavation.</td>
</tr>
<tr>
<td></td>
<td>Cat. # 23116, Field Specimen F469</td>
<td>interior flake (fragment of biface thinning flake)</td>
<td>Area 1, Excavation Unit 15I2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Cat. # 23095, Field Specimen F82</td>
<td>interior flake (utilized biface thinning flake)</td>
<td>Hartville Uplift chert: dark yellowish brown with branching inclusions suggestive of filaments of a fossil organism</td>
<td>Area 2, Excavation Unit 10F60</td>
<td>These artifacts are complete flakes. The ventral face of one flake refits onto the dorsal face of the other.</td>
</tr>
<tr>
<td></td>
<td>Cat. # 23095, Field Specimen F86</td>
<td>interior flake (biface thinning flake)</td>
<td>Area 2, Excavation Unit 10F60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Cat. # 30197, Item 190</td>
<td>utilized primary flake (fragment)</td>
<td>Dawson petrified wood</td>
<td>Area 2, ground surface</td>
<td>Edge damage along the break facet on each flake fragment suggests both were used after the flake broke.</td>
</tr>
<tr>
<td></td>
<td>Cat. # 30197, Item 191</td>
<td>utilized primary flake (fragment)</td>
<td>Area 2, ground surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Designation of Set of Conjoining or Refitting Artifacts</td>
<td>Artifact Catalog Number and Any Other Identifiers</td>
<td>Artifact Type</td>
<td>Tool Stone Description</td>
<td>Provenience</td>
<td>Comments</td>
</tr>
<tr>
<td>-------------------------------------------------------</td>
<td>-------------------------------------------------</td>
<td>---------------</td>
<td>-----------------------</td>
<td>-------------</td>
<td>----------</td>
</tr>
<tr>
<td>9</td>
<td>Cat. # 23099, Field Specimen F129</td>
<td>interior flake (biface thinning flake fragment)</td>
<td>White River Group gravel: greenish and yellowish medium brown, very rough-textured orthoquartzite</td>
<td>Area 2, Excavation Unit 11F51</td>
<td>These conjoining flake fragments are both from the eastern cluster of the artifact concentration defined by Wheat (1979: Figure 63) and from the same 2 m by 2 m excavation unit. The flakes are part of the set of 67 artifacts comprising Nodule 30 (Table B-2).</td>
</tr>
<tr>
<td></td>
<td>Cat. # 23099, Field Specimen F133</td>
<td>interior flake (biface thinning flake fragment)</td>
<td>White River Group gravel: light brown, very rough-textured orthoquartzite</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Cat. # 23099, Field Specimen F139</td>
<td>interior flake (biface thinning flake fragment)</td>
<td>White River Group gravel: light brown, very rough-textured orthoquartzite</td>
<td>Area 2, Excavation Unit 11F51</td>
<td>These conjoining flake fragments are both from the eastern cluster of the artifact concentration defined by Wheat (1979: Figure 63) and from the same 2 m by 2 m excavation unit. The flakes are part of the set of four flakes comprising Nodule 48 (Table B-2).</td>
</tr>
<tr>
<td></td>
<td>Cat. # 23099, Field Specimen F158</td>
<td>interior flake (biface thinning flake fragment)</td>
<td>White River Group gravel: light brown, very rough-textured orthoquartzite</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Cat. # 19567</td>
<td>projectile point (midsection fragment)</td>
<td>White River Group gravel: light-to-medium red, very fine-grained orthoquartzite</td>
<td>Area 3, Excavation Unit 5D41 or 5D64</td>
<td>These point fragments were recovered from different excavation units in Area 3. The fragments were then glued together and assigned a single catalog number. Judging from the excavation units in which the fragments were found, they were located between 4.5 to 10 m apart (Wheat 1979: Figure 26a).</td>
</tr>
<tr>
<td></td>
<td>Cat. # 19567</td>
<td>projectile point (midsection fragment)</td>
<td>White River Group gravel: light-to-medium red, very fine-grained orthoquartzite</td>
<td>Area 3, Excavation Unit 5D41 or 5D64</td>
<td></td>
</tr>
</tbody>
</table>
Table B-1. Conjoining and Refitting Artifacts from the Jurgens Site (Page 4 of 5).

<table>
<thead>
<tr>
<th>Designation of Set of Conjoining or Refitting Artifacts</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Tool Stone Description</th>
<th>Provenience</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Cat. # 19576</td>
<td>projectile point (proximal fragment)</td>
<td>Dawson petrified wood</td>
<td>Area 3, Excavation Unit 5D63 or 5D65</td>
<td>These point fragments were recovered from different excavation units in Area 3. Judging from the excavation units in which the fragments were found, they were located between 2 and 6.3 meters apart (Wheat 1979:Figure 26a). The fragments were then glued together and assigned a single catalog number. Wheat (1979:73) incorrectly identified the raw material as Knife River flint.</td>
</tr>
<tr>
<td></td>
<td>Cat. # 19576 (distal fragment)</td>
<td></td>
<td></td>
<td>Area 3, Excavation Unit 5D63 or 5D65</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Cat. # 19612</td>
<td>end scraper (fragment)</td>
<td>Flat Top chalcedony</td>
<td>Area 3, Excavation Unit 5D43 or 5D51</td>
<td>The end scraper was broken into at least four fragments by a thermal fracture. Two fragments were recovered from different excavation units in Area 3 and subsequently glued together. Judging from the excavation units in which the fragments were found, they were located between 2 and 7 meters apart (Wheat 1979:Figure 26a).</td>
</tr>
<tr>
<td></td>
<td>Cat. # 19625</td>
<td>end scraper (fragment)</td>
<td></td>
<td>Area 3, Excavation Unit 5D43 or 5D51</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Cat. # 30198, Item 1</td>
<td>utilized secondary flake</td>
<td>White River Group gravel: very rough-textured orthoquartzite</td>
<td>Area 3, ground surface</td>
<td>Evidently, after a flake broke, one fragment was prepared for use as an informal retouched tool.</td>
</tr>
<tr>
<td></td>
<td>Cat. # 30200k</td>
<td>informal retouched flake tool</td>
<td>general site area</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table B-1. Conjoining and Refitting Artifacts from the Jurgens Site (Page 5 of 5).

<table>
<thead>
<tr>
<th>Designation of Conjoined Set of Artifacts</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Tool Stone Description</th>
<th>Provenience</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Cat. # 30198, Item 26a</td>
<td>informal retouched flake tool (fragment)</td>
<td>Flat Top chalcedony</td>
<td>Area 3, ground surface</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cat. # 30198, Item 26b</td>
<td>informal retouched flake tool (fragment)</td>
<td></td>
<td>Area 3, ground surface</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cat. # 30198, Item 26c</td>
<td>informal retouched flake tool (fragment)</td>
<td></td>
<td>Area 3, ground surface</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cat. # 30198, Item 26d</td>
<td>informal retouched flake tool (fragment)</td>
<td></td>
<td>Area 3 ground surface</td>
<td>Marks on the dorsal face of the refitted artifact suggest it was broken in recent times.</td>
</tr>
<tr>
<td>Designation of Set of Artifacts from Same Nodule or Batch of Stone</td>
<td>Tool Stone Description</td>
<td>Artifact Catalog Number and Any Other Identifiers</td>
<td>Artifact Type</td>
<td>Provenience</td>
<td>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</td>
</tr>
<tr>
<td>---</td>
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<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>1</td>
<td>Hartville Uplift chert: dark yellowish brown with branching structures suggestive of fossils</td>
<td>Cat. # 23046</td>
<td>projectile point (distal fragment)</td>
<td>Area 2, Excavation Unit 10F60</td>
<td>Manufacture of projectile point near Area 2, loss or discard of point in Area 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23095, Field Specimen F82</td>
<td>utilized interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 10F60</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 30197, Item 108</td>
<td>utilized interior flake (biface thinning)</td>
<td>Area 2, ground surface</td>
<td>Two refitting flakes represent a sequence of flakes removed during biface thinning. The flakes are complete with the ventral face of one refitting onto the dorsal face of the other (Catalog # 23095, Field Specimens F82 and F86).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23095, Field Specimen F86</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 10F60</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 30197, Item 109</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, ground surface</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 30196, Item 34</td>
<td>utilized interior flake</td>
<td>Area 1, ground surface</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 19594</td>
<td>utilized interior flake (biface thinning)</td>
<td>Area 3, Excavation Unit 5D21</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 30199, Item 16</td>
<td>utilized interior flake (biface thinning)</td>
<td>Fill Area, ground surface</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Hartville Uplift chert: medium yellowish brown with black dendrites and purplish red veins and inclusions</td>
<td>Cat. # 19591</td>
<td>projectile point (fragment comprised of midsection and tip)</td>
<td>Area 3, Excavation Unit 5D</td>
<td>Manufacture of projectile point near Area 2, loss or discard of point in Area 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F56</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F157</td>
<td>interior flake</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F164</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td>(continued)</td>
<td></td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>
### Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone (Page 2 of 35).

<table>
<thead>
<tr>
<th>Artifacts Demonstrating Connections Between Site Areas:</th>
<th>Tool Stone Description</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Provenience</th>
<th>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 (concluded)</td>
<td>Cat. # 23099, Field Specimen F177</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
<td>Manufacture of projectile point near Area 2 (?), loss or discard of point in Area 3.</td>
</tr>
<tr>
<td>3</td>
<td>Dawson petrified wood: dark brown areas with parallel lines in a medium brownish yellow matrix</td>
<td>Cat. # 19570</td>
<td>projectile point (fragment comprised of base and midsection)</td>
<td>Area 3, Excavation Unit 5D52</td>
<td>Manufacture of projectile point near Area 2 (?), loss or discard of point in Area 3.</td>
</tr>
<tr>
<td></td>
<td>Cat. # 30197, Item 184</td>
<td>interior flake</td>
<td>Area 2, ground surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Hartville Uplift chert: medium yellowish brown with lighter speckles and a high luster</td>
<td>(no catalog #), &quot;Test C-1&quot;</td>
<td>projectile point</td>
<td>Area 3, Test Pit C</td>
<td>Manufacture of projectile point near Area 2 (?), loss or discard of point in Area 3.</td>
</tr>
<tr>
<td></td>
<td>Cat. # 30197, Item 117</td>
<td>interior flake</td>
<td>Area 2, ground surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Hartville Uplift chert: medium brown with non-parallel linear arrangements of black dendrites</td>
<td>Cat. # 19579</td>
<td>projectile point</td>
<td>Area 3, Excavation Unit 5D64</td>
<td>Manufacture of projectile point on-site, discard of point in Area 3 and use near Area 1 of one of the flakes from point manufacture, followed by discard in Area 3. The flake is slightly lighter in color than the point.</td>
</tr>
<tr>
<td></td>
<td>Cat. # 30196, Item 45</td>
<td>utilized interior flake (biface thinning)</td>
<td>Area 1, ground surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>White River Group gravel: multi-colored, very rough-textured orthoquartzite. Colors include: light brown, medium brown, light yellowish brown, light rust-colored and medium rust-colored, light gray, and light purple</td>
<td>Cat. # 30083</td>
<td>projectile point preform</td>
<td>Area 2, ground surface</td>
<td>Knapping of projectile point performs near Area 2, use of one of the flakes produced near Area 3 and later discard in that area, on-site use of another flake and transport to the Fill Area in modern times by earth moving machine.</td>
</tr>
<tr>
<td></td>
<td>Cat. # 30084</td>
<td>projectile point preform</td>
<td>Area 2, ground surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cat. # 30197, Item 6</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, ground surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(continued)</td>
<td>Cat. # 23095, Field Specimen F33</td>
<td>interior flake</td>
<td>Area 2, Excavation Unit 10F60</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone (Page 3 of 35).

Artifacts Demonstrating Connections Between Site Areas:

<table>
<thead>
<tr>
<th>Designation of Set of Artifacts from Same Nodule or Batch of Stone</th>
<th>Tool Stone Description</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Provenience</th>
<th>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 (concluded)</td>
<td></td>
<td>Cat. # 30198, Item 6</td>
<td>utilized interior flake (biface thinning)</td>
<td>Area 3, ground surface</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 30199, Item 3</td>
<td>utilized interior flake</td>
<td>Fill Area, ground surface</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Hartville Uplift Chert: medium yellowish brown with veins filled with clear quartz</td>
<td>30040</td>
<td>projectile point (basal fragment)</td>
<td>Area 2, ground surface</td>
<td>Manufacture of a projectile point near Area 2, breakage of the point during use in the field, and finally, the discard of the point base in Area 2.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>23099, Field Specimen F204</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>23099, Field Specimen F217</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>White River Group gravel: very rough-textured orthoquartzite. Greenish and yellowish medium brown. Similar to raw material of Nodule #34, only more translucent and with white sand grains.</td>
<td>Cat. # 23051</td>
<td>projectile point (short, possibly reworked point measuring 3.48 cm long)</td>
<td>Area 2, Excavation Unit 11F51</td>
<td>Manufacture of projectile points near Areas 1 and 2, breakage of two of the points during use in the field, and finally, discard of two point bases and one short, reworked point at the same spot in Area 2.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23049</td>
<td>projectile point (basal fragment)</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23050</td>
<td>projectile point (basal fragment)</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23095, Field Specimen F62</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 10F60</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23095, Field Specimen F67</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 10F60</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23095, Field Specimen F76</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 10F60</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23095, Field Specimen F89</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 10F60</td>
<td></td>
</tr>
<tr>
<td>(continued)</td>
<td></td>
<td></td>
<td></td>
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</table>
Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone (Page 4 of 35).

Artifacts Demonstrating Connections Between Site Areas:

<table>
<thead>
<tr>
<th>Designation of Set of Artifacts from Same Nodule or Batch of Stone</th>
<th>Tool Stone Description</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Provenience</th>
<th>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 (concluded)</td>
<td></td>
<td>Cat. # 23095, Field Specimen F94</td>
<td>interior flake</td>
<td>Area 2, Excavation Unit 10F60</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23095, Field Specimen F98</td>
<td>interior flake</td>
<td>Area 2, Excavation Unit 10F60</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23095, Field Specimen F101</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 10F60</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F89</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F166</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23102, Field Specimen F15</td>
<td>interior flake</td>
<td>Area 2, Excavation Unit 11F61</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23104, Field Specimen F2</td>
<td>interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 14H87</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23112, Field Specimen F13</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 15H91</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>White River Group gravel: light red, very rough-textured orthoquartzite. The matrix between the sand grains of the orthoquartzite patinates to a white color.</td>
<td>Cat. # 30076, Field # SL3-16</td>
<td>projectile point (midsection)</td>
<td>Area 3, ground surface</td>
<td>The bifacial artifact in the set of artifacts was classified by Wheat (1979:83-85, Table 85) as a stemmed knife, but is here considered to be a projectile point. Manufacture of a projectile point near Area 2 and later discard of waste flakes in Area 2, use and breakage of the point in the field, and discard of point midsection fragment in Area 3.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23095, Field Specimen F112</td>
<td>interior flake</td>
<td>Area 2, Excavation Unit 10F60</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F172</td>
<td>interior flake</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td>Designation of Set of Artifacts from Same Nodule or Batch of Stone</td>
<td>Tool Stone Description</td>
<td>Artifact Catalog Number and Any Other Identifiers</td>
<td>Artifact Type</td>
<td>Provenience</td>
<td>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</td>
</tr>
<tr>
<td>-----------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------</td>
<td>----------------------------</td>
<td>-----------------------</td>
<td>---------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>10</td>
<td>Hartville Uplift chert: medium brownish yellow with clusters of black dendrites</td>
<td>Cat. # 30070 stemless knife (distal fragment)</td>
<td>Area 3, ground surface</td>
<td></td>
<td>Manufacture of knife near Area 2, use of a flake from knife manufacture near Area 2 and discard of the used flake in Area 2, use and breakage of knife near Area 3, discard of knife fragment in Area 3.</td>
</tr>
<tr>
<td></td>
<td>Cat. # 30197, Item 138 utilized interior flake</td>
<td>Area 2, ground surface</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>White River Group gravel: very rough-textured orthoquartzite. Rust-colored, light yellow, light gray, and pink.</td>
<td>Cat. # 30086 projectile point preform (broken, with use wear)</td>
<td>Area 3, ground surface</td>
<td></td>
<td>Manufacture of perform near Area 1, use of preform near Area 3, discard of broken preform in Area 3.</td>
</tr>
<tr>
<td></td>
<td>Cat. # 30196, Item 20 interior flake (biface thinning)</td>
<td>Area 1, ground surface</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Flat Top chalcedony: light gray, light brown, and light purple with reddish speckles and off-white, basically spherical inclusions</td>
<td>Cat. # 30071 Stage 3 biface (fragment broken by thermal fractures)</td>
<td>Area 3, ground surface</td>
<td></td>
<td>Manufacture of biface and end scraper near Area 1, use of some of the manufacturing flakes near Area 1, discard of flakes in Area 1, use of biface and end scraper near Area 3 and discard in Area 3. Both the biface and the end scraper were broken by thermal fractures. The end scraper fragments have been glued together. Judging from the position of the excavation units in which the end scraper fragments were found, they were from 1.0 to 7.1 m apart.</td>
</tr>
<tr>
<td></td>
<td>Cat. # 19612 and 19625 end scraper</td>
<td>Area 3, Excavation Units 5D43 and 5D51</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cat. # 23108 interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 14H90</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cat. # 23117 utilized interior flake</td>
<td>Area 1, Excavation Unit 1513</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Cat. # 30196 utilized interior flake</td>
<td>Area 1, ground surface</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cat. # 23107, Field Specimen F22 interior flake</td>
<td>Area 1, Excavation Unit 14H89</td>
<td></td>
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<tr>
<td></td>
<td>Cat. # 23108, Field Specimen F1A interior flake</td>
<td>Area 1, Excavation Unit 14H90</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Cat. # 23108, Field Specimen F95 interior flake</td>
<td>Area 1, Excavation Unit 14H90</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Designation of Set of Artifacts from Same Nodule or Batch of Stone</td>
<td>Tool Stone Description</td>
<td>Artifact Catalog Number and Any Other Identifiers</td>
<td>Artifact Type</td>
<td>Provenience</td>
<td>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
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</tr>
<tr>
<td>12 (concluded)</td>
<td>Cat. # 23108, Field Specimen F104</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 14H90</td>
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<td></td>
<td>Cat. # 23108, Field Specimen F127</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 14H90</td>
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<td></td>
<td>Cat. # 23108, Field Specimen F137</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 14H90</td>
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<tr>
<td></td>
<td>Cat. # 23108, Field Specimen F145</td>
<td>interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 14H90</td>
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<tr>
<td></td>
<td>Cat # 23108, Field Specimen F157</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 14H90</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Cat. # 23110, Field Specimen F38</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 14H100</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Cat. # 23110, Field Specimen F40</td>
<td>interior flake (core reduction)</td>
<td>Area 1, Excavation Unit 14H100</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cat. # 23116, Field Specimen F379</td>
<td>interior flake (biface thinning)</td>
<td>Area 1 Excavation Unit 15I2</td>
<td></td>
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</tr>
<tr>
<td>13</td>
<td>Hartville Uplift chert: medium brown with dark brown dendrites</td>
<td>Cat. # 19623</td>
<td>utilized interior flake (biface thinning)</td>
<td>Area 3 Excavation Unit 5D3</td>
<td>Use of informal tools near Areas 2 and 3 with subsequent tool discard in those areas.</td>
</tr>
<tr>
<td></td>
<td>Cat. # 30197, Item 130</td>
<td>informal retouched flake tool</td>
<td>Area 2 ground surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Designation of Set of Artifacts from Same Nodule or Batch of Stone</td>
<td>Tool Stone Description</td>
<td>Artifact Catalog Number and Any Other Identifiers</td>
<td>Artifact Type</td>
<td>Provenience</td>
<td>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
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<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>14</td>
<td>South Platte River gravel: off-white to light gray metaquartzite with rust-colored cortex</td>
<td>Cat. # 30193</td>
<td>bifacial core</td>
<td>Area 2, ground surface</td>
<td>Knapping of core near Area 2, discard of core and waste flakes in Area 2, use of informal retouched tool (graver) near Area 1, discard of graver in Area 1. The graver from Area 1 and one of the secondary flakes from Area 2 (Cat. # 23095) refit onto the core.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23095, Field Specimen F 69</td>
<td>secondary flake</td>
<td>Area 2, Excavation Unit 10F60</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 30197, Item 30</td>
<td>secondary flake</td>
<td>Area 2, ground surface</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 30171</td>
<td>informal retouched flake tool (graver)</td>
<td>Area 1, ground surface</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Dawson petrified wood: two-tone medium yellowish brown and very dark brown</td>
<td>Cat. # 30178</td>
<td>informal retouched flake tool (graver made on a core reduction flake)</td>
<td>Area 2, ground surface</td>
<td>Striking flakes from a blocky core near Area 2, production of an informal retouched flake tool (a graver), use of the flake tool and several other flakes near Area 2, subsequent discard in Area 2, transport of some flakes from core reduction to near Area 1, use, and discard in Area 1.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 30197, Item 192</td>
<td>utilized interior flake (core reduction)</td>
<td>Area 2, ground surface</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 30197, Item 193</td>
<td>utilized interior flake</td>
<td>Area 2, ground surface</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 30197, Item 194</td>
<td>utilized interior flake (core reduction)</td>
<td>Area 2, ground surface</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Cat. # 23093, Field Specimen F1</td>
<td>utilized interior flake (core reduction)</td>
<td>Area 2, Excavation Unit 10F50</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Cat. # 23095, Field Specimen F90</td>
<td>utilized interior flake (core reduction)</td>
<td>Area 2, Excavation Unit 10F60</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23102, Field Specimen F19</td>
<td>utilized interior flake (core reduction)</td>
<td>Area 2, Excavation Unit 11F61</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 30196, Item 35</td>
<td>utilized interior flake (core reduction)</td>
<td>Area 1, ground surface</td>
<td></td>
</tr>
</tbody>
</table>

(continued)
### Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone (Page 8 of 35).

#### Artifacts Demonstrating Connections Between Site Areas:

<table>
<thead>
<tr>
<th>Designation of Set of Artifacts from Same Nodule or Batch of Stone</th>
<th>Tool Stone Description</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Provenience</th>
<th>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 (concluded)</td>
<td></td>
<td>Cat. # 30196, Item 36</td>
<td>utilized interior flake</td>
<td>Area 1, ground surface</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 30196, Item 37</td>
<td>utilized interior flake (core reduction)</td>
<td>Area 1, ground surface</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>White River Group gravel: very rough-textured orthoquartzite composed of a clean quartz sand with a light brownish yellow matrix and a light red stain. Similar to raw material of Nodule 49, but with a finer grain sand.</td>
<td>Cat. # 23110, Field Specimen F1a</td>
<td>secondary flake</td>
<td>Area 1, Excavation Unit 14H100</td>
<td>Knapping of a blocky core near either Area 1 or Area 2 and transport of some of the resulting flakes to the other area.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F107</td>
<td>interior flake</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F127</td>
<td>interior flake</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>Lyons sandstone: light brown with sparse, rust-colored to medium brown spots</td>
<td>Cat. # 30201g</td>
<td>grinding slab (fragment)</td>
<td>Area 1, ground surface</td>
<td>The two grinding slab fragments from Area 1 refit to one another, are relatively large, and have use wear evident on only one face. The fragment from Area 2 is comparatively small and use wear is evident on both faces. The set of artifacts suggests a grinding slab was used near Area 1 for food processing, then broken and a fragment was carried to the vicinity of Area 2 where it was used in an activity that produced use wear on both faces.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 30201l</td>
<td>grinding slab (fragment)</td>
<td>Area 1, ground surface</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 30201e</td>
<td>grinding slab (fragment)</td>
<td>Area 2, ground surface</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>Dawson petrified wood: brownish yellow with some areas reddened by fire</td>
<td>Cat. # 30074</td>
<td>stemless knife (fragment)</td>
<td>Fill Area, ground surface</td>
<td>Manufacture of a stemless knife from a piece of possibly heat treated petrified wood, use of flakes from knife manufacture and subsequent discard in Area 2, transport of knife to fill area by heavy earth moving machine in modern times.</td>
</tr>
</tbody>
</table>
Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone (Page 9 of 35).

Artifacts Demonstrating Connections Between Site Areas:

<table>
<thead>
<tr>
<th>Designation of Set of Artifacts from Same Nodule or Batch of Stone</th>
<th>Tool Stone Description</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Provenience</th>
<th>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 (concluded)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cat. # 30197, Item 169</td>
<td>utilized interior flake (possible biface thinning flake)</td>
<td>Area 2, ground surface</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cat. # 30197, Item 174</td>
<td>utilized interior flake</td>
<td>Area 2, ground surface</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Artifacts Demonstrating Connections Within Site Areas:

| 19 | Flat Top chalcedony: light gray and light brown with purple staining; partly subtly banded and partly spotted | Cat. # 30093 | end scraper | Area 1, ground surface | The scraper was made from a blocky core reduction flake and has a rounded and polished distal edge, suggesting it was used in processing hides. The artifacts suggest manufacture and use of an end scraper for hide working near Area 1 and subsequent discard of the tool and waste flake in Area 1. |
| 20 | Flat Top chalcedony: vividly colored light purple, light brown, and light gray | Cat. # 23081 | end scraper | Area 1, Excavation Unit 15 H13, possibly from Flake Concentration 2 | Possible manufacture of an end scraper and a biface near Area 1. Presumed use of the end scraper and use of a biface thinning flake near Area 1 and subsequent discard of the artifacts in Area 1. |
| 21 | Hartville Uplift chert: dark purple and dark reddish purple with black dendrites and transparent fossil inclusions | Cat. # 23110, Field Specimen F19 | interior flake | Area 1, Excavation Unit 14H100 | Two flakes are possibly from Flake Concentration 1 (in Area 1) Eleven flakes are associated with Flake Concentration 2 (Area 1): nine are definitely from the concentration and two are possibly from there. Six artifacts are definite biface thinning flakes, six are classified more generally as interior flakes, and one is a uniface sharpening flake. (continued) |
| (continued) | | Cat. # 23110, Field Specimen F21 | interior flake (biface thinning) | Area 1, Excavation Unit 14 H100 |
| | | Cat. # 23115, Field Specimen F4 | interior flake | Area 1, Excavation Unit 15I1 |
### Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone

<table>
<thead>
<tr>
<th>Designation of Set of Artifacts from Same Nodule or Batch of Stone</th>
<th>Tool Stone Description</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Provenience</th>
<th>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>21 (concluded)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The artifacts are thought to represent biface manufacture and uniface sharpening near Area 1 and discard of flaking debris in two disposal areas within Area 1.</td>
</tr>
<tr>
<td>Cat. # 23116, Field Specimen F114</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 15I2</td>
<td></td>
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</tr>
<tr>
<td>Cat. # 23116, Field Specimen F223</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 15I2</td>
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<tr>
<td>Cat. # 23116, Field Specimen F387</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 15I2</td>
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<td></td>
</tr>
<tr>
<td>Cat. # 23116, Field Specimen F393</td>
<td>utilized interior flake (uniface sharpening flake)</td>
<td>Area 1, Excavation Unit 15I2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cat. # 23116, Field Specimen F421</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 15I2</td>
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<tr>
<td>Cat. # 23116, Field Specimen F429</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 15I2</td>
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<tr>
<td>Cat. # 23119, Field Specimen F146</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 15I11</td>
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<tr>
<td>Cat # 23120, Field Specimen F158</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 15I12</td>
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<tr>
<td>Cat. # 23129, Item 30</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 15I2, back dirt pile</td>
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</tr>
<tr>
<td>Cat. # 23129, Item 31</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 15I2, back dirt pile</td>
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</table>
Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone (Page 11 of 35).

<table>
<thead>
<tr>
<th>Designation of Set of Artifacts from Same Nodule or Batch of Stone</th>
<th>Tool Stone Description</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Provenience</th>
<th>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>Hartville Uplift chert: relatively rough-textured, very translucent dark purple with darker undulating lines and black dendrites</td>
<td>Cat. # 23110, Field Specimen F2</td>
<td>utilized interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 14H100</td>
<td>Five flakes are definitely from Flake Concentration 2, one flake is possibly from Concentration 2, and one flake is possibly from Concentration 1. One flake demonstrates edge damage suggestive of use wear. The flakes are thought to represent activities that occurred near Area 1, including biface production and use of a biface thinning flake, as well as subsequent discard of flaking debris and the expedient tool at two trash disposal areas in Area 1.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23113, Field Specimen F11b</td>
<td>interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 15I92</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23116, Field Specimen F263</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 15I2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23117, Field Specimen F9</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 15I3</td>
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<tr>
<td></td>
<td></td>
<td>Cat. # 23117, Field Specimen F11</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 15I3</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23117, Field Specimen F31</td>
<td>interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 15I3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23120, Field Specimen F100</td>
<td>interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 15I12</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Hartville Uplift chert: yellowish medium brown with red speckles</td>
<td>Cat. # 23110, Field Specimen F12</td>
<td>interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 14H100</td>
<td>Two flakes are possibly from Flake Concentration 1 and two are definitely from Concentration 2. One flake displays possible use wear. The flakes are thought to represent activities that occurred near Area 1, including biface production and use of a biface thinning flake, as well as subsequent discard of flaking debris and the expedient tool at two disposal areas in Area 1.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23110, Field Specimen F57</td>
<td>interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 14H100</td>
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<td></td>
<td></td>
<td>Cat. # 23116, Field Specimen F6</td>
<td>utilized interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 15I12</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23120, Field Specimen F37</td>
<td>interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 15I12</td>
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</table>
## Artifacts Demonstrating Connections Within Site Areas:

<table>
<thead>
<tr>
<th>Designation of Set of Artifacts from Same Nodule or Batch of Stone</th>
<th>Tool Stone Description</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Provenience</th>
<th>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>White River Group gravel: very rough-textured orthoquartzite. Medium brownish yellow. Under magnification, it is evident that the raw material is essentially clear with rusting of iron providing the coloration. The material is transparent in spots.</td>
<td>Cat. # 23108, Field Specimen F216</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 14H90</td>
<td>Two flakes are possibly from Flake Concentration 1, one flake is possibly from either Concentration 1 or 2, and four flakes are definitely from Flake Concentration 2. The artifacts are thought to represent biface production near Area 1 and subsequent discard of the waste flakes in one or two trash disposal areas in Area 1.</td>
</tr>
<tr>
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<td>Cat. # 23108, Field Specimen F220</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 14H90</td>
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<tr>
<td></td>
<td></td>
<td>Cat. # 23112, Field Specimen F19</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 15H91</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23116, Field Specimen F173</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 15I2</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23116, Field Specimen F252</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 15I2</td>
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<tr>
<td></td>
<td></td>
<td>Cat. # 23116, Field Specimen F284</td>
<td>interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 15I2</td>
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<tr>
<td></td>
<td></td>
<td>Cat. # 23116, Field Specimen F307</td>
<td>interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 15I2</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Hartville Uplift chert: glassy, very translucent medium brown and medium red with red speckles and abundant, small, uniformly distributed black dendrites</td>
<td>Cat. # 23108, Field Specimen F204b</td>
<td>utilized interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 14H90</td>
<td>Two flakes are from Flake Concentration 1 and two are from Concentration 2. The artifacts are thought to represent biface production and use of a biface thinning flake near Area 1 and subsequent discard of the waste flakes and expedient tool in two trash disposal areas in Area 1.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23108, Field Specimen F244</td>
<td>interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 14H90</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23116, Field Specimen F427</td>
<td>interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 15I2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23120, Field Specimen F119</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 15I12</td>
<td></td>
</tr>
</tbody>
</table>
Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone (Page 13 of 35).

Artifacts Demonstrating Connections Within Site Areas:

<table>
<thead>
<tr>
<th>Designation of Set of Artifacts from Same Nodule or Batch of Stone</th>
<th>Tool Stone Description</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Provenience</th>
<th>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>Hartville Uplift chert: relatively rough-textured, very translucent, medium reddish purple with black dendrites</td>
<td>Cat. # 23110, Field Specimen F14</td>
<td>interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 14H100</td>
<td>One flake is definitely from Flake Concentration 2 and one is possibly from Concentration 1. The artifacts appear to represent biface manufacture near Area 1 and subsequent discard of waste flakes in two trash disposal areas in Area 1.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23112, Field Specimen F42</td>
<td>interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 15H91</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23116, Field Specimen F143</td>
<td>interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 15I2</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>White River Group gravel: very rough-textured orthoquartzite. Medium yellowish brown and medium rust-colored with medium purplish red splolches. For this tool stone type, the artifacts are relatively opaque.</td>
<td>Cat. # 23116, Field Specimen F71</td>
<td>interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 15I2</td>
<td>The three flakes are from Flake Concentration 2. They may represent biface manufacture near Area 1 and subsequent discard of waste flakes in one of the trash disposal areas in Area 1.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23116, Field Specimen F278</td>
<td>interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 15I2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23116, Field Specimen F444</td>
<td>interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 15I2</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Flat Top chalcedony: medium purplish red</td>
<td>Cat. # 23110A</td>
<td>utilized interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 14H100</td>
<td>Both artifacts are from Flake Concentration 1. They are thought to represent biface manufacture near Area 1 followed by use of two biface thinning flakes: one as a graver and the other as an expedient tool. Finally, the informal tools were discarded in one of the trash disposal areas in Area 1.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23110C</td>
<td>informal retouched flake tool (graver made on a biface thinning flake)</td>
<td>Area 1, Excavation Unit 14H100</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>White River Group gravel: very rough-textured orthoquartzite, medium brown</td>
<td>Cat. # 23108, Field Specimen F232</td>
<td>interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 14H90</td>
<td>One flake is definitely from Flake Concentration 1 and the other is possibly from Concentration 1. The artifacts may represent biface production near Area 1 and subsequent discard of waste flakes at one of the trash disposal areas in Area 1.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23110, Field Specimen F1b</td>
<td>interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 14H100</td>
<td></td>
</tr>
</tbody>
</table>
Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone (Page 14 of 35).

<table>
<thead>
<tr>
<th>Designation of Set of Artifacts from Same Nodule or Batch of Stone</th>
<th>Tool Stone Description</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Provenience</th>
<th>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>Hartville Uplift chert: very translucent medium brown with abundant, uniformly distributed, small black dendrites</td>
<td>Cat. # 23116, Field Specimen F27</td>
<td>interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 15I2</td>
<td>Both of these flakes are from Flake Concentration 2. They are thought to represent biface production near Area 1 and subsequent discard of waste flakes in one of the trash disposal areas in Area 1.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23116, Field Specimen F113</td>
<td>interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 15I2</td>
<td>Both of these flakes are from Flake Concentration 2. They are thought to represent biface production near Area 1 and subsequent discard of waste flakes in one of the trash disposal areas in Area 1.</td>
</tr>
<tr>
<td>31</td>
<td>Flat Top chalcedony: transparent</td>
<td>Cat. # 23121</td>
<td>interior flake (biface thinning)</td>
<td>Area 1, Excavation Unit 15I3</td>
<td>Both of these flakes are from Flake Concentration 2. They are thought to represent biface production near Area 1 and subsequent discard of waste flakes in one of the trash disposal areas in Area 1.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 30196, Item 91</td>
<td>interior flake</td>
<td>Area 1, ground surface</td>
<td>Both of these flakes are from Flake Concentration 2. They are thought to represent biface production near Area 1 and subsequent discard of waste flakes in one of the trash disposal areas in Area 1.</td>
</tr>
<tr>
<td>32</td>
<td>White River Group gravel: relatively rough, very translucent, dark brown and medium yellowish brown chert with black speckles (classified as brown-to-orange or yellow chert)</td>
<td>Cat. # 23125, Field Specimen F3</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 15I24</td>
<td>The flakes may represent reduction of a blocky core near Area 1 and discard of resulting waste flakes in Area 1.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23125, Field Specimen F9</td>
<td>interior flake (core reduction)</td>
<td>Area 1, Excavation Unit 15I24</td>
<td>The flakes may represent reduction of a blocky core near Area 1 and discard of resulting waste flakes in Area 1.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23129, JUBD3</td>
<td>secondary flake</td>
<td>general site area, back dirt</td>
<td>The flakes are thought to represent reduction of a blocky core near Area 1 and subsequent discard of waste flakes in Area 1.</td>
</tr>
<tr>
<td>33</td>
<td>White River Group gravel: light red, very fine-grained orthoquartzite</td>
<td>no catalog #, Item 7</td>
<td>secondary flake</td>
<td>Area 1, ground surface</td>
<td>The flakes are thought to represent reduction of a blocky core near Area 1 and subsequent discard of waste flakes in Area 1.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23124, Field Specimen F20</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 15I23</td>
<td>Two of the three flakes are from Flake Concentration 2. They are thought to represent flintknapping near Area 1 and subsequent discard of some of the resulting flakes in Area 1, in particular, in one of the trash disposal areas.</td>
</tr>
<tr>
<td>34</td>
<td>White River Group gravel: very rough-textured orthoquartzite. Similar to artifacts of Nodule #8, only without the white grains.</td>
<td>Cat. # 23108, Field Specimen F83</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 15H91</td>
<td>Two of the three flakes are from Flake Concentration 2. They are thought to represent flintknapping near Area 1 and subsequent discard of some of the resulting flakes in Area 1, in particular, in one of the trash disposal areas.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23116, Field Specimen F406</td>
<td>interior flake</td>
<td>Area 1, Excavation Unit 15I2</td>
<td>Two of the three flakes are from Flake Concentration 2. They are thought to represent flintknapping near Area 1 and subsequent discard of some of the resulting flakes in Area 1, in particular, in one of the trash disposal areas.</td>
</tr>
</tbody>
</table>
Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone (Page 15 of 35).

*Artifacts Demonstrating Connections Within Site Areas:*

<table>
<thead>
<tr>
<th>Designation of Set of Artifacts from Same Nodule or Batch of Stone</th>
<th>Tool Stone Description</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Provenience</th>
<th>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>34 (concluded)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35</td>
<td>Hartville Uplift chert: light yellow with rust-colored dendrites</td>
<td>Cat. # 23116, Field Specimen F519</td>
<td>interior flake</td>
<td>Area 1 Excavation Unit 15I2</td>
<td>Three of the four flakes are considered biface resharpening flakes. Two have step flaking and crushed edges along their platforms. The third has these characteristics as well as a rounded edge along its platform and rounding along the ridge between flake scars on the dorsal face. One flake is possibly from Flake Concentration 1 and the three resharpening flakes are definitely from the concentration. The artifacts represent resharpening of a bifacial tool and discard of the resulting flakes at one of the trash disposal areas in Area 1.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23107, Field Specimen F15</td>
<td>interior flake</td>
<td>Area 1 Excavation Unit 14H89</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23108, Field Specimen F24</td>
<td>interior flake (biface resharpening flake)</td>
<td>Area 1 Excavation Unit 14H90</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23108, Field Specimen F84</td>
<td>interior flake (biface resharpening flake)</td>
<td>Area 1 Excavation Unit 14H90</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23108, Field Specimen F249</td>
<td>interior flake (biface resharpening flake)</td>
<td>Area 1 Excavation Unit 14H90</td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>Dawson petrified wood: medium-to-dark yellowish brown with parallel undulating bands that cross-cut the wood grain</td>
<td>Cat. # 30157, Field Specimen F249</td>
<td>informal retouched flake tool</td>
<td>Area 2 ground surface</td>
<td>The artifacts are thought to represent use of informal retouch flake tools near Area 2 and later discard in Area 2.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 30161, Field Specimen F249</td>
<td>informal retouched flake tool</td>
<td>Area 2 ground surface</td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>White River Group gravel: very rough-textured orthoquartzite. Light brown, light yellowish brown, light orangish brown, and medium rust-colored.</td>
<td>Cat. # 30080, Field Specimen F249</td>
<td>projectile point preform</td>
<td>Area 2 ground surface</td>
<td>Both preforms are complete and appear to be manufacturing rejects. A band of irregular material cutting through one perform may have contributed to rejection. Another apparent problem was a flat surface along one edge that would have been difficult to remove. The artifacts suggest that projectile points were manufactured near Area 2 and some manufacturing rejects were later discarded in Area 2.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 30082, Field Specimen F249</td>
<td>projectile point preform</td>
<td>Area 2, ground surface</td>
<td></td>
</tr>
</tbody>
</table>
Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone (Page 16 of 35).

Artifacts Demonstrating Connections Within Site Areas:

<table>
<thead>
<tr>
<th>Designation of Set of Artifacts from Same Nodule or Batch of Stone</th>
<th>Tool Stone Description</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Provenience</th>
<th>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>38</td>
<td>South Platte River gravel: metaquartzite. Medium gray and medium dull red.</td>
<td>Cat. # 30197, Item 19</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, ground surface</td>
<td>The artifacts could represent use of a batch of local stone in tool manufacture near Area 2 that involved both the reduction of blocky cores as well as thinning of bifaces along with subsequent discard of knapping debris in Area 2.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 30197, Item 29</td>
<td>blocky core</td>
<td>Area 2, ground surface</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>White River Group gravel: very rough-textured orthoquartzite. Medium olive green.</td>
<td>Cat. # 23095, Field Specimen F31</td>
<td>interior flake (core reduction)</td>
<td>Area 2, Excavation Unit 10F60</td>
<td>A total of 67 artifacts are made from this batch of tool stone. Included are 20 core reduction flakes, 17 biface thinning flakes, 29 interior flakes that are not further classified as either core reduction or biface thinning flakes, and one piece of shatter. The only artifact demonstrating edge damage suggestive of use wear is one of the biface thinning flakes. Of the 67 artifacts, 64 were found in the flake concentration defined for Area 2. Of the 64 flakes, 60 were found in Excavation Unit 11F51, which encompasses the eastern cluster of flakes in the concentration and four flakes were recovered from 10F60, which is centered over the western flake cluster. Two fragments of a biface thinning flake from the eastern cluster (Cat. # 23099, Field Specimens F129 and F133) were found to refit to on another.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23095, Field Specimen F36</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 10F60</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23095, Field Specimen F54</td>
<td>interior flake</td>
<td>Area 2, Excavation Unit 10F60</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23095, Field Specimen F101</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 10F60</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F3</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F57</td>
<td>interior flake</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F63</td>
<td>interior flake (core reduction)</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F64</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F66</td>
<td>interior flake</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F74</td>
<td>interior flake (core reduction)</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
</tbody>
</table>
Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone (Page 17 of 35).

Artifacts Demonstrating Connections Within Site Areas:

<table>
<thead>
<tr>
<th>Designation of Set of Artifacts from Same Nodule or Batch of Stone</th>
<th>Tool Stone Description</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Provenience</th>
<th>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>39 (continued)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The artifacts are thought to represent knapping activity near Area 2 that included both blocky core reduction and biface thinning, use of a biface thinning flake as an expedient flake tool, and finally, discard of the knapping debris and utilized flake. The artifacts were principally tossed in the eastern cluster of the flake concentration of Area 2, which is interpreted as a trash disposal area.</td>
</tr>
<tr>
<td>Cat. # 23099, Field Specimen F77</td>
<td>interior flake (core reduction)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
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</tr>
<tr>
<td>Cat. # 23099, Field Specimen F80</td>
<td>interior flake</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cat. # 23099, Field Specimen F81</td>
<td>piece of shatter</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cat. # 23099, Field Specimen F84</td>
<td>interior flake</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cat. # 23099, Field Specimen F88</td>
<td>interior flake (core reduction)</td>
<td>Area 2 Excavation Unit 11F51</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cat. # 23099, Field Specimen F90</td>
<td>interior flake</td>
<td>Area 2 Excavation Unit 11F51</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Cat. # 23099, Field Specimen F91</td>
<td>interior (core reduction)</td>
<td>Area 2 Excavation Unit 11F51</td>
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<td></td>
</tr>
<tr>
<td>Cat. # 23099, Field Specimen F92</td>
<td>interior flake</td>
<td>Area 2 Excavation Unit 11F51</td>
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<tr>
<td>Cat. # 23099, Field Specimen F93</td>
<td>interior flake</td>
<td>Area 2 Excavation Unit 11F51</td>
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</tr>
<tr>
<td>Cat. # 23099, Field Specimen F95</td>
<td>interior flake</td>
<td>Area 2 Excavation Unit 11F51</td>
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<td></td>
</tr>
<tr>
<td>Cat. # 23099, Field Specimen F98</td>
<td>interior flake</td>
<td>Area 2 Excavation Unit 11F51</td>
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<tr>
<td>Cat. # 23099, Field Specimen F99</td>
<td>interior flake</td>
<td>Area 2 Excavation Unit 11F51</td>
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</tr>
<tr>
<td>Cat. # 23099, Field Specimen F108</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
<td></td>
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</tbody>
</table>
Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone (Page 18 of 35).

Artifacts Demonstrating Connections Within Site Areas:

<table>
<thead>
<tr>
<th>Designation of Set of Artifacts from Same Nodule or Batch of Stone</th>
<th>Tool Stone Description</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Provenience</th>
<th>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>39 (continued)</td>
<td>Cat. # 23099, Field Specimen F110</td>
<td>interior flake</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cat. # 23099, Field Specimen F111</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cat. # 23099, Field Specimen F112</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Cat. # 23099, Field Specimen F114</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cat. # 23099, Field Specimen F116</td>
<td>interior flake (core reduction)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cat. # 23099, Field Specimen F118</td>
<td>interior flake</td>
<td>Area 2 Excavation Unit 11F51</td>
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<td></td>
</tr>
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<td>Provenience</td>
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Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone (Page 20 of 35).

Artifacts Demonstrating Connections Within Site Areas:

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<th>Designation of Set of Artifacts from Same Nodule or Batch of Stone</th>
<th>Tool Stone Description</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Provenience</th>
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### Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone (Page 21 of 35).

**Artifacts Demonstrating Connections Within Site Areas:**

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<th>Tool Stone Description</th>
<th>Artifacts Following Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Provenience</th>
<th>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</th>
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<td>Cat. # 23102, Field Specimen F16</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F61</td>
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<tr>
<td></td>
<td></td>
<td>Cat. # 23102, Field Specimen F17</td>
<td>interior flake (biface thinning)</td>
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<tr>
<td></td>
<td></td>
<td>Cat. # 23102, Field Specimen F21</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F61</td>
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<tr>
<td>40</td>
<td>White River Group gravel: very rough-textured orthoquartzite. Off-white with short, undulating black lines</td>
<td></td>
<td></td>
<td></td>
<td>A total of 27 artifacts are made from this nodule of tool stone. Included are 23 biface thinning flakes and four interior flakes that are not further classified as either core reduction or biface thinning flakes. Of the 27 flakes, 25 were found in the flake concentration defined for Area 2 and of these, 22 were found in Excavation Unit 10F60, which is centered over the western flake cluster and three were recovered from 11F51, which encompasses the eastern flake cluster. None of the flakes exhibit evidence of having been used and all are relatively small, measuring less than two cm in maximum dimension.</td>
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Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone (Page 22 of 35).

Artifacts Demonstrating Connections Within Site Areas:

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<th>Tool Stone Description</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Provenience</th>
<th>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</th>
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<td>Cat. # 23095, Field Specimen F16</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 10F60</td>
<td>The artifacts are thought to represent later-stage biface thinning near Area 2 and discard of the waste flakes in Area 2. The flaking debris was principally tossed in the western cluster of the flake concentration of Area 2, which is interpreted as a trash disposal area.</td>
</tr>
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Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone (Page 23 of 35).

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<th>Designation of Set of Artifacts from Same Nodule or Batch of Stone</th>
<th>Tool Stone Description</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Provenience</th>
<th>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</th>
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<td>Area 2 Excavation Unit 11F61</td>
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<td>41</td>
<td>Hartville Uplift chert: medium brown with black dendrites</td>
<td>Cat. # 23095, Field Specimen F11</td>
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<td>Area 2 Excavation Unit 10F60</td>
<td>A total of 23 artifacts are made from this nodule of tool stone. Included are 12 biface thinning flakes and 11 interior flakes that are not further classified as either core reduction or biface thinning flakes. Of the 23 flakes, 22 were found in the flake concentration defined for Area 2 and of these, 18 were found in Excavation Unit 11F51, which encompasses the eastern flake cluster and four were recovered from 10F60, which is centered on the western flake cluster. Two of the flakes exhibit edge damage suggestive of having been used. (continued)</td>
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Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone (Page 24 of 35).

Artifacts Demonstrating Connections Within Site Areas:

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<th>Tool Stone Description</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Provenience</th>
<th>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</th>
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<td>The artifacts are thought to represent biface thinning and use of flakes as expedient tools near Area 2 and later discard of the waste flakes and tools in Area 2. The flakes were principally tossed in the eastern cluster of the flake concentration of Area 2, which is interpreted as a trash disposal area.</td>
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<td>Cat. # 23099, Field Specimen F76</td>
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<td>Cat. # 23099, Field Specimen F82</td>
<td>interior flake</td>
<td>Area 2 Excavation Unit 11F51</td>
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<td>Cat. # 23099, Field Specimen F83</td>
<td>interior flake</td>
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<td></td>
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<td>Cat. # 23099, Field Specimen F85</td>
<td>interior flake</td>
<td>Area 2 Excavation Unit 11F51</td>
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<td>Cat. # 23099, Field Specimen F87</td>
<td>interior flake</td>
<td>Area 2 Excavation Unit 11F51</td>
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<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F102</td>
<td>interior flake</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F137</td>
<td>interior flake</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
</tr>
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</table>
Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone (Page 25 of 35).

Artifacts Demonstrating Connections Within Site Areas:

<table>
<thead>
<tr>
<th>Designation of Set of Artifacts from Same Nodule or Batch of Stone</th>
<th>Tool Stone Description</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Provenience</th>
<th>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>41 (concluded)</td>
<td></td>
<td>Cat. # 23099, Field Specimen F160</td>
<td>utilized interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F176</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F182</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23103, Field Specimen F1</td>
<td>interior flake</td>
<td>Area 2 Excavation Unit 11F62</td>
<td></td>
</tr>
<tr>
<td>42</td>
<td>White River Group gravel: very rough-textured orthoquartzite. Medium brown to medium gray to off-white</td>
<td>Cat. # 23099, Field Specimen F145</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td>A total of 10 artifacts are made from this nodule of tool stone. Included are six biface thinning flakes and 4 interior flakes that are not further classified as either core reduction or biface thinning flakes. All ten of the flakes were found in the flake concentration defined for Area 2, specifically in Excavation Unit 11F51, which encompasses the eastern flake cluster. The artifacts are thought to represent biface thinning near Area 2 and subsequent discard of the waste flakes in Area 2. The flakes were tossed in the eastern cluster of the flake concentration of Area 2, which is interpreted as a trash disposal area.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F159</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F175</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
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<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F193</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F197</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F210</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F214</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F225</td>
<td>interior flake</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
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</table>
Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone (Page 26 of 35).

Artifacts Demonstrating Connections Within Site Areas:

<table>
<thead>
<tr>
<th>Designation of Set of Artifacts from Same Nodule or Batch of Stone</th>
<th>Tool Stone Description</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Provenience</th>
<th>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>42 (concluded)</td>
<td></td>
<td>Cat. # 23099, Field Specimen F229</td>
<td>interior flake</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F230</td>
<td>interior flake</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>White River Group gravel: Morrison orthoquartzite. Light brown and light gray with subtle light red staining</td>
<td>Cat. # 23099, Field Specimen F174</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td>Six biface thinning flakes are made of this nodule of stone. All of the flakes were found in the flake concentration defined for Area 2, specifically in Excavation Unit 11F51, which encompasses the eastern flake cluster. The artifacts are thought to represent biface thinning near Area 2 and subsequent discard of the waste flakes in Area 2. The flakes were tossed in the eastern cluster of the flake concentration of Area 2, which is interpreted as a trash disposal area.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F198</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F208</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F228</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F233</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F234</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>White River Group gravel: very rough-textured orthoquartzite. Opaque, medium yellowish brown.</td>
<td>Cat. # 23099, Field Specimen F196</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td>Four biface thinning flakes are made of this nodule of stone. All were found in the flake concentration defined for Area 2, which is interpreted as a trash disposal area. Specifically, they were found in Excavation Unit 11F51, which encompasses the eastern of two clusters of flakes in the concentration. The artifacts are thought to represent biface thinning near Area 2 and subsequent discard of the waste flakes in a portion of the trash disposal area in Area 2.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F202</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
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<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F203</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F205</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
</tr>
</tbody>
</table>
Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone (Page 27 of 35).

Artifacts Demonstrating Connections Within Site Areas:

<table>
<thead>
<tr>
<th>Designation of Set of Artifacts from Same Nodule or Batch of Stone</th>
<th>Tool Stone Description</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Provenience</th>
<th>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>45</td>
<td>White River Group gravel: very rough-textured orthoquartzite. Light brown and off-white.</td>
<td>Cat. # 23095, Field Specimen F26</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 10F60</td>
<td>Four biface thinning flakes are made of this nodule of stone. All were found in the flake concentration defined for Area 2, which is interpreted as a trash disposal area. Specifically, they were found in Excavation Unit 10F60, which is centered over the western of two clusters of flakes in the concentration. The artifacts are thought to represent biface thinning near Area 2 and subsequent discard of the waste flakes in a portion of the trash disposal area in Area 2.</td>
</tr>
<tr>
<td>45</td>
<td></td>
<td>Cat. # 23095, Field Specimen F40</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 10F60</td>
<td></td>
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<tr>
<td>45</td>
<td></td>
<td>Cat. # 23095, Field Specimen F63</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 10F60</td>
<td></td>
</tr>
<tr>
<td>45</td>
<td></td>
<td>Cat. # 23095, Field Specimen F71</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 10F60</td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>Hartville Uplift chert: dark yellowish brown with branching structures suggestive of fossils. The tool stone is similar to that of Nodule #1, but differs because the branching structures are much sparser in the clear matrix, thus Nodule #46 is noticeably more translucent.</td>
<td>Cat. # 23095, Field Specimen F50</td>
<td>utilized interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 10F60</td>
<td>Three biface thinning flakes are made of this nodule of stone. One displays edge damage suggestive of use wear. All were found in the flake concentration defined for Area 2, which is interpreted as a trash disposal area. Specifically, they were found in Excavation Unit 10F60, which is centered over the western of two clusters of flakes in the concentration. The artifacts are thought to represent biface thinning and expedient use of a flake near Area 2 and subsequent discard of the waste flakes and expedient tool in a portion of the trash disposal area in Area 2.</td>
</tr>
<tr>
<td>46</td>
<td></td>
<td>Cat. # 23095, Field Specimen F51</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 10F60</td>
<td></td>
</tr>
<tr>
<td>46</td>
<td></td>
<td>Cat. # 23095, Field Specimen F70</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 10F60</td>
<td></td>
</tr>
<tr>
<td>Designation of Set of Artifacts from Same Nodule or Batch of Stone</td>
<td>Tool Stone Description</td>
<td>Artifact Catalog Number and Any Other Identifiers</td>
<td>Artifact Type</td>
<td>Provenience</td>
<td>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</td>
</tr>
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</tr>
<tr>
<td><strong>47</strong></td>
<td>White River Group gravel: Morrison orthoquartzite. Rusty light brown and light gray.</td>
<td>Cat. # 23099, Field Specimen F32</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td>Three biface thinning flakes are made of this nodule of stone. One displays edge damage suggestive of use wear. All were found in the flake concentration defined for Area 2, which is interpreted as a trash disposal area. Specifically, they were found in Excavation Unit 11F51, which encompasses the eastern of two clusters of flakes in the concentration. The artifacts are thought to represent biface thinning and expedient use of a flake near Area 2, followed by discard of the waste flakes and expedient tool in a portion of the trash disposal area in Area 2</td>
</tr>
<tr>
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<td>Cat. # 23099, Field Specimen F79</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F213</td>
<td>utilized interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td><strong>48</strong></td>
<td>White River Group gravel: very rough-textured orthoquartzite. Light brown.</td>
<td>Cat. # 23099, Field Specimen F139</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td>Four flakes are from this nodule. Three are biface thinning flakes and one is classified more generally as an interior flake. They were found in the flake concentration defined for Area 2, which is interpreted as a trash disposal area. Specifically, they were found in Excavation Unit 11F51, which encompasses the eastern of two clusters of flakes in the concentration. Two flakes (Cat. # 23099, Field Specimens F139 and F158 were found to conjoin to form a single biface thinning flake. The artifacts are thought to represent biface thinning near Area 2 and subsequent discard of some of the waste flakes in a portion of the trash disposal area of Area 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F158</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F201</td>
<td>interior flake</td>
<td>Area 2 Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F222</td>
<td>interior flake (biface thinning)</td>
<td>Area 2 Excavation Unit 11F51</td>
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</table>
### Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone (Page 29 of 35).

#### Artifacts Demonstrating Connections Within Site Areas:

<table>
<thead>
<tr>
<th>Designation of Set of Artifacts from Same Nodule or Batch of Stone</th>
<th>Tool Stone Description</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Provenience</th>
<th>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>49</td>
<td>White River Group gravel: very rough-textured orthoquartzite composed of clean quartz sand with a light brownish yellow matrix and medium purplish red staining</td>
<td>Cat. # 23099, Field Specimen F55</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 11F51</td>
<td>Four flakes are from this nodule. Two are biface thinning flakes and two are classified more generally as interior flakes. They were found in the flake concentration defined for Area 2, which is interpreted as a trash disposal area. Specifically, they were found in Excavation Unit 11F51, which encompasses the eastern of two clusters of flakes in the concentration. The artifacts are thought to represent biface thinning near Area 2 and subsequent discard of some of the waste flakes in a portion of the trash disposal area of Area 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F78</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F97</td>
<td>interior flake</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F207</td>
<td>interior flake</td>
<td>Area 2, Excavation Unit 11F51</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F227</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F231</td>
<td>interior flake</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>Dawson petrified wood: medium yellowish brown with a very noticeable wood grain</td>
<td>Cat. # 23099, Field Specimen F187</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 11F51</td>
<td>Four flakes are from this nodule. Two are biface thinning flakes and two are classified more generally as interior flakes. They were found in the flake concentration defined for Area 2, which is interpreted as a trash disposal area. Specifically, they were found in Excavation Unit 11F51, which encompasses the eastern of two clusters of flakes in the concentration. The artifacts are thought to represent biface thinning near Area 2 and subsequent discard of the waste flakes in a portion of the trash disposal area of Area 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F200</td>
<td>interior flake</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F227</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F231</td>
<td>interior flake</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
</tbody>
</table>
Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone (Page 30 of 35).

Artifacts Demonstrating Connections Within Site Areas:

<table>
<thead>
<tr>
<th>Designation of Set of Artifacts from Same Nodule or Batch of Stone</th>
<th>Tool Stone Description</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Provenience</th>
<th>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>51</td>
<td>Hartville Uplift chert: medium brown with black dendrites. Similar to Nodule #41, only with large dendrites.</td>
<td>Cat. # 23099, Field Specimen F35</td>
<td>interior flake</td>
<td>Area 2, Excavation Unit 11F51</td>
<td>Three flakes are from this nodule. Two are biface thinning flakes and one is classified more generally as an interior flake. They were found in the flake concentration defined for Area 2, which is interpreted as a trash disposal area. Specifically, they were found in Excavation Unit 11F51, which encompasses the eastern of two clusters of flakes in the concentration. The artifacts are thought to represent biface thinning near Area 2 and subsequent discard of the waste flakes in a portion of the trash disposal area of Area 2.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F86</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F140</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td>52</td>
<td>Edwards chert: light gray with brownish red specks</td>
<td>Cat. # 30197, Item 200</td>
<td>utilized interior flake (biface thinning)</td>
<td>Area 2, ground surface</td>
<td>The two artifacts are thought to represent the thinning of a biface, use of resulting flakes as tools, and finally, discard of the utilized flakes in Area 2. Recovery of other biface thinning flakes of Edwards chert from the ground surface of Area 2, including one that is a waste flake and two that evidently were utilized, bolsters the thinking that flakes of Edwards chert were struck from bifaces somewhere near Area 2 and some were used as expedient tools nearby prior to being discarded in Area 2.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 30197, Item 201</td>
<td>utilized interior flake (biface thinning)</td>
<td>Area 2, ground surface</td>
<td></td>
</tr>
<tr>
<td>53</td>
<td>White River Group gravel: very rough-textured orthoquartzite. Light brownish yellow.</td>
<td>Cat. # 23095, Field Specimen F89</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 10F60</td>
<td>Two interior flakes and one biface thinning flake from Nodule 53 were recovered from Excavation Unit 10F60, which is centered on the western of two flake clusters in a flake concentration thought to represent a trash disposal area.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23095, Field Specimen F94</td>
<td>interior flake</td>
<td>Area 2, Excavation Unit 10F60</td>
<td>(continued)</td>
</tr>
</tbody>
</table>
Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone (Page 31 of 35).

<table>
<thead>
<tr>
<th>Designation of Set of Artifacts from Same Nodule or Batch of Stone</th>
<th>Tool Stone Description</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Provenience</th>
<th>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>53 (concluded)</td>
<td></td>
<td>Cat. # 23095, Field Specimen F98</td>
<td>interior flake</td>
<td>Area 2, Excavation Unit 10F60</td>
<td>The flakes represent thinning of a biface near Area 2 and discard of a few of the waste flakes in a portion of the trash disposal area of Area 2</td>
</tr>
<tr>
<td>54</td>
<td>Hartville Uplift chert: high-grade medium brownish yellow with microscopic black and yellow specks</td>
<td>Cat. # 23095, Field Specimen F56</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 10F60</td>
<td>Two biface thinning flakes from Nodule 54 were recovered from Excavation Unit 10F60, which is centered on the western of two flake clusters in a flake concentration thought to represent a trash disposal area. The flakes represent thinning of a biface near Area 2 and discard of two of the waste flakes in a portion of the trash disposal area of Area 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23095, Field Specimen F77</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 10F60</td>
<td></td>
</tr>
<tr>
<td>55</td>
<td>White River Group gravel: very rough-textured orthoquartzite. Light and medium greenish gray, light gray, and light brown with a scattering of dark opaque grains and light brown opaque matrix.</td>
<td>Cat. # 23099, Field Specimen F150</td>
<td>interior flake</td>
<td>Area 2, Excavation Unit 11F51</td>
<td>Three interior flakes from Nodule 55 were recovered from Excavation Unit 11F51, which encompasses the eastern of two flake clusters in a flake concentration thought to represent a trash disposal area. The flakes represent knapping near Area 2 and subsequent discard of but a few of the waste flakes in a portion of the trash disposal area of Area 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F179</td>
<td>interior flake</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23099, Field Specimen F240</td>
<td>interior flake</td>
<td>Area 2, Excavation Unit 11F51</td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>Hartville Uplift chert: medium yellowish brown with fossil inclusions and very small black dendrites</td>
<td>Cat. # 23095, Field Specimen F113</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 10F60</td>
<td>An interior flake and a biface thinning flake from the same nodule were recovered from Excavation Unit 10F60, which is centered over the western of two flake clusters in a flake concentration thought to represent a trash disposal area. (continued)</td>
</tr>
</tbody>
</table>
### Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone (Page 32 of 35).

Artifacts Demonstrating Connections Within Site Areas:

<table>
<thead>
<tr>
<th>Designation of Set of Artifacts from Same Nodule or Batch of Stone</th>
<th>Tool Stone Description</th>
<th>Artifact Catalog Number and Any Other Identifiers</th>
<th>Artifact Type</th>
<th>Provenience</th>
<th>Comments, Especially Possible Scenario Represented by Set of Artifacts from Same Nodule or Batch of Stone</th>
</tr>
</thead>
<tbody>
<tr>
<td>56 (concluded)</td>
<td>White River Group gravel: very rough-textured orthoquartzite. Opaque light brownish gray.</td>
<td>Cat. # 23095, Field Specimen F115</td>
<td>interior flake</td>
<td>Area 2, Excavation Unit 10F60</td>
<td>The flakes are indicative of biface thinning near Area 2 and discard of two of the waste flakes in a portion of the trash disposal area of Area 2.</td>
</tr>
<tr>
<td>57</td>
<td>White River Group gravel: very rough-textured orthoquartzite. Opaque light brownish gray.</td>
<td>Cat. # 23095, Field Specimen F48</td>
<td>interior flake (biface thinning)</td>
<td>Area 2, Excavation Unit 10F60</td>
<td>An interior flake and a biface thinning flake from the same nodule were recovered from Excavation Unit 10F60, which is centered over the western of two flake clusters in a flake concentration thought to represent a trash disposal area. The flakes are indicative of biface thinning near Area 2 and discard of two of the waste flakes in a portion of the trash disposal area of Area 2.</td>
</tr>
<tr>
<td>58</td>
<td>White River Group gravel: light red, very fine-grained orthoquartzite with black dendrites</td>
<td>Cat. # 30197, Item 31, 32</td>
<td>secondary flake (core reduction), interior flake (core reduction)</td>
<td>Area 2 ground surface, ground surface</td>
<td>The flakes are indicative of decortication of a blocky core as well as striking interior flakes from the resulting core somewhere near Area 2, possibly burning of the artifacts as part of an ancient cultural activity, and finally, discard of some of the flakes produced.</td>
</tr>
<tr>
<td>59</td>
<td>White River Group gravel: red chert with non-dendritic black specks</td>
<td>Cat. # 30197, Item 129, 131, 141</td>
<td>utilized secondary flake, utilized interior flake, decortication flake</td>
<td>Area 2 ground surface, ground surface, ground surface</td>
<td>The flakes are very fire-cracked. The artifacts may represent removing the cortex from a chert river cobble as well as striking off interior flakes from the resulting core somewhere near Area 2, possibly burning of the artifacts as part of an ancient cultural activity, and finally, discard of some of the flakes produced in Area 2.</td>
</tr>
<tr>
<td>Designation of Set of Artifacts from Same Nodule or Batch of Stone</td>
<td>Tool Stone Description</td>
<td>Artifact Catalog Number and Any Other Identifiers</td>
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<tr>
<td>---------------------------------------------------------------</td>
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</tr>
<tr>
<td>60</td>
<td>Flat Top chalcedony: medium purplish red and medium brown</td>
<td>Cat. # 23095, Field Specimen F12</td>
<td>interior flake (core reduction)</td>
<td>Area 2 Excavation Unit 10F60</td>
<td>Two core reduction flakes, one of which was utilized, are from the same nodule and were recovered from Excavation Unit 10F60, which is centered over the western flake cluster of two clusters in a flake concentration thought to represent a trash disposal area. The flakes are indicative of striking of flakes from a blocky core near Area 2, use of one of the flakes as an expedient tool, and subsequent discard of the artifacts in a portion of the trash disposal area of Area 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23095, Field Specimen F75</td>
<td>utilized interior flake (core reduction)</td>
<td>Area 2 Excavation Unit 10F60</td>
<td></td>
</tr>
<tr>
<td>61</td>
<td>Dawson petrified wood: yellow-to-brown, medium red, and dark red</td>
<td>Cat. # 30197, Item 172</td>
<td>utilized interior flake (core reduction)</td>
<td>Area 2, ground surface</td>
<td>The artifacts may possibly represent knapping of both a blocky core and a biface from the same batch of stone somewhere near Area 2, use of flakes produced as expedient tools, and finally discard of the expedient tools in Area 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 30197, Item 185</td>
<td>utilized interior flake (biface thinning)</td>
<td>Area 2, ground surface</td>
<td></td>
</tr>
<tr>
<td>62</td>
<td>Dawson petrified wood: medium brownish yellow and medium brown. Parts of the tool stone exhibit wood grain with parallel lines, parts have randomly arranged, short lines</td>
<td>Cat. # 23102, Field Specimen F13</td>
<td>interior flake</td>
<td>Area 2, ground surface</td>
<td>The artifacts represent knapping activity in the vicinity of Area 2 and subsequent discard of two of the waste flakes in Area 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cat. # 23102, Field Specimen F20</td>
<td>interior flake</td>
<td>Area 2, ground surface</td>
<td></td>
</tr>
<tr>
<td>63</td>
<td>Lyons sandstone: light reddish brown</td>
<td>Cat. # 23130</td>
<td>grinding slab (fragment)</td>
<td>Area 2, Excavation Unit 11F53</td>
<td>These four fragments are thought to derive from the same relatively thin grinding slab because they are basically the same color and are of similar thickness, ranging from 1.07 to 1.74 cm in thickness.</td>
</tr>
<tr>
<td>(continued)</td>
<td></td>
<td>Cat. # 30205b</td>
<td>grinding slab (fragment)</td>
<td>Area 2, ground surface</td>
<td></td>
</tr>
</tbody>
</table>
Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone (Page 34 of 35).

<table>
<thead>
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</thead>
<tbody>
<tr>
<td>63 (concluded)</td>
<td>Cat. # 30201m</td>
<td>grinding slab (fragment)</td>
<td>Area 2, ground surface</td>
<td>Microscopic pieces of possible red and yellow ochre are present on one face of Cat. # 30205b and grain-sized pieces of possible red ochre were noted on one face of Cat. # 23139[a]. The fragments may represent use and breakage of a grinding slab in the vicinity of Area 2, subsequent possible secondary use of some of the fragments in ochre pigment production or application, and finally, discard of the fragments in Area 2.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cat. # 23139[a]</td>
<td>grinding slab (fragment)</td>
<td>Area 2, Excavation Unit 11F53</td>
<td></td>
<td></td>
</tr>
<tr>
<td>64</td>
<td>Dawson petrified wood: dark orangish brown</td>
<td>Cat. # 19576</td>
<td>projectile point</td>
<td>Area 3, Excavation Units 5D63 and 5D65</td>
<td>The projectile point was found in two fragments in non-adjacent excavation units and thus were separated by a distance of anywhere from 2.0 to 4.1 meters. The fragments have been glued together. The end scraper was made by retouching a flake struck from a blocky core. The point and end scraper apparently result from use of the same batch of tool stone to produce both unifacial and bifacial tools. No matching debitage was recovered from the site, so this manufacture may have occurred previous to site occupation. The point apparently was broken in use near Area 3 with the resulting fragments left in Area 3. The end scraper was also discarded in Area 3.</td>
</tr>
<tr>
<td></td>
<td>Cat. # 30105</td>
<td>end scraper</td>
<td>Area 3, ground surface</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table B-2. Jurgens Site Artifacts from the Same Nodule or Batch of Stone (Page 35 of 35).

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</thead>
<tbody>
<tr>
<td>65</td>
<td>Flat Top chalcedony: light purple with light brown mottling</td>
<td>Cat. # 30198, Item 28</td>
<td>interior flake</td>
<td>Area 3, ground surface</td>
<td>The flakes are large, with the utilized flake measuring 3.93 cm in maximum dimension and the waste flake measuring 5.27 cm in maximum dimension. The artifacts may represent knapping of a nodule in the vicinity of Area 3, subsequent use of a flake as an expedient tool, and discard of two flakes from the nodule in Area 3.</td>
</tr>
<tr>
<td></td>
<td>Cat. # 30198, Item 29</td>
<td>utilized interior flake</td>
<td>Area 3, ground surface</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>