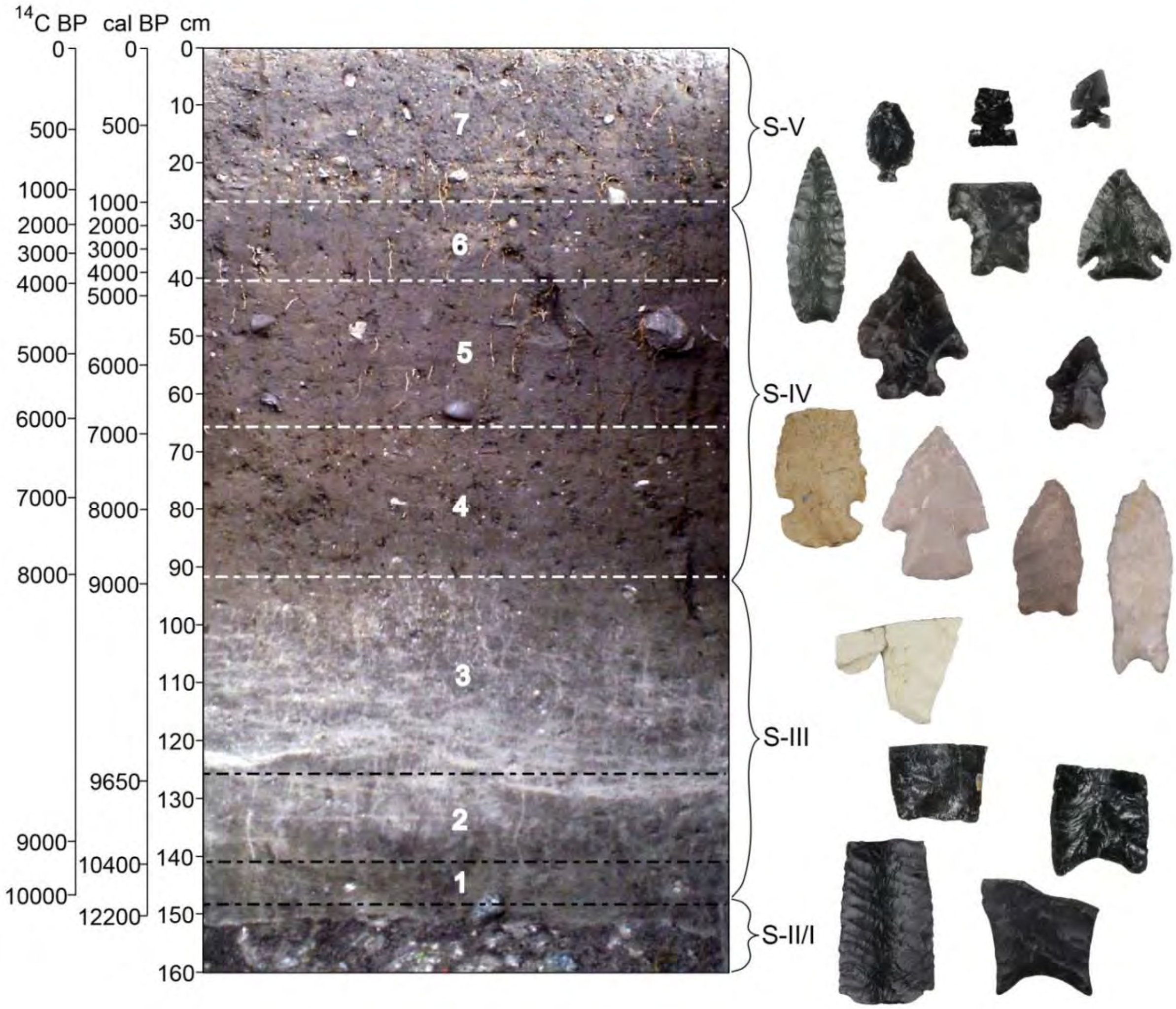
THE GAME CREEK SITE AND
THE PREHISTORY OF JACKSON HOLE



Edited by
Michael K. Page

With Contributions by

Michael K. Page, William Eckerle, Sasha Taddie,
James Mayer and Orion Rogers

2017

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Wyoming State Parks & Cultural Resources

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The Teton County Public Library
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The Wyoming Department of Transportation and
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I would like to acknowledge and thank the American people whose tax dollars funded, through the Federal Highway Administration, the field work, laboratory analysis and reporting of the investigations at the Game Creek site. A great many people participated in the excavations at Game Creek or otherwise provide assistance. This project would not have been successful without them. I would like to extend my sincere thanks and gratitude to Julie Francis for her guidance and support. Her careful and thoughtful review of the chapters in this report is deserving of more than a mere acknowledgement, regardless of its sincerity. Field personnel included Dr. Richard Adams, Rita Bolton, Gale Brow, Sven Bultema, Beth Ann Camp, Hung Wei (Davey) Chen, Carmen Clayton, Ashley Dillon, Regan Driver, Dan Eakin, Julie Eakin, Jesse Harris, Ryan Harris, Sam Holmes, Claire Kenyon, Jordan Kluver, Trevor Lindland, Chris Pettyjohn, Kelly Phillips, Crystal Reynolds, Hana Romes, Dr. Bryon Schroeder, Christina Servetnick, Matt Stirn, Christopher Tinti, Dr. Jason Toohey, Mark Voorhes, Dulce Wassil, Matt Weaver, Dale Wedel, Melanie Wing, and Andrew Woodhouse. The success of the investigations at Game Creek is due to their hard and careful work. Additional assistance was provided by Larry Amundson, Carolyn Buff, Shay Davis, Sylvia Huber, Don and Eva Peden (and their Boston terrier Midge) and others who volunteered their time to dig at Game Creek. The tedious tasks of washing, cataloging and curating the more than 170,000 artifacts recovered from Game Creek was performed by Jordan Kluver, Kelly Phillips, Mark Voorhes, Dulce Wassil and Dale Wedel. I would like to extend a special thanks to Beth Ann Camp, Kelly Phillips, Mark Voorhes and Dulce Wassil, who provided skilled, thoughtful and unwavering assistance throughout the duration of the field and laboratory work. Jamie Schoen, archaeologist with the Bridger-Teton National Forest, deserves special acknowledgement and my sincere thanks for coordinating and facilitating lodging for the crew at the Bryan Flats Ranger Station, a truly marvelous place. Mike and Cindy West, seasonal employees with the Bridger-Teton National Forest who also spent their summers residing at Bryan Flats, were kind and helpful neighbors who graciously and gracefully endured three summers with an archaeological field crew. I would also like to extend my gratitude to the engineering, surveying and maintenance crews from the Wyoming Department of Transportation in Jackson who cut the grass, backfilled our excavations and assisted in the mapping and land survey at Game Creek. Lastly, I would like to thank the Wyoming Department of Game and Fish for assisting and facilitating excavations at Game Creek.

Forward

The Game Creek Site and the Prehistory of Jackson Hole is a redacted and condensed version of the technical report on the investigations titled *The Game Creek Site (48TE1573): 10,350 years of Human Occupation in Southern Jackson Hole, Wyoming.* The technical report was prepared for the Wyoming Department of Transportation and submitted pursuant to a Memorandum of Agreement (MOA) between WYDOT and the Wyoming State Historic Preservation Office. In addition to the technical report the MOA requires that a version of the report be submitted to the Teton County Public Library and made available to the general public. Federal regulations prohibit the disclosure to the public of information concerning the nature and location of archaeological resources (43 CFR 7.18). Consequently, all detailed maps, photographs and descriptions of the Game Creek site have been redacted in order to comply with Federal regulations and to prevent harm to the site. The appendices, two chapters and several hundred pages of the original technical report were also cut to allow the entire work to be printed in a single volume.

Copies of the technical report are available to qualified researches through the Wyoming Cultural Records Office and the Office of the Wyoming State Archaeologist in Laramie, Wyoming.

Page, Michael K. (editor)
2017 *The Game Creek Site (48TE1573): 10,350 years of Human Occupation in Southern Jackson Hole, Wyoming*. Office of the Wyoming State Archaeologist. Submitted to the Wyoming Department of Transportation. Cultural Resource Series No. 2. Copies available from the Wyoming Cultural Records Office, Laramie.

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CHAPTER 1 INTRODUCTION

Michael K. Page

Overview of Investigations

Section 106 of the National Historic Preservation act requires that an assessment of the presence and potential impacts to cultural resources be conducted prior to a Federal or federally assisted undertaking (16 U.S.C. 470f). Pursuant to these requirements, in 2001 the Wyoming Department of Transportation authorized the Office of the Wyoming State Archaeologist (OWSA) to conduct an archaeological survey in advance of planned highway construction south of Jackson, Wyoming. The survey resulted in the discovery of several prehistoric and historic sites the most significant among them was the Game Creek site (Eckles and Rosenberg 2002). Initial work at the site consisted of a systematic pedestrian survey and the excavation of six shovel tests. Based on their preliminary findings Eckles and Rosenberg (2002) recommended that the site receive formal evaluative testing in the event of future impacts.

In 2002, WYDOT authorized OWSA to conduct formal evaluative testing of the Game Creek site. In the summer of 2002, OWSA personnel under the direction of Dan Eakin excavated 18 1-x-1-m test units, 59 shovel tests and five backhoe trenches to assess the presence, extent and integrity of subsurface cultural materials (Eakin and Eckerle 2004). The survey and testing of the Game Creek site resulted in the documentation of intact, stratified cultural deposits dating from the Late Paleoindian through Late Prehistoric periods (Eakin and Eckerle 2004). Three sequential terraces, T1, T2 and T3, and an alluvial fan, S3, were documented and their depositional histories outlined.

2010–2012 Data Recovery Excavations

In 2010, WYDOT authorized OWSA to conduct data recovery excavations in order to mitigate adverse impacts to the Game Creek site arising out of the proposed highway expansion. Work began on June 1 with the opening of several excavation blocks on the T3 terrace as outlined in the data recovery plan (Eakin and Eckerle 2004). A total of six excavation blocks were opened, and a total of 56 m^2 was excavated (Table 1-1). In all, one unprepared hearth, one hearth cleanout, two rock-lined roasting pits, three roasting pit cleanouts and 15,961 artifacts were recovered. Fourteen temporally diagnostic projectile points were found, nine of which were discovered *in situ*. The most common type is an eared dart similar to the Elko Eared and Hanna types. Excavation concluded on September 15, 2010.

The second season of excavation began on June 6, 2011 and continued in 8-day sessions until September 21, 2011. We returned to the T3 terrace and expanded excavations in several blocks opened the previous year and opened an additional small excavation lock. We also excavated 21 1-x-1-m units along the T3 terrace east of the highway in order to tie together the stratigraphy and cultural levels and further asses the distribution of cultural deposits. The single excavation units were systematically placed between excavation blocks as well as along the APE. A total of 49 m^2 was excavated on the T3 terrace in the 2011 field season. In all, an unprepared hearth, a rock-lined roasting pit, and 22,432 artifacts were recovered from the T3 terrace in the 2011 excavations (Table 1-1). Three corner-notched dart point fragments, three Late Paleoindian point fragments and four Mountain-Foothills Paleoindian points or point fragments were also found.

Also during the 2011 field season, excavations began on the S3 fan where 8 m^2 were excavated. Artifact frequencies were significantly higher on the S3 than within most of the T3 terrace. The six units that were completed in 2011 produced 11,750 artifacts including 1,249 pieces of butchered bone. Moreover, the cultural deposits on the S3 fan were significantly shallower than those on the T3 terrace. Four corner-notched dart point fragments similar to the Late Archaic Pelican Lake type, one Late Prehistoric Desert tri-notch and one Late Prehistoric Rose Spring point fragment were recovered in addition to the base of a large hafted biface.

On June 11, 2012, we returned for the final field season. The first 8-day session was spent wrapping-up loose ends on the T3 terrace. Another block consisting of 6 m^2 was placed around a 2011 test unit that yielded evidence of a Late Paleoindian activity area. Three units were excavated at the northern end of the T3 terrace where a Late Paleoindian projectile point and a scatter of charcoal and burned bone were recovered the previous year in hopes of recovering additional materials. In addition, a unit that was begun in 2011, but not completed by the end of the season was finished. Five units were also excavated south of Block A to clarify some stratigraphic ambiguity and ascertain whether previously identified cultural levels extended into this. In sum, 20 m^2 were excavated and 9,712 artifacts recovered from the T3 terrace in the 2012 field season. Only one identifiable projectile point fragment, a barb from a corner-notched point, was found.

Table 1-1 Summary of Data Recovery Phase of Excavations.

Season	Excavation		Artifacts						Artifact Totals
	m^2 Excavated	m^3 Excavated	Debitage	Chipped Stone Tools	Ground Stone	Bone	Bone Tools	Historic Artifacts	
2010	56	78.2	15,260	291	6	404	0	0	15,961
2011	54	59.6	31,658	267	6	2,243	1	7	34,182
2012	81	66	93,461	606	8	26,529	6	22	121,157
Total	191	203.8	140,379	1,164	20	29,176	7	29	171,300

Most of our efforts were concentrated on the S3 alluvial fan during the remainder of the 2012 season. The block begun in 2011 was expanded with the excavation of 15 m^2. Two additional blocks consisting of 17 m^2 and 7 m^2, respectively, were excavated. Eighteen individual units, some of which were contiguous but not assigned block designations, were excavated between and adjacent to the blocks in order to document gradual changes in stratigraphy as well as the spatial extent of cultural levels. Artifact recovery on the S3 fan was remarkably higher than within any other site locality with 110,200 artifacts recovered in the 2012 season alone. The faunal assemblage is particularly impressive with 26,535 pieces of bone, elk antler and freshwater mussel shell recovered, including fragments of five bone tools and one antler tool. Projectile points were also abundant with 75 complete or fragmentary specimens recovered. Of these, 60 retained enough of the base to allow identification of haft morphology, the most prevalent variety of which is the corner-notched dart of the Elko or Pelican Lake type. Other types include Duncan/Gatecliff stemmed, Desert Side and Tri-Notch, Bitterroot Side-Notch, McKean or Humboldt Lanceolate and Rose Spring Corner-Notched. Several hundred kilograms of fire-cracked rock were also encountered, mapped and documented across the S3 fan, but only three possible thermal features (Features 12, 13 and 14) were identified.

A limited amount of work was also conducted on the T2 terrace as outlined in the data recovery plan. Two units were excavated east of the highway on what is believed to be a T2 terrace remnant. One cultural level containing the remains of one butchered bison and a few chipped stone tools was found near the surface. No features were encountered, and no diagnostic artifacts recovered. The two units yielded 1,193 artifacts, 440 of which were bone associated with the butchered bison. Although the total frequency of artifacts was relatively high, only the upper levels containing the butchered bison appear to represent a discernable cultural level. The remaining portion of the 150–175 cm deep deposit contained only a diffuse scatter of debitage and the occasional chipped stone tool.

Research Design

To date, Game Creek is the most thoroughly investigated prehistoric site in Jackson Hole. Three years of intensive excavation resulted in the documentation of multiple stratified cultural levels, the recovery of over 170,000 artifacts, including nearly 100 temporally diagnostic specimens, and the acquisition of 45 radiocarbon dates. These data allow us to address a number of research topics, some of which were outlined in the data recovery plan but others arose during the course of investigations. These combined topics can be summarized under four broad research domains (Eakin and Eckerle 2004). Each of these domains addresses a number of questions and contained multiple goals.

Chronostratigraphy

As discussed in Chapter 3, relatively few Paleoindian sites have been systematically investigated in the region, and no intact Paleoindian components had ever been excavated in Jackson Hole. Moreover, most of the Paleoindian sites from the surrounding regions that have received the attention of professional archaeologists were excavated in the 1960s and 1970s when radiocarbon dating was still in its infancy and field methods were less precise than today. Consequently, there is some temporal ambiguity surrounding the emergence and duration of Late Paleoindian complexes in the Central Rockies. Nevertheless, numerous styles of Late Paleoindian projectile points have been identified in dated contexts in the region (Davis et al. 1988, 1989; Frison 1973, 1983; Gruhn 1961; Husted 1969; Husted and Edgar 2002; Kornfeld et al. 2001; Lahren 1976; Swanson 1964, 1972). Furthermore, it has long been known that many projectile point types were contemporaneous and that the spatial distribution of these types overlapped (Kornfeld et al. 2010; Pitblado 2003). Since archaeologists frequently use projectile points to cross-date sites, it is important that the range of variation present within any one type and the temporal and spatial distribution of types are known.

Therefore, the data recovery plan called for the intensive excavation of the Late Paleoindian and components identified in 2002 with the objectives of documenting the stratigraphy on each landform, correlating, if possible, the strata from the various landforms and obtaining as many radiocarbon dates as possible "in order to gain information on the temporal and typological variation of Late Paleoindian projectile points" (Eakin and Eckerle 2004:121). In Chapter 4, Eckerle and colleagues report the stratigraphy of the T3 terrace and S3 alluvial fan with particular attention given to the temporal parameters of the various strata. These data confirm the presence of multiple Late Paleoindian components spanning approximately 1,650 years in relatively good stratigraphic context. The small assemblage of projectile points recovered from the Late Paleoindian components is described in Chapter 6. Unfortunately, the hopes of recovering large projectile point assemblages from well-dated Late Paleoindian components were not realized.

The significant Early Archaic occupations, although not recognized during the 2002 testing phase, and therefore not incorporated into the data recovery plan, provided invaluable information on projectile point styles and variability during a poorly understood period of time. There is as much ambiguity over the development and internal variation of Mountain-Foothill Paleoindian and Archaic projectile point types as there is for Late Paleoindian diagnostics. This is especially true in Jackson Hole where the absence of well-dated assemblages has forced archaeologists to pigeonhole projectile point types into chronologies developed on the Northwestern Plains (Bartholomew 2001; Bender and Wright 1988; Connor 1998; Love 1972; Reeve 1986; Wright 1975, 1984; Wright et al. 1980). As discussed in Chapters 3, 6 and 8 the evidence from Game Creek strongly suggests that the Northwestern Plains projectile point chronology does not apply to Jackson Hole. These findings not only call the cultural historical reconstructions of Connor (1998) and Bender and Wright (1988) into question, but they also have broader implications concerning the development and spread of technological and subsistence systems throughout the Archaic period (Chapter 3).

Paleoenvironmental Studies

The climate changed dramatically at the end of the Pleistocene and continued to change throughout the Holocene, fluctuating between warmer and cooler and wetter and drier episodes. The pollen records from the Greater Yellowstone Ecosystem (GYE) clearly show that there were dramatic changes in vegetation communities as a response to climatic fluctuations, particularly during the Early Holocene (Whitlock 1993; Whitlock and Bartlein 1993; Whitlock et al. 2008). Although difficult to assess, it is reasonable to infer that these fluctuations had a corresponding effect on game populations as well. Thus, climate change resulted in alterations of the distribution and availability of the plants and animals on which hunter-gatherers depended for their subsistence.

In Chapter 2 Eckerle and colleagues summarize the paleoenvironmental proxy data and present a paleoclimatic overview from the Late Pleistocene to present. As discussed in Chapter 3, the paleoclimatic reconstruction provides context of the environmental setting of Jackson Hole and surrounding regions during the periods of human occupation and further offers evidence of “push” and “pull” stimuli upon which hypotheses of human migration and adaptation can be founded. The paleoclimatic reconstruction also affords a framework within which to assess depositional trends documented at Game Creek (Chapter 4). Another important purpose of paleoenvironmental studies is to provide empirical evidence to evaluate models developed by Eckerle and colleagues that are presented in Chapter 2. The Macrophysical Climate Model (MCM) developed for the town of Jackson retrodicts annual and summer effective moisture throughout the Holocene. Eckerle and colleagues also modeled the distribution and availability of 17 high-value plant food resources near the Game Creek site under wetter than average and drier than average conditions. These models provide frames of reference to evaluate seasonal resource availability and the subsistence patterns (Binford 2001) used by occupants of Game Creek throughout the Holocene. Moreover, climate change and the availability of plant and animal resources are intricately linked to our understanding of the impetus behind the transition from specialized big game hunting, characteristic of Paleoindian subsistence strategies, to broad-spectrum foraging, the hallmark of Archaic subsistence.

Late Paleoindian–Early Archaic Mobility and Subsistence

For millennia highly mobile Paleoindian populations specialized in the pursuit of large terrestrial mammals until increasingly dry conditions during the Early Holocene forced widespread adaptational responses in hunter-gatherer subsistence and settlement strategies (Larson and Francis 1997). With this transition came changes in toolkits such as the adoption of new styles of projectile points, manos and metates for intensive processing of edible plants and the appearance of rock-lined roasting pits for the processing of edible roots and tubers (Frison 1973; 1997, 1998; Husted 1969; Kornfeld et al 2010). There was also a marked change in the exploitation of fauna with a wider variety of animals of all sizes being utilized and a reduction in large-scale kills of big game (Frison 1997, 1998). These technological and subsistence changes reflect a pervasive shift to broad-spectrum foraging throughout the Northwestern Plains and Central Rockies (Kornfeld et al. 2010). Yet, these changes did not occur everywhere at the same time. Husted (1969) was the first to recognize that the Paleoindian-Archaic transition occurred earlier in the foothills and mountains of northwestern Wyoming than in the surrounding Northwestern Plains and Intermontane basins. Subsequent investigations in the Bighorn and Absaroka ranges of

Wyoming (Frison 1973; Frison and Walker 2007; Husted and Edgar 2002; Kornfeld et al. 2001) and the Northern Rocky Mountains of Montana (Davis et al 1988, 1989; Hill et al. 2005) have confirmed Husted's (1969) findings. The peoples of the Foothill-Mountain Paleoindian complex, as they have come to be called (Frison 1997), practiced an Archaic way of life at least 1,000 years before a similar transition occurred on the plains. Detailed explanations of the cultural processes that led to this foothill/mountain-plains dichotomy have yet to be formulated, but the evidence to date points to a "distinct separation in lifeways between the two ecosystems" (Kornfeld et al. 2010:95).

The 2002 testing at Game Creek produced evidence of Late Paleoindian, Foothill-Mountain Paleoindian and Early Archaic occupations in stratified contexts thus providing an ideal opportunity to study changes in subsistence and settlement (Eakin and Eckerle 2004). The small faunal assemblage recovered from these early components and reported in Chapter 7 is strikingly diverse, which is also indicative of broad-spectrum Archaic subsistence practices, but also displays a clear emphasis on big game. Additional data relating to subsistence was sparse in the early components, but a metate fragment recovered from deposits dating to circa 9000 cal BP does point to plant processing. Mobility and settlement are typically assessed through lithic source analysis, and the results of the 2010-2012 excavations, presented in Chapters 5 and 6, show a nearly exclusive use of locally available stone suggesting somewhat restricted mobility similar to that postulated for groups practicing an Archaic lifeway. These data generally corroborate the finding of other studies in the Central and Northern Rockies, but the large suite of radiocarbon dates associated with the early components at Game Creek helps to further refine the timing and material cultural parameters of Foothills-Mountain Paleoindian complexes.

Testing of the High Country Adaptation Model

The High Country Adaptation Model was first proposed by Wright, Bender and Reeve (1980) and was formulated using data gathered in northern Jackson Hole. The model was further refined and expanded upon by Wright (1984), Reeve (1986) and Bender and Wright (1988). The impetus behind the model was a belief that archaeologists had inappropriately relegated mountainous environments to a marginal status (Bender and Wright 1988). In particular, these scholars argued that abrupt changes in elevation common to all mountain environments created subsistence opportunities not found in the surrounding plains and basins. Elevationally delayed maturation and patterning of resource availability, or *periodicity*, of plant resources, especially blue camas, is central to the model (Bender and Wright 1988; Reeve 1986; Wright et al 1980).

To briefly illustrate (Wright et al. 1980), the model predicts that bands of hunter-gatherers set out from the Snake River Plain traveling up the Fall River into extreme southwestern Yellowstone Park where base camps were established near blue camas meadows in time to exploit the ripening blue camas. Once this harvest was complete, the band traveled over a low pass onto Glade Creek then down the Snake

River into northern Jackson Hole for a second harvest of blue camas near the inlet of Jackson Lake. Once plant resources began to ebb on the valley floor, bands moved their base camps into the northern Tetons via Berry Creek and over either Conant or Jackass pass to exploit the late summer ripening camas meadows in the high country. Once this harvest was complete, the bands moved westward onto the winter hunting territories on the Snake River Plain.

Although this model was formulated with site data from northern Jackson Hole, the same periodicity of plant and animal resources, but not all the same resources, is present in southern Jackson Hole. Thus, the data recovery plan called for an evaluation of the High Country Adaptation Model using data recovered from the investigations at Game Creek (Eakin and Eckerle 2004). In Chapter 8, the model is applied to the evidence. The underlying principles of Bender and Wright's (1988) model are sound, but the data do not support their historical reconstruction of population movements into and out of Jackson Hole.

CHAPTER 2 ENVIRONMENTAL SETTING: PAST AND PRESENT

William Eckerle, James Mayer, Orion Rogers, Sasha Taddie and Michael Page

Prehistoric activities occurred within an environmental setting that provided the occupants with certain economic food opportunities. Paleoenvironmental reconstruction can provide evidence of available biotic resources, as well as information on climatic and environmental trends that humans experienced in the past. This study relies on a regional paleoenvironmental synthesis to interpret site events. It also utilizes a macrophysical climate model (MCM) to visualize the scale of temperature and precipitation variation in the past. Modeling of food resource availability is undertaken as an encouragement for archaeologists to investigate prehistoric economic opportunities in Jackson Hole. One aspect of this study presents geographic information system (GIS) modeled distributions of economic plant-food resources and game animal forage for present day, wetter than present, and drier than present climate states.

Modern Environment

Geographic Location

The project area is situated south of the town of Jackson, in northwest Wyoming's South Park, a southward extension of Jackson Hole. Jackson Hole is an intermontane basin in the central portion of the Middle Rocky Mountain physiographic province (Fenneman and Johnson 1946). It is drained by the Snake River and flanked by the Teton Range to the west and Gros Ventre Mountains to the east. East Gros Ventre Butte and West Gros Ventre Butte separate northern Jackson Hole from South Park of Jackson Hole (Figure 2-1).

Geologic and Geomorphic Context

Jackson Hole is a topographic, structural, and depositional basin (Figure 2-1 [Thornbury 1965]) lying immediately west of the Continental Divide. The basin is drained by the Snake River and several of its tributaries. The Snake River heads on the Pitchstone Plateau and Pinyon Peak Highlands in Yellowstone National Park at elevations ranging from 2,743 m (9,000 ft) to 3,048 m (10,000 ft). The main branch of the river heads near Heart Lake and flows southwest to merge with the south-flowing Lewis River. The Snake River flows south into Jackson Hole where it is flanked on the west by the Teton Range (>4,267 m [14,000 ft]) and on the east by the Gros Ventre Mountains (>3,658 m [12,000 ft]). Once in Jackson Hole, the river flows into Jackson Lake reservoir (shoreline elevation is 2,064 m [6,772 ft]). Jackson Lake reservoir inundates a basin formed by down-faulting of Jackson Hole along the west-flanking Teton Fault. This basin has been scoured and deepened by Pleistocene glaciation. Prior to damming by the Corps of Engineers in 1916, it was a natural lake (i.e., Jackson Lake) which maintained

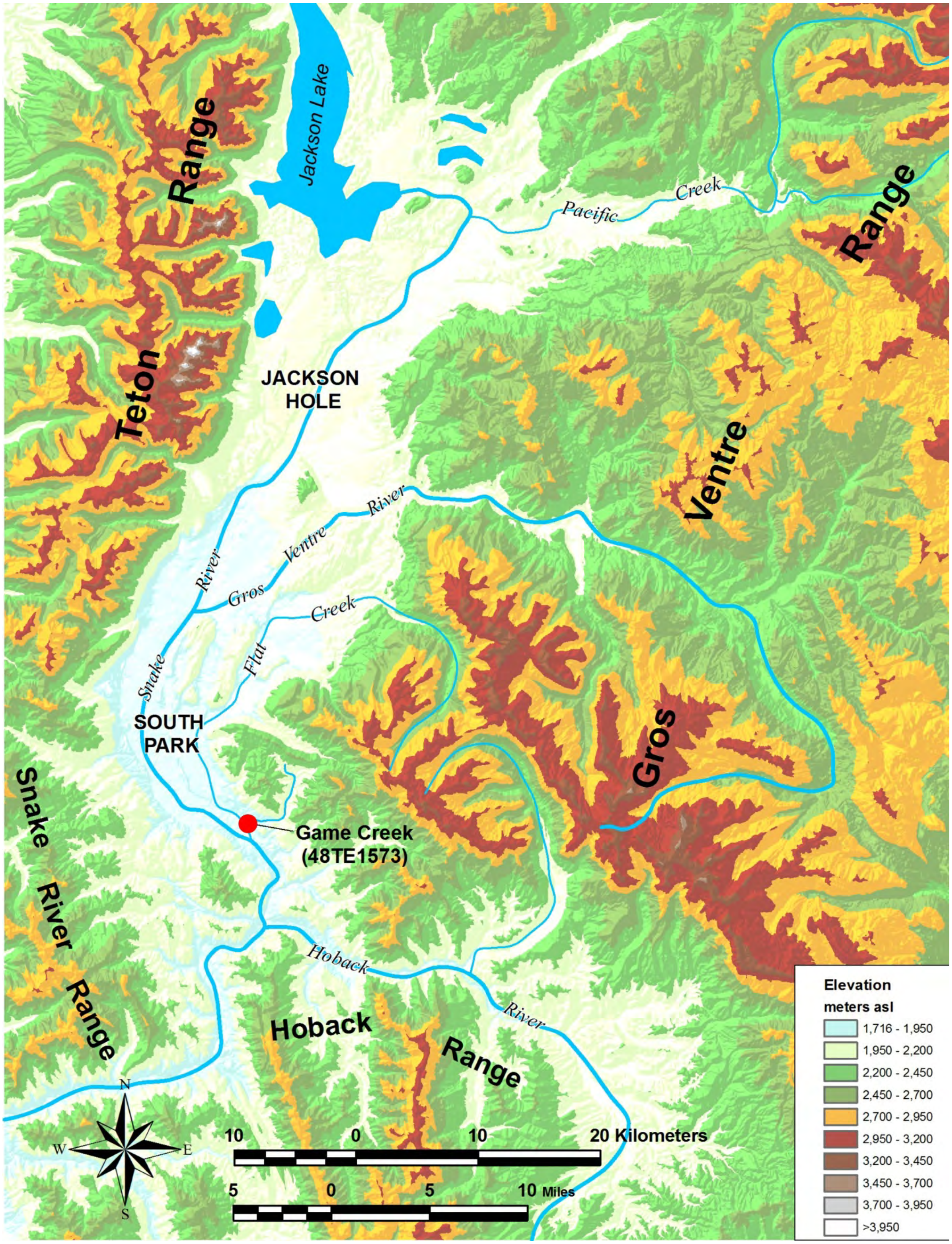


Figure 2-1 Topographic map of Jackson Hole.

an average shoreline elevation of 2,052 m (6,733 ft). Downstream of the reservoir outlet, the Snake River is joined by Pacific Creek and Buffalo Fork. As the river flows through Jackson Hole, it passes west of West Gros Ventre Butte and enters South Park where it is joined from the east by the Gros Ventre River (which flows between West and East Gros Ventre Buttes), and is subsequently joined by Flat Creek. The latter flows between East Gros Ventre Butte and the Gros Ventre Range. From the mouth of Flat Creek, the Snake River continues downstream to Hoback Junction and the confluence of the northwest flowing Hoback River. From Hoback Junction, the Snake River enters Snake River Canyon. Eventually, the Snake River exits the Rocky Mountains and flows onto the Snake River Plain, a portion of the Columbia Plateau.

Initial uplift of the Jackson Hole area occurred during regional upwarping 34 million years before present (mybp) (Smith and Siegel 2000). Subsequent crustal extensions caused development of normal faulted mountain blocks and intervening fault-block valleys including the Teton Range and Jackson Hole (Good and Pierce 1996). Uplift of the Tetons and the down-dropping of Jackson Hole along the Teton normal fault are temporally limited by dates on the Colter Formation of 15-17 mybp. Original flat-lying beds in the Colter Formation were tilted and then buried by the overlying Teewinot Formation sometime prior to 10 mybp (Miocene). Movement has continued along the Teton fault up to the present (Smith and Siegel 2000).

Jackson Hole's evolution is intimately associated with the geological history of the Yellowstone Hotspot (Good and Pierce 1996; Smith and Siegel 2000). It is theorized that this hotspot is the surface manifestation of a thermal mantle plume (Pierce and Morgan 1992). The North American lithospheric plate migrated over the plume to create a series of calderas trending southwest to northeast across the Snake River Plain and up into the Yellowstone area (Smith and Siegel 2000). Remnants of three calderas forming the "Yellowstone Group" have been identified in proximity to Jackson Hole, including: (1) the 2.1 mybp Big Bend Ridge caldera responsible for the deposition of the Huckleberry Ridge tuff; (2) the 1.3 mybp Island Park caldera which deposited the Mesa Falls tuff; and (3) the final 630,000 BP Yellowstone caldera which deposited the Lava Creek tuff (Smith and Siegel 2000). Regionally, northeast-southwest lithospheric extension has been accentuated by local uplift resulting from passage of the plate over the hotspot (Smith and Siegel 2000). At Jenny Lake, up to 21 m (70 ft.) of post-glacial (<15,000 BP) vertical displacement on the Teton fault has been documented, although little fault movement has been recorded south of Wilson or in the South Park area (Good and Pierce 1996).

The Teton Range is cored with Precambrian quartz monzonite (Love et al. 1992), and overlying sedimentary rocks have eroded from most of the highest peaks. Paleozoic Flathead sandstone caps Mount Moran where it is displaced across the Teton fault. Displacement across the Teton fault may be as much as 7,010 m (23,000 ft) in the last 13 million years, a date constrained by the tilted rocks in the 15-17 mybp Colter Formation (Smith and Siegel 2000). Younger Paleozoic and Mesozoic rocks dip westward off the backside of the Teton block at an angle of approximately 15°. Relatively rapid uplift of the Teton fault block gives the east-flowing streams greater erosive power causing the drainage divide to be offset 3-5 km (2-3 mi) west of the topographic crest of the range.

A thick sequence of late Cenozoic rock underlies the Snake River valley (Love and Reed 1971). The sequence formed as uplifted beds were eroded from mountain flanks and the resulting sediments carried to the progressively down-dropping floor of Jackson Hole. As individual streams flowed east and west off the Teton uplift's central spine, a drainage system formed as a result of the progressive lowering of the Jackson Hole block, with east-flowing streams having substantially higher gradients than west-flowing streams.

The Teton Mountains and Jackson Hole have been sculpted by glaciation (Fryxell 1930) and contain extensive glacial deposits. An early to middle Pleistocene glaciation (Ghost) is postulated but is based on limited data (Love and Reed 1971). The Bull Lake (Illinoisan; Isotope Stage 6; >135,000 BP) piedmont glacier, that capped the Yellowstone and Beartooth plateaus and flowed south through Jackson Hole, is locally called the "Munger Glacier" (Pierce and Good 1992). Munger ice flowed as far south as Hoback Junction onto Munger Mountain, and at its maximum, it rose nearly 427 m (1,400 ft) above the floor of Jackson Hole in the proximity of the city of Jackson (Good and Pierce 1996). Munger-age glaciofluvial outwash, till, and proglacial inflow-kame fan deposits veneer the slopes above the South Park of Jackson Hole. Munger ice disappeared with the initiation of the Sangamon Interglacial (Isotope Stage 5; 130,000-120,000 BP), a period much like the present. Withdrawal of the Munger glacier furnished a setting for eolian deposition during the Sangamon Interglacial and through the Wisconsin glacial and interglacial periods. Interbedded paleosols within the loess sequence imply pulses of loess deposition separated by periods of eolian stability (Pierce and Good 1992; Pierce et al. 2011). It is postulated that eolian stability would have been the result of interglacial vegetation colonization due to more temperate climates.

Jackson Hole remained ice free until the later Pleistocene (Isotope Stage 2) when Pinedale ice flowed into northern Jackson Hole from the highlands to the north (Love and Reed 1971). A more detailed record is available for the more recent Pinedale glaciation than for the Munger glaciations, with good evidence for at least three separate Pinedale glacial pulses: (1) Burned Ridge ~65,000 BP; (2) Hedrick Pond/Dogleg ~35,000 BP; and (3) Jackson Lake ~18,000 BP (Pierce and Good 1992). All of these advances terminated north of Moose, Wyoming and did not extend down-valley to South Park. Downstream from the glacier terminus near Jackson Lake proglacial and deglacial fluvial runoff created braided, gravelly, alluvial outwash plains. Pinedale outwash near Jenny Lake is over 60 m thick (Lageson et al. 1999). The older glaciofluvial outwash plains were eventually entrenched and now stand as abandoned terrace treads, while the younger outwash plains are nearly the same elevation as the present-day Snake River channel. In plan view, each abandoned outwash plain is fan-shaped, and in profile, their treads appear to project under the deposits located immediately downstream.

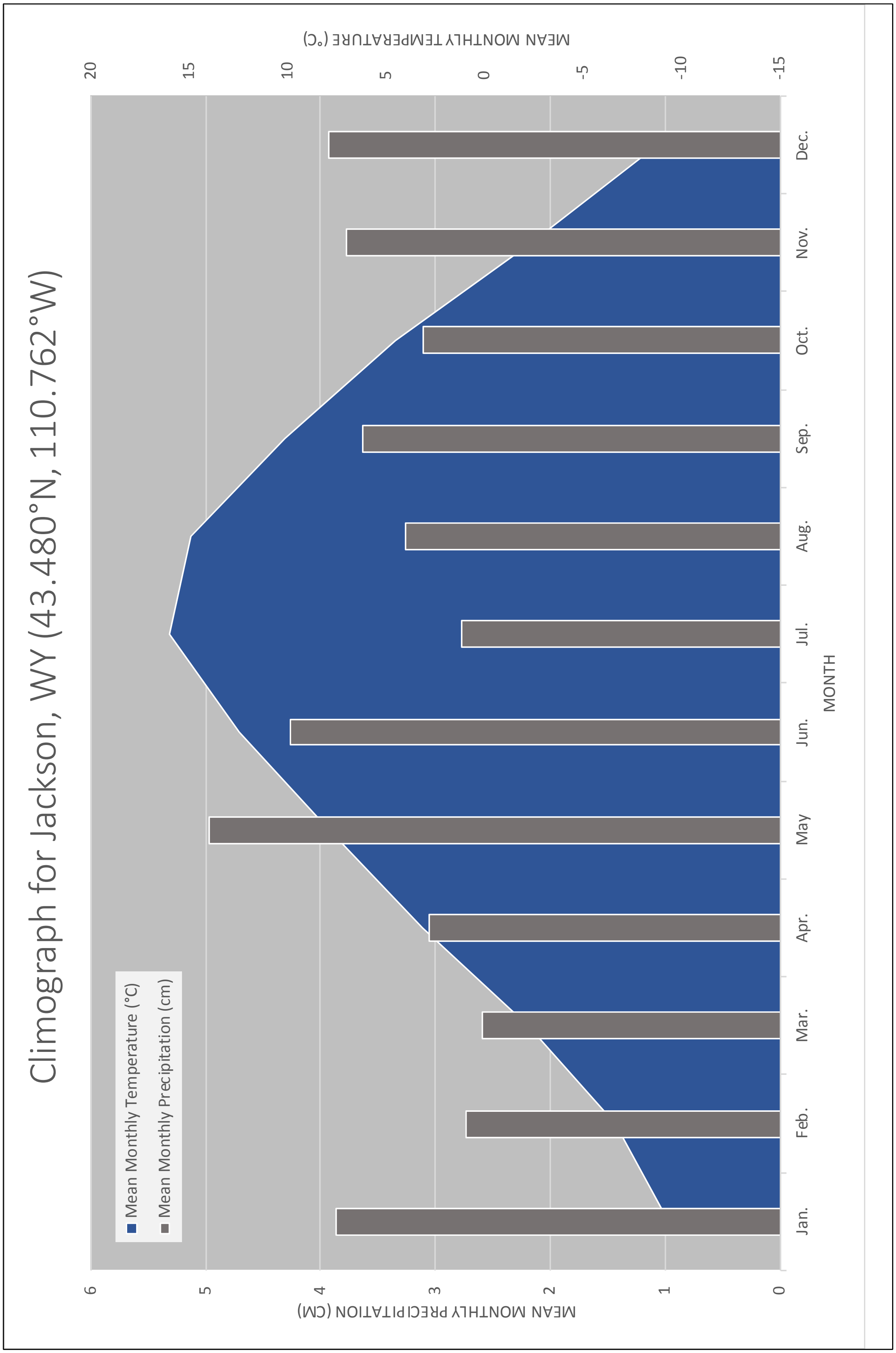
There is evidence for very violent Pinedale-age floods at Deadman Bar along the Snake River north of Game Creek (Lageson et al. 1999). Isostatic rebound, movement of the Teton fault, and pulsating depositional episodes have created a complex assortment of valley bottom landforms. The relationships between landforms indicate both ancient and modern channel abandonment. Dramatic floods resulting from rapid erosion of dams created by earthquake-induced landslides in the Gros Ventre River canyon have also caused dramatic alterations to the Snake River Valley. Of the two better known landslides, the Devil's Elbow slide occurred between 5000-4000 BP, and the later Lower Gros Ventre slide occurred in AD 1927 (Love and Love 1988). These floods may have played a key role in the creation of the terraces at Game Creek.

Game Creek heads at an elevation of 2543 m (8342 ft) on the south flank of Snow King Mountain on Paleozoic rocks that compose the Jackson thrust fault slab. The creek then flows down-section (south-southwest) along the thrust slab for a distance of 6-8 km (4-5 mi) where it crosses Mesozoic rock before encountering the trace of the Game Creek thrust fault and re-enters Paleozoic rock of the overlying Game Creek slab. The creek then turns west to cross the down-thrown side of the Hoback normal fault. At the mouth of its canyon, it encounters the Tertiary Camp Davis Formation before flowing out into the Snake River valley atop the Cretaceous Aspen Shale.

In the uplands, just upstream from the site, Cretaceous and Tertiary rock are veneered by Quaternary loess. A topographic bench formed from a Munger age outwash terrace (kame fan) paleo-valley bottom (Pierce et al. 2011) flanks Game Creek as it approaches the canyon mouth upstream of the Flat Creek confluence. This terrace defines the margins of South Park (Lageson et al. 1999; Pierce et al. 2011) locally at 1950-1980 m (6400-6500 ft), but descends sharply to the south, as Munger terminal moraines are approached on the flank of Munger Mountain, south of Hoback Junction. An approximately >8 m thick, post-Munger loess cap veneers much of the bench. The west-facing scarps of the bench form the lower valley walls for much of South Park including the area immediately adjacent to the mouth of Game Creek.

Climate

The climate of the project area is continental and characterized by very cold winters and cool summers (Figure 2-2). The average maximum January temperature is -3 °C (26 °F), and the average maximum July temperature is 24 °C (76 °F) (National Oceanic and Atmospheric Administration 1985). Minimum January and July temperatures are -18 °C (0 °F) and 4 °C (40 °F), respectively. Average annual precipitation is 41 cm (16 in) (National Oceanic and Atmospheric Administration 1985). Extreme differences in elevation create steep temperature and precipitation gradients between the crest of the Tetons and the floor of Jackson Hole. Precipitation decreases from 100 cm (40 in) at Teton Pass to 39 cm (16 in) at the center of Jackson Hole. Annual precipitation in Jackson, WY is more or less evenly


Climograph for Jackson, WY (43.480°N, 110.762°W)
Mean Monthly Temperature (°C)
Mean Monthly Precipitation (cm)
MEAN MONTHLY TEMPERATURE (°C)
20
15
10
5
0
-5
-10
-15
MEAN MONTHLY PRECIPITATION (CM)
6
5
4
3
2
1
0
MONTH
Jan.
Feb.
Mar.
Apr.
May
Jun.
Jul.
Aug.
Sep.
Oct.
Nov.
Dec.

distributed during the cold and warm months (Figure 2-7). Just over half (55%) of the annual precipitation occurs between October and April primarily as snowfall. The remainder of annual precipitation occurs as rainfall during summer convective storms; however, peak precipitation values during May and June are likely delivered by frontal storms originating over the Pacific and delivered by westerly winds.

Soils

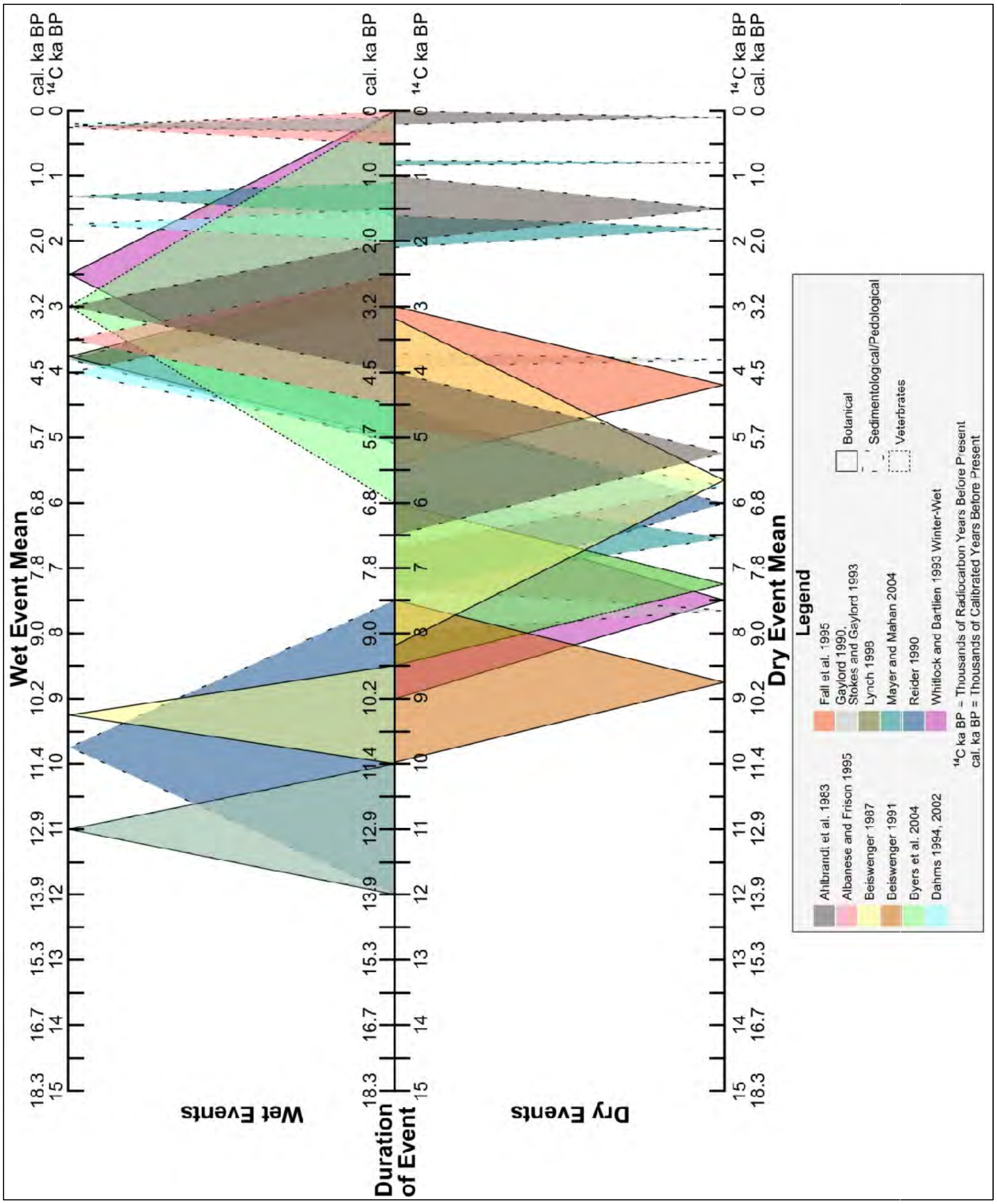
Soil development in Jackson Hole reflects the semi-humid and cold climatic regime (Young and Singleton 1977). Residuum derived from sedimentary rocks, granite, and glacial deposits provides the parent material for mountain slope soils. Spruce-fir forest occurs at higher elevations, and Douglas fir forest dominates lower slopes (Küchler 1966). A sub-climax lodgepole pine forest occurs on many mountain slopes above 2133 m (7000 ft). Soils on forested areas vary by age and slope stability. Clay-enriched B horizons (Cryoboralfs) occur on older parent materials, whereas, younger soils are characterized solely by the accumulation of humic organic material (Cryoborolls). Glacially and glacio-fluvially redeposited sediments provide the parent material for soils on the floor of Jackson Hole. West- to south-facing, lower elevation upland slopes commonly support sagebrush steppe and typically produce organic enriched A horizons (Cryoborolls). Riparian communities occur on poorly drained lowland soils (Cryaquolls).

Regional Paleoenvironmental History

William Eckerle, James Mayer, Sasha Taddie and Michael Page

This section presents a review of post-glacial paleoenvironments to provide a framework for evaluating stratigraphic and soils data from 48TE1573. Although climatic and ecological parameters always limited the prehistoric human subsistence base, adaptive systems would have remained flexible. Paleoenvironmental analysis reconstructs environmental conditions, and consequently is an important zone of research projects where a cultural or behavioral ecology approach is emphasized (Broughton and O'Connell 1999; Butzer 1982).

Paleoenvironmental change in any part of western North America is intricately tied to global climatic change (Thompson et al. 1993). Modeling Late Pleistocene and Holocene climatic change as a response to global changes in atmospheric circulation has become a focus of paleoclimatology during the last 20 years (Bradley 1999). Below, mechanisms of climate change are briefly discussed, followed by description of a model designed to predict paleoclimatic conditions. Global circulation model (GCM) predictions are presented, and then regional and local paleoenvironmental reconstructions of the Late Pleistocene and Holocene are reviewed in light of the model's predictions. A paleoenvironmental chart illustrates trends in regional climatic history (Figure 2-3).


Wet Event Mean
Dry Event Mean
Wet Events
Dry Events
Duration of Event
cal. ka BP
¹⁴C ka BP
Legend
Ahlbrandt et al. 1983
Albanese and Frison 1995
Beiswenger 1987
Beiswenger 1991
Byers et al. 2004
Dahms 1994, 2002
Fall et al. 1995
Gaylord 1990, Stokes and Gaylord 1993
Lynch 1998
Mayer and Mahan 2004
Reider 1990
Whitlock and Bartlein 1993 Winter-Wet
Botanical
Sedimentological/Pedological
Vertebrates
¹⁴C ka BP = Thousands of Radiocarbon Years Before Present
cal. ka BP = Thousands of Calibrated Years Before Present

Mechanisms of Climatic Change

Recent studies utilizing historical events hypothesize four major causes of global climate change: these include changes in atmospheric composition, tectonics, astronomical causes, and industrial activity (Thompson and Turk 1997). Changes in atmospheric composition include changes in CO_2 as well as changes in airborne dust, including volcanic aerosols. The atmosphere cools when carbon dioxide is removed but warms when released. Tectonic changes in the configuration of the continents alter continental climate, ocean currents, wind currents, and circulation patterns. Two mechanisms of atmospheric climate change are solar radiation alteration and meteorite impacts. Finally, the historical input of greenhouse gases and other industrial pollutants into the earth's atmosphere may be causing global warming and/or cooling to occur (Thompson and Turk 1997).

Over Quaternary timescales (i.e., glacial-interglacial), cyclical alterations of Earth's orbital geometry have probably been the primary mechanism of climate change (Imbrie and Imbrie 1980; Bradley 1999). Changes in orbital geometry (axial tilt, precession of the equinox, and orbital shape) cause variation in the amount of solar insolation the earth receives, which in turn forces the earth's atmospheric circulation to behave in a predictable manner.

General Circulation Model

Several types of numerical and conceptual models have been developed in an attempt to explain past variations in Earth's climate, as well as to constrain future climatic change due to anthropogenic factors (Bartlein and Hostetler 2004). General circulation models (GCM) are the models most commonly applied to paleoclimatology, and are also among the most complex (Bartlein and Hostetler 2004). A GCM typically defines external controls, or boundary conditions (i.e. solar insolation, atmospheric composition, anthropogenic activities), and examines their effect on various climatic parameters such as surface air temperature, wind speed, and precipitation. Though GCM's have been in use since the 1950s, the COHMAP project (COHMAP Members 1988; Wright et al. 1993) was the first to produce regional syntheses of paleoclimatic data compared with paleoecological data for several time periods, or "snapshots", over the past 21,000 years. The model retrodicts the position of the jet stream, positions of cyclonic and anticyclone activity, strength of the summer monsoon over western North America, annual surface temperature, and annual precipitation (Thompson et al. 1993). Subsequent global paleoclimatic simulations (Bartlein et al. 1998; Kutzbach et al. 1998) are in close agreement with most of the broad-scale features in previous results (Webb et al. 1993). Bryson (1994) offers an alternative paleoclimatic model that utilizes earth-sun geometry and volcanic aerosol effects to predict changes in insolation, temperature, and precipitation.

More recent models have focused on specific time periods, such as the last glacial maxima (~21.0 ka) or the middle Holocene (~6.0 ka) (Joussaume and Taylor 2000). In regards to the latter time period, the Laurentide Ice Sheet is gone, seasonal and latitudinal distribution of incoming solar radiation differed from present, and atmospheric CO_2 levels were 60-70 ppm lower than present (Sawada et al. 2004). Thus, as mentioned by Sawada et al. (2004:226) "from a modeling perspective, the 6 ka time period is ideal for examining the climate response to orbitally induced changes in the seasonal and latitudinal distribution of insolation."

On the local level, the growing body of paleoenvironmental proxy data such as pollen, diatoms and charcoal recovered from lake varves, paleoshoreline reconstructions and dendro-climatology has begun to allow the evaluation of paleoenvironmental-circulation models. GCM results were evaluated with respect to present day conditions, and are available for 18,000, 12,000, 9000, and 6000 years ago (COHMAP Members 1988). These models are presented below, and are compared with regional and local paleoenvironmental reconstructions.

The challenge of human adaptation to climate change is nothing new. The climate has changed dramatically over the last 12,000 years or so of human occupation in the Greater Yellowstone Ecosystem (GYE). Changes in annual and seasonal temperature and/or precipitation directly impacted plant and animal communities on which hunter-gatherers depended. Human response to these changes is reflected in the archaeological record, but without some understanding of the timing, duration and intensity of local climate change it is difficult to interpret the impetus and scale of human adaptation. This section presents a review of local and regional post-glacial paleoenvironments to provide a framework for evaluating broad human adaptation and demographic changes presented in Chapter 3 and site-specific stratigraphic and soils data presented in Chapter 4.

Glacial (>18,200 cal BP)

Mountain glaciation was widespread in the region prior to 18,200 cal BP (Andrews 1987; Clayton and Moran 1982; Gosse et al. 1995; Licciardi et al. 2001; Pierce 2004; Porter et al. 1983; Richmond 1986). During this time, pluvial lake levels in the eastern Great Basin and Range were high (Benson 2004; Currey 1990), permafrost was widespread (Mears 1981), and vegetation zones were elevationally depressed (Barnosky et al. 1987; Plager and Holmer 2002). The Peoria loess was being deposited across much of the western High Plains (Forman et al. 2001; Osterkamp et al. 1987).

Paleoclimatic modeling (COHMAP Members 1988) for the last glacial maximum (at ~24,000 cal BP) retrodicts a jet stream that was split into two halves, one north and one south of the Laurentide Ice Sheet, both flowing west to east. The southern stream was depressed far below the present position of the jet stream. Interaction of these streams is modeled as producing strong anticyclonic circulation over the ice sheet with the predicted result of cold, dry, easterly, summer winds. Winters were probably no harsher than at present, but seasonality was much reduced, resulting in colder summers. Average temperature in the study region was 12 °C colder than present. The summer monsoon was absent, and the Pacific subtropical high was very weak. Thus, cold dry conditions are modeled for the study area.

Deglaciation (18,200-17,000 cal BP)

Regional data suggest that deglaciation of the mountains and the cessation of the periglacial regime in the basins was well underway by 18,000 years ago (Gosse et al. 1995; Licciardi et al. 2001; Pierce 2004; Porter et al. 1983; Richmond 1986; Teller 1987), though some disagreement exists between chronologies based on ^{14}C and cosmogenic ages on the exact timing of valley glacier retreat. Pluvial lake levels dropped to post-glacial lows (Benson 2004; Currey 1990), and vegetation zones shifted upward in elevation (Barnosky et al. 1987). Eolian sand activity may have occurred at this time (Ahlbrandt 1974).

Changes in the geometry of the earth's orbit and axial tilt initiated a trend toward warming and an increase in seasonality (COHMAP Members 1988). Paleoclimatic modeling predicts the Pacific subtropical high was too weak to provide much moisture to the area. A northward shift of the jet stream occurred as a result of the wasting of the continental ice sheet, but the shift was not pronounced enough to draw monsoonal flow into the study region. As a result, dry conditions prevailed. Locally, however, patches of spruce parkland appear to have been present as early as ~18,000 cal BP at Hendrick Pond southwest of Jackson Lake (Whitlock 1993).

Immediate Post-Glacial (17,000-13,350 cal BP)

The warming trend and increased seasonality that were initiated by changes in the geometry of the earth's orbit and axial tilt continued to develop during the immediate post-glacial period (COHMAP Members 1988). Regional data suggest that pluvial lake levels dropped to post-glacial lows (Currey 1990) during this period. Generally, conditions were dry, especially around 12,000 ^{14}C BP (Haynes 1990). Deglaciation of the continental ice sheet progressed (Richmond 1986; Teller 1987). Vegetation zones shifted upward in elevation (Barnosky et al. 1987). Pollen assemblages from 11 locations in northern Jackson Hole and Yellowstone reveal that alpine meadow and shrub communities composed of sagebrush, grasses and sedges dominated the landscape with some juniper, birch and willow stands present as well thus supporting the GCM (Whitlock 1993).

Latest Pleistocene (13,350 -11,500 cal BP)

Dramatic, post-glacial climatic change occurred on a worldwide scale between 12,800-11,600 cal BP correlating to the Younger Dryas cooling event, which is well documented in Greenland ice cores (Alley 2000; Fiedel 2003). Cooling in the Northern Hemisphere at this time is responsible for the rejuvenation of mountain glaciers in the Rocky Mountains (Reasoner and Jodry 2000; Davis et al. 2003). The Great Salt Lake rose to a post-glacial high-stand at the Gilbert shoreline (Currey 1990) in response to greater snow melt and runoff from the Wasatch Range. Pollen cores show that spruce parkland developed and spread during this time in northern Jackson Hole, with corresponding decreases in sagebrush, grass and sedge pollen. However, meadow and shrub communities apparently still covered large parts of the GYE (Whitlock 1993). At Lake of the Woods, a small lake near Union Pass 70 km east of Jackson Hole

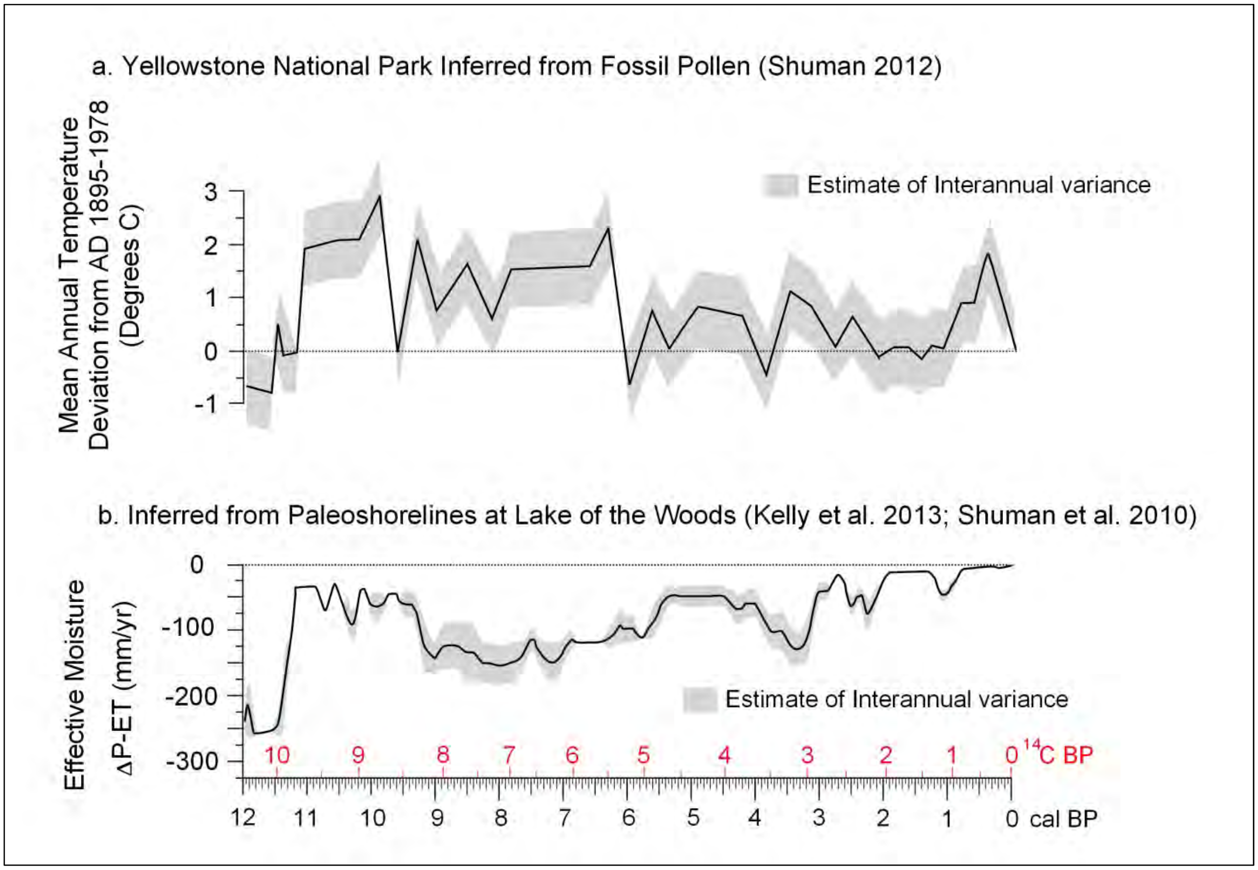


Figure 2-4 Inferred man annual temperature (a) and effective moisture (b) for GYE.

in the Gros Ventre Range, Shuman and colleagues (2010) found evidence for a decrease in effective moisture between ~11,900 cal BP and 11,500 cal BP suggesting cool, dry conditions prevailed (Figure 2-4).

Early Holocene (11,500-8300 cal BP)

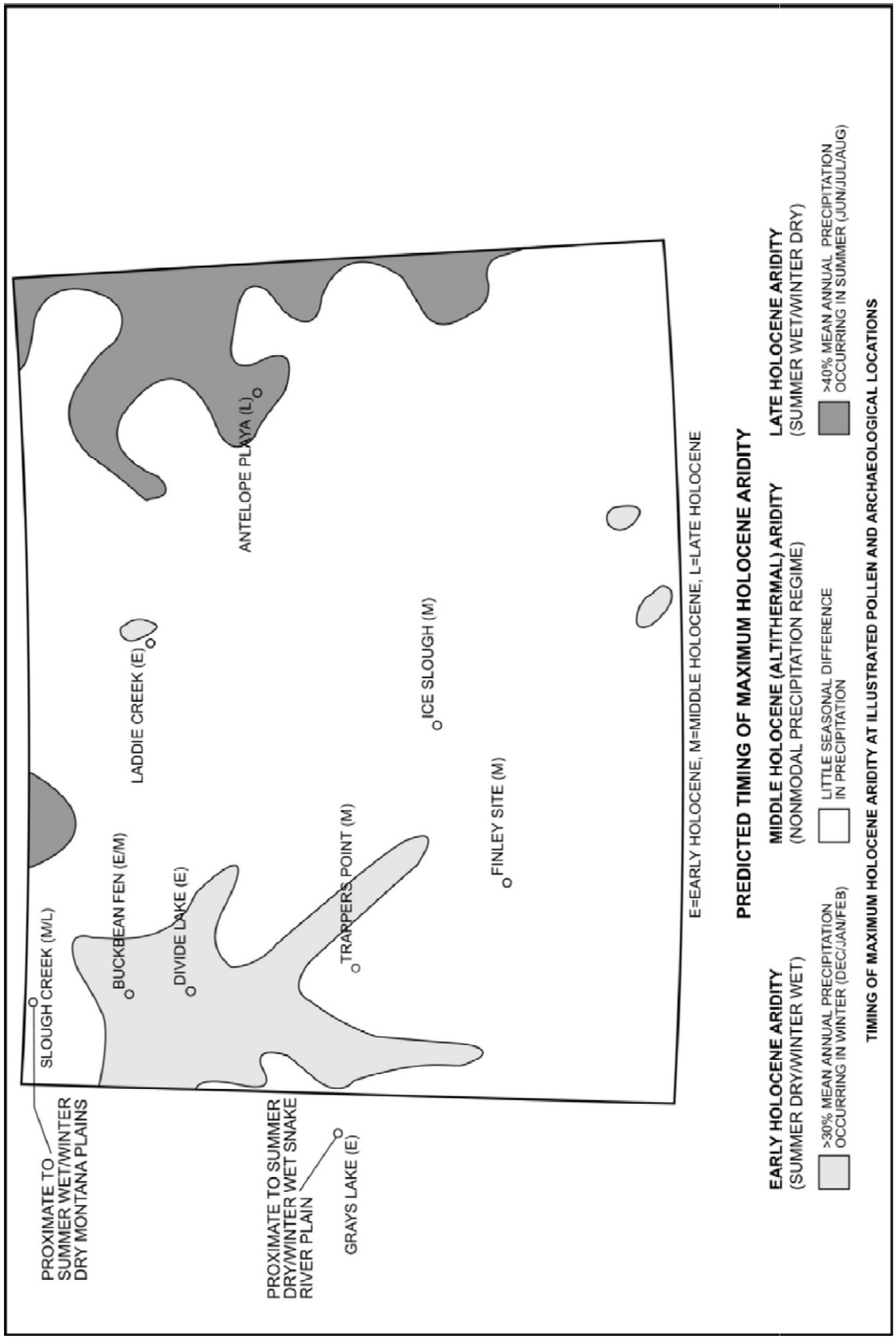
For this time, period, the general circulation model retrodicts summer insolation and seasonality at post-glacial maximum values with worldwide solar radiation 8 percent higher in summer and 8 percent lower in winter than at present. Worldwide temperatures were as much as 2-4 °C higher than at present during this time (COHMAP Members 1988). In response, seasonality is thought to have been pronounced, and summer warming caused the jet stream to shift northward producing stronger monsoonal flow from the Gulf of Mexico and the Sea of Cortez (Bryson and Bryson 1997; Thompson et al. 1993; Whitlock 1993).

The interaction of mountainous topography with both the Early Holocene summer insolation maximum (Davis 1984) and the northern migration of the jet stream caused spatial variation in the timing of periods of maximum post-glacial moisture and maximum post-glacial aridity (Millspaugh et al. 2000; Whitlock and Bartlein 1993, 2004). The peak in insolation during the Early Holocene is thought to have amplified modern seasonal precipitation patterns (Whitlock and Bartlein 1993). This led to contrasting wet and dry climatic trends during the same time frame and may explain why maximum Holocene aridity dates to the Early Holocene in summer dry-winter wet areas and the Middle Holocene in others (Figure 2-5).

There was a fairly brief period of wet and cool conditions at the beginning of the Early Holocene in the GYE. Shuman et al. (2010) found that water levels increased dramatically at Lake of the Woods between 11,500 cal BP and 10,800 cal BP. Pollen evidence from Soda Lake, near Boulder, Wyoming suggests the coolest, wettest interval during the entire span of regional cultural occupancy occurred at ~10,721 cal BP followed by an extremely warm, dry period at ~10,400 cal BP, which together produced the most dramatic post-glacial climate transition (Eckerle et al. 2014). This same record indicates a rebound in cool, moist conditions at 10,160 cal BP. These extreme wet and dry events are reflected in the paleoshorelines of Lake of Woods that witnessed marked increase in water levels at ~10,800 cal BP, followed by a significant decrease between ~10,400 cal BP and 10,200 cal BP, and yet another increase between ~10,200 cal BP and 10,000 cal BP (Figure 2-4 [Shuman et al. 2010]). Pollen data from the GYE show the spread of subalpine forests dominated by spruce, subalpine fir and whitebark/limber pine between ~11,500 cal BP and 10,800 cal BP similar to that of today (Whitlock 1993) providing further support for an increase in effective moisture during the initial period of the Early Holocene likely brought on by stronger monsoonal flow retrodicted by the GCM.

The onset of dry conditions in the GYE is indicated by an increase in lodgepole pine and Douglas fir after about 10,800 cal BP (Whitlock 1993; Whitlock and Bartlein 1993). However, wet conditions may have continued for several centuries at other places in the area. Pollen from Soda Lake does not indicate a decrease in moisture until 9950 cal BP. At Lake of the Woods, shorelines appear to have fluctuated between 10,000 cal BP and 9300 cal BP perhaps reflecting an increase in drought frequency and/or severity before falling to an Early Holocene low between ~9300 cal BP and 9050 cal BP (Figure 2-4 [Shuman et al. 2010]). There was a slight increase and stabilization in lake levels at Lake of the Woods between 9050 cal BP and 8600 cal BP but then shorelines gradually fell throughout the remainder of the Early Holocene (Figure 2-4 [Shuman et al. 2010]).

A well-documented, region-wide shift in stream systems occurred during the Early Holocene as high energy fluvial regimes in the Pleistocene changed to low energy regimes in the post-glacial era (Hunt 1953). This probably reflects a reduction in runoff from glacier and snowfield melting. Albanese (1990) and Leopold and Miller (1954) document such a shift in the Powder River Basin. Miller (1992) suggests a similar shift in alluvial regimes for the Wyoming Basin in general. Albanese (1980) and Reider (1990) postulate a transition from perennial to intermittent flow regimes beginning in the Early Holocene in the Owl Creek Mountains. McFaul (1985) reports encroachment of foot slope deposits onto a former alluvial floodplain in the Rawlins Uplift during the Early Holocene. Early Holocene debris flow and slopewash


PROXIMATE TO SUMMER WET/WINTER DRY MONTANA PLAINS
SLOUGH CREEK (M/L)
BUCKBEAN FEN (E/M)
DIVIDE LAKE (E)
TRAPPERS POINT (M)
LADDIE CREEK (E)
ANTELOPE PLAYA (L)
ICE SLOUGH (M)
FINLEY SITE (M)
PROXIMATE TO SUMMER DRY/WINTER WET SNAKE RIVER PLAIN
GRAYS LAKE (E)
E=EARLY HOLOCENE, M=MIDDLE HOLOCENE, L=LATE HOLOCENE
PREDICTED TIMING OF MAXIMUM HOLOCENE ARIDITY
EARLY HOLOCENE ARIDITY
(SUMMER DRY/WINTER WET)
>30% MEAN ANNUAL PRECIPITATION OCCURRING IN WINTER (DEC/JAN/FEB)
MIDDLE HOLOCENE (ALTITHERMAL) ARIDITY
(NONMODAL PRECIPITATION REGIME)
LITTLE SEASONAL DIFFERENCE IN PRECIPITATION
LATE HOLOCENE ARIDITY
(SUMMER WET/WINTER DRY)
>40% MEAN ANNUAL PRECIPITATION OCCURRING IN SUMMER (JUN/JUL/AUG)
TIMING OF MAXIMUM HOLOCENE ARIDITY AT ILLUSTRATED POLLEN AND ARCHAEOLOGICAL LOCATIONS

sediments fill valleys that previously exhibited perennial flow (Albanese 1987b, 2001). Larson (1992) reports hillslope instability during the Early Holocene at the Laddie Creek site on the west slope of the Bighorn Mountains. A transition from overbank alluvial deposition to slopewash deposition is also documented at the Game Creek site at ~8900 cal BP (Chapter 5). All of these examples suggest a reduction in stream competency and an increase in hillslope sediment availability in the Early Holocene, both of which can be interpreted as the result of a reduction in effective moisture after about 10,100 cal BP.

Early Middle Holocene (8300-6800 cal BP)

Aridity intensified in most of the region during the early Middle Holocene. This marks the first half of the postulated dry Altithermal interval between 8300 cal BP and 5700 cal BP (Antevs 1955). The initial portion of this period (8300-7800 cal BP) coincides with a worldwide, episode of cooling, the so-called 'early to mid-Holocene transition' (Stager and Mayewski 1997). This event is thought to have produced dry and windy conditions in the interior United States (Alley et al. 1997). A decrease in mean annual temperature is inferred from pollen records in the GYE between ~8300 cal BP and 8000 cal BP (Figure 2-4 [Shuman 2012]).

Regionally, the palynological record suggests aridity and the altitudinal lowering of vegetation communities (Plager and Holmer 2002). In the GYE pollen records indicate that Holocene drying was pronounced in summer dry-winter wet areas between 10,200-5700 cal BP with an expansion of lodgepole pine forests (Baker 1976; Whitlock 1993; Whitlock and Bartlein 1993). The shoreline at Lake of the Woods dropped to its lowest point in from 8300 cal BP to 7600 cal BP (Shuman et al 2010). There was, however, an increase in effective moisture documented at Lake of the Woods between ~7600 cal BP and 7400 cal BP (Shuman et al. 2010). Lake levels then fell after ~7400 cal BP before beginning to gradually rise after ~7100 cal BP (Shuman et al. 2010).

The mid-Holocene alluvial history at many places suggests that reduced stream flows began in the Early Holocene and continued through the early Middle Holocene. Flash flood (debris flow) and slope deposits form the bulk of sediments at confined valley locations throughout Wyoming and Montana, including Sage Creek (McFaul 1985), Indian Creek (Albanese 1987a), Barton Gulch (Eckerle 1988; Davis et al. 1989), Guffy Peak (Albanese 1980; Reider 1990), Split Rock (Albanese 1987b), Dead Indian Creek (Eckerle 1990) and Game Creek (Chapter 5). Flood magnitude, especially during convectional storms, is an important control on overbank deposition. The lack of Middle Holocene overbank sediment suggests lowered flood magnitudes during this period. However, Larson (1992) documents less slope activity at the Laddie Creek site during the early Middle Holocene than during the Early Holocene. This example, along with evidence for drying documented at Antelope Playa in the Powder River basin during this time interval, suggests that present day summer-wet locations may have different paleoenvironmental trajectories than winter-wet locations (Figure 2-5).

Late Middle Holocene (6800-5200 cal BP)

Climate modeling suggests that by 6800 cal BP, summer temperatures were still 2–4 °C higher than present, but began to decline in response to decreased summer insolation (COHMAP Members 1988). Other modeling combines the influence of solar input and volcanic aerosols to predict Holocene climatic change (Bryson 1994). This model predicts that 5700-4500 cal BP was transitional between the dry winters and warm/wet summers of the early Middle Holocene and the warmer and wetter winters of the Neoglacial episodes after 5700 cal BP. Thus, as modeled, the late Middle Holocene was transitional.

At Lake of the Woods, low but stable lake levels prevailed between 6800 cal BP and 6300 cal BP followed by a small increase between 6300 cal BP and 6000 cal BP. This coincided with marked decrease in temperatures inferred from the pollen records in the GYE (Figure 2-4 [Shuman 2012; Shuman et al. 2010]). The increase in lake levels thus may have been a product of decreased temperature rather than a significant increase in precipitation. Temperatures appear to have increased after 6000 cal BP, and there was a decrease in the shoreline of Lake of the Woods between 6000 cal BP and 5700 cal BP (Shuman et al. 2010). The remainder of the Late Middle Holocene at Lake of the Woods saw lake levels increase after 5700 cal BP (Shuman et al. 2010) and temperatures generally stabilize (Shuman 2012). The trend toward increasing effective moisture is reflected in the pollen records from the southern GYE, a trend that has continued up to the present (Whitlock 1993; Whitlock and Bartlein 1993). As mentioned above, Holocene drying began much later in summer-wet locations, like Antelope Playa in the Powder River Basin, with aridity beginning after 7800 cal BP and especially after 3200 cal BP (Whitlock and Bartlein 1993). Timing of aridity at Ice Slough along the Sweetwater River in Central Wyoming implies that present day summer-wet locations have different paleoenvironmental trajectories than winter-wet locations, with Ice Slough being only slightly winter-wet and Antelope Playa being distinctly summer-wet.

The late Middle Holocene has sometimes been referred to as the “early Neoglacial.” However, application of this term to the study area does not seem appropriate, as a resurgence of cirque glaciers did not begin until the very end of the late Middle Holocene. By around 5400 cal BP small cirque glaciers had begun to occupy high cirques in the Wind River Mountains (Dahms 2002). In other ranges, a shift in cirque lake sedimentation from fine to coarse textured sediment occurred at around 5700 cal BP and is thought to coincide with the beginning of increased Neoglacial runoff (Dahms 2002).

The alluvial record for the late Middle Holocene indicates that conditions remained similar to those that existed during the early Middle Holocene interval. Powder Wash in the Washakie Basin (48SW7933) was aggrading by foot slope and lateral fan encroachment during this period (Eckerle 1994). Dry conditions appear to have continued effecting depositional processes at several archaeological sites such as Indian Creek (Albanese 1987a; Ottersberg 1987), Barton Gulch (Eckerle 1988; Davis et al. 1989), and Dead Indian Creek (Eckerle 1990). At Game Creek there was a marked increase in the volume of gravel within slopewash deposits between ~7400 cal BP and 5400 cal BP suggesting slope instability caused by a decrease in vegetation cover (Chapter 5).

Early Late Holocene (5200-1750 cal BP)

This time interval is also known as the "middle Neoglacial." There is widespread evidence for a resurgence of cool conditions with higher timberlines and renewal of cirque glaciers at this time (Benedict 1985; Currey and James 1982; Denton and Karlén 1973; Zielinski 1987). Several periods of glacial activity are documented within high elevation cirques in the Wind River Range (Dahms 2002). The first glacial pulse formed the Alice Lake alloformation, deposited from 5400 to 3900 cal BP. The Early Late Holocene record at Lake of the Woods indicates stable conditions that were wetter than the preceding Late Middle Holocene but slightly drier than the historical mean between 5200 cal BP and 4500 cal BP (Shuman et al. 2010). A small decrease in inferred effective moisture occurred between 4500 cal BP and 4200 cal BP followed by a slight increase between 4200 cal BP and 3900 cal BP. Dahms (1994) reported evidence for renewed soil formation on slope soils in the Wind River Mountains dating to after 5500 cal BP, which he attributes to increased moisture. Other evidence for soil formation during the early Late Holocene was found at the Trappers Point site near Daniel (Eckerle and Hobey 1995), and in the Deer Hills west of Marbleton, Wyoming (Eckerle 1993). At Game Creek there was a significant decrease in depositional rates after ~5400 cal BP suggesting an increase in effective moisture that led to stabilization of slopes (Chapter 4). Macrofossils from packrat middens in the Bighorn Basin support the paleosol data and indicate that the period from 5000 cal BP to 2800 cal BP was cooler and wetter than today and markedly so in comparison to the preceding dry Middle Holocene (Lyford et al. 2002). These data lend further support to the interpretation for increased moisture in the region at least during the first millennium of the early Late Holocene.

After ~3900 cal BP and until approximately 3200 cal BP there was marked drop in the shoreline of Lake of the Woods nearly approaching the Holocene low (Figure 2-4 [Shuman et al. 2010]). Pollen evidence from the GYE suggests that temperatures rose sharply during this period (Figure 2-4 [Shuman 2012]). However, there is no indication in the GYE pollen records for drastic changes to vegetation communities during this period (Whitlock 1993; Whitlock and Bartlein 1993) perhaps reflecting decreases in winter precipitation. Lake levels rebounded at Lake of the Woods after 3200 cal BP, but were highly variable over the next thousand years (Figure 2-4 [Shuman et al. 2010]).

Annual temperatures in the GYE decreased after ~2600 cal BP and remained near the historic mean until ~1100 cal BP (Figure 2-4 [Shuman et al. 2010]). This decrease corresponds with the Black Joe glaciation in the Wind River Range from circa 1950-1400 cal BP (Dahms 2002). The shoreline at Lake of the Woods also rose to levels slightly below the modern mean after 1950 cal BP and appears to have remained stable until ~1300 cal BP.

Middle Late Holocene (1750-820 cal BP)

Lake levels decreased at Lake of the Woods between 1300 cal BP and 1000 cal BP followed by a gradual increase over the next two hundred years (Figure 2-4 [Shuman et al. 2010]). Multiple proxy data from Crevice Lake in northern Yellowstone National Park also indicate persistent dry conditions between 1250 cal BP and 920 cal BP, although the latter half of this period was slightly wetter and warm with at least one extreme wet event circa 920 cal BP (Whitlock et al. 2008). There is also evidence for extreme flood events at the Game Creek site around this time (Chapter 4).

Late Late Holocene: Medieval Warm Period (820-500 cal BP)

Records from various parts of western North America suggest a period of warming correlative with the Medieval Warm Period of Europe (Graumlich 1993). Although proxy data from other parts of interior North America show arid conditions, the evidence from Crevice Lake in the northern GYE suggests that there were alternating wet and dry extremes between 920 cal BP and 650 cal BP. One extreme wet event documented at circa 650 cal BP (Whitlock et al. 2008) was either closely proceeded or followed by a severe drought recorded in tree rings at 646 BP (AD 1304 [Gray et al. 2007]). Yet, evidence from the southern GYE indicate relatively stable effective moisture over this time (Figure 2-4 [Shuman et al. 2010; Shuman 2012])

Late Late Holocene: Little Ice Age (500-180 cal BP)

According to the GCM, temperatures during this period were 1-3 °C lower than present day (Munroe 2003; Plummer 2003). Good evidence for Holocene glaciation dates to the Little Ice Age. This glaciation is termed the Gannett Peak in the Wind River Range where it dates to 500-180 cal BP (Dahms 2002; Richmond 1986). Mesic indicator species reappear in small mammal assemblages from deposits in the northern GYE dating to the Little Ice Age (Hadly 1996). However, there is an increase in charcoal, presumably from forest fires, at Crevice Lake after circa 500 cal BP that points to drier spring/summer conditions throughout most of the Little Ice Age (Whitlock et al. 2008). Gray et al. (2007) report two severe droughts at 370 BP (AD 1580) and 233-234 BP (AD 1717-1718) during the Little Ice Age. Multiple proxy data from Crevice Lake in northern Yellowstone show that spring and/or summer temperatures began to increase as early as 170 cal BP, slightly earlier than in the Wind River Range, but remained dry until circa 180 ^{14}C BP (Whitlock et al. 2008).

Paleoenvironmental Summary

The preceding discussion shows that the climate of Jackson Hole and the surrounding region varied widely through time. The effects of climate change on local plant and animal communities likely caused adaptational responses in human populations in the region. Kelly and colleagues (2012) argue that increased aridity in the Bighorn Basin during the Altithermal was severe enough to cause the abandonment of the area. As discussed further in Chapter 3, abandonment of one area generally led to increased populations elsewhere. In the case of the Jackson Hole and the GYE, the available data points to several influxes in human population that are correlated with climate change. It would be an exaggeration, however, to argue that hunter-gatherer mobility and subsistence strategies were dictated by environmental conditions. Given the intricacies of topography, seasonal variation in precipitation and environmental tolerances of key plant and animal resources, hunter-gatherers could effectively and successfully mitigate the impacts of climate change by altering their yearly schedule. Two models are presented in the following sections to address the impacts climate change may have had on the distribution of high-value plant resources and the productivity of forage available to big game for winter range.

Macrophysical Climate Modeling for Jackson Hole

William Eckerle

Macrophysical climate modeling (MCM) (Bryson and DeWall 2007) is a method that retrodicts temperature and precipitation for the late Pleistocene and Holocene. It is an alternative to general circulation models (GCMs) at a variety of spatial scales. It was developed by Reid A. Bryson and Robert U. Bryson (Bryson 1997, 2005; Bryson and Bryson 2000). The term 'climate' as used within the context of the method is the result of:

> "…'boundary conditions' [which] force the state of the climate system, which in turn produces and requires sets of weather complexes, which differ as the climate differs from one time to another" [Bryson and Bryson 1997:3].

Therefore, climate results from the movement and relative position of major semi-permanent circulation features of the atmosphere (i.e., centers of action). Major circulation features in the northern hemisphere include the Azores high, North Pacific high, Aleutian low, and Icelandic low, while more minor circulation features include the jet stream and the Intertropical Convergence Zone (Bryson and DeWall 2007). This method uses a set of interconnected analytical modules where each module calculates the position of a feature by estimating horizontal and vertical temperature gradients.

The factors included in the modules incorporate the variation in solar energy from orbital forcing (earth-sun geometry) combined with the effect of volcanic aerosols on albedo (Bryson and DeWall 2007). These factors control the amount and distribution of heat energy over the earth, including ocean temperature, glacier mass and the resultant distribution and transfer of heat within the atmosphere. The latter controls atmospheric circulation, which determines the position of major circulation features. Synoptic climatology determines the local relationships to the centers of action by mathematically expressing how modern temperature or precipitation varies as the position of the major circulation features change (Bryson and DeWall 2007). The result is a non-linear regression equation (least squares best fit) that is extrapolated into the past to retrodict past temperature and precipitation.

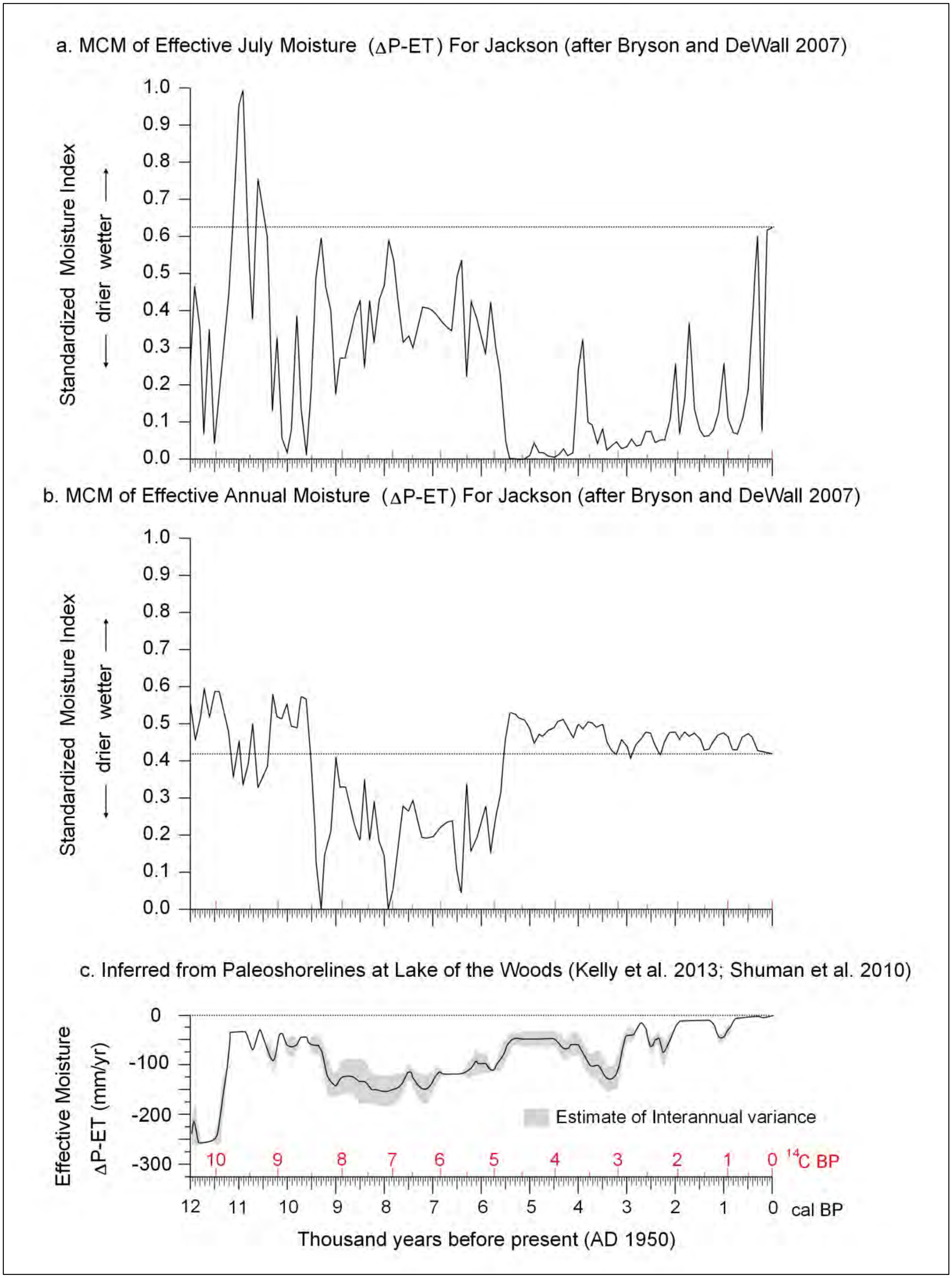


Figure 2-6 MCM Modeled changes in effective July (a) and annual (b) moisture for Jackson and inferred effective moisture for Lake of the Woods (c).

A MCM was prepared for the town of Jackson, Wyoming (Bryson and Bryson 2000). Monthly temperature and precipitation values were calculated at 100 year intervals back to 14,000 cal BP. Modeled precipitation minus pan evaporation (ΔP-E) is calculated to model effective moisture available for plant use. Annual ΔP-E values at 100 year intervals were normalized (standardized) on a scale of 0-1 (Figure 2-6) with 0 being drier and 1 being wetter.

As modeled, approximately modern values of effective moisture occurred around 12,100 cal BP, just prior to the Pleistocene-Holocene transition (Figure 2-6). Early Holocene effective moisture fluctuated at values similar to present-day from 11,500–9500 cal BP. Dry, early to middle Holocene conditions are retrodicted from 9500 – 5700 ^{14}C BP, agreeing with regional paleoenvironmental records and multiple dry events are apparent at 9300, 7820, and 6380 cal BP. Effective precipitation rebounds after 5700 cal BP, prevailing at moderate post-Pleistocene values through the historic record. The MCM for Jackson corresponds closely to the proxy data from Lake of the Woods (Figure 2-4 [Shuman et al 2010]) as well as the pollen evidence from the GYE (Whitlock 1993; Whitlock and Bartlein 1993; Whitlock et al. 2008) discussed above.

Modeled Prehistoric Food Resource Distributions in South Park

William Eckerle and Sasha Taddie

One of the goals of the Game Creek project is to model prehistoric food resource distributions and change in these distributions over time (Eakin and Eckerle 2004). It is widely acknowledged that food resource availability influences hunter-gatherer subsistence strategies (Binford 2001; Kelly 1995). This influence does not so much determine the nature of a cultural adaptation as it limits subsistence opportunities. The spatial and seasonal characteristics of the subsistence resource base in some cases encourage different styles of mobility, such as foraging or collecting (Binford 1980).

The current study expands on previous investigations by presenting GIS modeling of prehistoric plant foods and game animal forage productivity under present day, wetter than present and drier than present paleoclimatic regimes in southern Jackson Hole This sort of analysis is important because site data usually do not reflect the full range of potential food resource availability within the site's catchment basin due to preservation processes and/or selective procurement. Like many sites in Jackson Hole and elsewhere, subsistence activities at the Game Creek site were conditioned by competing food and non-food economic goals within a seasonal and ecological framework. Assessing site artifactual and ecofactual data against potential resource availability provides valuable insight into subsistence and settlement patterns.

Methodology

The GIS spatial model of food resources utilized in this study relies on Natural Resource Conservation Service (NRCS) ecological site data. NRCS ecological sites have previously been used for archaeological research (Eckerle 1997; Eckerle and Hobey 1999; Eckerle et al. 2003; Eckerle et al. 2000; Eckerle and Taddie 2002; Raven and Elston 1989; Raven 1990; Zeanah 1996; Zeanah et al. 1999). NRCS ecological sites are structured within the NRCS Major Land Resource Area (MLRA) framework (Soil Conservation Service 1981; United States Department of Agriculture 2006). MLRA's are ecological divisions that are defined by the co-occurrence of similar climate, physiography, and soils. Within each MLRA, the NRCS defines a number of ecological sites that contain characteristic potential natural vegetation that is the result of the local climate and soils based primarily on the ability of the soil to store water for plant growth (Dyksterhuis 1958).

When NRCS soil surveys are prepared, ecological sites are documented for each soil map unit. Soils mapping for this investigation was accessed online from the NRCS Soil Survey Geographic (SSURGO) database (Soil Survey Staff 2011a; Soil Survey Staff 2011b). A custom Microsoft Access database was created for this project, and it contains data on edible plants and game animal forage for all soil map units present in the project region. This edible plant and forage database is joined with SSURGO tabular and spatial data, which is used within a GIS to display map units containing individual plant species and a specific range of game animal forage production values. This analysis allows the construction of maps showing the distribution of present-day edible plants and ranges of forage values. It also provides an estimate of potential forage production and big game carrying capacity.

Jackson, Wyoming modeled precipitation minus evaporation for the post-glacial era (Figure 2-6) suggest that annual effective moisture was well above present prior to 11,900 cal BP; varied at or slightly above (cooler/wetter) present day from 11,900–9600 and 5300–0 cal BP, and was predominantly lower (warmer/drier) than present from 9600–5300 cal BP.

Analogs for wetter than present and drier than present ecological sites are assigned using the NRCS Ecological Site database. These analogs are assigned by choosing same or similar substrate-texture ecological sites that have appropriate higher or lower precipitation. For instance, if a SSURGO map unit is assigned a present-day ecological site of Clayey (Cy) 10-14" (precipitation) Foothills and Basins West, typical of clayey soils, then the drier than present analog is Clayey (Cy) 7-9" (precipitation) Green River and Great Divide Basin and the wetter than present analog is Clayey (Cy) 15-19" (precipitation) Foothills and Mountains West Green River and Great Divide Basin. In some cases, analogs could not be found within the same MLRA, such as in the case where a drier than present analog was needed for the driest present day ecological site in the Green River Basin. In such a case, we choose an analog from an adjacent and drier MLRA such as the Wind River Basin. Or, in some cases an exact soil texture (moisture holding) analog could not be found, in which case we choose the closest match in soil texture.

In utilizing this methodology it must be recognized that paleo-vegetation change was complex. Species-composition of vegetation communities has changed over time, but not necessarily through geographic movement in response to temperature and moisture changes. One limitation of this study is that changes in mean annual values of temperature and precipitation, and changes in the seasonality of precipitation, which are important factors in the evolution of vegetation structure, are unaccounted for here (Grayson 2011). In time, as paleoenvironmental studies, especially packrat/woodrat midden analysis, provide more information on plant community structure under a variety of paleoclimatic regimes, it will be possible to better calibrate ecological site information to the paleo-vegetation record. Until then, the vegetation analog approach presented here provides a rational strategy to model changes in the distribution of prehistoric food resources under post-glacial era climates.

This investigation mapped the distribution of edible plants and game forage within the project area. The distribution of food resources is modeled under three climate states: present day, wetter than present, and drier than present. Predicted distributions of edible plants and game animal forage are presented in both plan view and along a topographic transect from somewhat east of the head of Squaw Creek, passing over the Game Creek site, across the Snake River valley bottom, and then westward to Butler Creek.

Modeled Big Game Productivity

The role high value big game, such as bison, elk, deer, sheep and pronghorn, played in the subsistence strategies of prehistoric peoples of Jackson Hole is a matter of debate (Bender and Wright 1988; Cannon et al 2015; Wright 1984; Wright et al. 1980). Much of the discussion has focused specifically on bison and elk, the highest rank game species in the area. Wright et al. (1980:186) argue "[e]lk and bison . . . numbers and location at any one point in time seem to have been highly unpredictable. It appears unlikely that hunting could have been the primary motivating factor for bringing prehistoric peoples across the mountains and into the valley." Much of this argument is based on the absence of specific mention of bison and elk in Jackson Hole during the early historic period and the dearth of faunal specimens in tested sites in northern Jackson Hole and the Tetons (Wright 1984). Although Bender and Wright (1988), Wright (1984) and Wright et al. (1980) acknowledge hunting as an important facet of their postulated "high country adaptation model," they emphasize the role of bighorn sheep and perhaps deer. However, recent research in Jackson Hole has called Wright's (1984) argument into question.

According to Cannon et al. (2015) bison remains have been recovered from 14 sites in Jackson Hole. Elk remains have also been reported from at least three sites (Connor 1998). Butchered bison and/or elk bone was recovered from every cultural level at Game Creek spanning a nearly 10,000 year period. Bison and elk represented the first and third most frequent identifiable species in the assemblage, respectively. Overall the large artiodactyl assemblage, including bison and elk, comprises 65 percent of the total identifiable faunal assemblage. Bison remains were also recovered at the Goetz (48YE455) site (Cannon et al. 2015; Love 1972). Bison and elk bone was recovered in archaeological context at several sites along Jackson Lake (Cannon et al. 2015; Connor 1998). Conversely, medium sized artiodactyls, such as deer, bighorn sheep and pronghorn, remains are infrequent or absent at most tested sites in Jackson Hole (Connor 1998). At Game Creek medium artiodactyls, including deer, pronghorn and sheep, were rare representing only about 4 per cent of the identifiable assemblage. These data show that, contrary to the assertions of Wright (1984) and Wright et al. (1980), bison and elk were not only important and persistent targeted species throughout most of the prehistoric period in Jackson Hole, but appear to have been the primary targeted species.

Wright (1984) may have underestimated the carrying capacity of the Jackson Hole. Cannon et al. (2015:414) argue that Jackson Hole "may have supported fairly large herds of bison, an assumption supported by modern bison numbers. People in the valley could have hunted bison on a regular basis without significant impact to animal populations." The modeled animal forage production, a proxy for game populations (Eckerle 1997), shows that southern Jackson Hole is capable of producing large quantities of forage. Present day forage production ranges from 0.25 annual tons/acre to as much as 3.5 annual tons/acre, depending on setting (Figure 2-7). At current conditions the study area of roughly 12,500 acres could produce roughly 8,300 to 19,500 tons of forage a year. During drier times, valley bottom production would have been in the 1.0 annual tons/acre range, but uplands would have dropped to the 0.20 -.75 annual tons/acre range with large areas of the foothills yielding 0.25-0.75 annual tons/acre. Annual forage production, under drier than present conditions, is estimated to be between 5,800 and 15,400 tons per year. During wetter than present times, forage for much of the project area would have been in the 1.0-3.5 annual tons/acre range with some smaller areas of 0.75-1.0 annual tons/acre. Under such conditions the study area could produce between 10,150 and 32,500 tons of forage annually.

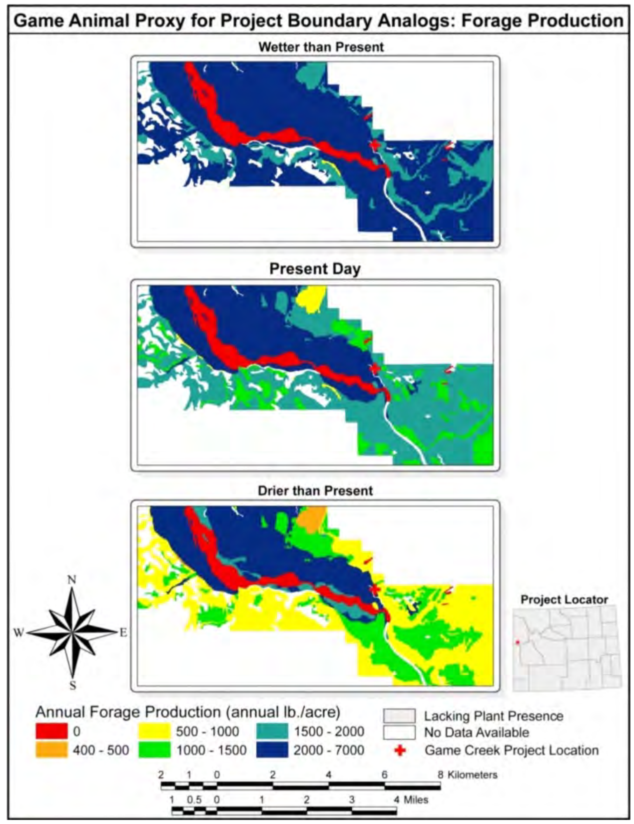


Figure 2-7 plan view of the modeled distribution of animal forage production in a present day, drier than present, and wetter than present climate.

To put this in perspective, a non-lactating domestic cow weighing 1,200 lbs. consumes about 34 lbs. of forage (88% dry matter) in a day, or roughly 6.2 tons a year (Rasby 2017). At present conditions the roughly 12,000 acre study area could produce enough forage to feed between 1,300 and 3,050 bison. Even under drier than present conditions the area would have produced enough forage to feed between

900 and 2,450 bison. The study area comprises less than 5 percent of Jackson Hole. Granted, there are many other animals that compete with bison for grass, but these simple estimates show that Jackson Hole is capable of supporting sizeable populations of bison.

Modeled Edible Plant Distributions

The maps presented in Figures 2-8 through 2-13 illustrate the distribution of edible plants. Edible tubers and root resources are common in the project area. American bistort is part of the HCPC which occurs on the Snake River valley bottom, extending westward of the Game Creek site (Figures 2-8) and is modeled with a similar distribution under dry climates but expands in distribution in the foothills under wetter conditions.

American licorice is not part of the HCPC under present day conditions (Figures 2-8). It is modeled as becoming widespread under both wetter than present and drier than present climates. When present it occurs in both valley bottom and mountainous settings, including at the Game Creek site. American licorice was used as a food resource as well as medicinally (Kindscher 1987). According to the USDA (2012):

> *The Cheyenne ate the young shoots of licorice plant raw in the early spring. The Indians later would roast the roots in their campfire embers, and then pound the roots with a stick to remove the tough woody string from the center of the root. When the string was removed it left a food that had a taste similar to sweet potatoes.*

Balsamroot is absent from the valley bottom but occurs in the foothills and mountains, including adjacent to the Game Creek site under the HCPC, both today and modeled during wetter than present conditions (Figures 2-8). It is not predicted as occurring in the study area during drier than present conditions.

> *The leaves, stems, roots and seeds of arrowleaf balsamroot were commonly eaten by several western tribes. The Flathead, Kutenai, Montana, Nez Perce, Okanagan-Colville, Paiute, Thompson and Ute tribes ate raw or cooked leaves and young stems. Arrowleaf balsamroot seeds were a staple for many tribes. They were eaten raw, ground into flour for making cakes, used for cooking oil, or mixed with other foods by the Atsugewi, Gosiute, Klamath, Miwok, Montana, Nez Perce, Okanagan-Colville, Paiute and Thompson tribes. [Tilley et al. 2012:2].*

One or more edible tuber (and seed) producing species in the Apiaceae (or Umbelliferae) family, including biscuitroot, desert parsley, and wild parsley (Figures 2-8) occur as part of the HCPC in narrow elevation bands in the foothills and mountains under present day conditions and mapped on slopes immediately east of the site. The distribution of these species is modeled as becoming more widespread in the foothills and mountains during wetter than and drier than eras. Experimental studies (Simms 1984, 1985, 1987) suggest that collecting return rates for some of the members of this group are relatively high for plant foods as whole.

Bitterroot (Figures 2-9) occurs in the HCPC in the foothills and mountains under present day climate conditions. It is mapped as occurring on the slopes above the site to the east. It does not occur in either wetter or drier analog ecological sites suggesting that it is not present when effective moisture deviates much from present day conditions.

Onion (Figures 2-9) is not part of the HCPC in the study area either under present day or modeled under drier than present conditions. Its modeled distribution becomes widespread during wetter than present times, including at or adjacent to the Game Creek site area. Onion is an edible plant species whose nutritional value is greatly increased by cooking (Smith et al. 2001).

Sego lily (Figures 2-9) occurs in scattered locations under HCPC climate conditions. This plant has an edible bulb and is mapped as occurring on the hillslopes above the site to the east. It is modeled as maintaining a widely scattered distribution during drier than present times but not being available during wetter than present times. Like onion, sego lily is an edible plant species whose nutritional value is greatly increased by cooking (Smith et al. 2001).

Sweetroot is a similar plant to American licorice and, similarly, is not present in the HCPC (Figures 2-9). Like licorice, it is modeled as becoming widespread under both wetter than present and drier than present climates. When present, its distribution is restricted to the Snake River valley bottom and adjacent foothills, including adjacent to the Game Creek site.

Several ethnographic important edible grasses occur in the project area. Basin wildrye is mapped/modeled as occurring on the Snake River valley bottom in all climate states (Figures 2-10). Experimentally documented return rates for this species are on the upper end for all grass seed return rates (Simms 1984, 1985, 1987).

Indian ricegrass (Figures 2-10) is neither present in the HCPC nor modeled in wetter than present climate states. During drier intervals it is modeled as occurring in the foothills. Like all grass seeds, this sand-adapted edible seed producing plant has relatively low foraging return rates (Eckerle 1997; Simms 1984).

Shrubs with edible berries or seeds occur in the area. Chokecherry is part of the HCPC on the Snake River valley bottom and in small patches in the foothills. As modeled, it persists in the valley bottom during drier than present conditions. It becomes more restricted to scattered patches in the foothills during wetter than present eras (Figures 2-10). During all climate eras, it is not far to patches of chokecherry from the Game Creek site.

Currant shrubs (Figures 2-10) occur in the HCPC on the Snake River valley bottom under present day climate. It is modeled as disappearing from the valley floor and occupying scattered patches in the foothills and mountains during both wetter than and drier than present conditions. It would occur in or adjacent to the Game Creek site during all climate states.

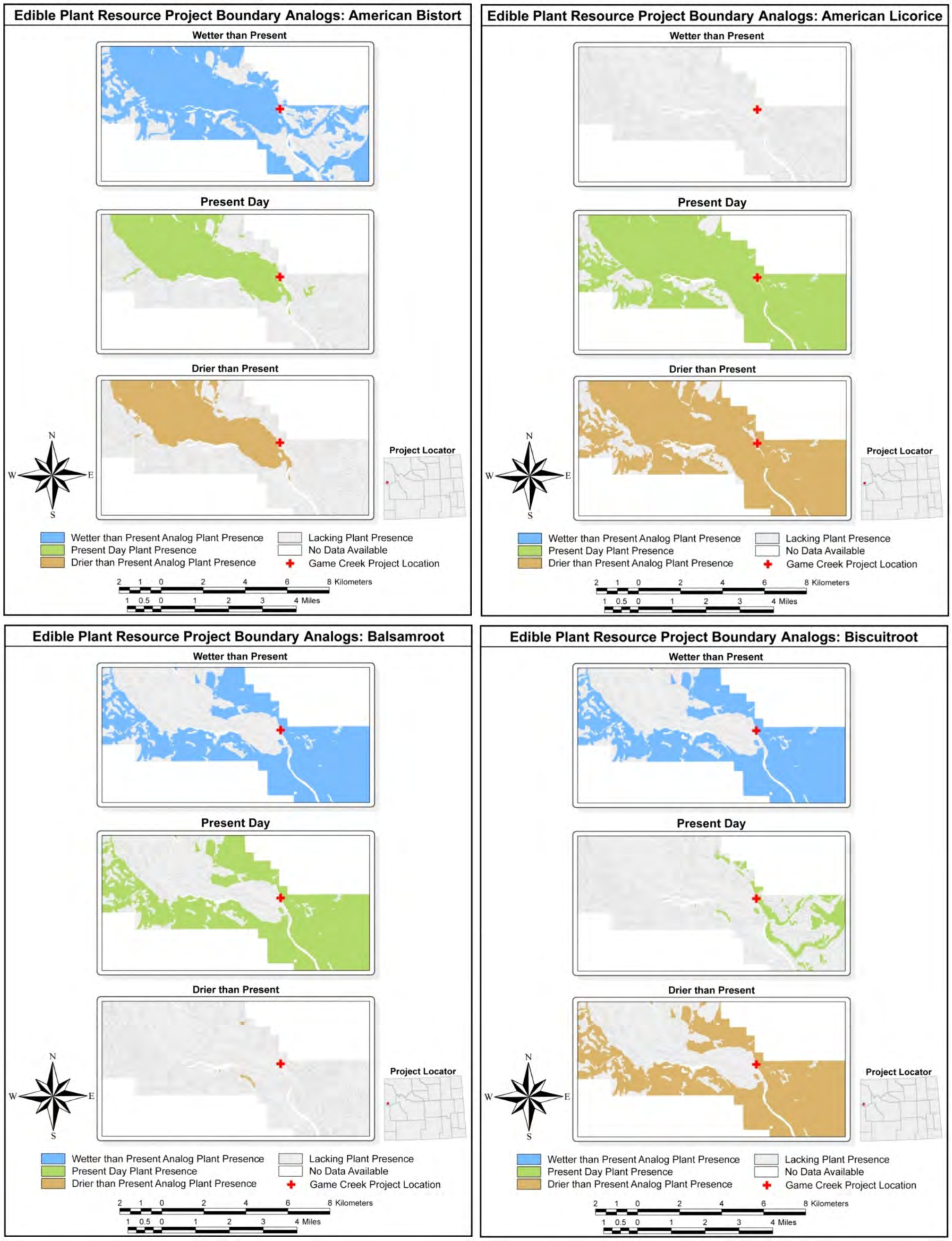


Figure 2-8 Modeled distribution of American bistort, American licorice, balsamroot and biscuitroot in a present day, drier than present, and wetter than present climate.

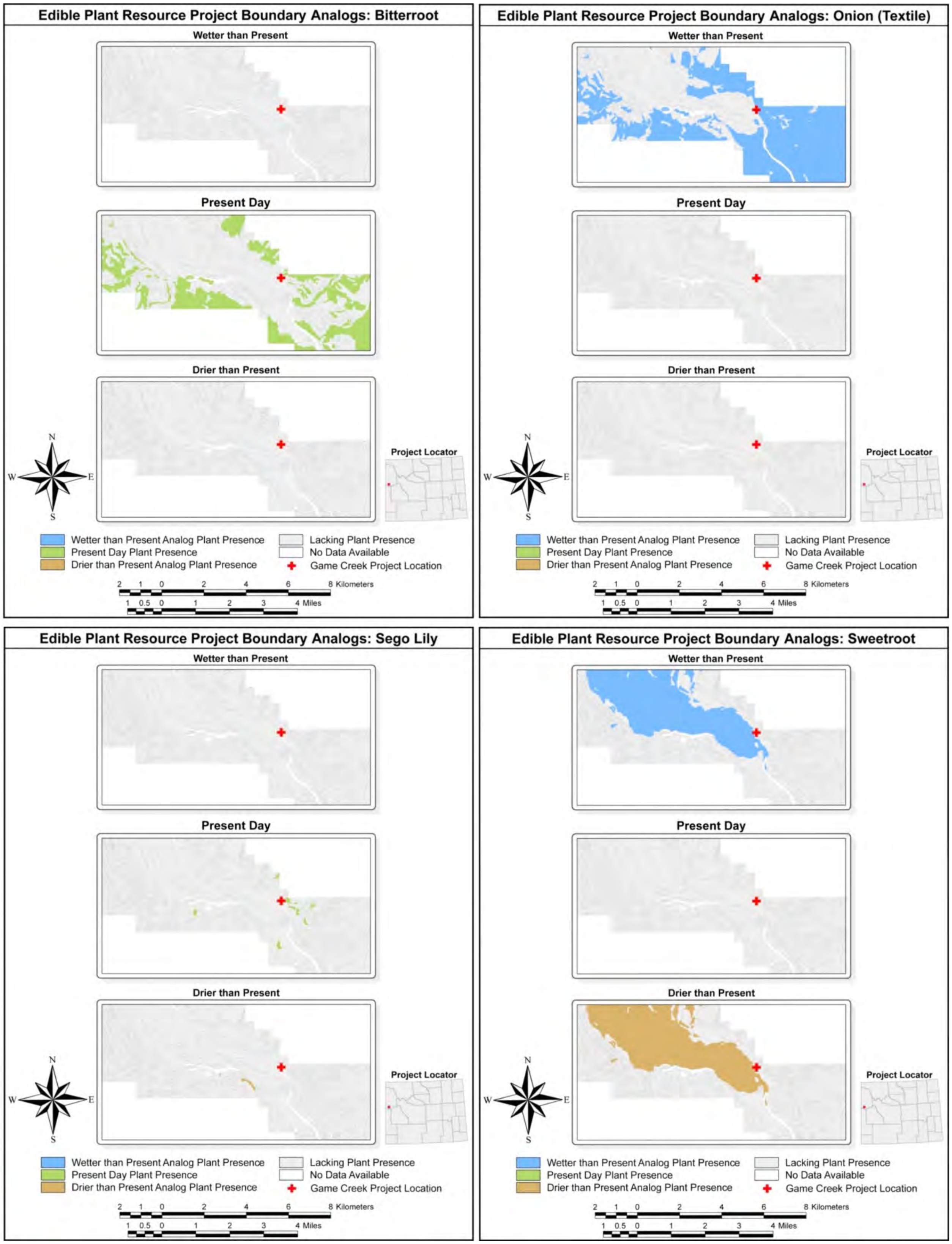


Figure 2-9 Modeled distribution of bitterroot, onion, sego lily and sweetroot in a present day, drier than present, and wetter than present climate.

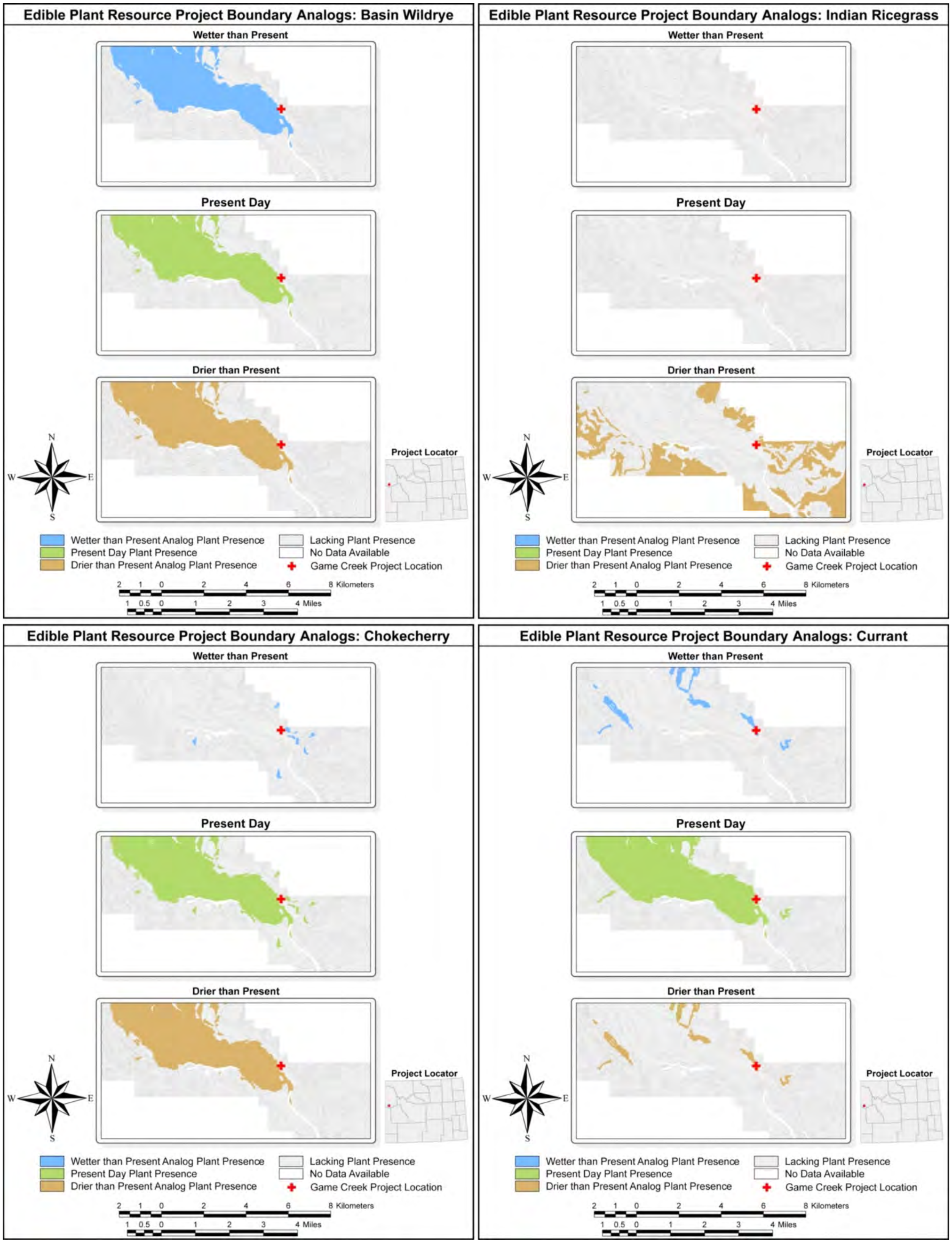


Figure 2-10 Modeled distribution of Basin wildrye, Indian ricegrass, chokecherry and currant in a present day, drier than present, and wetter than present climate.

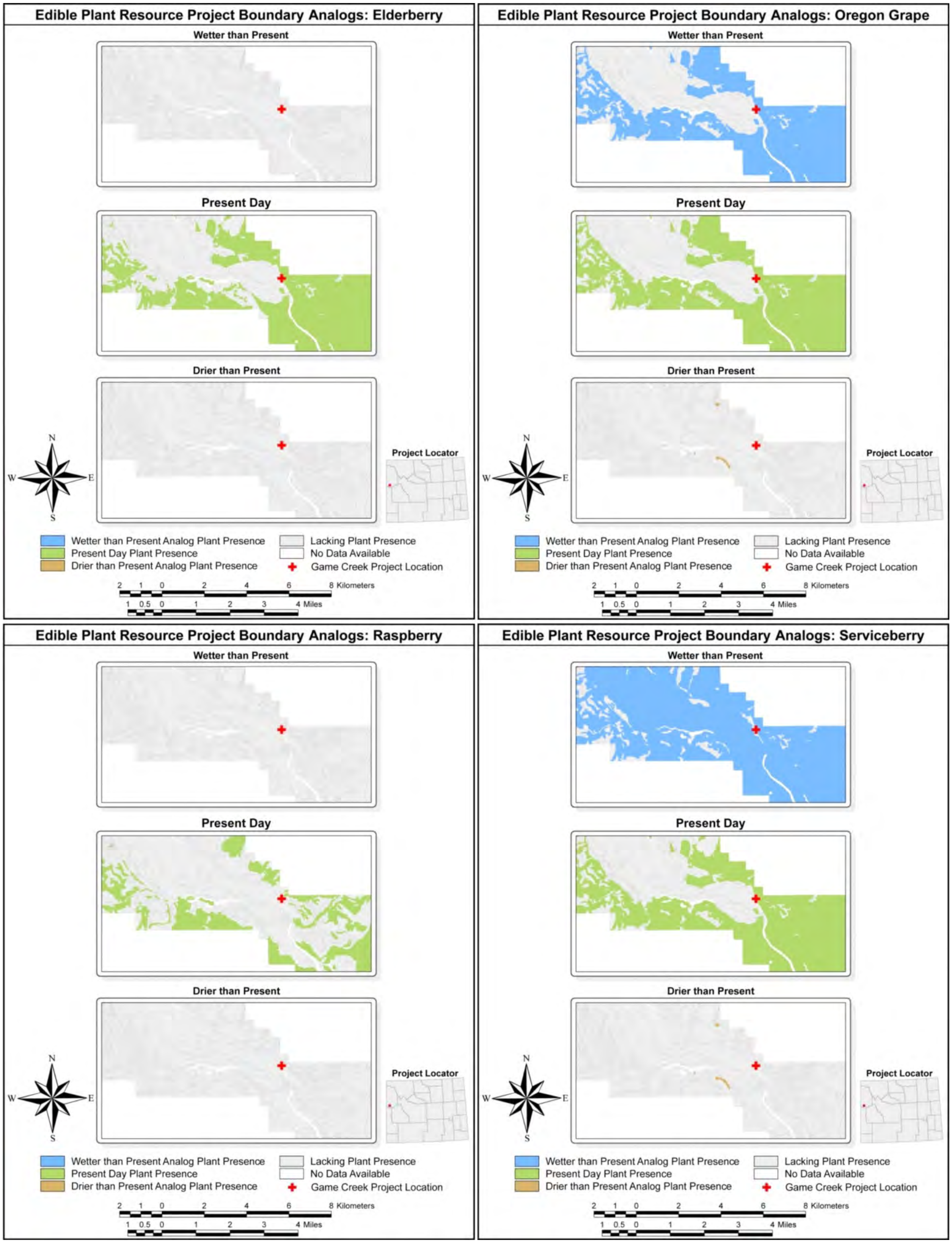


Figure 2-11 Modeled distribution of elderberry, Oregon grape, raspberry and serviceberry in a present day, drier than present, and wetter than present climate.

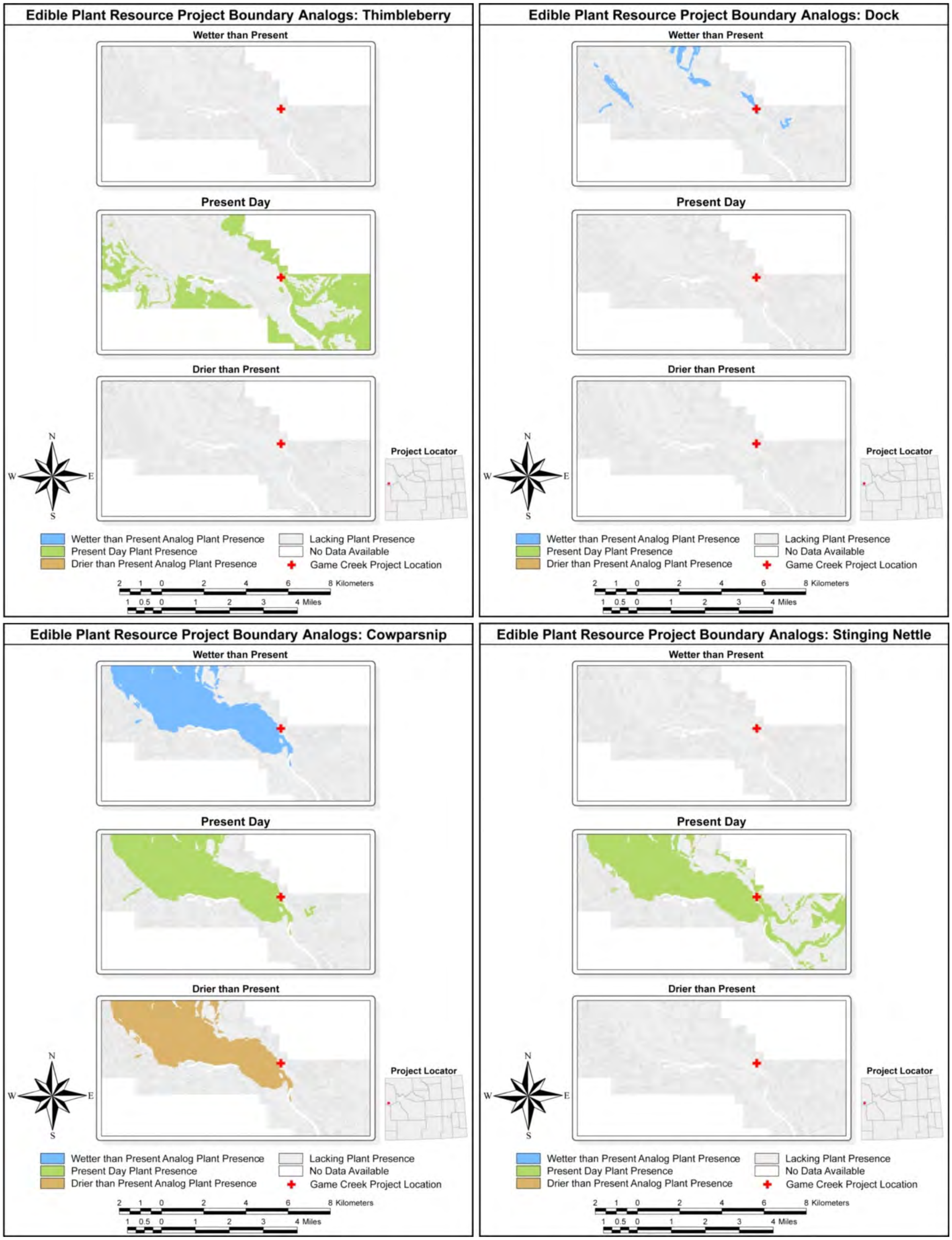


Figure 2-12 Modeled distribution of thimbleberry, dock, cowparsnip and stinging nettle in a present day, drier than present, and wetter than present climate.

Table 2-1 Edible plants in project vicinity and their modeled occurrence under wetter and drier than present conditions.

Resource Type/Name	Present Day Climate Near Site	Wetter Than Present Near Site	Drier Than Present Near Site
Tubers			
American bistort	Y / Y	Y / Y	Y / Y
American licorice	Y / Y	N / N	Y / Y
Balsamroot	Y / Y	Y / Y	Y / N
Biscuitroot, Desert parsley, etc.	Y / Y	Y / Y	Y / Y
Bitterroot	Y / Y	N / N	N / N
Onion	N / N	Y / Y	N / N
Sego lily	Y / Y	N / N	Y / N
Sweetroot	N / N	Y / Y	Y / Y
Grasses			
Basin wildrye	Y / Y	Y / Y	Y / Y
Indian ricegrass	N / N	N / N	Y / Y
Shrubs (berries)			
Chokecherry	Y / Y	Y / Y	Y / Y
Currant	Y / Y	Y / Y	Y / Y
Elderberry	Y / Y	N / N	N / N
Oregon grape	Y / Y	Y / Y	Y / N
Raspberry	Y / Y	N / N	N / N
Serviceberry	Y / Y	Y / Y	Y / N
Thimbleberry	Y / Y	N / N	N / N
Forbs (berries, greens, seeds)			
Cowparsnip	Y / Y	Y / Y	Y / Y
Dock	N / N	Y / Y	N / N
Stinging nettle	Y / Y	N / N	N / N
Strawberry	Y / Y	N / N	N / N
Total Near Site	Y=17	Y=12	Y=9

Elderberry (Figures 2-11) is present in the HCPC occurring in the foothills and mountains. It is not predicted to occur in the study area during either wetter than or drier than present conditions.

Oregon grape (Figures 2-11) is in the HCPC in foothills and mountain settings, at or near to the Game Creek site. It is also modeled in the same settings during wetter than present times. It is predicted to be nearly absent during drier times with widely scattered patches, none closer than 2 km to the site.

Raspberry (Figures 2-11) occurs in the foothills and mountains under HCPC climate conditions. It is mapped as occurring on the slopes above the site to the east. It is not modeled to occur in either wetter or drier analog ecological sites suggesting that it is not present when effective moisture deviates much from present day conditions.

Serviceberry (Figures 2-11) is part of the HCPC in the foothills at or very near the site during present day conditions. Several serviceberry thickets are present on the T3 terrace of Game Creek site today. During wetter than present eras, it became nearly ubiquitous. It is predicted to occur in widely scattered patches in the foothills during drier than present times.

Thimbleberry (Figures 2-12), similar to raspberry, occurs in the foothills and mountains in the HCPC. It is modeled as occurring on the slopes above the site to the east. It does not occur in either wetter or drier analog ecological sites.

Wild forbs that produce edible greens, seeds, and berries are widespread in the project area. Dock (Figures 2-12) is not part of HCPC nor is it modeled as occurring during drier than present conditions. It is predicted to occur in the foothills, including at or near the site, during wetter times. Remains of this species are commonly found in prehistoric hearths (Smith 1988).

Cowparsnip (Figures 2-12) is part of the HCPC occurring on the Snake River valley bottom at or near to the Game Creek site. It is predicted to occur in the same locations during drier than and wetter than climate intervals. It would have been easy to procure from the Game Creek site.

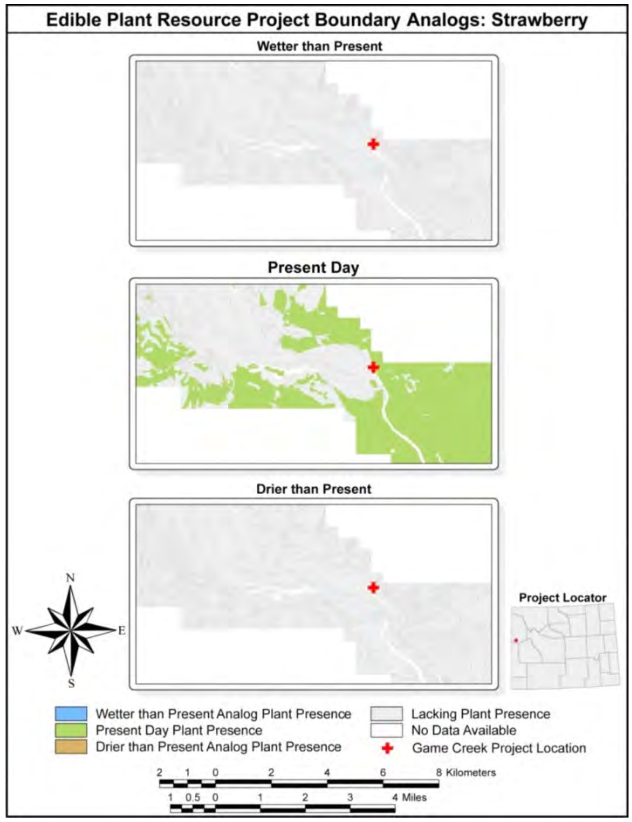


Figure 2-13 Modeled distribution of strawberry in a present day, drier than present, and wetter than present climate.

Stinging nettle (Figures 2-12) is mapped as occurring in the HCPC in foothills and valley bottom, including very near the site, under present day conditions. It is not present in wetter than or drier than ecological site analogs and thus not predicted to occur under those conditions.

Strawberry (Figures 2-13) is part of the HCPC occurring in the foothills at or very near the site during present day conditions. It is not predicted to occur in either drier than or wetter than present eras.

In summary, present day resources in the study area include tubers: American bistort, American licorice, balsamroot, biscuitroot (Desert parsley, etc.), bitterroot, onion, sego lily, and sweetroot; grasses: Basin wildrye, Indian ricegrass; shrubs: chokecherry, currant, elderberry, Oregon grape, raspberry, serviceberry, thimbleberry; and forbs: cowparsnip, dock, stinging nettle, and strawberry. Seventeen (17) edible plant species (Table 2-1) are modeled to occur near the site during climate regimes similar to the historic era: American bistort, American licorice, balsamroot, biscuitroot, bitterroot, sego lily, basin wildrye, chokecherry, currant, elderberry, Oregon grape, raspberry, serviceberry, thimbleberry, cowparsnip, stinging nettle, and strawberry. During wetter than present times 12 edible plant species are present, and during drier than present eras nine edible plant species are present. The following edible plant species were available near the site during all climate states: American bistort, biscuitroot, Basin wildrye, chokecherry, currant, and cowparsnip. By comparison to drier areas in the region such as the

Green River Basin (Eckerle and Taddie 2011), edible plants species were numerous and forage abundant at the Game Creek site.

Conclusions

Based on climate modeling presented above, the Late Paleoindian occupation at Game Creek is modeled (at 100 year class-intervals) to have accumulated during a time of high annual and cold season effective moisture but low warm season (July) moisture. Modeled paleoclimate for Jackson Hole generally agrees with proxy data from the GYE. The balance between high annual but low summer effective moisture probably resulted in forage production and game animal densities much like present day conditions that support relatively abundant big game populations.

High annual precipitation would have enhanced the Snake River–Flat Creek bottomland water table allowing good food resource production from lowland-adapted plants including American bistort, American licorice, currant, chokecherry, cowparsnip, serviceberry, stinging nettle, and sweetroot. Likewise, upland early-season winter moisture-dependent root and tuber-producing plants like arrowleaf balsamroot, biscuitroot, and bitterroot would have produced well during this time. Summer moisture-dependent upland plants like dock, elderberry, and Indian ricegrass would have been relatively unavailable during the 10,391±61 cal BP to 9660±53 cal BP occupation interval. Modeled climate and resource availability suggests the potential for a balanced hunting and gathering adaptation with abundant big game and plant resources during the this late Paleoindian occupation interval but with somewhat limited winter procurement opportunities compared to historical conditions.

Low modeled effective precipitation between 9000 cal BP and 5590 cal BP, supported by regional studies, would have lowered the water table on the Snake River-Flat Creek bottomland and reduced plant food resource production from American bistort, American licorice, currant, chokecherry, cowparsnip, serviceberry stinging nettle, and sweetroot. Similarly, early-season moisture-dependent root and tuber-producing plants like arrowleaf balsamroot, biscuitroot, and bitterroot would have produced poorly during this time. Summer moisture-dependent upland plants like dock, elderberry, and Indian ricegrass would have been much more available during the 9000 cal BP to 5590 cal BP occupation interval. Low annual but high summer moisture may have increased warm season grasses but overall game animal forage production and game animal densities were probably lower than present. Modeled climate and resource availability suggests the potential for a balanced hunting and gathering adaptation but with limited reliance on plant collection from lowland settings and enhanced winter occupation opportunities.

The period between 5590 cal BP and 780 cal BP is modeled as a time with some similarity to those that existed during the Late Paleoindian occupation (~10,400-9000 cal BP). According to the models, this was a time of high annual but low warm season (July) effective moisture. High annual precipitation during this time is supported by regional proxy data and would have enhanced the Snake

River-Flat Creek bottomland water table allowing good food resource production from lowland adapted species such as American bistort, American licorice, currant, chokecherry, cowparsnip, serviceberry, stinging nettle, and sweetroot. As well, early-season moisture-dependent root and tuber-producing plants like arrowleaf balsamroot, biscuitroot, and bitterroot would have been available during this interval. However, upland species like dock, elderberry, and Indian ricegrass would not have been as available at this time. The balance between high annual but low summer moisture probably resulted in forage production and game animal densities much like present day conditions that support relatively abundant big game populations. Modeled climate and resource availability suggests the potential for a balanced hunting and gathering adaptation with abundant big game and plant resources and some winter game procurement opportunities.

CHAPTER 3 CULTURE HISTORY OF JACKSON HOLE

Michael K. Page

> [C]ontemporary American archaeology has . . . three primary and sequentially ordered objectives: archaeology's initial goal is to define cultural chronologies; the intermediate objective is to reconstruct prehistoric lifeways; the ultimate objective is to explain cultural processes . . . Simply stated, archaeologists must spend the time to flesh out the nuances of chronology and lifeways before tackling the processes which allegedly explain such prehistoric behavior. There are no shortcuts." [Thomas 1981:7].

It has been nearly 20 years since the culture history of Jackson Hole was last summarized (Connor 1998). Since that time a great deal of new information has come to light, no small amount of which was derived from the excavations at Game Creek. This chapter is more than a mere overview of previous research. In order to fully address the temporal variation in projectile point styles, changes in mobility, settlement and subsistence patterns as well as the environmental conditions that may or may not have influenced these changes it is necessary to present a thorough review of our present understanding of the cultural history of Jackson Hole and surrounding regions.

Cultural histories, or chronologies, are based primarily on two lines of evidence; stratigraphic sequences from key sites and distributions of radiocarbon dates (Kornfeld et al. 2010:63-71). The interpretive value of the key stratified sites, on which much of our understanding of prehistory rests, is limited to some degree by the methods used in the original excavations and the imprecision of the absolute dates available. Some of these shortcomings can be ameliorated through comparisons with more carefully excavated and better dated single components, but even these are too few in number to provide a complete picture of prehistory. Recently, large datasets of modern radiocarbon dates have been used to model prehistoric human population levels resulting in new insights into the environmental impetus behind changes in population, settlement and subsistence (Surovell et al. 2009; Kelly et al. 2013). Given the utility of this approach a sample of nearly 2,000 radiocarbon dates from archaeological contexts in western Wyoming was compiled, processed, separated into four geographic groups, and is presented below to facilitate discussion of the cultural history of western Wyoming.

Key Stratigraphic Site Chronologies

In northwestern Wyoming the deeply stratified Mummy Cave (48PA201[Husted and Edgar 2002]) and Medicine Lodge Creek (48BH499 [Frison and Walker 2007]) sites provide much of the chronological information for the Central Rockies (Figure 3-1 [Connor 1998; Dyck and Morlan 2001; Frison and Walker 2007]). To the west the cultural chronology of the Snake River Plain was documented at Bison (10CL10) and Veratic (10CL3) rockshelters (Swanson 1972) and Wilson Butte Cave (10JE6 [Gruhn 1961]). In the eastern Great Basin Hogup Cave (42BO36) provided much of the cultural chronological data (Aikens 1970). In southwestern Montana the Myers-Hindman site (24PA504)

Table 3-1 Cultural chronologies proposed for the Central Rockies, Northwest Plains and southwest Wyoming basins (After Connors 1998;Kornfeld et al. 2010:Figure2.16)

<table>
<tr><th>cal BP</th><th>Mulloy
1958, 1965</th><th>Frison
1978, 1991</th><th colspan="2">Metcalf 1987
Thompson and Pastor 1995</th><th>Reeves 1983</th><th>Connor 1998</th></tr>
<tr><td>150</td><td>Historic</td><td>Historic</td><td>Historic</td><td rowspan="2">(Phases)</td><td>Historic</td><td>Historic</td></tr>
<tr><td></td><td rowspan="4">Late
Prehistoric</td><td>Protohistoric</td><td>Protohistoric</td><td>Protohistoric</td><td>Protohistoric</td></tr>
<tr><td></td><td rowspan="3">Late
Prehistoric</td><td rowspan="3">Late
Prehistoric</td><td>Firehole</td><td rowspan="4">Late
Prehistoric</td><td rowspan="2">JHP-VII</td></tr>
<tr><td>600</td><td rowspan="2">Uinta</td></tr>
<tr><td></td><td>JHP-VI</td></tr>
<tr><td>1950</td><td>Late Middle
Prehistoric</td><td rowspan="2">Late
Plains
Archaic</td><td rowspan="4">Late

Archaic</td><td rowspan="2">Deadman
Wash
(McKean)</td><td>JHP-V</td></tr>
<tr><td></td><td rowspan="4">Early
Middle
Prehistoric</td><td rowspan="2">Late
Middle
Prehistoric</td><td rowspan="3">JHP-IV</td></tr>
<tr><td>4500</td><td rowspan="2">Middle
Plains
Archaic</td><td rowspan="2">Pine Spring
(McKean)</td></tr>
<tr><td></td><td rowspan="5">Early
Middle
Prehistoric</td></tr>
<tr><td></td><td rowspan="7">Early
Plains Archaic

- - ? - -

Foothill-
Mountain

Paleoindian</td><td rowspan="5">Early

Archaic</td><td rowspan="3">Opal</td><td rowspan="3">JHP-III</td></tr>
<tr><td>6850</td><td>Hiatus</td></tr>
<tr><td></td><td rowspan="5">Early

Prehistoric</td></tr>
<tr><td></td><td rowspan="2">Great Divide</td><td rowspan="3">JHP-II</td></tr>
<tr><td>8900</td><td rowspan="3">Early

Prehistoric</td></tr>
<tr><td></td><td colspan="2" rowspan="2">Paleoindian</td></tr>
<tr><td>11500

14,000</td><td>JHP-I</td></tr>
</table>

produced stratified deposits that have contributed to our understanding of the cultural history of the region (Lahren 1976). The data from these excavations in large part forms the foundation for several cultural chronologies proposed for the Central Rocky Mountains, Northwestern Plains and Wyoming Basin (Table 3-1). The system proposed by Frison (1978, 1991) is used throughout this report, not because it is necessarily better than the other schemes, but because it is the most commonly employed cultural chronology for the Central Rockies (Bartholomew 2001; Cannon and Hale 2013; Eakin 2011; Eckerle et al. 1999; Hale and Livers 2013; Kornfeld et al. 2001; Larson 2012; Larson et al. 1995; MacDonald 2013, 2013). The chronology that Connor (1998) proposed would at first glance seem a more appropriate means to outline the prehistory of Jackson Hole, but the temporal boundaries and material culture content of Connor's Jackson Hole phases are in part no longer supported by the available evidence.

None of the key sites listed above contains a complete stratigraphic sequence of human occupation of any region or even locale, but they do provide a basic outline of temporal trends in weapon technology, subsistence and settlement patterns throughout the prehistoric period (Kornfeld et al. 2010:70-71). Projectile points found within dated contexts of these key sites provide the foundation for


Medicine Lodge Creek
Paint Rock V
Laddie Creek
Southsider
Schiffer
Sorenson
Bottleneck Cave
Colby
Split Rock
Dead Indian
Mummy Cave
Moss Creek
Horner
Pagoda Creek
Goff Creek
Helen Lokingbill
Bugas-Holding
48SU4000
Eden-Farson
Deadman Wash
Myers-Hindman
Trappers Point
48SU6439
Pine Springs
GAME CREEK
Osprey Beach
Lawrence
Bison and Veratic Shelters
Barton Gulch
Wasden (Owl Cave)
Wahmuza
Weston Canyon Shelter
Baker Caves
Wilson Butte Cave
Hogup Cave
POWDER RIVER BASIN
BIGHORN MOUNTAINS
BIGHORN BASIN
PRYOR MTNS
BEARTOOTH MTNS
ABSAROKA RANGE
WIND RIVER BASIN
OWL CREEKS
WIND RIVER RANGE
WASHAKIE RANGE
GRANITE MTS.
LARAMIE RANGE
SHIRLEY
FERRIS
SEMINOE
GREAT DIVIDE BASIN
WASHAKIE BASIN
SIERRA MADRE RANGE
SNOWY RANGE
LARAMIE BASIN
GREEN RIVER BASIN
GROS VENTRE
OVERTHRUST BELT
YELLOWSTONE PLATEAU
TETONS
SNAKE R. RANGE
GALLATIN RANGE
MADISON RANGE
GRAVELLY RANGE
CENTENNIAL MTNS
BEAVERHEAD MTNS
LEMHI RANGE
LOST RIVER RANGE
PIONEER MOUNTAINS
NORTHERN ROCKY MOUNTAINS
SNAKE RIVER PLAIN
BEAR RIVER RANGE
BANNOCK RANGE
WASATCH RANGE
GREAT BASIN
North Platte River
Sweetwater River
Bighorn River
Yellowstone River
Wind River
Green River
Snake River
0 50 100 Kilometers

projectile point chronologies that in turn are used to cross-date the age of other less well-studied sites. There is nothing inherently wrong with this practice, but there are several problems with relying too heavily on the interpretations of a handful of widely scattered key sites.

The methods used in the early days of archaeological excavation were much less thorough than today. Frequently deposits were excavated by shovel (Aikens 1970; Mulloy 1958; Swanson 1972) in either thick arbitrary levels or by following natural stratigraphic boundaries (Aikens 1970; Gruhn 1961; Mulloy 1958; Swanson 1972) that at times were difficult to discern (Husted and Edgar 2002:31). Fortunately, most of the major excavations utilized some screening through 1/4” mesh of excavated deposits, but some did not (Mulloy 1958; Kelly et al. 2006). Features were only minimally recorded and were not processed using fine-screen techniques (Husted and Edgar 2002:31). Records of excavation typically were taken in notebooks without the use of standardized forms (Gruhn 1961:14; Husted and Edgar 2002:31), thus the amount and thoroughness of information varied widely between projects as well as individual excavators. For the time these methods were cutting edge and the care that many field directors and excavators took is truly commendable, but there are reasons why archaeologists no longer use these methods for data recovery.

Another problem with the interpretations of key sites concerns the precision of absolute dating. Most of the key sites with deep stratigraphic records, such as Mummy Cave, Medicine Lodge Creek, Bison and Veratic rockshelters, Wilson Butte Cave, Hogup Cave and Myers-Hindman, were dated using standard radiometric techniques of the day that produced age estimates with large standard deviations. Frequently, only a single date was obtained for each cultural level. Furthermore, most of the radiocarbon dates from Hogup Cave and Myers-Hindman were run by the Gakushuin Laboratory, a facility that has been shown to have produced unreliable dates (Blakeslee 1994, 1997). Given the imprecision and outright inaccuracy of the absolute dates and the ambiguity of stratigraphic integrity, the temporal parameters of the cultural complexes documented at these key sites remain unclear.

Despite methodological shortcomings and the imprecision of the absolute dates, the key sites provide relatively large assemblages of projectile points in stratigraphic sequence. Even without precise dates the law of superposition allows archaeologists to make reasonable inferences regarding the relative chronological position of particular styles of projectile points. However, none of the key sites listed above are in Jackson Hole. Mummy Cave, the closest of the key sites, is about 100 kilometers to the northeast and Bison and Veratic rockshelters, the next most proximal sites, are approximately 190 kilometers to the northwest. Although these three sites produced many of the same styles of projectile points, the timing and stratigraphic position of these styles differed significantly (Husted and Edgar 2002:137). Prior to the excavation at Game Creek, the absence of well-studied stratified sites or well-dated single component sites in Jackson Hole hindered the development of a local cultural chronology. Nevertheless, Connor (1998:71) formulated a chronology of Jackson Hole by pigeonholing projectile points recovered mostly from disturbed contexts along Jackson Lake into the Mummy Cave sequence. The excavations at Game Creek and Trappers Point (Francis and Widman 1999), a stratified Early-Middle Archaic aged site some 80 kilometers southeast of Game Creek, resulted in the recovery of projectile points from well-dated contexts that simply do not fit into Husted and Edgar's (2002) interpretation of the Mummy Cave sequence. Thus, a culture history based solely on the cross-dating of projectile points is of only limited value. These chronologies assume that there was little variation in prehistoric populations from one region to another. Another shortcoming of point type chronologies is that they are based solely on changes in weapons technology and thus fail to account for the broader and perhaps more interesting aspects of culture such as adaptational response to climate change.

Projectile Points: Style and Culture

Often cultural histories consist of little more than descriptions and temporal ranges of projectile point styles that give the impression that styles of projectile points reflect cultural or ethnic identities. To some extent this assumption is valid. Technology, like all other aspects of culture, is a passive consequence of learning and enculturation and thus *can* reflect cultural, ethnic, or social identity, but it is overly presumptuous to assume that it invariably does (Binford 1965:204). Wiessner's (1983) ethnoarchaeological study of San projectile points showed there are distinct styles manufactured and used by individual bands and broader stylistic similarities of projectile points within linguistic groups (Wiessner 1983:272-273). !Kung as well as G/wi and !Xo informants could differentiate between their own arrows and those produced by other linguistic groups.

On the other hand, there are no significant differences in style of projectile points produced in the Northwestern Plains during the end of the Late Prehistoric Period. At the time of European contact there were numerous bands and tribes in the Great Plains speaking Algonquin, Siouan, Kiowa-Tanoan, Athabaskan and Caddoan languages (Goddard 2001), all of whom manufactured side notched arrow points (Dyck and Morlan 2001; Kornfeld et al. 2010). Similarly, during the Early Archaic period side and corner notched dart points have a geographic distribution covering most of the continental United States (Justice 1987, 2002; Kornfeld et al. 2010). In short, projectile points in and of themselves are a poor proxy for culture.

Nevertheless, most of the cultural periods and complexes discussed below are named or otherwise defined in part by styles of projectile points. Moreover, many of the cultural historical inferences and hypotheses concerning the prehistory of the Central Rockies are based in part on the underlying assumption that projectile point styles, in some instances, reflect cultural identity.

Radiocarbon Date Frequency Distributions

Another approach to cultural historical reconstructions is through analyzing distributions of radiocarbon dates. The use of radiocarbon date frequency distributions as a means of inferring demographic trends has increased in recent years (Kelly et al. 2013; Peros et al. 2010; Surovell et al. 2009; Williams 2012). The explicit assumption is that the frequency of radiocarbon dates from archaeological sites is positively correlated with human population or occupational intensity (Kelly et al. 2013; Peros et al. 2010; Surovell et al. 2009; Williams 2010). Yet, human population levels are subject to change through emigration, immigration and natural reproductive growth or decline. These processes can occur within one culture or involve multiple contemporaneous cultures. Without an adequate understanding of the cultural dynamics at play it is doubtful that a cultural chronology based solely on demographic changes presents a realistic view of prehistory. Nevertheless, population trends in the archaeological record are potentially useful in reconstructing culture histories because they provide greater contextual support to interpretations. Over the last three decades intensive archaeological survey in western Wyoming has resulted in the documentation of thousands of archaeological sites and the acquisition of nearly two thousand radiocarbon dates. This research has coincided with an increasing refinement of radiocarbon dating, particularly accelerator mass spectrometry (AMS) that has allowed us to begin looking at temporal trends on a much larger scale and far greater degree of precision than ever before.

Methods

Demographic trends of prehistoric human populations can be modeled if an adequate and reasonably unbiased sample or radiocarbon dates exists and one accounts for problems inherent in the calibration process and the taphonomic loss of archaeological sites (Kelly et al. 2013:443; Williams 2012). The radiocarbon date frequency distributions presented below were created from a dataset of radiocarbon dates obtained from the Wyoming Cultural Records Office (WYCRO), Kelly et al. (2012:Supplementary Information) as well as numerous CRM reports from western Wyoming.

The physiographic region (Jones 2002) of each dated site was determined using GIS software. It was necessary to combine several regions and split another in order to maintain significant sample sizes. All of the mountainous regions of Western Wyoming including the western slope of the Bighorn Mountains, Absaroka Range, Wind River Range, Washakie Range, Jackson Hole, the Yellowstone Volcanic Plateau and the Overthrust Belt (Wyoming Range) were combined into a single Central Rocky Mountain category. The Bighorn and Wind River basins were also combined. In southwestern Wyoming the Bridger Basin, Rock Springs Uplift, Green River Basin south of Sublette County, Washakie Basin, Great Divide Basin, Granite, Green and Ferris Mountains were also combined into a Wyoming Basin category. Given its large dataset and distinct distribution of dates, the Upper Green River Basin, that portion of the basin within Sublette County, comprised a single analytical unit for the purposes of this study.

With few exceptions, dates with a standard deviation (age uncertainty) greater than 100 years were immediately excluded from the analysis. Radiocarbon dates with calibrated median ages of less than

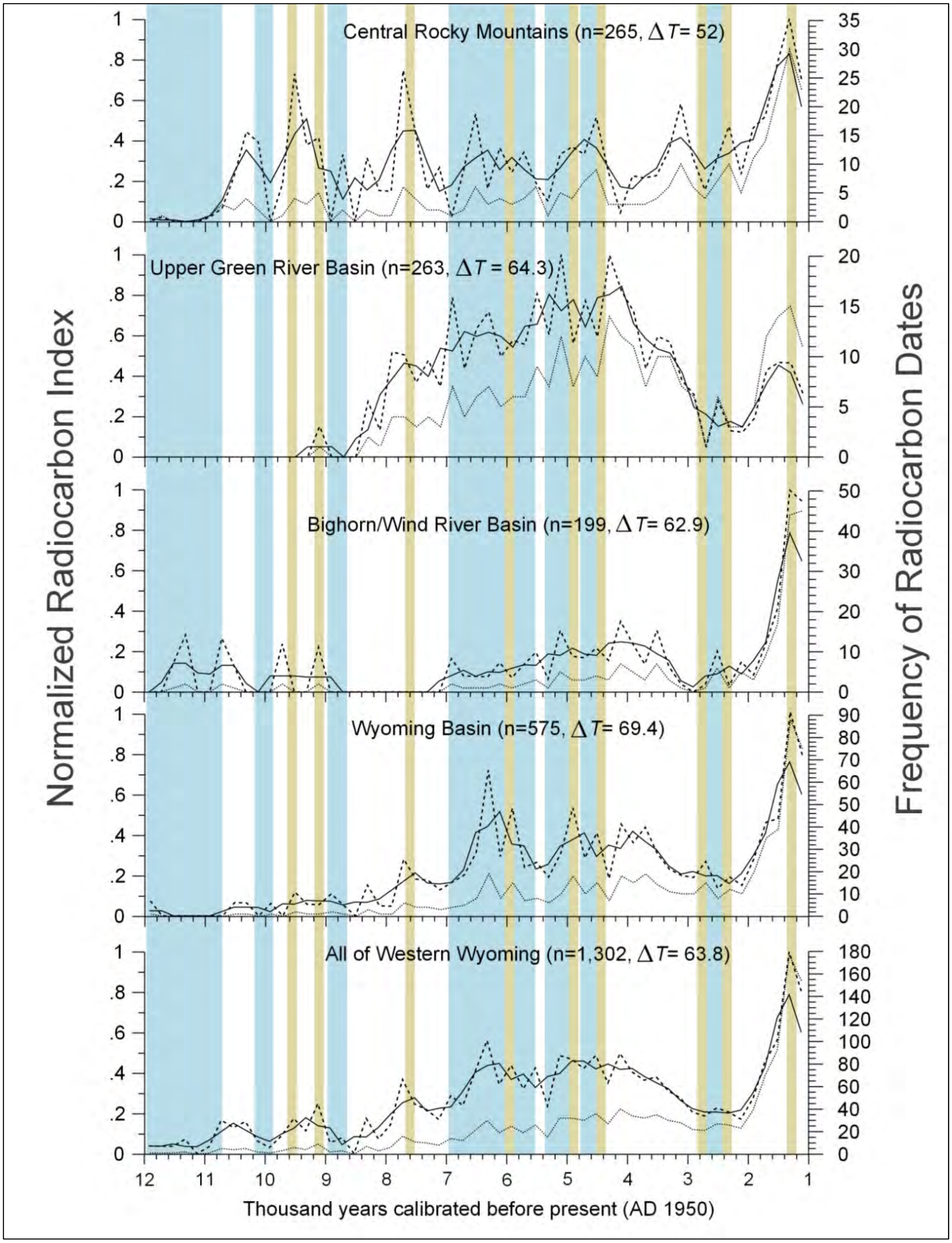


Figure 3-2 Calibrated radiocarbon date frequency distributions for western Wyoming. Dotted lines are raw frequency, dashed lines are corrected for taphonomic loss and solid lines are the 600 year moving average of corrected distributions. Blue shaded areas represent plateaus and brown shaded areas highlight calibrated age steps.

1000 cal BP were also excluded from the study due to a pronounced underrepresentation of radiocarbon dates from this time (see below). Once compiled the database was sorted by site and date. Pooled means were created in instances where there were multiple dates from one site that were statistically the same (95% confidence) using the “Test Sample Significance” and “Create Pooled Mean” tools in Calib 7.0.4 (Stuiver and Reimer 1993). This process had the effect of reducing the overall number of radiocarbon dates to 1,364, but the pooling of similar dates significantly reduced the mean standard deviation (ΔT), or uncertainty, of the dataset. Radiocarbon dates were then calibrated with the IntCal13 (Reimer et al. 2013) calibration curve using the OxCal 4.2 (Ramsey 2009) calibration program to generate summed probability values (minimum and maximum calibrated age range) as well as median calibrated ages.

Sample Size

The resulting sample consists of 1,302 dated components from 717 sites. In a recent review of methods for summed radiocarbon probability distributions Williams (2012:581) suggested that samples of between 200 and 500 dates are necessary to produce reliable results. Michczynska and Pazdur (2004:737) reached a similar conclusion using different methods, but also showed that the mean uncertainty (ΔT) of the dataset is inversely correlated with the reliability of the resulting distribution. Michczynska and Pazdur (2004:737) concluded that for a dataset with a ΔT=115 a minimum of 200 radiocarbon dates are needed to produce a reliable distribution. The regional date distributions presented here have between 199 and 575 dated components with mean uncertainty ranging from ΔT=52 to ΔT=69.4 with an overall ΔT=63.8 (Figure 3-2). Based on the criteria established by Michczynska and Pazdur (2004:737) and Williams (2012), the regional samples, with the exception of the Bighorn/Wind River sample, are sufficiently large enough to produce “reliable” distributions. Be that as it may, it would be naïve to presume that the acquisition of more dates will have no appreciable effect on the radiocarbon date frequency distributions from the sample areas.

Taphonomic Bias

The effect of taphonomic processes such as erosion and weathering on the survival of archaeological sites has been another persistent concern (Benedict and Olson 1978; Metcalf 1987; Wright 1982). Surovell et al. (2009) recently formulated a mathematical model to correct for the taphonomic loss of sites using records of terrestrial volcanism recovered from ice cores in Greenland and radiocarbon dated sedimentary contexts. Surovell et al. (2009:1716) found that rates of volcanism were relatively stochastic during the late Quaternary based on concentrations of SO_4^{2-} in ice cores (Zielinski et al 1994, 1996). Yet, radiocarbon dates of terrestrial volcanism in sedimentary contexts (Bryson et al. 2006) showed a steady increase throughout the Late Quaternary. Surovell et al. (2009:1716) concluded that taphonomic bias has “severely affected the terrestrial record of volcanism.” It was assumed that the same taphonomic processes that destroyed evidence of volcanism in sedimentary contexts also affected the preservation of archaeological sites. Using the radiocarbon dates of volcanic events as a proxy, Surovell et al. (2009) modeled taphonomic loss using a non-linear regression technique. The regression model was found to be highly significant and able to explain 90% of the variance in radiocarbon frequencies through time.

A disproportionate number of the dated components in the Central Rockies came from caves and rockshelters. Most of these occur along the western slope of the Bighorn Mountains where the Frison Institute and University of Wyoming have conducted extensive excavations in the Paintrock Canyon Archaeological Landscape District and the Black Mountain Archaeological District (Finley 2008; Finley et al. 2005; Kornfeld 2007). According to Finley (2008) and Surovell et al. (2009) erosional unconformities are rare in the rockshelters of the western Bighorns. Consequently, Surovell (2009) reasoned that rockshelters were less impacted by taphonomic processes than open air sites and used the former as a proxy for past population trends in the Bighorn Basin. In order to show this relationship Surovell et al. (2009:1718) created radiocarbon date frequency distributions of open and closed sites and found that open sites were rare in the period from circa 7000 BP to 12,000 BP when compared to closed sites. Surovell et al. (2009) concluded that taphonomic bias has disproportionately affected the open sites in the basin. For this reason Kelly et al. (2012) only applied the taphonomic correction to open sites then summed the results with the rockshelters and calculated a mean for the entire basin. The same method is used here for taphonomic correction of open sites, but not for rockshelters and caves.

Early Paleoindian Period ca. 13,400 – 11,400 cal BP

Clovis ca. 13,400 – 12,400 cal BP

The environment of Jackson Hole during Early Paleoindian times was dramatically different than today. Conditions were generally dry throughout this period with increasing temperatures. Pollen records indicate that alpine meadows and shrub communities dominated the landscape with patches of spruce, juniper, birch and willow (Whitlock 1993). Though there is no modern analogue for the fossil pollen record, Whitlock (1993:187) suggests that “it may have resembled a subalpine parkland.” Abundant grasses and shrubs would have provided excellent forage for large grazing animals including extinct megafauna.

The earliest incontrovertible evidence of human occupation of the region is attributed to the Clovis complex. The temporal range of Clovis has been hotly debated in recent years. Waters and Stafford (2007), using dates from 11 sites, argue that the complex dates from roughly 13,250 to 12,800 cal BP. However, Haynes et al. (2007) question their selective use of dates and argue that more work is needed to resolve the issue. If all of the early dates available are considered, including those rejected by Waters and Stafford (2007), the temporal range of Clovis is expanded to about 13,400-12,400 cal BP (Prasciunas 2008). Large lanceolate projectile points typically bearing flutes on both faces are the hallmark of the Clovis complex (Figure 3-3 a [Bradley 2010; Kornfeld et al. 2010]). Other technological characteristics include a blade tool technology and well-crafted ivory, bone, and antler tools (Bradley 2010; Kornfeld et al. 2010; Waters et al. 2011). According to Bradley (2010), the distinctive shape of platforms and the high incidence of overshot flakes are also diagnostic characteristics of Clovis lithic technology. Exotic raw materials are often associated with Clovis occupations (Bradley 2010). Clovis people have been characterized as highly-mobile big game hunting specialists (Haynes 2002; Kelly and Todd 1988) and comparatively less-mobile broad-spectrum foragers (Anderson 1990; Meltzer 2004). Given the enormous geographic distribution of Clovis culture (most of North America) it is unlikely if any single subsistence or settlement strategy was employed by all people in all places throughout the existence of the culture.

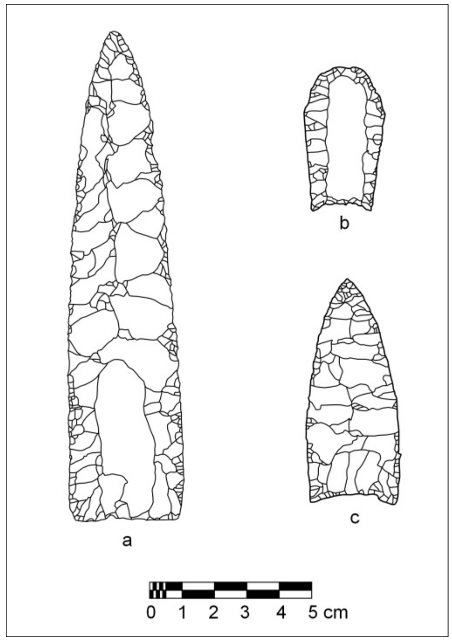


Figure 3-3 (Early Paleoindian projectile points: (a) Clovis from the Anzick site (redrawn from Frison 1991:Figure 2.7), (b) Folsom from the Hanson site (redrawn from Frison 1991:Figure 2.21) and (c) Goshen from Kaufman Cave (Redrawn from Frison 1991:Figure 2.18 (c).

A base fragment of a Clovis point was found in disturbed context at the Lawrence site (48TE509) along Jackson Lake (Figure 3-4 [Connor 1998]). A Clovis component has long been rumored to exist near the Astoria Hot Springs (48TE372) site where an obsidian "unfluted Clovis" point was found in unknown context (Love 1972). Another Clovis point fragment was recently found in Yellowstone National Park at 48YE357 along the Yellowstone River (Maas and MacDonald 2009). Several Clovis caches have been found in relative proximity to the GYE including the Simon site cache in the Snake River Plain of south-central Idaho (Butler 1965) and the Anzick burial and cache near Wilsall Montana (Figure 3-4 [Wilke et al. 1991]). The Colby site (48WA322) in the Bighorn Basin is the only Clovis occupation in the area to receive formal archaeological excavations (Figure 3-4). The remains of several mammoth as well as pronghorn, deer and a possible musk ox were found at the site in clear association with Clovis points (Frison and Todd 1986). An occupation at Alm Shelter (48BH3457) in the Bighorn Mountains has recently been dated to 12,841±62 cal BP (Finley 2008), but the assemblage from this stratum was very small and the three point fragments recovered have yet to be reported (Ostahowski and Kelly 2014). Clovis projectile points have been found in a wide range of physiographic environments from above timberline to the lowest elevations of the plains (Kornfeld et al. 2010). Yet, the role mountainous environs played in Clovis subsistence and settlement remains unknown.

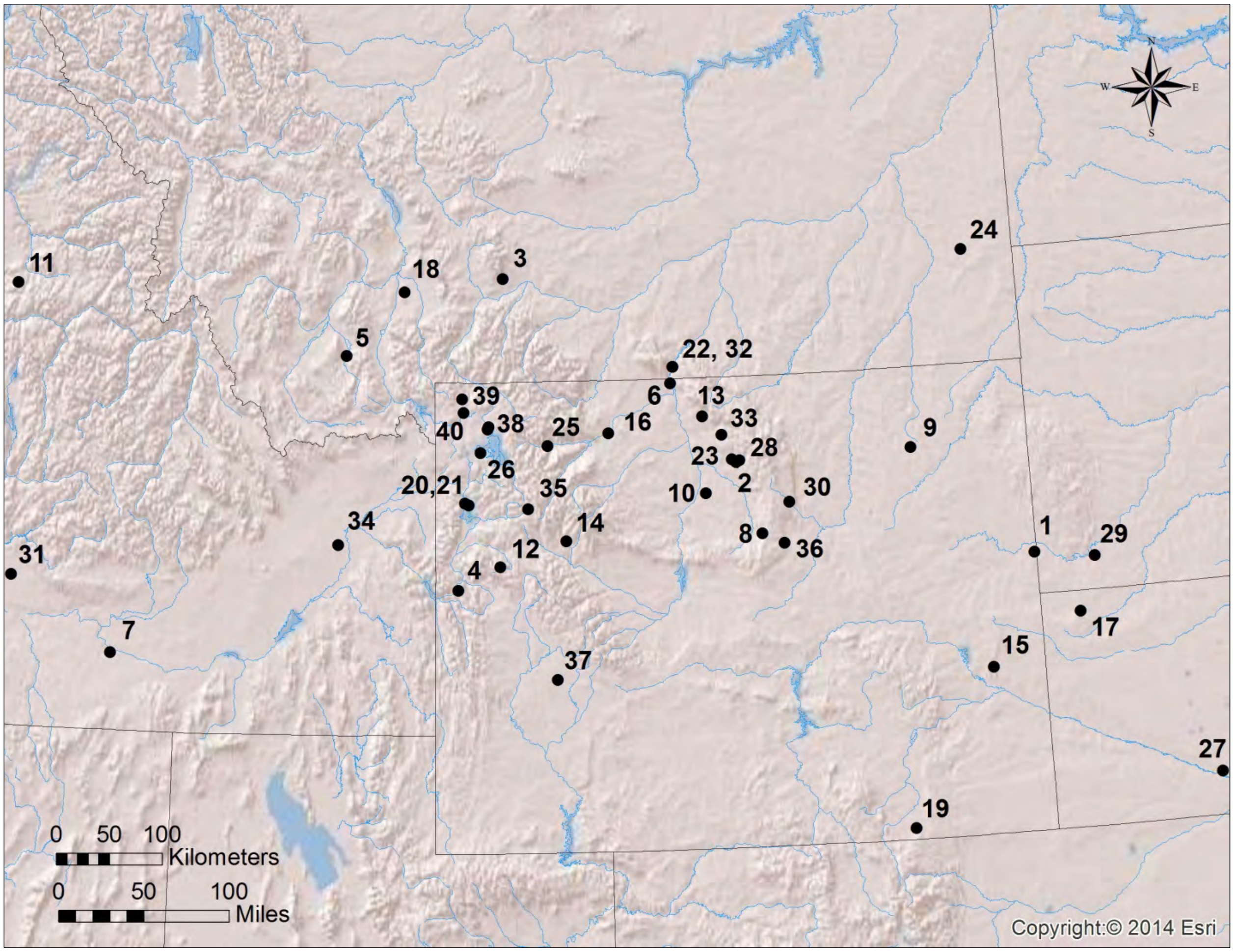


Figure 3-4 Map showing locations of Paleoindian sites discussed in text: 1. Agate Basin (48NO201), 2. Alm Shelter (48BH3457); 3. Anzick Burial ; 4. Astoria Hot Springs (48TE372); 5. Barton Gulch (24MA171); 6. Bottleneck Cave (48BH206); 7. Buhl Burial; 8. Bush Shelter (48WA324); 9. Carter/Kerr-McGee (48CA12); 10. Colby; 11. Cooper's Ferry; 12. Fraser (48TE487); 13. Hanson (48BH329); 14. Helen Lookingbill (48FR308); 15. Hell Gap (48GO305); 16. Horner (48PA29); 17. Hudson-Meng; 18. Indian Creek; 19. James Allen; 20. Lawrence site (48TE509); 21. Lizard Creek (48TE700); 22. Mangus (24CB221); 23. Medicine Lodge Creek (48BH499); 24. Mill Iron (24CT30); 25. Mummy Cave (48PA201); 26. Osprey Beach (48YE409/410); 27. O.V. Clary/ Clary Ranch; 28. Paint Rock V (48BH349); 29. Ray Long (39FA65); 30. Schiffer Cave (48JO319); 31. Simon Site; 32. Sorenson (24CB202); 33. Two Moon Shelter (48BH1827); 34. Wasden/Owl Cave; 35. 48FR3942; 36. 48JO303; 37. 48SU4000; 38. 48YE243; 39. 48YE357; 40. 48YE406.

Goshen and Folsom Complexes ca. 12,900 – 11,600 cal BP

Temperatures and effective moisture fell significantly with the rapid onset of the Younger Dryas stadial round 12,800 cal BP. Spruce parkland spread throughout northern Jackson Hole replacing grass and shrubs. This would have reduced the availability of forage for the large ungulates on which Early Paleoindians appear to have relied. However, the low water levels recorded at Lake of the Woods during this time likely reflect decreased snowpack that may have resulted in increased availability of winter forage for herbivores and perhaps made the high elevations more hospitable for human occupation. It was about this time that several megafauna species including mammoth, horse, camel, short-faced bear and dire wolves went extinct (Goebel et al. 2011). The role that Paleoindians played in this extinction has remained a point of contention for many decades (; Kornfeld et al. 2010). That these extinctions occurred during the most pronounced and dramatic episode of climate change over the last 20,000 years is difficult to discount.

The Goshen and Folsom cultural complexes are believed to have developed and persisted through the Younger Dryas stadial. There is considerable ambiguity regarding the temporal range of each of these complexes (Surovell 2009). However, Goshen was found stratigraphically below Folsom at the Hell Gap (48GO305) and Carter/Kerr-McGee (48CA12) sites (Kornfeld et al. 2010). Based on limited radiocarbon dates, a temporal range of 12,900 cal BP to 12,000 cal BP is estimated for the Goshen Complex (Kornfeld et al. 2010; Sellet et al. 2009). The Folsom complex has a temporal range of about 12,700 cal BP to perhaps as late as 11,600 cal BP (Kornfeld et al. 2010). Sites and isolated finds attributed to Goshen and Folsom are found throughout the Northwestern Plains and Southern Rockies (Kornfeld et al. 2010; Sellet et al. 2009; Surovell 2009).

According to Bradley (2010) Goshen lithic technology is more similar to Folsom than Clovis and may have possible roots in the Great Lakes region. Both Goshen and Folsom points were exceptionally well-crafted through multiple stages of thinning by percussion (including diving flakes) and pressure flaking with extensive marginal retouch to produce a remarkably thin tool (Figure 3-3 [Bradley 2009; 2010]). Folsom Points were typically fluted and the tips further refined through pressure flaking (Bradley 2010). Unfluted Folsom points, known as Midland also occur (Bradley 2010; Kornfeld et al. 2010). Given the similarities between Goshen and Folsom lithic technology and the overlapping geographic and temporal distributions and similar subsistence base, the two complexes may have emerged from a common cultural or technological complex (Bradley 2010).

Bison were the top-ranked prey of both Goshen and Folsom hunters. Evidence for mass kills that likely involved coordinated communal hunting strategies by Goshen Complex people has been recovered at the Mill Iron (24CT30) site (Kornfeld et al. 2010) in eastern Montana and the Upper Twin Mountain site (5GA1513) in Middle Park Colorado (Kornfeld 2013; Kornfeld et al. 1999). Similar evidence of specialized bison procurement was uncovered in the Folsom component at the Agate Basin (48NO201) site (Kornfeld et al. 2010).

No Goshen sites or isolates have thus far been positively identified in Jackson Hole or the GYE, but high elevation occupations, such as Upper Twin Mountain, are known from the Southern Rockies (Kornfeld 2013; Kornfeld et al. 1999). On the other hand, Folsom points have been found at the Fraser (48TE487) site in the Gros Ventre Range just east of Jackson Hole (Love 1972) and at Boulder Lake in the Wind River Range. The latter point has been geochemically sourced to Obsidian Cliff confirming use of the Yellowstone Plateau by Folsom people (Cannon et al. 2001). In the foothills of the Bighorn Mountains two rockshelters yielded evidence of Folsom or Folsom aged occupations. At Alm Shelter (48BH3457) an AMS date of 11,721±83 cal BP was obtained from a piece of dispersed charcoal, but no diagnostic artifacts have thus far been reported from this context (Ostahowski and Kelly 2014). A Folsom point was found in Two Moon Shelter (48BH1827) with an associated date of 11,596±153 cal BP (Finley et al. 2005). Several Folsom sites have been investigated in the basins surrounding the Central Rockies. The Hanson (48BH329) site in the Bighorn basin is one of the largest documented Folsom campsites known (Kornfeld et al. 2010). An isolated Folsom point was recovered from the Rabbit Ear Rock site (48SU3876), one locale within the 48SU4000 Archaeological District, in the Upper Green River Basin (Miner 2001). On the eastern Snake River Plain a Folsom component was excavated at the Wasden/Owl Cave site (Plew 2008). In the Lower Green River Basin a Folsom component was identified at the Krmpotich (48SW9826) site (Kornfeld et al. 2010).

These sites and isolated finds indicate that Folsom and probably Goshen people occupied a wide range of ecosystems from the grasslands of the basins and plains to the alpine meadows of the Central Rockies. There is no compelling evidence for a shift in subsistence practices for Folsom people occupying the high elevations. The few scattered sites and projectile point isolates in the high country could reflect intermittent use for the acquisition of lithic raw materials or hunting of bighorn sheep or deer whose hides may have been preferred for clothing. Another possibility is that decreased snowpack resulted in increased availability of winter forage and a concomitant increase in bison populations that drew hunters into the high country.

Western Stemmed Tradition 13,300 – 9000 cal BP

There is mounting evidence that people of the Western Stemmed Tradition (WST), the dominant Paleoindian complex in the Pacific Northwest, Columbia Plateau, Great Basin and Snake River Plain, entered the Central Rockies during early Paleoindian times. The initial appearance of WST people in the Central Rockies occurred during the Younger Dryas stadial that ushered in cooler, dryer conditions in the Central Rockies. In the Great Basin, however, moister conditions prevailed, resulting in a dramatic increase in pluvial lake levels and expansion of wetlands (Goebel et al. 2011). Thousands of WST points have been found along the shores of long vanished lakes throughout the Great Basin often in association with chipped stone crescents (Goebel and Keene 2014).

Dated WST components range in age from ca. 13,200 cal BP at the Cooper’s Ferry site (Davi et al. 2014) to as late as 9000 cal BP (Chatters et al. 2012; Goebel et al. 2011; Jones and Beck 2014). Sites occur in a wide range of environmental settings, but wetlands and pluvial lakes appear to have been preferred locations of base camps (Chatters et al. 2012; Goebel et al. 2011; Jones and Beck 2014). Redundant site occupation is evident, which suggests patterned annual subsistence rounds (Chatters et al. 2012; Goebel et al. 2011). Most WST lithic assemblages contain raw material that was procured 100-200 km from the site, which suggests large band territories (Goebel et al. 2011) and is a trait shared with Clovis, Folsom and Goshen complexes (Frison 1997).

Subsistence practices were highly variable though deer, elk and bison typically outrank smaller animals in NISP on the Columbia Plateau (Chatters et al. 2012). In the Great Basin, however, there is little evidence that WST people depended heavily on high ranked big game because artiodactyl remains are rare (Jones and Beck 2014). Though the data are sparse, the high incidence of sites adjacent to wetlands and lakes suggests that resources associated with such settings were the focus of subsistence strategies (Grayson 2011; Jones and Beck 2014). Unlike contemporary Clovis, Goshen and Folsom, no evidence of intensive communal hunting has been found. The discovery of grinding stones at the Lind Coulee site provides some evidence for intensive plant exploitation, but no actual botanical remains have been recovered and overall groundstone artifacts are rare (Chatters et al. 2012). Like other early Paleoindian complexes, formal, curated tools, such as projectile points, scrapers, drills, gravers, eyed needles and other bone implements are common in WST assemblages. Some refer to the WST as a "Paleoarchaic" tradition due to the combination of Paleoindian attributes, such as large territories, large lanceolate and stemmed points and diverse toolkits, and a broad-spectrum hunting and foraging, Archaic-like, subsistence strategy (Beck and Jones 2007).

There are a variety of named projectile point types within the WST (Beck and Jones 2010; Chatters et al. 2012; Goebel et al. 2011; Jones and Beck 2014), but the types fall into two general categories; stemmed and contracting base lanceolates (Figure 3-5). The earliest well-dated points of the WST are stemmed (Davi et al. 2014; Goebel and Keene 2014), with weak to pronounced shoulders, and flat to convex basal edges (Figure 3-5 d-i). On the Columbia Plateau these points are called Lind Coulee, Parman or Windust (Beck and Jones 2010; Davi et al. 2014) and have been dated as early as 13,215 cal BP at Cooper's Ferry and 12,622 cal BP at the Buhl Burial sites in the Columbia Basin (Davi et al. 2014; Goebel and Keene 2014). Similar points found in the Great Basin are known as the Silver Lake type (Beck and Jones 2010; Justice 2002), or Great Basin Stemmed type (Pitblado 2003). The large, tapered base lanceolates, known variously as Haskett, Cougar Mountain or Lake Mohave (Figure 3-5 a-c [Beck and Jones 2010; Justice 2002]), have been recovered from contexts dated to ca. 12,600 – 12,200 cal BP at Smith Creek Cave, Bonneville Estates Rockshelter and Connley Cave in the Great Basin (Goebel and Keene 2014); as well as the Helen Lookingbill site in the Central Rockies (Kornfeld et al. 2001).

WST lanceolate points conform to two basic styles that Butler named Haskett Type 1 and Type 2 (Figure 3-5). Haskett Type 1 points are large (up to 220 mm) and thick (7-10 mm), lenticular in cross-section, with long (~2/3 length) tapering stems with convex to flat bases. Basal margins are often, though not invariably, ground or dulled. Surfaces of finished specimens bear broad, shallow parallel comedial, or flake scars that feather-out near the midline of the point, produced through pressure or indirect percussion flaking. Haskett Type 2 points differ from Type 1 in the absence of a tapering stem, but are otherwise

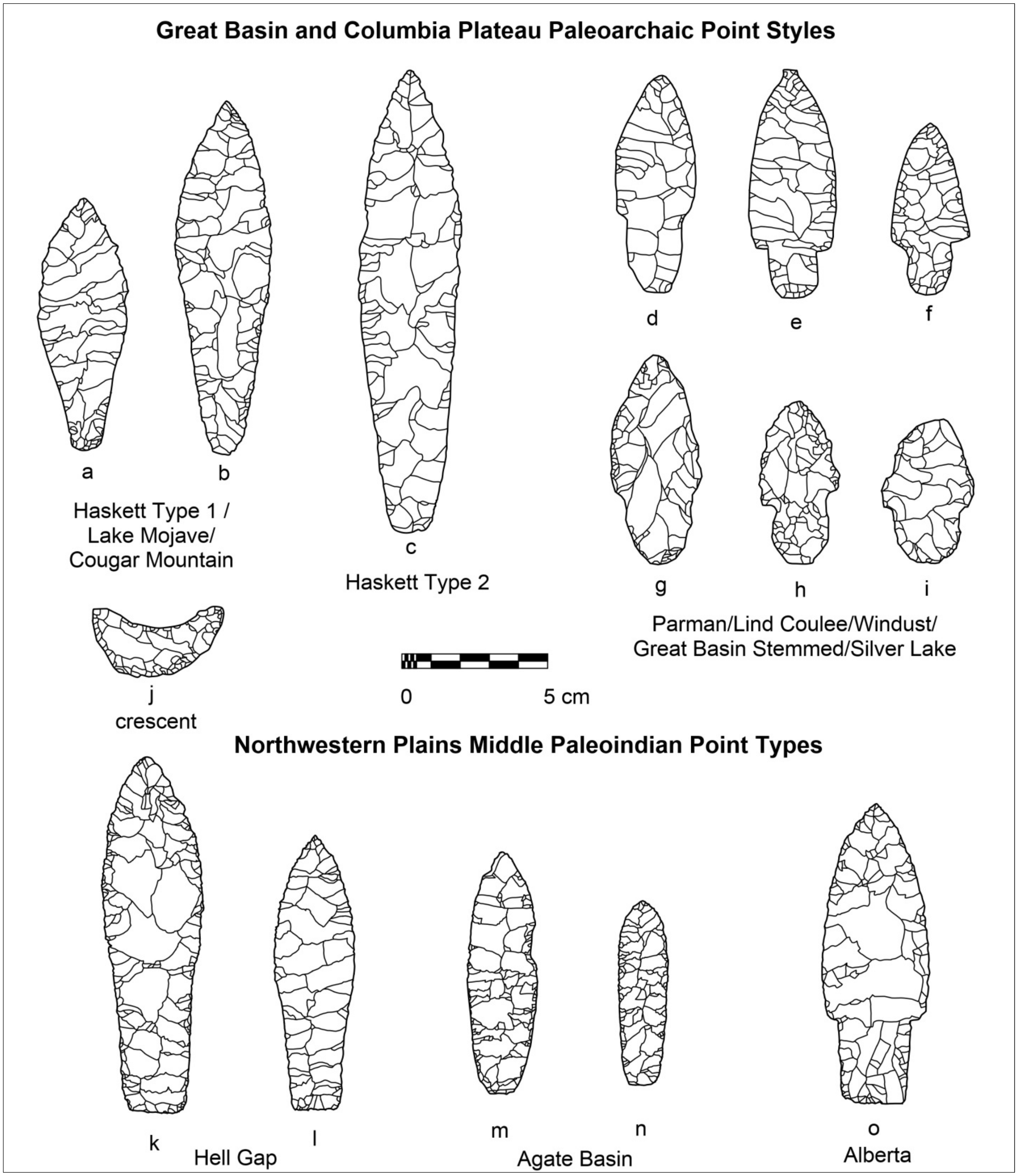


Figure 3-5 WST projectile point types and chipped stone crescent. Artifacts redrawn from other publications (a, Hill et al. 2005:Figure 108; b, Holmer 2009:49; c, e, Beck and Jones 2010: Figure 12; d, Goebel et al. 2011:Figure 9a; g, h, Justice 2002:Figures 12.14 and 12.20; I, Chatters et al. 2012:Figure 3.2j; (k-o Frison 1991:Figures 2.26 and 2.27).

technologically identical (Butler 1965). WST points are remarkably similar in morphology and technology to the Agate Basin, Hell Gap and Alberta types of the Northwestern Plains (Figure 3-5).

The only well-dated WST component in the Central Rockies was found at the Helen Lookingbill (48FR308) site in the Washakie Range, dated to 12,277±165 cal BP, which is one the earliest dates for the WST. The component contained several projectile points identified as Haskett (Figure 3-6 [Frison 1983; Kornfeld et al. 2001; Larson et al. 1995]). Two stemmed (Great Basin Stemmed/Silver Lake) WST points were recovered from Area 2 at Medicine Lodge Creek (48BH499 [Pitblado 2003]), bracketed by dates of 11,375±141 cal BP and 10,662±43 cal BP (Frison 2007) and stratigraphically below a Cody complex point. The "Agate Basin-like," "Scottsbluff-like" and "Alberta-like" points reported from the earliest occupation at the Sorenson (24CB202) site in Bighorn Canyon share more of a resemblance with WST points than Alberta or Cody and were found stratigraphically below Foothill-Mountain complex components (Husted 1969). A great many points that most closely resemble WST types have been found in undated contexts throughout western Wyoming. The "Agate Basin-like" and "Hell Gap-like" points reported from the Lawrence site assemblage on Jackson Lake (Bartholomew 2001; Connor 1998; Reeve 1986) are likely Haskett points (Figure 3-6). Several points with markedly tapering stems, indistinguishable from Haskett Type 1 (Johnson et al. 2004:Plate A2-4, Plate A3-2, Plate A17-1, Plate A18-4, Plate A19-5, 6, 9), as well as one nearly textbook example of a Great Basin Stemmed point (Figure 3-6 [Johnson et al. 2004:Figure A4-5]) were found at the Osprey Beach (48YE409/410) site on Yellowstone Lake. Another Great Basin Stemmed point was found near the Osprey Beach site at 48YE406 (Figure 3-6 [Toohey and Sanders 2012:Figure 4.7]). Eakin (2005) recorded a complete isolated Haskett point during a post-fire survey on Boulder Ridge in the Absaroka Range (Figure 3-7). Many of the points found in the Wyoming Basin and reported by Wimer (2001) and Frison et al. (2015) may well be WST rather than Hell Gap (Frison et al. 2015:Figures 7 a, k, 8 i, j, k; 9 i, o; Wimer 2001:Figures 5.1 d , 6.2), especially considering the environmental setting since all were found adjacent to lakes or wetlands, the preferred habitat of early WST people.

A small number of chipped stone crescents, which are almost invariably associated with WST points in the Great Basin, have also been found in Wyoming. One crescent was recovered from the Tyrrell Tie Rod site in the upper Green River basin on the shores of a playa lake (Wimer 2001). Two crescents were also recovered from the Hartville Uplift, not far from the Hell Gap Site, the type site of the Hell Gap complex (Kornfeld, personal communication 2015).The role WST people played in the prehistory of the Central Rockies remains open to debate. According to Bradley (2010:485), the WST is a probable progenitor of the Agate Basin, Hell Gap and Alberta complexes. Similarly, Husted (1969) and Husted and Edgar (2002) argue that the Agate Basin complex represents an intrusive population originating to the northwest that replaced Folsom and Goshen complex peoples on the Northwestern Plains. In recent years there has been a concerted effort to date WST sites. The resulting radiocarbon

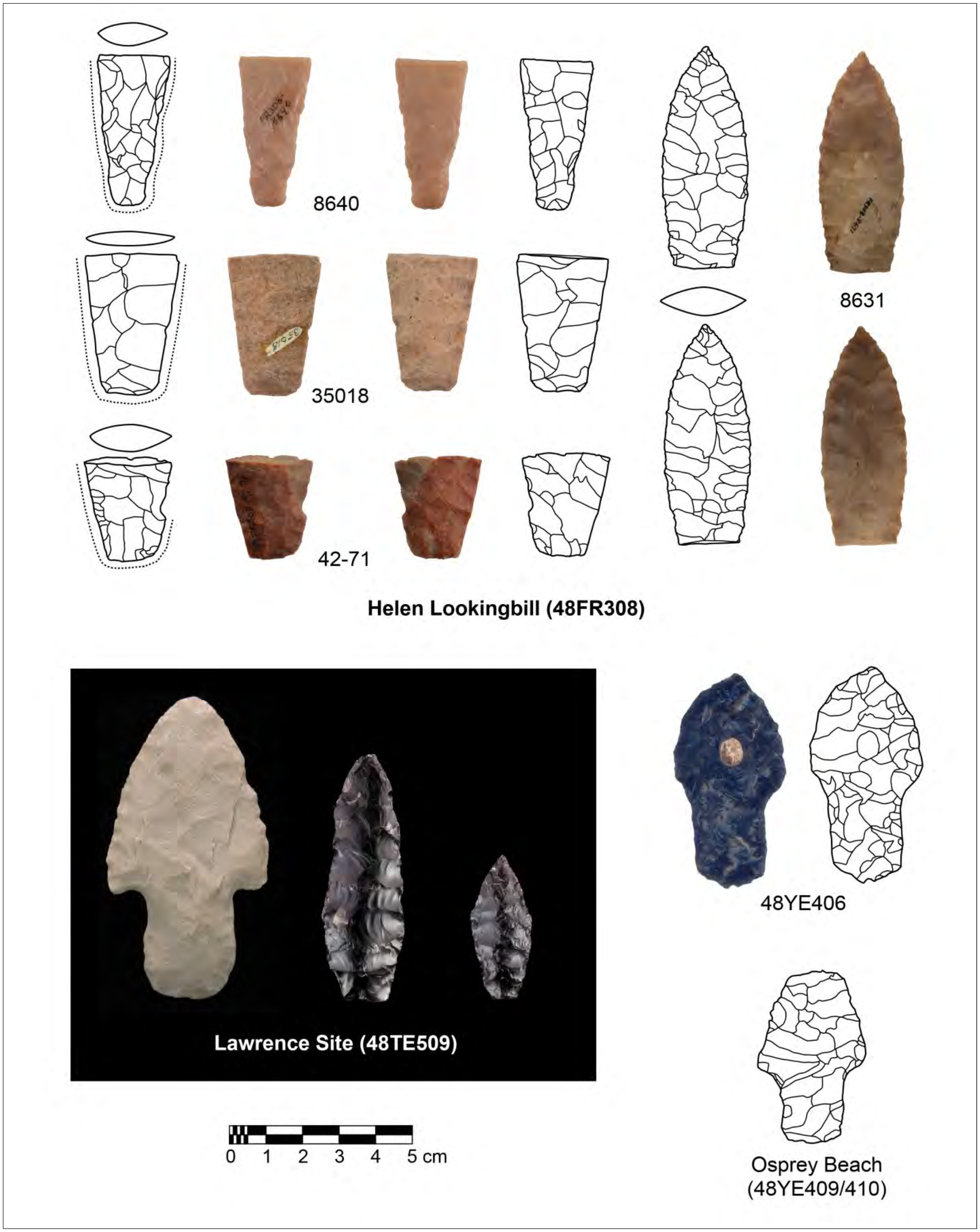


Figure 3-6 WST points found at the Helen Lookingbill (48FR308) site, 48YE406 (Toohey and Sanders 2012:Figure 4.7), Osprey Beach (redrawn from Johnson et al. 2004:Figure A4) and the Lawrence site (48TE509) on Jackson Lake (Material from the Jackson Hole Historical Society & Museum).

Figure 3-7 Isolated Haskett point recorded by Eakin (2005) on Boulder Ridge (Eakin 2005).

record (Beck and Jones 2010; Davi et al. 2014; Goebel and Keene 2014) clearly shows that the WST sites in the Great Basin, Columbia Plateau, Snake River Plain and Central Rockies predate the Agate Basin,Hell Gap and Alberta complexes by at least several centuries. At present, there is only one well-dated WST component in the Central Rockies, but artifacts diagnostic of the WST are widely distributed throughout the region and, where stratigraphic data are available, such as Medicine Lodge Creek and Sorenson, they are found beneath Cody and Foothill-Mountain components.

Middle Paleoindian Period ca. 11,400 – 10,200 cal BP

Temperatures and effective moisture increased significantly at about 11,400 cal BP with the end of the Younger Dryas stadial. Grass and shrubland continued to contract in Jackson Hole, replaced by spruce, subalpine fir and whitebark/limber pine. This period also witnessed an increase in seasonality with hot summers and cold winters. The warm and relatively wet conditions continued until about 10,550 cal BP when there is evidence at Soda Lake and Lake of the Woods for decreasing effective moisture and an increase interannual variance in precipitation over the next 250 years (Chapter 2).

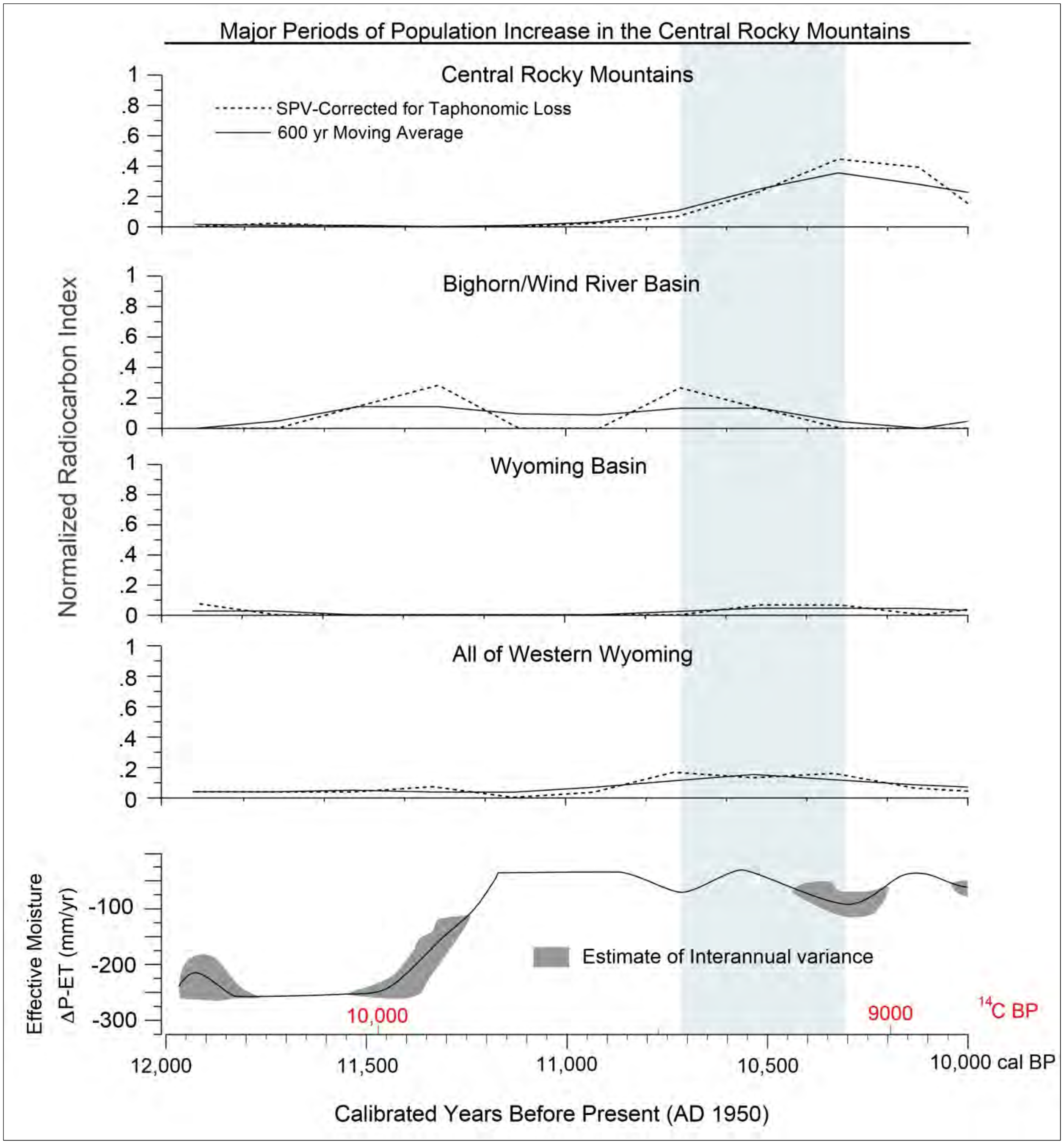


Figure 3-8 Calibrated radiocarbon date frequency distributions during the Early and Middle Paleoindian periods in western Wyoming.

The distribution of radiocarbon dates suggests that human populations in the Bighorn and Wind River Basins appear to have increased during the end of the Younger Dryas and then suddenly declined between 11,300 cal BP and 11,100 cal BP with the onset of warmer and moister conditions (Figure 3-8). There is an apparent 200 year gap (11,100 – 10,900 cal BP) in the radiocarbon record from the Bighorn and Wind River Basins, which is surprising given the relatively favorable climatic conditions during this time. Following the apparent hiatus, populations again increased in the Bighorn and Wind River Basins between 10,900 cal BP and 10,700 cal BP followed by a sharp and steady decline throughout the remainder of the Middle Paleoindian period. Conversely, in the Central Rockies human populations steadily increased between 11,000 cal BP and 10,700 cal BP and then showed a marked increase in the rate of growth that coincided with the population decline in the Bighorn and Wind River Basins (Figure 3-8). This pattern may indicate an increased use of the foothill and mountain environments, as suggested by the discovery of several Cody Complex sites in the foothills and mountains (Kelly et al. 2013).

Agate Basin/Hell Gap/Alberta Complex ca. 12,000-10,600 cal BP

Although cultural complexes have been, and continue to be assigned to the Agate Basin, Hell Gap and Alberta projectile points, the three types overlap in time and space (Frison 1997), frequently co-occur in the same assemblages (Bradley 2009:Figures 17.6 and 17.8) and are all likely derived from earlier WST point types such as Haskett, Windust, Lind Coulee and Great Basin Stemmed (Bradley 2010). It is entirely possible that these types were produced by the same cultural groups. It is possible, if not likely, that there was variation in morphology and flaking technology through time and across space (Bradley 2010). Perhaps Agate Basin style points were gradually replaced by Hell Gap and Alberta styles, but at present the data are insufficient to demonstrate a clear temporal sequence of the Agate Basin, Hell Gap and Alberta point types.

Well-dated components bearing Agate Basin, Hell Gap or Alberta points are relatively rare. A date of 12,325±178 cal BP from the Hell Gap component in Area 3 at the Agate Basin site (Kornfeld et al. 2010) suggests temporal overlap with Folsom, but Agate Basin, Hell Gap and Alberta points have been consistently recovered above Folsom in stratified contexts (Kornfeld et al. 2010). The youngest well-dated component with Hell Gap points, 11,280±104 cal BP, was identified at the Indian Creek site in Montana (Pitblado 2003). Alberta points appear to have been produced as late as 10,609±82 cal BP based on dates from the Hudson-Meng site (Pitblado 2003), and they may have entirely replaced the lanceolate types towards the end of the Middle Paleoindian period.

Agate Basin points are substantially similar to Haskett Type 2 points (Figure 3-5). They are narrow, long and relatively thick (~7 mm [Bradley 2009]) with heavily ground basal margins (Bradley 2010). The points were made by bifacial percussion flaking followed by random invasive pressure flaking that covers most of the surface (Bradley 2010). However, several of the Agate Basin points illustrated by Bradley (2009:Figure 17.6 r, 2010:Figure 9.19 b, k) also display broad parallel comedial flake scars similar to Haskett points. Hell Gap points are markedly similar to both Agate Basin and Haskett Type 1 points (Figure 3-5). The primary technological difference between the two types is that percussion thinning and shaping of Hell Gap points terminated at an earlier stage producing a wider point (Bradley 2009, 2010). Hell Gap points have a long tapering stem that is usually not as pronounced as Haskett Type 1 points and rounded shoulders. Alberta points have wide, long stems and straight to slightly convex bases, the lateral margins of which are almost invariably ground (Figure 3-5 [Bradley 2009]). Shoulders are typically distinct, but not barbed like Haskett, Alberta points were formed through comedial percussion flaking followed by selective invasive pressure flaking (Bradley 2010). Two points recovered from the Hell Gap site in direct association with Agate Basin and Hell Gap points have pronounced shoulders and convex bases that are morphologically identical to WST stemmed (Lind Coulee, Windust, Parman, Silver Lake) types (Bradley 2009:Figure 17.8 l, m).

Most of what is known about the subsistence practices of the people who made Agate Basin, Hell Gap and Alberta points has come from bison bone bed sites in the Northwestern Plains (Kornfeld et al. 2010). The evidence indicates that bison were the focal prey species. There is also strong evidence for well-organized communal hunting using natural arroyo and sand dune traps (Frison 1974; Frison and Stanford 1982). If, as Bradley (2010) and Husted (1968) argue, these complexes originated from the WST, then there was a dramatic shift in subsistence practices, since there is no evidence of specialized big game hunting strategies in earlier WST sites to the west. It is unclear whether Agate Basin/Hell Gap people devised these big game hunting strategies independently or whether they adopted the practices from contemporaneous Folsom and/or Goshen people.

Most sites that have produced Agate Basin, Hell Gap and Alberta points, such as Hell Gap, Carter/Kerr-McGee, Casper, Indian Creek and Jones Miller are found on the Northwestern Plains . To date, the only dated component with unambiguous points of one of these styles in the Central Rockies was found at Eagle Shelter in the Bighorn Mountains. However, numerous sites in or adjacent to the Central Rockies have produced points that have been characterized as "Agate Basin-like" or "Hell Gap-like" (Husted 1969). Many of the "Agate Basin-like" points were described in the 1960s, such as the earliest components at the Sorenson (24CB202) and Mangus (24CB221) sites in the Bighorn Canyon (Husted 1969), when Paleoindian archaeology was still in its infancy and the imprecision of radiocarbon dating prevented all but the most general temporal assignment. Some of the "Agate Basin-like" points described by Husted (1969) display parallel oblique flaking and have associated dates centuries or even a millennium later than Agate Basin. It is now generally agreed that these points are Angostura points diagnostic of the Late Paleoindian-aged Foothill-Mountain complex (Davis et al. 1988, 1989; Kornfeld et al 2010; Larson 2012; Pitblado 2003). However, the stemmed points from the poorly dated Occupation 1 at the Sorenson site are almost certainly WST types. It is possible that some of the "Agate Basin-like" points found at sites in the Central Rockies, such as the Lawrence and Osprey Beach sites, could represent specimens that are technologically and temporally intermediate between the WST and later point types of the Foothill-Mountain Paleoindian complex.

Cody Complex ca. 11,300-10,000 cal BP

The Cody complex is well-documented on the Northwestern Plains and intermontane basins (Kornfeld et al. 2010). The stemmed projectiles that are diagnostic of the complex are believed to be derived from the earlier Alberta type (Bradley 2009, 2010). The Horner II (48PA29) component in the Bighorn Basin, dated to 11,317±139 cal BP, contained a large assemblage of projectile points that appear to be transitional between Alberta and Cody (Frison and Todd 1987). The evidence, though sparse, suggests cultural continuity between Cody and the earlier Middle Paleoindian people who produced Agate Basin, Hell Gap and Alberta points. The youngest well-dated Cody complex date came from the Eden component at Hell Gap, where two bone dates produced a mean estimated age of 10,035±138 cal BP (Knell et al. 2009).

There are several named projectile point types that have been assigned to the Cody complex (Figure 3-9). The earliest, found at Horner II, are known as Alberta/Cody I and II (Bradley and Frison 1987). Alberta/Cody I are large, well-made, points, lenticular in cross-section with convex blade edges, well defined squared to slightly rounded shoulders and uniform, parallel-sided and straight bases. Basal margins are invariably ground. Points were initially shaped through percussion flaking followed by selective invasive transmedial pressure flaking of the blade. The pressure flakes often cross the midline and interfinger with flakes struck from the opposite side. There is no medial crest or ridge. Stems were shaped and finished using selective invasive pressure flaking and margin retouch. Alberta/Cody II points are typically narrow than type I specimens, but differ primarily in flaking, which consists of serial comedial pressure flaking that covers the entire blade surface. The Scottsbluff point type, Like Alberta/Cody II, frequently exhibit serial comedial pressure flaking, but they differ in having a distinct comedial ridge that results in a point that is biconvex or diamond-shaped in cross-section. Selective invasive and margin pressure flaking was used to shape and form the base, but blades received minimal margin retouch. Eden points are substantially similar to Scottsbluff, but are narrower and often longer and the median ridges are typically more pronounced. Another difference is that points often exhibit extensive margin retouch.

Many Cody complex sites on the Northwestern Plains consist of mass kill bison bone beds, such as Horner I and II (Kornfeld et al. 2010). There is evidence of coordinated communal hunting using some sort of artificial corrals or traps (Frison et al. 1987). The Horner I component, dated at approximately 10,621±131 cal BP, appears to have represented one or more short term, late fall through early winter occupations and contained the remains of over 100 bison (Frison et al 1987). Yet, there is also evidence for Alberta/Cody complex occupation of the high country as well.

The Osprey Beach (48YE409/410) site, dated at roughly 10,581±89 cal BP, or roughly contemporaneous with Horner I, contained a Cody complex component. Other high elevation Cody sites in the region include what appears to have been either a long term occupation or multiple occupations. The Lawrence (48TE509) site yielded a large number of diagnostic Cody artifacts (Bartholomew 2001; Connor 1998; Reeve 1986). A fragment of what appears to be a Cody knife was recovered from trench backfill during the 2002 testing at Game Creek. There is also a small Alberta/Cody component at

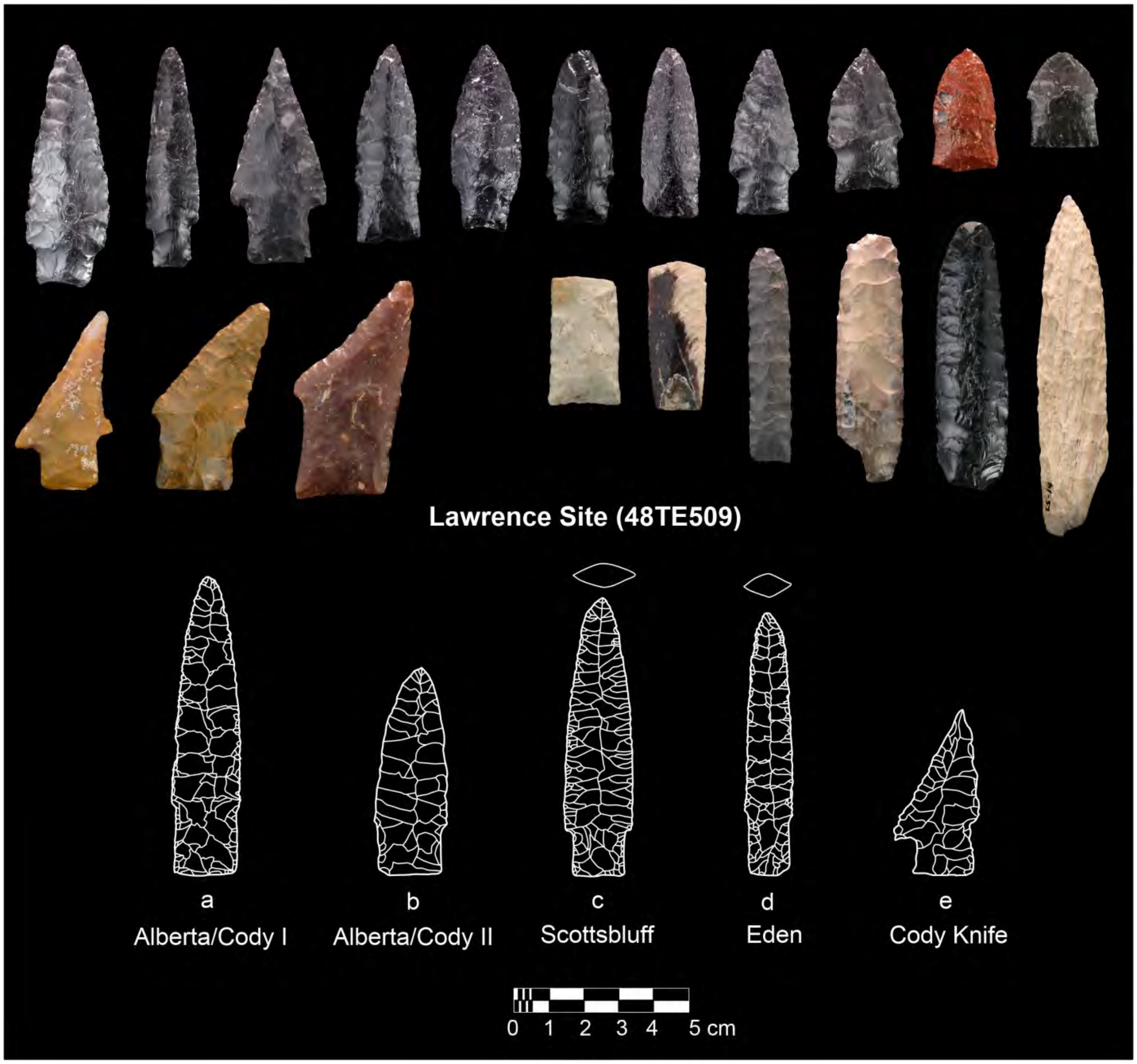


Figure 3-9 Alberta/Cody and Cody Complex points and knives: (a) Alberta/Cody I from Horner site; (b) Alberta/Cody II from Osprey Beach; (c) Scottsbluff point from Finley site; (d) Eden point from Carter/Ker-McGee; (e) Cody knife from Osprey Beach. Artifacts redrawn from other publications (a, c, d, Frison 1991:Figures 2.28 b, 2.30; b and e Johnson et al. 2004:Figures A1, and A5). Upper two rows are Scottsbluff and Eden points and Cody knives from the Lawrence site (Material from the Jackson Hole Historical Society & Museum).

Medicine Lodge Creek (Frison 2007) and Goff Creek (Page 2016). These high country sites contain little evidence for bison procurement, but bone preservation at Osprey Beach was poor (Johnson et al. 2004) and the Lawrence site has been completely destroyed. Although it seems unlikely that Alberta/Cody people traveled to Yellowstone Lake or Jackson Hole for communal bison hunt, the Osprey Beach and Lawrence sites did produce large numbers of diagnostic tools, a trait which sets them apart from other contemporary complexes in the high country.

Plainview ca. 11,400 – 10,800

A small number of points identified as Plainview have been found in western Wyoming. The earliest component at Medicine Lodge Creek dated at 11,375±141 cal BP produced a point reminiscent of the Goshen or Plainview types (Frison 2007). Two similar points were found at Bush Shelter (48WA324) with an associated date of 10,872±165 cal BP (Figure 3-10 [Miller 1988]). The Plainview point type is substantially similar to the earlier Goshen type, which has led some to regard the two types as synonymous (Pitblado 2003). However, Goshen sites from the Northwestern Plains are 500-1,000 years older than Plainview components in the Southern Plains, which may indicate a precedent-antecedent relationship between the two types. Plainview points are lanceolate in shape with parallel to slightly lateral margins, collateral flaking pattern and concave basal edges that are often thinned (Krieger 1947). Like Goshen, Plainview points are exceptionally thin (~5 mm [Krieger 1947]) and wide. Plainview people practiced the same bison-centric subsistence strategy and most sites are found in short or mixed grass prairie in the Northwestern and Southern Plains.

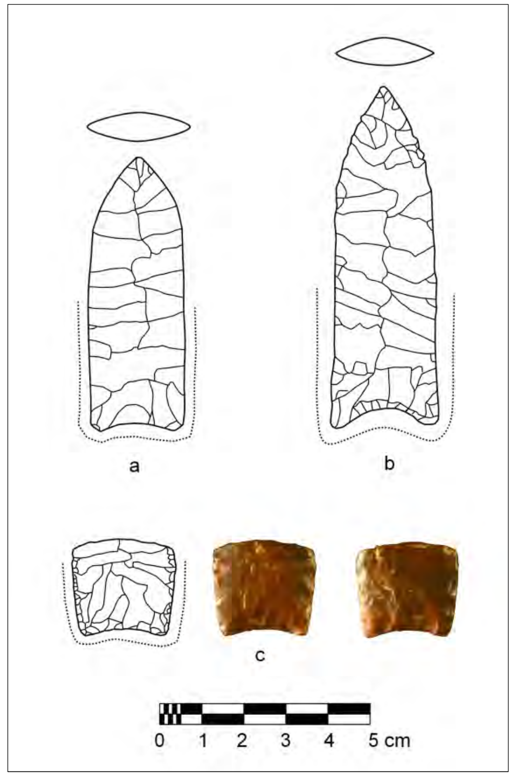


Figure 3-10 Photo and Illustrations of Plainview points: (a) and (b) redrawn from Krieger 1947; (c) Bush Shelter (48WA324 [courtesy of Danny Walker]).

Unnamed "Fish-Tail" ca. 10,650 cal BP

Another unusual, and presently unnamed, point type "thick in cross-section, with heavily ground lateral restrictions and a deeply concave and expanding base" with pronounced rounded ears was identified immediately above the Great Basin Stemmed points at Medicine Lodge Creek in association with the 10,662±43 cal BP date (Frison 2007:36). Reeve (1986) describes four points from the Lawrence (48TE509) site with similar characteristics. Fragments of two points of this type were also found at 48YE243 (Figure 3-11 [Sanders 2000]) and another at Osprey Beach (Figure 3-11 [Johnson et al. 2004:Figure 1.9, 6]). The specimen from Osprey Beach has parallel oblique flake scars. These points may be some of the earliest specimens that exhibit parallel-oblique flaking, a trait that continues in several complexes for the next two thousand years. The origin of this point type is unclear as they bear little resemblance to contemporary styles on the Northwestern Plains. These points are occasionally lumped into the later Lovell Constricted type (Larson 2013), but they are also tantalizingly similar to the Beaver

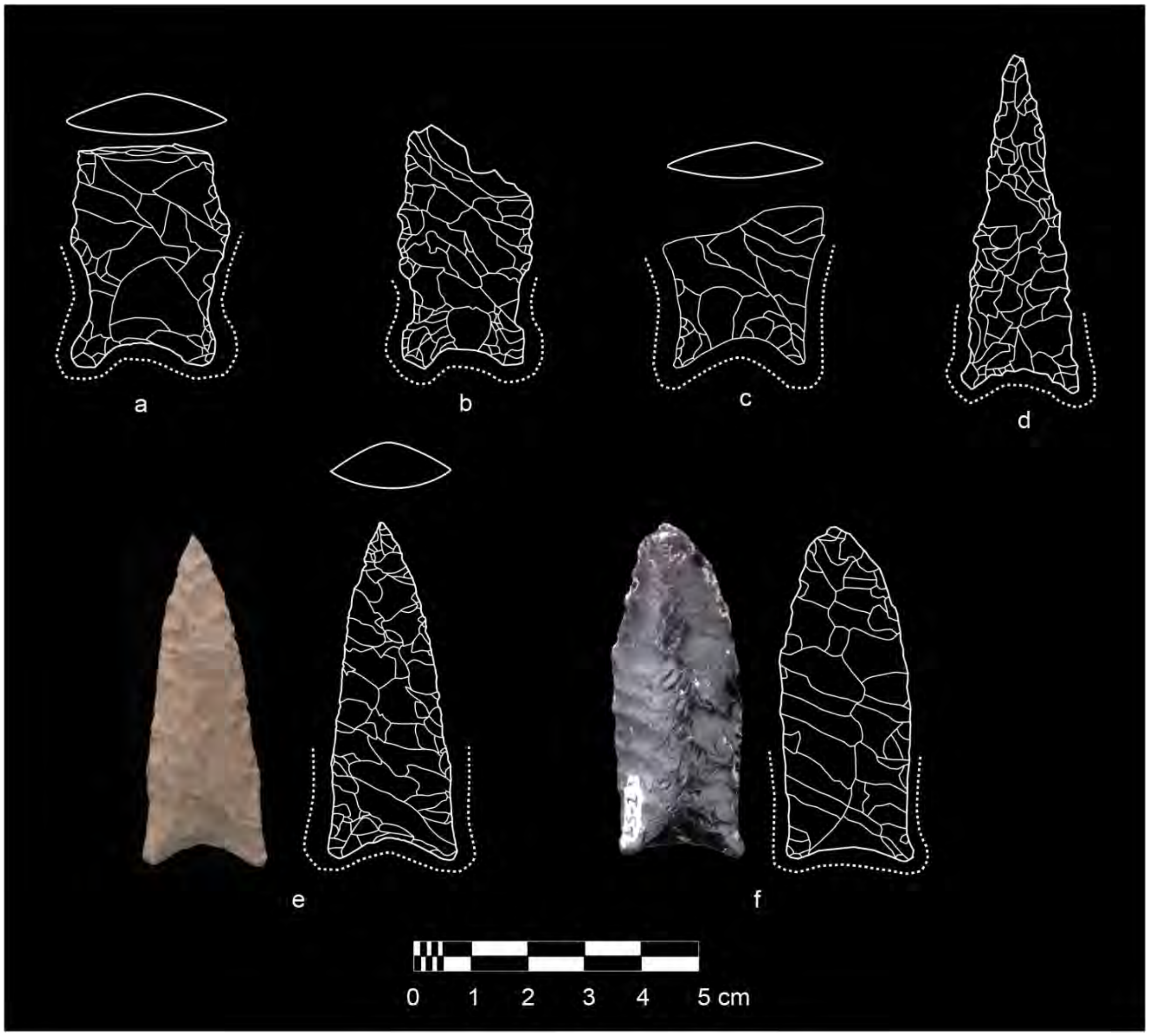


Figure 3-11 Illustrations and photographs of "Unnamed Fishtail" points: (a) 48YE243; (b) and (d) Osprey Beach; (c) Game Creek; (e) 48FR3942, (f) Lawrence Site. Redrawn from other publications: (a) Sanders 2000:Figure 32; (b), (d), Johnson et al. 2004:Figure A17(7) and (5).

Lake and Quad types of the Eastern Woodlands (Justice 1987). A complete specimen was found in cultural layer 4 at Mummy Cave dated to 10,422±103 cal BP (Husted and Edgar 2002). The point is relatively thick, plano-convex in cross-section, with parallel-oblique flaking, slightly constricted lateral margins and a markedly concave expanding base that forms one pointed and one rounded ear. Margins are heavily ground (Husted and Edgar 2002). Two fragments of a similar point were found in Cultural Level 1 at Game Creek with an associated date of10,391±61 cal BP. Isolated examples of this point style occur in Jackson Hole and surrounding regions. A complete, but heavily resharpened, specimen was found in the Absaroka Range at 48FR3942. Superficially these points resemble James Allen, with similar haft morphology and parallel-oblique flaking, but they are considerably thicker and plano-convex in cross-section suggesting a different production technology. Moreover, the dates from Mummy Cave layer 4 and Game Creek Cultural Level 1 predate the earliest dated occurrence of James Allen (see below).

Late Paleoindian Period ca. 10,200 – 8650 cal BP

Paleoclimatic data from Soda Lake and Lake of the Woods indicate that the climate in the Central Rockies became cooler and wetter between about 10,200 and 10,000 cal BP. There is evidence for an increase in drought frequency and/or duration after 10,000 cal BP. At about this same time there is an apparent decline in human populations throughout western Wyoming that persisted until circa 9900 cal BP (Figure 3-12). Populations appear to have rebounded in the Central Rockies between 9900 and 9300 cal BP. However, in the Bighorn, Wind River and southwestern Wyoming basins populations appear to have been relatively stable. The climate again changed rather abruptly after 9300 cal BP with significant decreases in effective moisture and inferred increases in temperature. These conditions appear to have led to steady declines in human population between 9300 and 8650 cal BP throughout western Wyoming culminating in an apparent 200-250 year hiatus in human occupation that marks the end of the Paleoindian period.

Techno-culturally, the Late Paleoindian period was less diverse than the Middle Paleoindian period. The James Allen or Frederick complex is the only well-documented cultural complex on the Northwestern Plains (Kornfeld et al. 2010). The WST continued to persist during the early part of the Late Paleoindian period in much of the Great Basin. On the Columbia Plateau there is evidence of a new group or technologically related groups of people known as the Old Cordilleran tradition (Butler 1961; Chatters et al. 2012). On the eastern Snake River Plain Haskett points were gradually replaced by a slightly different form of point, known as the Birch Creek type, produced using very similar technological stages (Holmer 2009; Plew 2008). Yet, there does not appear to have been any substantial changes in subsistence (Gruhn 1961; Swanson 1972). In the Central Rockies the Late Paleoindian Period was marked by the appearance of the Angostura or Ruby Valley point type, which is similar in morphology to Agate Basin and Haskett, but typically bears distinctive parallel-oblique flaking patterns. A stemmed point type, known as Lovell Constricted (Husted 1969), was later added to the tool kit. The subsistence practices of the people in the Central Rockies differed markedly from earlier and contemporary cultural complexes of the Northwestern Plains. Rather than a clear focus on bison procurement, there is evidence that a broader spectrum of plants and animals were exploited (Frison 1997; Frison and Grey 1980). The overwhelming majority of the sites containing Angostura and Lovell Constricted points have been found in the foothills and mountains of the Rocky Mountain west (Larson 2012). The Foothill-Mountain Paleoindian complex, as it has come to be called, was the dominant cultural complex in the Central Rockies throughout the Late Paleoindian period (Frison 1991; Frison and Grey 1980; Kornfeld et al. 2010).

James Allen/Frederick Complex ca. 10,200 – 8700 cal BP

The James Allen and Frederick complexes were identified and defined from the James Allen (Mulloy 1959) and Hell Gap (Irwin-Williams et al. 1973) sites in southeastern Wyoming. It is now generally accepted that James Allen and Frederick represent the same cultural complex (Hill 2005;

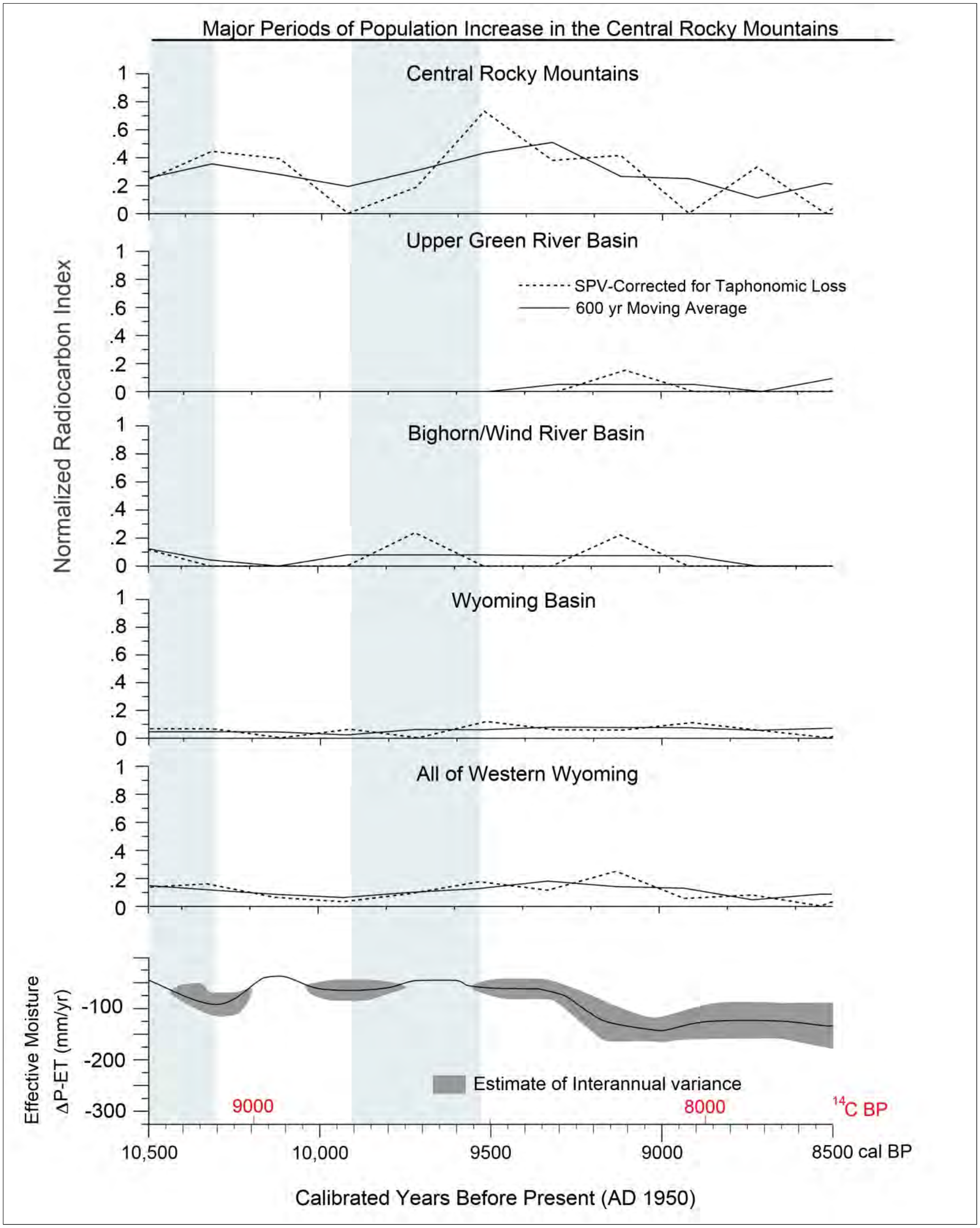


Figure 3-12 Calibrated radiocarbon date frequency distributions during the Late Paleoindian period in western Wyoming. Periods of inferred population growth in the Central Rockies are highlighted in gray.

Kornfeld et al. 2010; Pitblado 2007), which for the sake of brevity will be called Allen hereafter. The earliest dates for the Allen complex came from the Central Plains of Kansas and Nebraska at circa 10,200 cal BP (Hill 2005; Hoffman et al. 1995). Based on several standard radiocarbon dates from the Sutter site in eastern Kansas, the Allen complex may have persisted until circa 8700 cal BP (Hill 2005; Katz 1973).The James Allen/Frederick point type is an exceptionally thin (~5.5 mm [Bradley 2009; Wiesend and Frison 1998]) and wide lanceolate point that typically displays parallel or slightly expanding bases, a concave, heavily ground base and a serial transverse parallel oblique flaking pattern (Figure 3-13 [Bradley 2009]). Points from the Frederick component at Hell Gap differ somewhat from points found at the James Allen site in that the bases are only slightly concave or straight, rather than markedly concave (Bradley 2009). Allen points are often confused with or uncritically assigned to the Angostura type (Pitblado 2003, 2007), but the two types show statistically significant differences. Allen points are wider and thinner than Angostura and typically have parallel to expanding bases (Pitblado 2003, 2007).

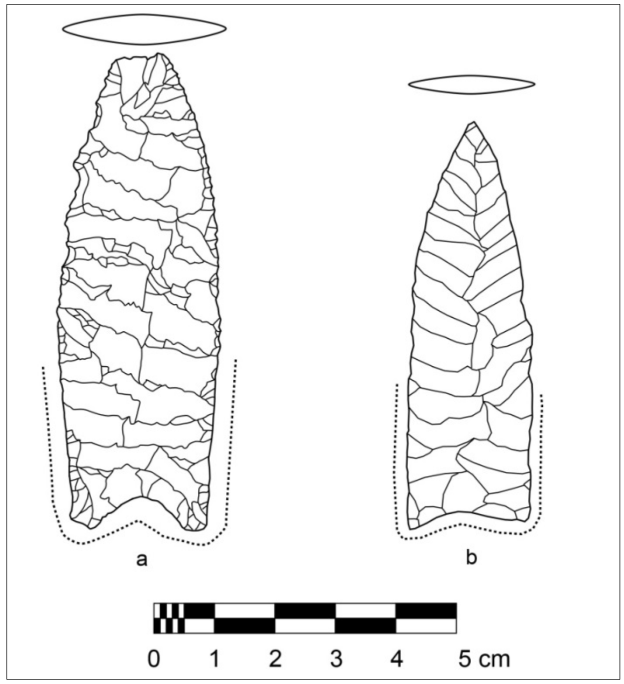


Figure 3-13 Illustrations of James Allen/Frederick projectile points: (a) James Allen site; (b) Hell Gap site. Artifacts redrawn from other publication (Kornfeld et al. 2010: Figures 2.35 and 2.38).

The origins of the Allen complex are obscure. Some have noted the similarities between Allen points and the Dalton point type, which is the dominant Late Paleoindian projectile point style in the lower Midwest and Southeast, and hinted at some sort of the cultural connection (Kornfeld et al 2010). Yet, apart from the parallel-oblique flaking pattern, Allen points are substantially similar to the earlier Plainview type. Given the geographic distribution and similar subsistence systems of the Plainview and Allen complexes it is possible that there was an antecedent -precedent relationship between the two.

In a comprehensive study of Paleoindian projectile points from the Southern Rocky Mountains, Pitblado (2003, 2007) found that James Allen sites are most commonly located on the Plains, but also occur in montane environments especially in the subalpine and alpine zones at high elevations. This spatial pattern of sites led Pitblado (2003, 2007) to the hypothesis that Allen complex people migrated seasonally between the Plains and high elevation alpine zones. Presumably high elevation sites were occupied during the summer months and spent their winters on the Plains. A similar pattern of Plains and high elevation occupations is found in the Folsom sites in the region (Kornfeld 2013; Pitblado 2007).

Evidence of high elevation Allen complex occupations in the Central Rockies is limited. In Wyoming, most Allen complex components have been found on the Plains and intermontane basins (Frison et al. 2015; Kornfeld et al. 2010; Wimer 2001), but an Allen point was recovered from Cultural Level 3 at Game Creek, dated between 9660 cal BP and 9000 cal BP. Thus, it is possible that Allen complex people also utilized the high elevations of the Central Rockies, perhaps in a similar seasonal pattern as in the Southern Rockies.

The evidence suggests that subsistence practices of Allen complex people were focused on the procurement of high-value artiodactyls, in particular bison, but may have included elk and bighorn sheep when they were in the high country (Kornfeld 2013; Pitblado 2007). At the O.V. Clary and Clary Ranch sites in western Nebraska, Hill et al. (2008) found evidence of a mass kill, although the bonebed itself was not excavated. There was also evidence at these sites of "encounter-type" hunting (Hill et al. 2008:127). Fauna other than bison do not appear to have been targeted resources and played a "minor role" in the subsistence base of Allen complex people (Hill et al. 2008).

Foothill-Mountain Paleoindian Complex ca. 10,700 – 8800 cal BP

Although there is evidence that the Foothill-Mountain Paleoindian complex was emerging during the Middle Paleoindian period, most of the excavated sites and components date to the Late Paleoindian period (Frison 1997; Kornfeld et al. 2010). There are two basic forms of projectile point that are diagnostic of the Foothill-Mountain Paleoindian complex. The earliest well-documented point type is a constricted base lanceolate variously known as the Ruby Valley or Angostura type. Ruby Valley points are morphologically and technologically similar to, and at least partially contemporaneous with, the Angostura point type (Kornfeld et al. 2010; Larson 2012; Pitblado 2003) first described from the Ray Long (39FA65) site in South Dakota (Wheeler 1995). The primary difference between Ruby Valley and Angostura points is the tendency for bases of the latter type to be slightly concave (Figure 3-15 [Bradley 2013; Davis et al. 1989; Pitblado 2007]). Davis et al. (1989) do not discuss why they chose to coin a new name for the points from Barton Gulch, but the reason may lie in the widespread misuse of the term "Angostura" to describe almost any lanceolate point with parallel-oblique flaking (Bradley 2013; Pitblado 2007). However, Pitblado (2007) and Bradley (2013) have thoroughly addressed the typological issues surrounding the Angostura point type refining and further defining its characteristics. For this reason the older and more precisely defined term Angostura will be used here.

The Angostura type is a lanceolate point with contracting lateral margins and a squared, flat to slightly concave or convex base that typically exhibits marginal grinding (Figure 3-14 [Bradley 2013; Davis et al. 1989; Pitblado 2007]). The points are usually fairly thick (~6.6 mm) and biconvex in longitudinal cross-section, but slightly plano-convex specimens are common (Bradley 2013; Pitblado 2007). The majority of points have serial parallel-oblique flaking patterns that are transverse to comedial and are oriented from upper-left to lower-right (Bradley 2013; Davis et al. 1989; Pitblado 2003).

Resharpening of broken or dulled specimens is common and is often done to produce a bi-beveled edge (Davis et al. 1989). Angostura points are most commonly found in the mountains and foothills of the Southern, Central and Northern Rocky Mountains as well as the Black Hills (Larson 2012; Pitblado 2007). Although not discussed by Bradley (2013) or Pitblado (2007), the Angostura type is morphologically similar to the constricted base lanceolates of the WST and may well have been derived from this earlier technological complex.

The earliest dated occurrence of the Angostura type came from the Barton Gulch (24MA171) site (Davis et al. 1989) in southwestern Montana dated at 10,555±110 cal BP (Pitblado 2003). A relatively large assemblage of Angostura points was recovered from the Helen Lookingbill site with an associated date of 10,039±94 cal BP (Kornfeld et al. 2001). Cultural Level 2, dated to 9660±53 cal BP, at Game Creek produced two Angostura point fragments (Chapters 5 and 6). At Medicine Lodge Creek several Angostura points were found (Frison 2007), albeit in poorly dated contexts, stratigraphically above the unnamed “fishtail” points discussed above and below a date of 9690±87 cal BP. Numerous Angostura points were also found in cultural layers 8-12 at Mummy Cave dated from 9396±74 cal BP to 9092±148 cal BP. Similarly aged components that produced Angostura points have been found at Schiffer Cave (48JO319) and Paint Rock V (48BH349 [Frison and Grey 1980). The youngest dated component yielding Angostura points came from site 48JO303, which produced a date of 8615±155 cal BP. Thus, this style of point appears to have been produced for nearly 2,000 years. Angostura points are fairly common in undated assemblages from Jackson Hole. According to Reeve (1986), there are 78 points from the Lawrence site assemblage that generally correspond to the Angostura type and an Angostura point was found at the Lizard Creek (48TE700) site north of Jackson Lake (Reeve 1983).

Lovell Constricted and Pryor Stemmed are two named types of stemmed point that are also diagnostic of the Foothill-Mountain Paleoindian complex (Figure 3-15). Both types were defined by Husted (1969) based on components excavated at the Sorenson (24CB202) and Bottleneck Cave (48BH206) sites in Bighorn Canyon. The two types are markedly similar in form, size and flaking pattern, which had led many to consider them variations of the same type (Kornfeld, personal communication 2015; Reher, personal communication 2005). The only distinguishing feature is that Pryor Stemmed points often display bi-beveled resharpening (Frison 1973; Frison and Grey 1980; Husted 1969). Lovell and Pryor Stemmed points were produced using the same techniques as Angostura, and the types have been found together in the same context (Frison 1973, 2007; Frison and Grey 1980; Kornfeld et al. 2001), suggesting they were both part of the toolkit of Foothill-Mountain complex people. Specimens are typically thick (~6.6 mm), plano-convex in cross section with contracting ground stems, weak blade shoulders and parallel-oblique flaking patterns (Figure 3-15). Lovell/Pryor Stemmed points have been recovered from numerous well dated contexts in the Central Rockies (Frison 1973, 2007; Frison and Grey

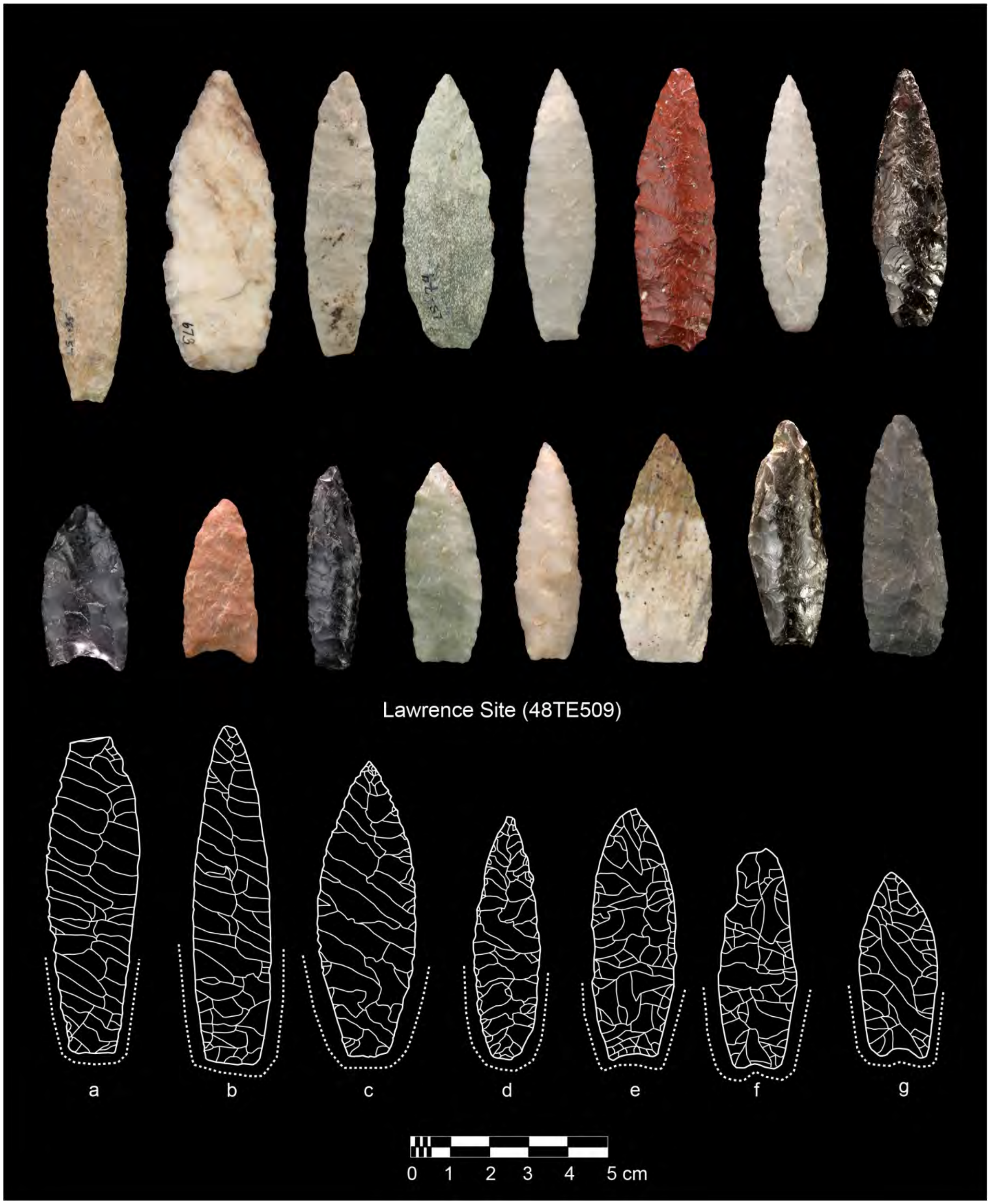


Figure 3-14 Angostura Points: Upper photographs from Lawrence site (48TE509 [Material from the Jackson Hole Historical Society & Museum]); Illustrated points redrawn from other publications (a) and (d), Davis et al. 1989:Figure 1; (b) Bradley 2013:Figure 17; (c) Davis and Root 2005:Figures 103; (e) and (g) Frison and Grey 1980:Figure 3; (f) Frison 1991:Figure 2.3.

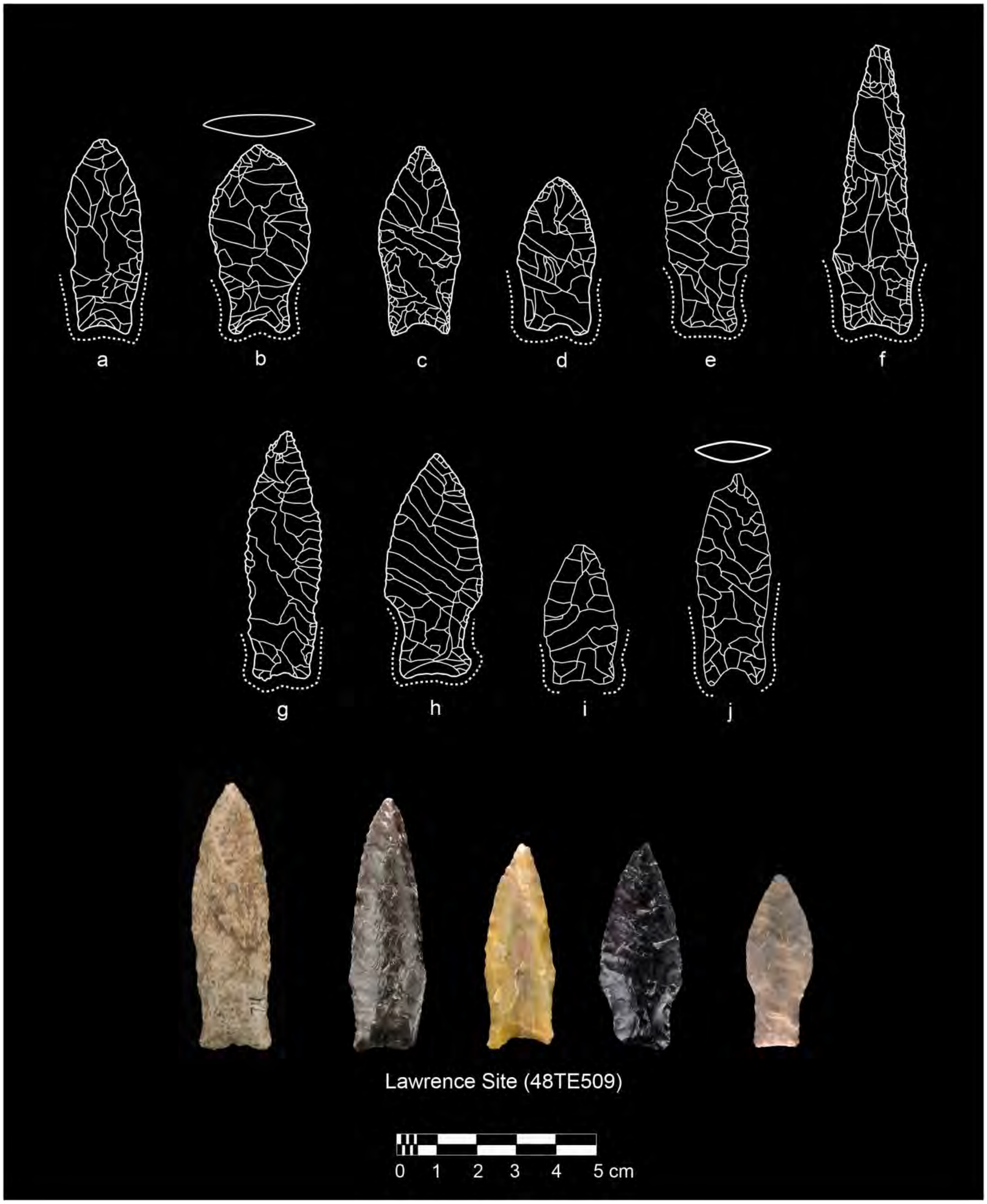


Figure 3-15 Lovell Constricted (a-d) and Pryor Stemmed (e-k) points. (a) Bottleneck Cave, (b) Helen Lookingbill, (c) Medicine Lodge Creek, (d) Williams Spring, (e) Paint Rock V, (f) 48JO303, (g) Schiffer Cave, (h) 48TE1261, (i-j) Game Creek. Artifacts redrawn from other publications (a, Husted 1969:Figure 20; c, Frison 1978:Figure 2.3 c; e, f and g, Frison and Grey 1980:Figures 9, 3 and 7, respectively). Bottom row from the Lawrence site (Material from the Jackson Hole Historical Society & Museum).

1980; Husted 1969; Husted and Edgar 2004; Kornfeld et al. 2001, Kornfeld et al. 2010), and are a relatively common type from undated surface contexts such as the Lawrence site on Jackson Lake (Bartholomew 2001; Reeve 1986) and the Osprey Beach site on Yellowstone Lake (Johnson et al. 2004). Several Lovell/Pryor Stemmed points were also found at Game Creek (Chapters 5 and 6). Lovell/Pryor Stemmed points first appeared around 9500 cal BP at the Helen Lookingbill site (Kornfeld et al. 2001) and continued to be produced until 8650 cal BP (Kornfeld et al. 2001; Larson 2012).

Foothill-Mountain toolkits also regularly include an assortment of formal tool types such as end scrapers, gravers, small bifacial drills or reamers, large ovate bifacial knives and burins produced from the blade edges of broken projectile points (Kornfeld et al. 2010; Frison 1973, 1983, 2007; Frison and Grey 1980). However, there are fewer formal tool types than in earlier Paleoindian assemblages (Frison 1973), but more extensive reuse and repurposing of broken or exhausted projectile points (Davis 1991; Frison 1973). Exotic stone is infrequently found in Foothill-Mountain complex sites, unlike many earlier Paleoindian sites where stone from sources hundreds of miles distant is routinely recovered (Frison 1978, 1997; Goebel et al. 2011). This may indicate smaller band territories and/or less interaction with neighboring groups. There is some evidence for the preferential use of quartzite to produce bifaces and projectile points (Larson et al. 1995). Groundstone tools, consisting of simple, minimally modified cobble manos and tabular sandstone metates, appear (Frison and Grey 1980; Husted 1969) perhaps as early as 10,200 cal BP (Frison 2007).

Foothill-Mountain complex subsistence practices are well documented (Frison 1973, 2007; Frison and Grey 1980; Husted 1969; Hughes 2003; Husted and Edgar 2002; Larson 2012). Although bison remains have been reported from several sites (Husted 1969, Chapter 7), medium artiodactyls, specifically bighorn sheep and mule deer are the dominant species represented in most of the faunal assemblages (Larson 2012). Yet, smaller prey, such as marmot, porcupine, rabbit and beaver are also reported (Frison 1973; Frison and Grey 1980). As previously noted there is evidence for intensive processing of small starchy seeds by Foothill-Mountain Paleoindians, which remains an integral aspect of human subsistence in the region for the next 9,000 years. Evidence of food storage, likely of vegetal products, also appears for the first time during the Foothill-Mountain (Frison 2007; Frison and Grey 1980). Overall the subsistence practices of Foothill-Mountain Paleoindians differed markedly from the bison hunting strategy employed by contemporaneous cultural complexes on the surrounding plains and basins (Frison 1997; Frison and Grey 1980). On the other hand, the breadth of utilized animal resources, and at least occasional intensive processing of seeds and food storage are all attributes of the WST subsistence strategy. In this respect, the Foothill-Mountain Paleoindian complex more closely resembles later Archaic complexes, but it also shares many attributes with the earlier WST.

What became of the Foothill-Mountain Paleoindian complex is one of the more intriguing mysteries in the prehistory of the Central Rockies. The apparent disappearance of the culture at circa 8650 cal BP coincides with the onset of the Holocene Climatic Optimum, during which time there was an apparent decrease in effective moisture levels and an increase in interannual variation in precipitation (Figure 3-12). Yet, human populations in the Central Rockies weathered similar climatic episodes both before and after 8650 cal BP. Whatever the impetus, the evidence suggests that human populations in the Central Rockies and surrounding regions were very low for about 200 years. It is even possible that the entire region was abandoned because the people who appear to have repopulated the Central Rockies had toolkits that differed in many ways from the Foothill-Mountain complex. Yet, as Frison and Grey (1980:44) point out there is "no detectable changes in the life style" of the people who later came to occupy the Central Rockies during the Early Archaic period. "The only real change that can be detected archeologically is that of projectile point types" (Frison and Grey 1980:44).

Early Archaic Period ca. 8650 – 5700 cal BP

The Early Archaic period roughly coincided with the Holocene Climatic Optimum, also variously known as the Altithermal or Hypsithermal (Chapter 2). The pollen record and global climatic modeling show that mean annual temperatures in the Central Rockies were 1° to 3° degrees (c) higher than the historical (1895-1978) average (Bryson and Bryson 1997; Shuman 2012). This was also the driest period of the Holocene with annual effective moisture levels 8-19 cm lower than the historical (1895-1978) average (Shuman et al. 2010). These climatic changes were probably due in part to cyclical changes in the earth's orbit brought the northern hemisphere into its closest approach to the sun during the summer months (Bradley 1999). The radiocarbon records indicates that human populations were particularly low during the first centuries of the Early Archaic period, but gradually increased in the Central Rockies, Upper Green River Basin and southwestern Wyoming Basins after circa 8400 cal BP (Figure 3-16). However, evidence for human occupation in the Bighorn and Wind River Basins is lacking until around6800 cal BP. There was period of marked cooling that affected much of the northern hemisphere circa 8200 cal BP that produced dry and windy conditions in the interior United States (Alley et al. 1997). This climatic episode lasted two to three hundred years and appears to have negatively impacted human populations, as there are marked declines in radiocarbon index in the Central Rockies, Upper Green River Basin and southwestern Wyoming basins. Populations appear to have stabilized by circa 8000 cal BP followed by sharp increases between 7900 and 7700 cal BP, especially in the Central Rockies and Upper Green River Basin. The Central Rockies then experienced a sharp decline in population after circa 7700 cal BP that continued till around 6900 cal BP. Conversely, there were apparent increases in human population in the Upper Green River basin throughout the same period, which may indicate migration out of the Central Rockies into the basin. This pattern was reversed from circa 6900 to 6700 cal BP and again between 6300 and 6100 cal BP, with increasing population in the Central Rockies and decreasing populations in the surrounding basins.

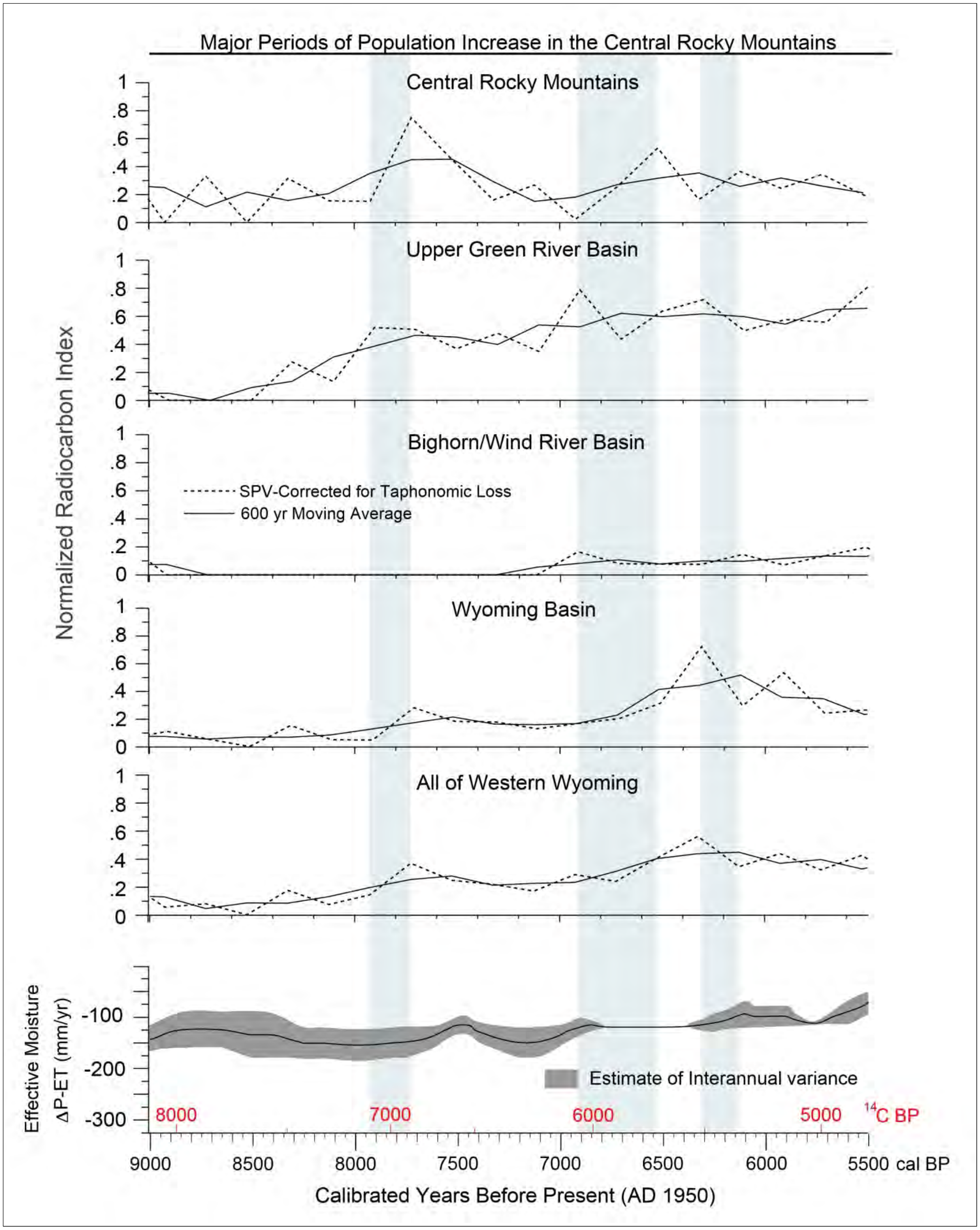


Figure 3-16 Calibrated radiocarbon date frequency distributions during the Early Archaic period in western Wyoming. Periods of inferred population growth in the Central Rockies are highlighted in gray.

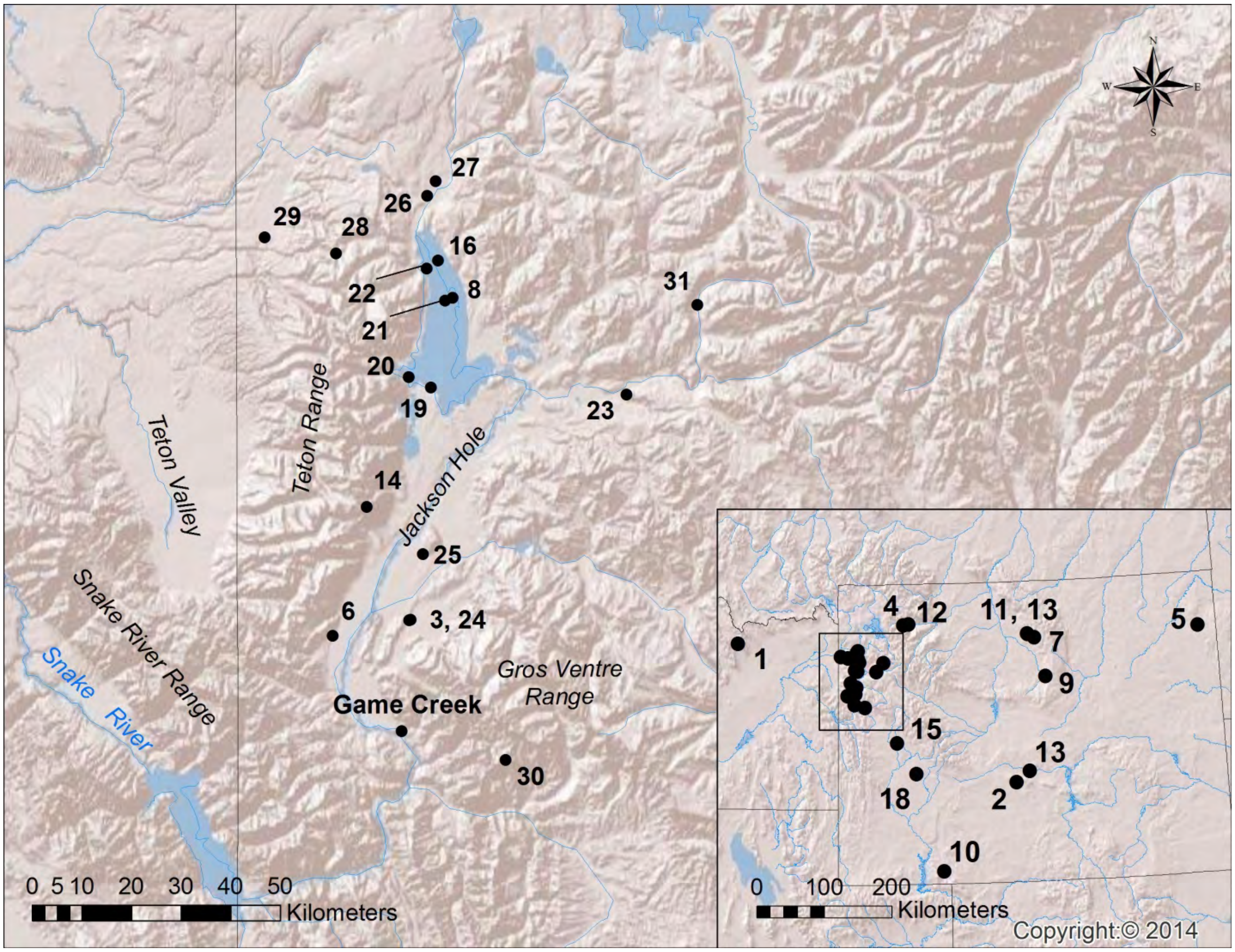


Figure 3-17 Early Archaic sites discussed in text: 1. Bison Rockshelter (10CL10); 2. Crooks (48FR1602); 3. Fish Hatchery (48TE1291); 4. Goff Creek (48PA325); 5. Hawken (48CK303); 6, Hunt (48TE605); 7. Laddie Creek (48326); 8. Lawrence (48TE509); 9. Little Canyon Creek Shelter (48WA323); 10. Maxon Ranch (48SW2590); 11. Medicine Lodge Creek (48BH499); 12. Mummy Cave (48PA201); 13. Split Rock Ranch (48FR1484); 14. Timberline Lake (48TE555); 15. Trappers Point (48SU1006); 16. W. Lizard Creek (48TE701); 17. 48BH331; 18. 48SU4000; 19. 48TE1061; 20. 48TE1062; 21. 48TE1067; 22. 48TE1071; 23. 48TE1664; 24. 48TE1841; 25. 48TE391; 26. 48TE424; 27. 48TE577; 28. 48TE601; 29. 48TE906; 30. 48TE956; 31. 49TE1787.

In the mid-20th century when evidence of the hot and dry Holocene Climatic Optimum, or Altithermal period, first began to emerge, Mulloy (1958) cautiously hypothesized that the reduction in the carrying capacity of the Northwestern Plains may have caused widespread abandonment of the region. Husted (1969) expanded upon this hypothesis using data from the foothills of the Bighorn Mountains to argue that human populations seeking refuge from increasingly inhospitable conditions moved into the mountains. Benedict (1975) and Benedict and Olson (1978) presented similar conclusions using data, including radiocarbon dates, gathered from high elevation sites in the Southern Rocky Mountains.

The "Mountain Refugium Hypothesis," has been heavily criticized (Bender and Wright 1988; Larson 1997; Reeves 1973), and subsequent investigations in western North America have shown that the both high and low elevation areas were occupied throughout the Early Archaic (Aikens 1970; Kornfeld et al. 2010; Larson 1997; Larson and Francis 1997). Nevertheless, the rate of population growth in the Central Rockies and upper Green River Basin during the Early Archaic, as inferred from the radiocarbon index, is much more pronounced than in other regions of western Wyoming (Figure 3-16), more than would be expected by reproduction alone. This could well be explained by migration and/or increased occupational intensity. Environmental characteristics, unique to mountains, such as increased and more predictable precipitation and fewer and less severe droughts (Larson 1997), would have provided an impetus for migration. Moreover, abrupt changes in elevation common to all mountain environments create subsistence opportunities not found in the surrounding plains and basins. Elevationally-delayed plant maturation, or *periodicity*, and dispersed and patchy availability of resources may have ameliorated some of the impacts of increased temperatures and decreased moisture in the surrounding lower elevations (Bender and Wright 1988; Larson 1997; Wright 1982). Though the Mountain Refugium Hypothesis, as proposed by Husted (1969) and others (Benedict 1975; Benedict and Olson 1978) is no longer supported by the evidence, there does appear to have been increased occupation of the Central Rockies, as compared to surrounding lower elevations, during the Early Archaic that was likely the result of adaptive responses to climate change.

Unlike the earlier Paleoindian periods, no cultural complexes and relatively few projectile point types have been defined for the Early Archaic period (Larson 2012). Metcalf (1987) has devised a cultural chronology for southwestern Wyoming that divides the Early Archaic the Great Divide and Opal phases based on fluctuations in the radiocarbon date record. However, there are no significant differences in cultural attributes, such as projectile point style or subsistence practices, between these two phases (Metcalf 1987). Thus, the “phases” are merely temporal periods that provide no further insight into the culture or cultures they are, at least in theory, meant to describe.

Pronounced stylistic variation of Early Archaic projectile point assemblages has been documented at numerous sites in western Wyoming (Francis and Widman 1999; Larson 2012; Page 2016b). The reasons behind this variation are poorly understood and given the limited amount of data are difficult, if not hazardous, to address. By circa 8400 cal BP there appeared a variety of novel stemmed and notched point styles. There are some indications that at least some of the stylistic variation is patterned in time and/or space. However, at present the data are too sparse to support clear temporal trends in Early Archaic projectile point styles.

One of, if not the earliest dated Early Archaic point types identified in the Central Rockies is stemmed with barbed blade edges. Specimens are typically biconvex in cross-section with a wide, slightly expanding, stem with a slightly convex base (Figure 3-18 a-e). There is no discernible flaking pattern. The points appear to have been shaped through percussion flaking followed by selective invasive and margin pressure flaking, particularly on the stem and tip. The bases are usually thinned by removal of a percussion flake from each face with minor margin retouch. With its barbed blade and wide and long stem, these points are dissimilar to most reported projectile points from Early Archaic contexts in the region. However, similar projectile points have been recovered from the Trappers Point (48SU1006) site and 48SU2527 (District 48SU4000) in the Upper Green River Basin (Francis and Widman 1999; Miner 2001) and site 48BH331 near Medicine Lodge Creek in the foothills of the Bighorn Mountains (Walker and Bach 2007). A complete specimen was also recovered from a well-preserved component at the Game Creek site dated to 8390±38 cal BP, which is one of the earliest AMS radiocarbon dates from an Early Archaic context in the region. The period of production for this style of point is unclear since only one has been found in well-dated context. The specimens from the Trappers Point site were all found in Strata II and III, the earliest levels at the site (Francis and Widman 1999). Unfortunately, these early levels were poorly preserved and not well-dated (Francis and Sanders 1999). These points closely resemble the Borax Lake Widestem type of northern California and surrounding regions where it has been found to be roughly contemporaneous with the Early Archaic period of the Central Rockies (Justice 2002). However, it is unclear whether this style of point evidences an intrusion of people from the west.

Elko Eared points have wide corner notches and concave or notched bases and distinct rounded basal ears (Figure 3-18 f-i). Though highly variable, point blades are slightly plano-convex or irregular in cross-section. Elko Eared points were produced using a variety of reduction stages. The specimens from the Game Creek and Trappers Point sites site were formed through percussion flaking with limited marginal pressure flake retouch. The concave bases were formed by the removal of deep percussion flakes on both faces followed by minimal retouch around haft margins, similar to the Broad Stem point discussed above. In the Great Basin, Elko Eared points were manufactured through randomly oriented invasive pressure flaking with subsequent margin retouch used mostly to shape the haft (Justice 2002). Relatively small flake blanks were used resulting in points that are often plano-convex in cross-section, occasionally curved, with remnants of the original ventral flake surface showing on the plane face (Justice 2002). Thus, the reduction strategy and flaking pattern used for Elko Eared points in the Great Basin does not closely resemble the samples western Wyoming (Chapter 6). However, the samples from Western Wyoming do share many metric variables, such as haft width, thickness, base width and length with Great Basin assemblages.

The Elko Eared point was in use in Jackson Hole by circa 7900 cal BP and at Mummy Cave in cultural layer 16 perhaps as early as 8450 cal BP (Husted and Edgar 2002). Examples of the Elko Eared type occur sporadically and in low frequency throughout the Early Archaic, in cultural layer 24 at Mummy Cave (Husted and Edgar 2002), stratum V at Trappers Point (ca. 6500-6100 [Francis and Widman 1999]), in poorly preserved contexts at Medicine Lodge Creek (Frison 2007) and Laddie Creek (Kornfeld et al. 2010) and in stratigraphic context (ca. 7100-4500) at Bison rockshelter in eastern Idaho (Swanson 1972). All of the eared points from Game Creek were found in stratigraphic contexts

Figure 3-18 Photograph of Early Archaic stemmed and corner-notched projectile points. (a-e) broad stemmed, (f-i) Elko Eared, (j-q) Corner-notched, (s) Mt. Albion. Specimens are from the following sites: (a and f) Game Creek (Chapters 5 and 6), (b-d, g-i, l-m,o, s) Trappers Point (Francis and Widman 1999), (j-k, n, q) Goff Creek (Page 2016), (e, p, r) Little Canyon Creek (Shaw 1980). Material from UWAR, Department of Anthropology, University of Wyoming.

with bracketing dates of 7951±23 cal BP and 5519±86 cal BP (Chapters 5 and 6). The data, though limited, indicate that Elko Eared points were manufactured throughout most of the Early Archaic period.

Points with this basic morphology have been variously defined as Pinto, Elko Eared and Hanna. The Pinto type, common to the western Great Basin, where they have been dated from about 8000-5000 cal BP, though highly variable, often displays barbed blades, corner notching and concave bases with pronounced, rounded basal ears (Harrington 1957; Aikens 1970; Holmer 1980; Justice 2002). Pinto points were produced through percussion flaking followed by limited margin retouch, though extensive reuse and resharpening of points frequently obscures evidence of production technique (Harrington 1957; Justice 2002). Pinto points are typically thick and have wide hafts and longer bases than most Elko Eared specimens recovered from western Wyoming (Justice 2002; Vaughn and Warren 1987).

The Hanna type is one of four projectile point styles diagnostic of the Middle Archaic McKean complex (Kornfeld et al. 2010; Wheeler 1954). However, a recent review of radiocarbon dates from McKean sites shows that of 120 dated components from 47 sites from western North America, there are only four dates from three sites that are older than circa 5400 cal BP (Webster 2004). All of these were conventional radiocarbon dates with large standard deviations (Webster 2004). Thus, the dated Elko Eared points from the Central Rockies and adjoining regions are significantly older than the McKean complex. The similarities between McKean complex Hanna and Elko Eared points warrant further investigation. It is entirely possible that they are but one “type” known by two different names. If so, then the Elko Eared/Hanna type emerged during the Early Archaic period in the eastern Great Basin, Central Rockies and southwest Wyoming basins. During the Middle Archaic period the type was retained and appears to have increased in frequency. There may be spatially and temporally significant variation in the type, but presently the data are not available to make this determination.

Previous cultural historical reconstructions of Jackson Hole were created by pigeonholing all eared dart points into the Middle Archaic McKean complex or Late Archaic period (Bartholomew 2001; Bender and Wright 1988; Connor 1998). For instance, Bender and Wright (1988:634-635) cite the recovery of “Hanna (McKean)” points from both high and low elevation sites in Jackson Hole as evidence for increased occupational intensity during the Middle Archaic. Likewise, Bartholomew (2001:47-48), who assigned all eared points to the Late Archaic period after Thomas’ (1981) chronology for the eastern Great Basin, found that there was a “drastic reduction in numbers of Early Archaic period diagnostics” in Jackson Hole, which then was used to support the contention of low population levels during the period. If many eared points date to the Early Archaic rather than later periods, as the evidence suggests, then previous population estimates for Jackson Hole based on cross-dated projectile point styles are likely inaccurate.

Corner-notched projectile points are relatively common in Early Archaic assemblages of the Central Rockies, though they never comprise more than a minority of specimens in any assemblage

(Francis and Widman 1999; Husted and Edgar 2002; Page 2016). Early Archaic corner-notched points are highly variable in size and shape, but typically display straight to slightly convex blade edges with pronounced barbs (Figure 3-18 o-r). Bases are nearly as wide as the blade and are usually straight or concave (Page 2016). Some of the concave specimens resemble the Oxbow point type, an Early-Middle Archaic complex from the Northern Plains (Husted and Edgar 2002). Notches are usually wide and relatively shallow producing proximal shoulder angles of around 130°, or just 10° below the side-notched cut-off (Page 2016). Points were manufactured through percussion flaking followed by randomly oriented invasive and margin pressure flaking. Percussion flake scars can often be seen on blade surfaces. Although there is overlap in the ranges of variation of Early Archaic and Late Archaic corner-notched dart assemblages, Early Archaic specimens from the Central Rockies have bases that are nearly as wide, or wider than the blade, shallower and wider notches, higher proximal shoulder angles (ca 133°), and more frequently exhibit straight and concave bases (Page 2016; Chapter 6). Based on an analysis of Early Archaic points recovered from Goff Creek, Mummy Cave and Trappers Point, corner and side-notched darts "appear to form opposite ends of a continuum with no clear plane of demarcation" (Page 2016:12-35). Many Early Archaic points can and have been identified as Elko corner-notched. This style has been found in the same context as Elko Eared and may well have been a contemporaneous style.

The Pahaska side-notch type, also known as Northern or Bitterroot Side-Notched (Holmer 2009; Justice 2002; Swanson 1972), is the quintessential Early Archaic point type (Figure 3-19). Though variable in size and morphology Early Archaic side-notched points are usually have straight to convex blades with pronounced shoulders that are occasionally slightly barbed. Notches are usually wide and placed to produce proximal shoulder angles that average around 150° plus or minus three or four degrees depending on assemblage. Straight and concave bases are most common, but convex bases also occur. Basal margins are often lightly ground. Flaking was identical to that found on most corner-notched specimens with evidence of initial reduction through percussion flaking following by pressure flaking. Some specimens have serrated blade edges.

The Blackwater "Side-Notched" type was defined by Husted and Edgar (2002) based on a small sample from Cultural Layer 16 at Mummy Cave. Blackwater points have deep, wide notches placed near the base, which produces slightly pointed ears. The proximal shoulder angle varies between 129°-146°, which straddles the corner/side notch demarcation, and many points would be typed as corner-notched based on proximal shoulder angle. Bases are typically ground. The small type assemblage from Mummy Cave exhibited only straight to slightly convex bases, but several similar specimens from Goff Creek had concave bases

Given the stratigraphic position of the Blackwater points at Mummy Cave, Husted and Edgar (2002) hypothesized that the type predates and was replaced by the Pahaska type. Yet, points substantially similar to Blackwater were recovered from much younger contexts at Goff Creek and Trappers. Since the

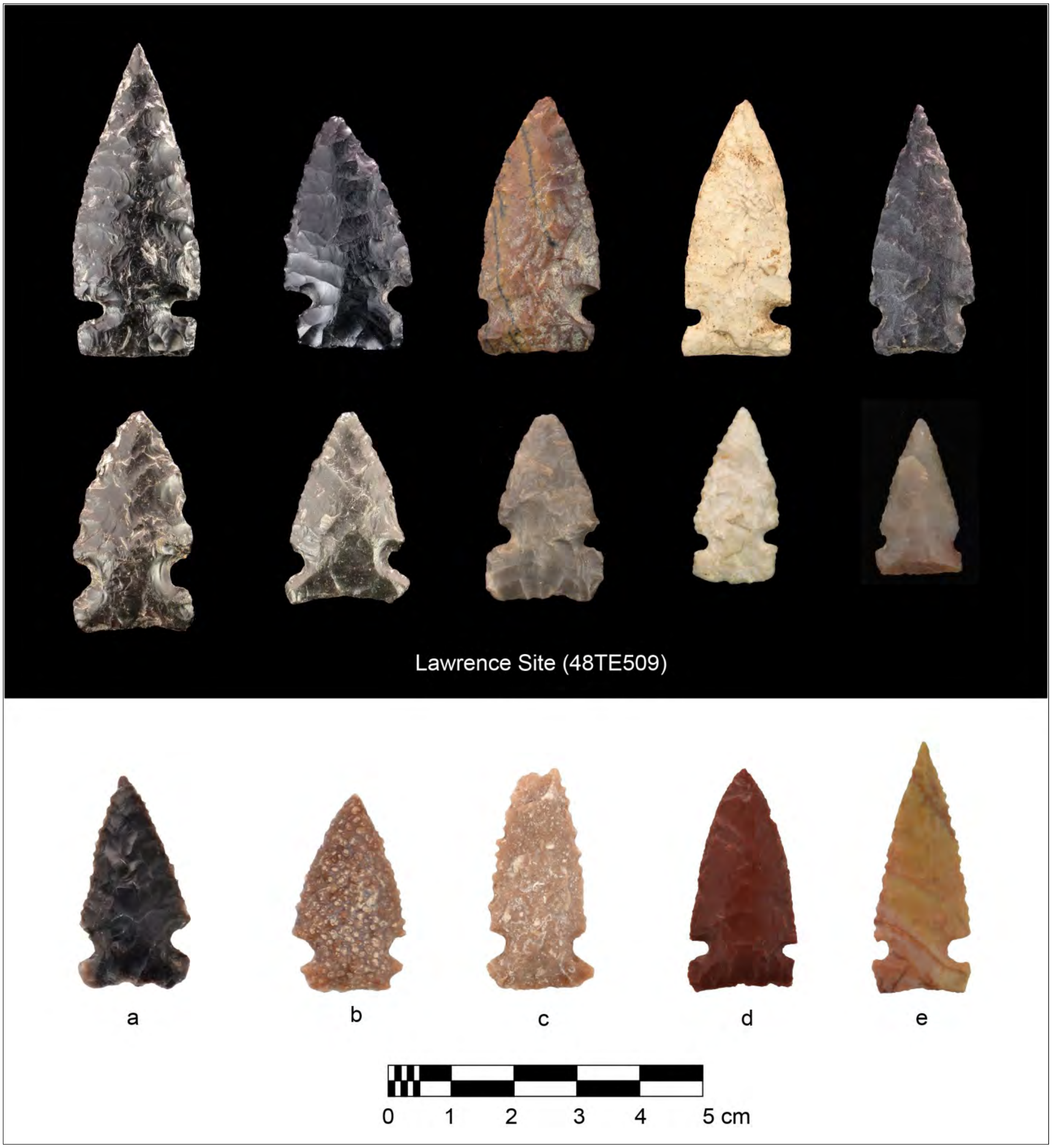


Figure 3-19 Early Archaic side-notched projectile points. Top two rows are from the Lawrence site (Material from the Jackson Hole Historical Society & Museum). (a-c) Trappers Point; (d) Little Canyon Creek; (e) Goff Creek (Material from UWAR, Department of Anthropology, University of Wyoming).

Early Archaic occupations at Trappers Point spanned at least 1,000 radiocarbon years (ca. 6180-5160 BP) and post-date Cultural Layer 16 (7630 BP) at Mummy Cave by over a thousand years, it would seem that the Blackwater type has a much longer temporal duration than suggested by Husted and Edgar (2002). The Pahaska type has been found in contexts dated from circa 8400-5700 cal BP and is nearly ubiquitous

Figure 3-20 Early Archaic knives and hafted drills/reamers. Specimens are from the following sites: (a-c, h) Little Canyon Creek (Shaw 1980); (d and i) Trappers Point; (e) Goff Creek (Page et al. 2016); (f and g) Game Creek (Chapter 6). Material from UWAR, Department of Anthropology, University of Wyoming.

in Early Archaic assemblages throughout the Central Rockies and surrounding regions (Kornfeld et al. 2010; Larson 1997, 2012; Plew 2008). However, relatively few side-notched darts were found at Game Creek (Chapters 5 and 6), and side-notched darts are one of the least common point types in surface collections from Jackson Hole (Bartholomew 2001; Connor 1998; Reeve 1986). The low frequency of side-notched darts in Jackson Hole may be due to multiple factors and is worthy of further investigation. It is possible that the people who lived in Jackson Hole during much of the Early Archaic were a distinct cultural group that produced and used Elko Eared points rather than side-notched forms.

Large corner and side-notched hafted knives have been reported from several Early Archaic sites in the region (Figure 3-20 [Francis and Widman 1999; Page et al. 2016; Shaw 1980]). There is evidence for another formal, patterned, knife type two of which were found at Game Creek and several more at

Goff Creek. They are made from a large blade and are plano-convex in cross-section. The dorsal surfaces have both invasive pressure flaking and margin retouch, but the ventral surfaces have only margin retouch (Figure 3-20 f-g). Edges have been heavily worn, and the dorsal and ventral surfaces of at least one specimen had numerous scratches and striations indicative of bag-wear. Corner-notched drills or reamers have also been recovered from Little Canyon Creek and Trappers Point (Figure 3-20 h-i [Francis and Widman 1999; Shaw 1980]). Bifacial knives of varying shape and size and end scrapers also occur with some regularity. By far the most common tools in Early Archaic assemblages are retouched and utilized flakes (Husted and Edgar 2002; Page et al. 2016; Chapter 5). Stone from distant sources is uncommon in most reported assemblages, but obsidian artifacts have been sourced to several locales including the Yellowstone Plateau, Jackson Hole, Snake River Plains and southwestern Montana (Larson et al. 1995; Page 2016; Scheiber and Finley 2011). Groundstone artifacts are more common than in the preceding Foothill-Mountain complex, and many specimens display deliberate shaping and were used on both faces (Eakin et al. 1997; Chapter 6).

Subsistence and settlement patterns may have differed in the Central Rockies from the surrounding plains and basins (Larson 1997). The dry and arid conditions of the Holocene Climatic Optimum likely had a negative effect on high-ranked artiodactyl prey. The evidence from Mummy Cave (Hughes 2003), Lookingbill (Kornfeld et al. 2001) Goff Creek (Page 2016) and Little Canyon Creek (Shaw 1980) indicate that bighorn sheep and mule deer were the primary target species of the hunter-gatherers who inhabited the Central Rockies during the Early Archaic, though smaller mammals such as rabbits, marmots, beaver, porcupine and canids are also reported, though in small frequencies. Bison and elk have also been recovered from Early Archaic contexts, but, with the exception of the Game Creek components (Chapter 7), are infrequent compared to medium-sized artiodactyls (Larson et al. 1995). The preponderance of bison and elk in the Game Creek assemblage likely reflects larger and/or more stable populations of these species in Jackson Hole as compared to the rest of the Central Rockies, rather than a concerted shift in subsistence. Analyses of faunal assemblages reflect intensive processing of bone for extraction of marrow and grease (Page 2016). There is no evidence of coordinated mass kills in the Central Rockies. The appearance of stone-lined roasting pits evidences an increased utilization of starchy roots and tubers, which though nutritious, require intensive processing. There is also an increased occurrence of grinding implements over the preceding Foothill-Mountain complex that suggests small seeds were more frequently and/or intensively utilized. Large logistical base camps and evidence of food storage are lacking in the Central Rockies. The evidence suggests that the Early Archaic people of the Central Rockies lived in small highly mobile groups that utilized a wide range of plant and animal resources.

There is evidence for coordinated communal hunting and mass kills of bison at the Hawken site on the Northwestern Plains (Frison et al. 1976), but climatic conditions in the Powder River Basin may not have been as severe through much of the Early Archaic as they were in western Wyoming (Chapter 2). The Trappers Point site (48SU1006), in the Upper Green River Basin (Francis and Sanders 1999), produced evidence of multiple Early Archaic components (Francis and Sanders 1999). Trappers Point is located within the present migration corridor of the Sublette pronghorn herd that annually migrates to Jackson Hole from the Green River Basin (Miller et al. 1999). Excavations uncovered a stratified pronghorn bone bed with evidence of at least one mass kill event. The use of some sort of trap or corral appears likely given the local topography and comparison with known examples (Miller et al. 1999). These data suggest the work of a small community rather than a single band and reflect a sophisticated understanding of pronghorn behavior (Frison 2004). Bighorn sheep may also have been taken in mass in traps or corrals through the efforts of communal hunting, though direct evidence of which is lacking.

Many Early Archaic sites investigated in the basins, such as Split Rock Ranch (48FR1484), Maxon Ranch (48SW2590) and Crooks (48FR1602), to name but a few, that surround the Central Rockies have produced evidence small semi-subterranean house pits, storage and roasting pits, and faunal assemblages dominated by low-rank prey such as rabbits (Eakin et al. 1997; Eckles and Waitkus 1997; Harrell et al. 1997). Early Archaic house pit sites are typically located along perennial streams such as the Green and Sweetwater Rivers in close proximity to predictable plant resources. The low frequency of projectile points, but abundant evidence of plant processing and storage point to heavy reliance on low-ranked food resources. House pit sites have been interpreted as winter base camps where food collected during the spring and summer was stored for use during the lean winter months (Watikus and Eckles 1997). Despite evidence of food storage and relatively long-term residential base camps, the wide variety of utilized resources and absence indicates that a foraging way of life was also practiced in the basins, though some collecting strategies were clearly incorporated into the subsistence pattern.

It is unclear what, if any, relationship existed between Early Archaic foragers of the Central Rockies and those of the surrounding basins. Bender and Wright (1988) argue that high and low elevation areas were utilized by the same groups on a seasonal basis, with occupations in the high country in the spring through fall and those at low elevations on the Snake River Plain in the winter. However, Hughes (2003) found that all of the Early Archaic occupations at Mummy Cave occurred during the winter months. It is therefore questionable whether the high country was consistently abandoned every winter for the basins. The dearth of diagnostic projectile points at house pit sites in the basins preclude detailed comparisons of the stylistic attributes that might elucidate cultural relationships between environmental zones.

However, the presence of basin-derived stone in the Early Archaic assemblages at Game Creek provides some evidence for mobility between the upper Green River Basin and Jackson Hole (Chapter 5). Similarly, Scheiber and Finley (2011) found that of a sample of 46 Early Archaic obsidian projectile points recovered from the basins of southwestern Wyoming, 80.3% were sourced to Jackson Hole.

Likewise, most of the obsidian from Trappers Point also originated in Jackson Hole (Francis and Widman 1999). Conversely, there is limited evidence of interaction between Jackson Hole and Snake River Plain during the Early Archaic (Connor and Kunselman 1997; Peterson 1991), though several specimens have been identified to the Packsaddle Creek and Malad sources in eastern Idaho (Connor and Kunselman 1997; Chapters 5 and 6). The data may support a subsistence/settlement pattern for the Early Archaic of Jackson Hole similar to that proposed by Bender and Wright (1988), but with winter occupations concentrated in the Upper Green River Basin instead of the Snake River Plain.

The radiocarbon record shows similar dramatic increases in human populations in the Central Rockies and Upper Green River basin during the Early Archaic (Figure 3-16). Moreover, the record appears to reflect some sort of relationship between populations in these two regions. Both regions experienced apparent increases in populations between circa 7900 and 7700 cal BP. After 7700 cal BP populations decreased in the Central Rockies, but increased in the upper Green. This trend reversed between circa 6900-6500 cal BP and again from 6300-6100 cal BP. This pattern could reflect adaptive responses to changing environmental conditions in these regions resulting in increased or decreased occupation of the high country. Environmental triggers for these shifts in populations trends are elusive, but could include factors such as changes in winter snowpack levels or duration that are not easily evaluated through paleoclimatic proxy data.

East of the continental divide, there is little evidence for human occupation in the Bighorn and Wind River Basins, but numerous sites have been found in the foothills of the Big Horn and Absaroka Mountains. At present the data are inadequate to support or refute seasonal use of high and low elevation areas. It is possible that winter occupations were concentrated in the foothills, where Early Archaic occupations have been documented at numerous rockshelters (Shaw 1980). Yet, it is also possible that the high country was occupied on a year-round basis by small highly mobile groups who focused on bighorn sheep procurement (Hughes 2003; Page 2016).

It is also possible, if not likely, that some Early Archaic hunter-gatherers lived year-round in the basins with only occasional forays into the high country. The fluctuations in inferred human populations noted in the Central Rockies and upper Green River Basin are not apparent in the record from the basins of southwestern Wyoming, where populations appear to have been low but relatively stable circa 7800-6600 (Figure 3-16). There was a pronounced increase in population after circa 6600 cal BP when populations in the Central Rockies and upper Green appear to have been relatively stable. Although these data are limited, they do suggest differing cultural histories for the sampled regions.

Middle Archaic Period, circa 5700-3200 cal BP

Temperatures decreased after circa 6000 cal BP, and effective moisture gradually increased until circa 5700 cal BP when they reached levels just slightly below the historic mean (1895-1978 [Bryson and Bryson 1997; Shuman et al. 2010; Shuman 2012). The increase in effective moisture and lower temperatures likely led to increased productivity of edible plants as well as forage that, in turn, produced higher and more stable big game populations. Hunter-gatherers appear to have benefited from the changes in climate and experienced relatively stable or slightly increasing rates of population between 5700 cal BP and 3700 cal BP (Figure 3-21). However, the radiocarbon record indicates that human populations in western Wyoming gradually decreased during the latter half of the Middle Archaic period population. The decline appears to have impacted people in the Central Rockies earlier than in the basins (ca. 4500 cal BP). There is again some apparent relationship between human populations in the Central Rockies and upper Green River basin because sharp declines in the former at circa 4500-4300 coincide with steep increases in the latter. Human populations in the Bighorn and Wind River Basins as well as the basins of southwestern Wyoming appear to have been stable or increasing until circa 3700 cal BP. The downward population trend after 3700 cal BP coincides with a period of decreased precipitation documented at Lake of the Woods that may have been as severe as much of the Holocene Climatic Optimum (Shuman et al 2010, Shuman 2012). Negative impacts from climate change were likely more severe at lower elevations than in the high country because populations appear to have increased sharply in the Central Rockies while they declined in the basins. Some of this increase may have been due to *in situ* population growth and survival rates, but some amount of immigration or increased occupational duration and/or intensity could also have occurred.

The McKean complex appeared on the Northwestern Plains around 5700 cal BP (Kornfeld et al. 2010; Webster 2004). The origins of the McKean complex are unclear. Jennings (1964), Wedel (1961) and Reeves (1983) have proposed an antecedent-descendent relationship between the Archaic Desert cultures of the Great Basin and the McKean complex. Others have suggested that the McKean complex descended directly from the Foothill-Mountain Paleoindian complex in the Central and Southern Rockies(Husted 1969; Benedict 1981), but evidence of a continuous unbroken sequence has yet to be found. Wright (1995) argues that the Oxbow and McKean complexes are culturally related and that the latter emerged from the former (Husted and Edgar 2002; Wright 1995). Syms (1969) suggested that the complex originated from earlier cultural complexes in the vicinity of the Bighorn Basin, since most of the earliest McKean dates are from sites in the vicinity. The evidence from Game Creek shows that Elko Eared points, which are very similar to the McKean Hanna type were in production by circa 7900 cal BP and continued to be produced into the Middle Archaic period. Thus, there is some evidence for continuity in projectile point styles that may also support Syms' (1969) hypothesis. However, the data are as yet insufficient to put the question McKean origins to rest.

There are four projectile point styles routinely recovered from Middle Archaic McKean complex sites including Hanna, Duncan, Mallory and McKean Lanceolate (Kornfeld et al. 2010; Wheeler 1954). All four types were manufactured using collateral to randomly oriented pressure flaking of either small flake blanks or from bifaces reduced first through percussion flaking (Davis and Keyser 1999; Keyser and

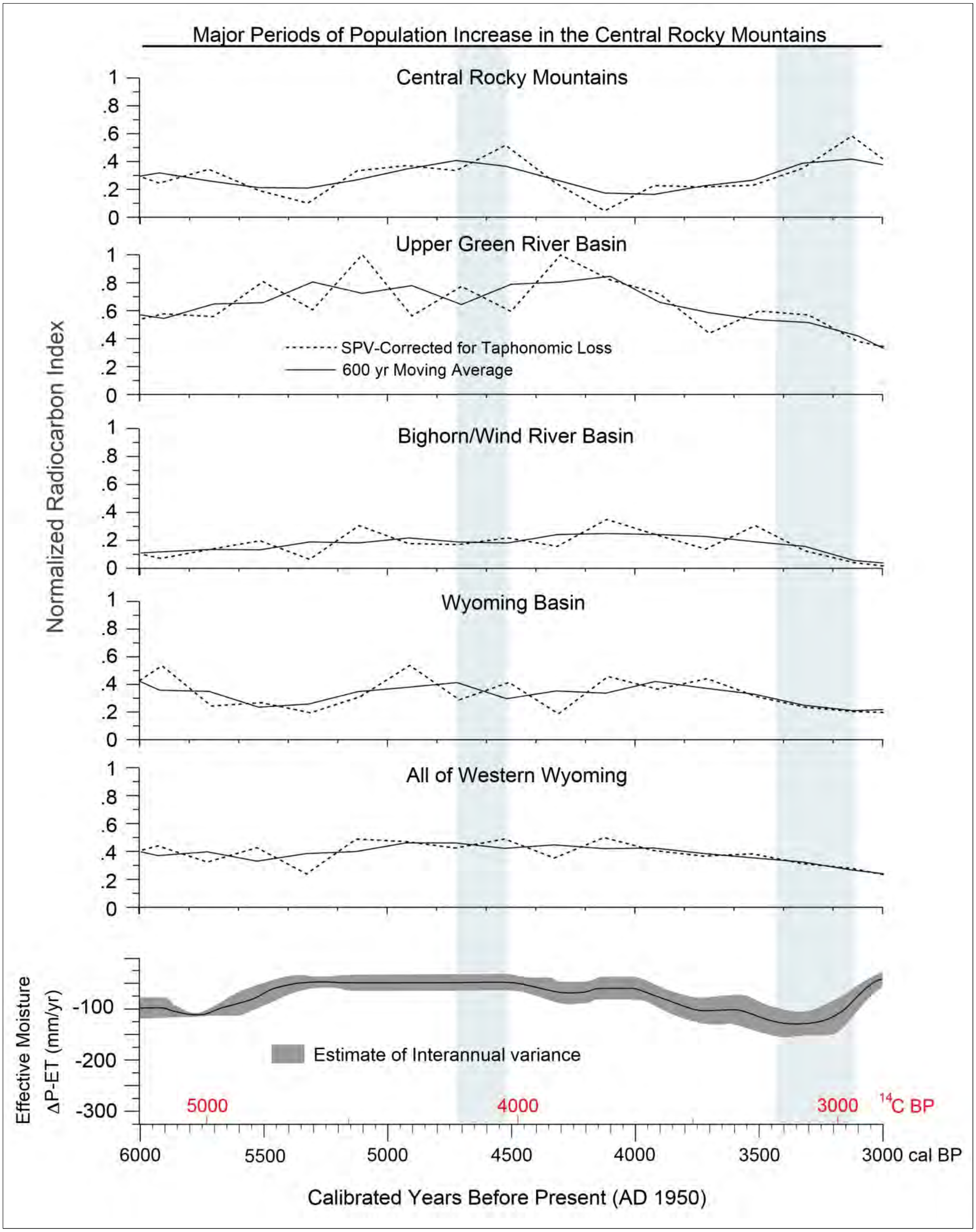


Figure 3-21 Calibrated radiocarbon date frequency distributions during the Middle Archaic period in western Wyoming. Periods of inferred population growth in the Central Rockies are highlighted in gray.

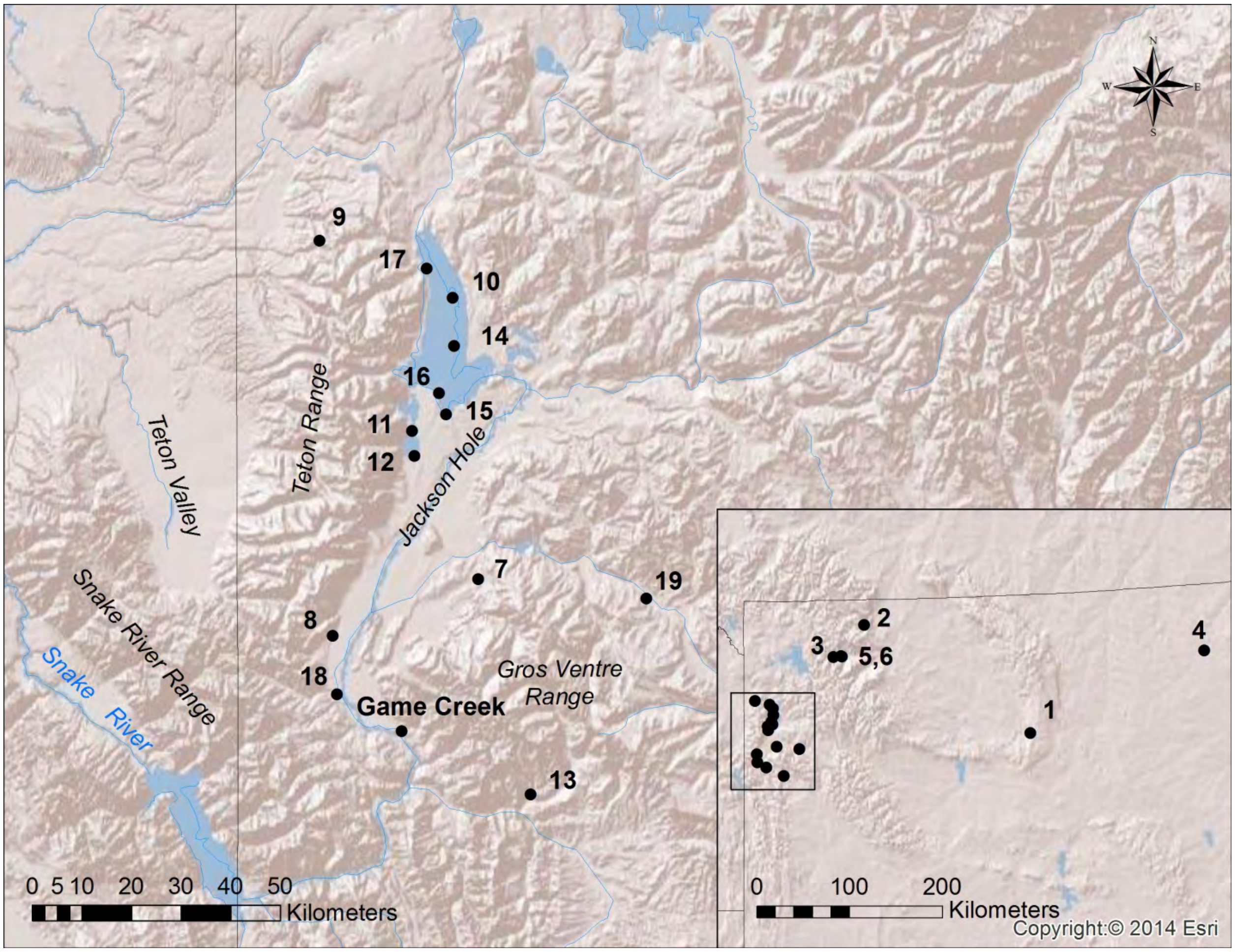


Figure 3-22 Middle Archaic sites discussed in text: 1. Bush Shelter (48WA324); 2. Dead Indian Creek (48PA551); 3. Goff Creek (48PA3215); 4. McKean (48CK7); 5. Moss Creek (48PA919); 6. Mummy Cave (48PA201); 7. Goetz (48TE455); 8. Hunt (48TE605); 9. Jackass I (48TE367); 10. Lawrence (48TE509); 11. String Lake (48TE412); 12.Jenny Lake (48TE414); 13. 48TE1013; 14. 48TE1039; 15. 48TE1042; 16. 48TE1050; 17. 48TE1071; 18. 48TE1080; 19. 48TE1747.

Fagan 1993). Percussion flake scars from earlier stages of bifacial reduction rarely remain on the faces of finished specimens. Davis and Keyser (1999) argue that the Hanna and Duncan point types, in their idealized forms, represent ends of a continuum with no clear demarcation and should be considered a single type. McKean lanceolates and Mallory points, however, are argued to represent distinct types (Davis and Keyser 1999). On the other hand, Walker and Frison (1984) argue that the named types are merely variants of a single point type. Regardless of the taxonomic ambiguity, the data indicates that there was considerable morphological variation in projectile points in McKean complex assemblages.

The Hanna point type is characterized by wide corner notches and a markedly concave or notched based with distinctive rounded basal ears (Figure 3-23 g-l, t-v). Blades may or may not be barbed. As noted above Hanna points are very similar to the earlier Elko Eared type in morphology. The basal ears of Hanna points, however, are not as pronounced as the Elko Eared type.

Figure 3-23 Photographs of Middle Archaic projectile points: (a-f, s) McKean Lanceolate; (g-l, t-v) Hanna; (m-r, w-x) Duncan. (a-r) Lawrence site (Material from the Jackson Hole Historical Society & Museum), (s-x) Dead Indian Creek site (Material from UWAR, Department of Anthropology, University of Wyoming]).

Figure 3-24 Photographs of Mallory (a) and Oxbow (b-d) projectile points. (a-b) Lawrence site, (c) Bush Shelter (48WA324), (d) Moss Creek (48PA919)

The Duncan type, also known as Gatecliff Split-Stem in the Great Basin and Snake River Plain where they date to roughly the same period (Holmer 2009; Justice 2002; Thomas 1981), is a stemmed form with parallel to slightly expanding sides with pronounced concave or notched bases (Figure 3-23 m-r, w-x). McKean Lanceolate points, called Humboldt in the Great Basin (Aikens 1970; Holmer 1980; Justice 2002; Keyser and Fagan 1993; Kornfeld et al. 2010; Thomas 1981; Wheeler 1954) are small with convex blade edges and concave bases (Figure 3-23 a-f, s). Humboldt points from the Great Basin and Snake River Plain often, though not invariably, display parallel-oblique flaking (Green1975; Justice 2002), a trait that is not found in McKean complex assemblages in the central Rockies and Northwestern Plains. However, small lanceolate points with parallel-oblique flaking could be mistaken for a Foothill-Mountain complex Angostura points, so it is possible that specimens have been recovered but misidentified. Mallory points typically have broad side notches and a notched base. Basal corners are usually square and much longer than the rounded ears of Hanna points (Figure 3-24 a). Mallory points may be a regional sub-style that is most common in McKean assemblages from central and southern Wyoming and Colorado (Davis and Keyser 1999; Kornfeld et al. 2010).

All types have been recovered from numerous stratified sites dated from roughly 5700 cal BP to about 3200 cal BP (Eakin 2011; Husted and Edgar 2002; Kornfeld et al. 2010; Webster 2004). Davis and Keyser (1988) argue that the Hanna, Duncan and perhaps Mallory types served as darts and the McKean Lanceolate as a thrusting spear tip.

Points highly reminiscent of the Oxbow point type have also been recovered from Middle Archaic contexts. Oxbow points typically have shallow side notches and markedly concave bases (Figure 3-24 b-d). The Oxbow complex emerged towards the end of the Early Archaic period in the Northwestern

Plains but persisted into the Middle Archaic (Frison 1991; Greiser et al. 1985). An Oxbow point was recovered from Early Archaic aged (6496±92 cal BP) deposits at Bush Shelter (Miller 1988), and several specimens from at Trappers Point, also dated to the Early Archaic (ca. 6500-6100 cal BP) also closely resemble the Oxbow type. Many Oxbow, or Oxbow-like, points were recovered from cultural layers 28 and 30 at Mummy Cave (ca. 5350-4750 cal BP [Husted and Edgar 2002]); one was also found at Moss Creek (48PA919) in a component dated to 4337±103 cal BP (Figure 3-24 j [Eakin 2011]).

The toolkits of Middle Archaic McKean complex people were substantially similar to those in use during the Early Archaic. A wide assortment of end scrapers, drills/reamers and bifacial knives of various sizes and shapes has been recovered from dated and/or stratified sites, but expediently produced retouched and utilized flakes remain the most common chipped stone tools (Eakin 2011; Husted and Edgar 2002; Scott and Zeimens 1984). Missing however, are the large side or corner-notched hafted knives of the Early Archaic period. Chipped stone raw materials are dominated by locally available materials (Eakin 2011; Page 2016). There appears to have been a shift in obsidian procurement during the Middle Archaic period in the basins of southwestern Wyoming (Scheiber and Finley 2011). Although based on a relatively small sample (n=25), Scheiber and Finley (2011) found that nearly 80% of Middle Archaic-aged obsidian diagnostics were made from sources found in eastern Idaho, rather than Jackson Hole, which was the primary utilized source during the preceding Early Archaic. The reasons for the shift in obsidian procurement are unclear, but worthy of further investigation. Groundstone tools such as manos and metates are quite numerous in many McKean complex assemblages (Husted and Edgar 2002; Miller and Bedord 1984; Page 2016). There is evidence from Goff Creek (Page 2016) and Mummy Cave (Husted and Edgar 2002) for a dramatic increase in the frequency of groundstone tools during the Middle Archaic period. Rock-filled roasting pits also become much more common during the Middle Archaic, which provides further evidence for an increase in intensive plant processing (Walker and Frison 1984). Bone and antler tools, including awls, punches/flakers, scrapers and billets, remain an integral component of McKean complex toolkits (Husted and Edgar 2002; Jefferson 1984; Page 2016). The morphology and variation of bone tool assemblages do not appear to have changed from the preceding Early Archaic period.

The evidence suggests that the types of subsistence and settlement practices employed during the Early Archaic period continued to be utilized throughout the Central Rockies and surrounding regions during the Middle Archaic period. However, though the general strategies may have changed very little from earlier times, there was intensification in the procurement of edible plants (Page 2016). Rock-filled or lined roasting pits, likely used to cook starchy roots and tubers such as biscuitroot, blue camas, sego lily, tobaccoroot and balsamroot, are nearly ubiquitous features at Middle Archaic sites (Eakin 2011; Francis 2000; Hillman 1984; Husted and Edgar 2002; Kornfeld et al. 2010; Page 2016). In Jackson Hole numerous roasting pits found along Jackson Lake were dated to the Middle Archaic period or are associated with Middle Archaic projectile points (Bender and Wright 1988; Connor 1998). An increase in effective moisture at circa 5700 cal BP would have resulted in increased productivity of plant resources in many areas (Chapter 2), which may account for proliferation of roasting pits. Yet, it is also possible that there was a concerted shift in foraging effort to maximize root crop harvests. The higher elevations of the Central Rockies continued to be incorporated into a seasonal round of foraging with logistical moves scheduled to coincide with ripening of high-value resources (Bender and Wright 1988). The Dead Indian Creek site, located in the foothills of the Absarokas, produced evidence of multiple winter occupations and appears to represent a winter base camp (Walker and Frison 1984). Bighorn sheep and mule deer were the target species and, as with the Early Archaic, the evidence points to intensive processing of bone for marrow and grease extraction (Fisher 1984). Redundant occupations of favorable sites, such as Dead Indian, Mummy Cave and McKean, resulted in the accumulation of fairly dense occupational layers (Kornfeld et al. 1995). What is believed to have been a house pit was discovered at the Dead Indian Creek site (Kornfeld et al. 201), which remains the only documented example in the Central Rockies.

Apart from the stylistic changes in projectile points there is little evidence for culture change in the Basins of southwestern Wyoming. Sites continue to reflect a broad subsistence base that included a wide range of plant and animal resources (Harrell et al. 1997; Waitkus and Eckles 1997). Numerous house pits differing only in age from Early Archaic examples have been documented (Waitkus and Eckles 1997). There may have been a renewed concentration on bison hunting in the Northwestern Plains since several mass kill sites, mostly dating to the end of the Middle Archaic (Frison 1978), have been found. Yet, as Kornfeld (1997) suggests, communal hunts may have occurred rarely and contributed relatively little to the day to day subsistence needs of McKean complex people.

The last three or four centuries of the Middle Archaic period witnessed a steady decline in human populations in the basins of western Wyoming (Figure 3-21). During this same interval in the Central Rockies, human populations appear to have increased abruptly. These demographic trends correspond with a period or dry and possible cold temperatures that likely resulted in decreased carrying capacity of low elevation environments surrounding the Central Rockies. These data again point to potential population movements in response to poor climatic conditions. Although this pattern does not support the simple migration scenario put-forth in the Mountain Refugium Hypothesis, it does show yet again, that human populations in the Central Rockies increased during a period of climate change, perhaps through immigration, natural reproductive success or a combination of both factors.

Late Archaic Period, circa 3200-1400 cal BP

Although effective moisture increased gradually in the Central Rockies after circa 3200 cal BP and reached near modern levels by 3000 cal BP, human populations continued to contract in most regions of western Wyoming until circa 2700 cal BP (Figure 3-25). This downward demographic trend was followed by marked population increases in the Central Rockies that lasted until about 2300 cal BP.

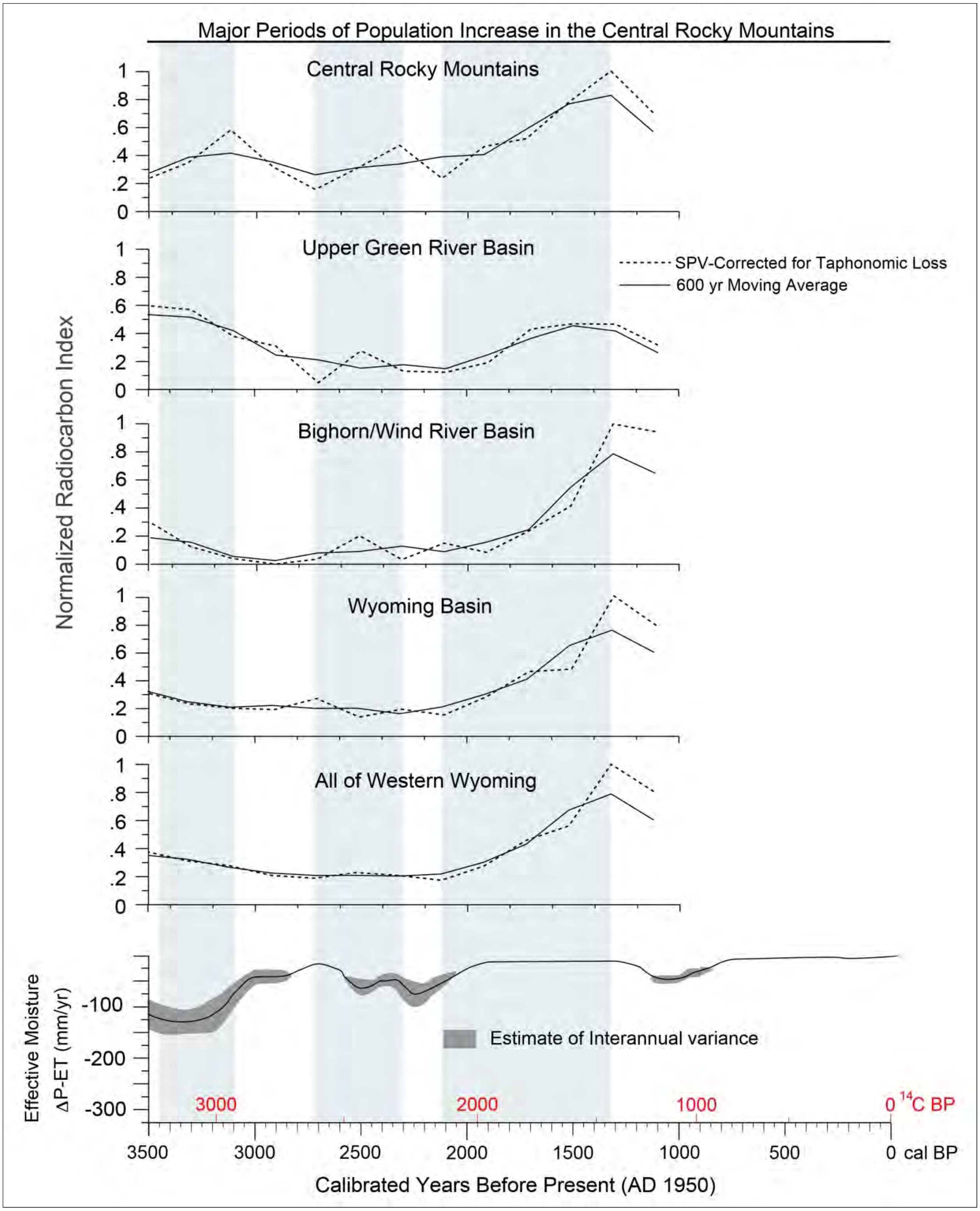


Figure 3-25 Calibrated radiocarbon date frequency distributions during the Late Archaic period in western Wyoming. Periods of inferred population growth in the Central Rockies are highlighted in gray.

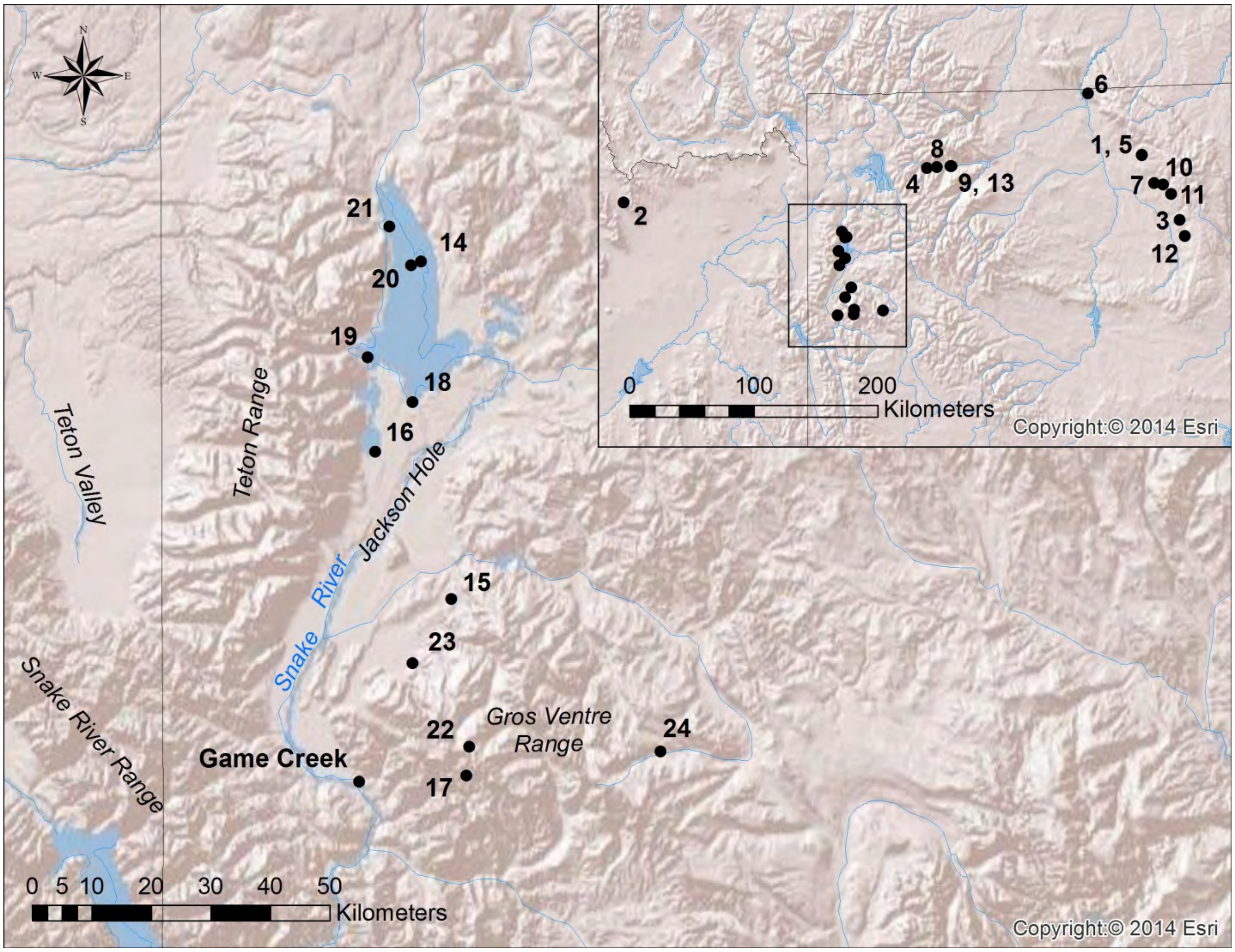


Figure 3-26 Late Archaic sites discussed in text: 1. BA Cave (48BH1065); 2. Bison/Veratic Rockshelters (10CL10/3); 3. Daugherty Cave (48WA302); 4. Goff Creek (48PA325); 5. Greyhound (48BH1064); 6. Juniper Cave (48BH3178); 7. Medicine Lodge Creek (48BH499); 8. Mummy Cave (48PA201); 9. Pagoda Creek (48PA853); 10. Paintrock V (48BH349); 11. Southsider (48BH364); 12. Spring Creek Cave (48WA1); 13. 48PA852; 14. Lawrence (48TE509); 15. Goetz (48TE455); 16. Jenny Lake (48TE414); 17. 48TE962; 18. 48TE1042; 19. 48TE1062; 20. 48TE1067; 21. 48TE1071; 22. 48TE1397; 23. 48TE1402; 24. 48TE1817.

A similar population increase is apparent in the upper Green River, Bighorn and Wind River Basins but lasted only till around 2500 cal BP. Overall, population levels in western Wyoming were stagnant throughout most of the Late Archaic period. Climate change is again the most parsimonious explanation for these demographic trends, as there is evidence for decreases and greater interannual variation in effective moisture from circa 2700-2000 cal BP. Human populations increased dramatically throughout western Wyoming after circa 2000 cal BP with a return to near modern levels of effective moisture and temperature.

In the Central Rockies, components dated to the Late Archaic period have been intensively investigated at Mummy Cave (Husted and Edgar 2002), Pagoda Creek (Eakin 1989), Goff Creek (Page 2016), 48PA852 (Eakin and Sutter 1991), Medicine Lodge Creek (Frison 2007b), Lawrence (Connor

1998) and Game Creek (Chapter 5). Numerous other Late Archaic-age components have been identified in the region (Figure 3-26), particularly in rockshelters along the western slope of the Big Horn Mountains, such as Juniper Cave (48BH3178), Greyhound (48BH1064), BA Cave (48BH1065), Paintrock V (48BH349) and Southsider (48BH364 [Finley 2008]), but the results of these investigations have not been fully reported. Late Archaic-aged sites and diagnostic artifacts are also quite numerous on the Yellowstone Plateau (MacDonald 2013). Furthermore, corner-notched dart points, the primary diagnostic artifact of the Late Archaic period, are particularly common in surface assemblages from Jackson Hole (Bartholomew 20011; Connor 1998).

By circa 3200 cal BP there was a near complete transition to corner-notched projectile point styles throughout the Northwestern Plains, Intermontane basins and Central Rockies. In western Wyoming corner-notched darts are typically identified as either Pelican Lake or Elko (Kornfeld et al. 2010; Holmer 2009), but both types are so broadly defined that there are no significant differences between them (Holmer 2009; Reeves 1983). There are some indications of temporal and/or spatial variation or trends in Late Archaic corner-notched dart morphology (Frison 1978; Reeves 1983), but the question has not received enough attention to fully address. Stratigraphic evidence from the Yonkee and Kobold sites in the Northwestern Plains suggests that the corner-notched darts developed directly out of the McKean complex, with one transitional, Hanna-like, style called Yonkee (Frison 1970, 1978). However, a similar sequence cannot be demonstrated in the Central Rockies.

Late Archaic corner-notched projectile points tend to be plano-convex in longitudinal cross-section and are often curved in latitudinal cross-section with straight to slightly convex blade edges (Figure 3-27). Blades are frequently, though not invariably barbed. Notches are narrow and relatively deep and positioned to create proximal shoulder angle of around 125° (Chapter 6). Most specimens have either straight or convex bases that are usually narrower than the maximum width of the blade (Frison Points appear to have been produced from flake blanks using bifacial pressure flaking that often failed to completely eradicate the original ventral surface of the flake blank.

Corner-notched dart points were produced throughout the Archaic but were most common during the Early (ca. 8300-5700 cal BP) and Late Archaic periods (ca. 3400-1400 cal BP [Holmer 1986; Page 2016]). Although there is overlap in the ranges of variability, Early and Late Archaic corner-notched darts differ is several ways. First, Late Archaic corner-notched dart points on average have wider blades and narrower bases than Early Archaic specimens (Page 2016; Chapter 6). Second, notching on Late Archaic corner-notched darts also tends to be deeper and narrower than on points made during the Early Archaic (Page 2016; Chapter 6). Third, convex bases are much more, and concave much less, common in Late Archaic than in Early Archaic corner-notched point assemblages (Page 2016; Chapter 6).

There is another Late Archaic point type identified and defined based on a large sample from the Bison and Veratic rockshelters in eastern Idaho known as Blue Dome side-notched (Swanson 1972). Two

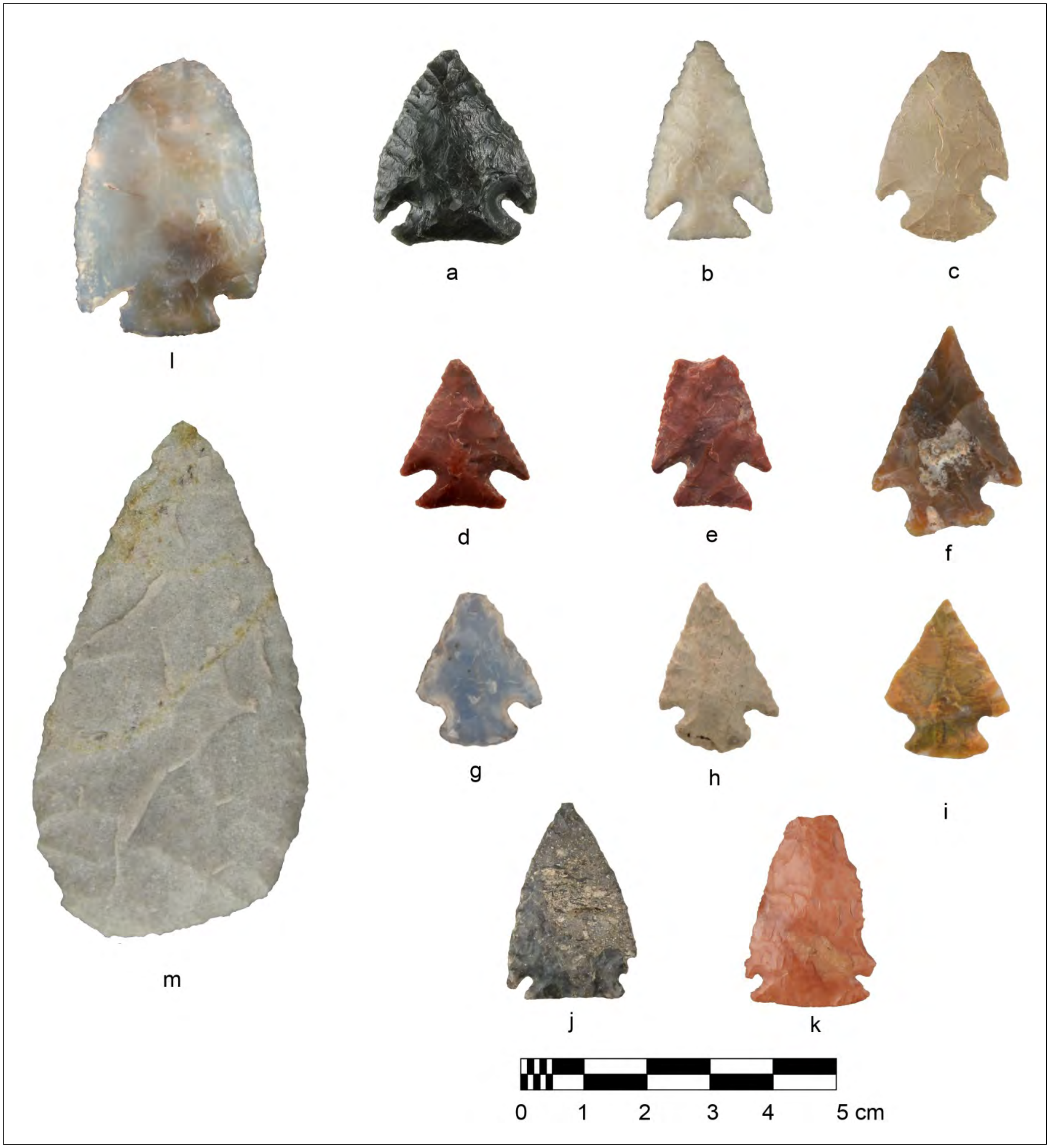


Figure 3-27 Photographs of Late Archaic projectile points and knives; (a-i) Pelican Lake/Elko, (j-k) Blue Dome "Side-Notched," (l) corner-notched hafted knife, (m) bifacial knife. Specimens are from the following sites: (a-c, j-k, m) Game Creek; (d-e) Little Canyon Creek Cave (Shaw 1980); (f-g) Pagoda Creek (Eakin 1989); (h-I, l) Goff Creek (Page 2016). Material from UWAR, Department of Anthropology, University of Wyoming.

of these specimens were recovered from the Game Creek site, and the type appears to have a limited distribution in the Central Rockies. Blue Dome points are well made with slightly ovate blade edges and small barbs. Although Swanson describes the type as "side-notched", illustrated specimens as well as the small sample from Game Creek have proximal shoulder angles less than 140° and are therefore classified here as corner-notched. Notches are shallow, narrow and placed very near the base of the point (Figure 3-27 j-k). Bases are straight and concave, and one has a slightly ground basal edge. The components from Bison and Veratic rockshelters were dated to 1474±85 cal BP or near the end of the Late Archaic (Swanson 1972). Swanson (1972:112) argues that the type is technologically and temporally related to the Avonlea point type, but noted that Blue Dome points are thicker, more crudely made, and more variable than Avonlea. Furthermore, the size of these specimens is closer to the range of Late Archaic dart points than Avonlea arrow points. Nevertheless, this type may represent a terminal Late Archaic point form of limited geographic and temporal range.

Chipped stone assemblages changed little from the Middle Archaic, and expedient retouched and utilized flakes continue to be the most frequent tool type. Large corner-notched hafted knives, similar to Early Archaic types, reappear during the Late Archaic period (Figure 3-27 [Frison 2007b; Page 2016]). A distinct type of corner-tang knife has also been recovered from Late Archaic components (Frison 2007b). Groundstone, bone and antler tool assemblages were unchanged from earlier periods. Late Archaic components from Daugherty and Spring Creek Caves in the Bighorn Basin have produced well-preserved wood, fiber and leather artifacts (Frison 1965, 1968).

Subsistence and settlement practices of Late Archaic hunter-gatherers in the Central Rockies and surrounding basins differed little from the earlier McKean complex. Sites continue to be found at high and low elevations reflecting seasonal use of the high country. Bighorn sheep were the target prey species at many sites, such as Mummy Cave, Pagoda Creek, Goff Creek and 48PA852 and were intensively processed for marrow and bone grease extraction (Eakin 1989; Eakin and Sutter 1991; Hughes 2003; Page 2016). Bison and perhaps elk may have played a greater role in subsistence in Jackson Hole than in the rest of the central Rockies (Chapter 7). Yet, smaller animals such as beaver, porcupine and marmot are also commonly recovered (Hughes 2003; Page 2016). Numerous rock-lined roasting pits dated to the period show that root crops continued to play an important dietary role. Sites are frequently located in the same locations as earlier Middle Archaic sites and in close proximity to resource-rich patches, which may indicate some degree of cultural continuity. There is marked increase in the use of obsidian along the North Fork of the Shoshone River that may provide evidence for an increased use of the Yellowstone Plateau (Page 2016). Winter base camps, though generally believed to have been located at lower elevations, have yet to be identified. However, both Eakin (1989) and Hughes (2003) have demonstrated winter occupations in the heart of the Absaroka Mountains, which may indicate that the high country was at least occasionally inhabited year round. Obsidian from Jackson Hole, as during the Middle Archaic, does not appear with regularity in the basins of Southwestern Wyoming (Scheiber and Finley 2011). Thus, it is unclear whether the Green River Basin and Jackson Hole were utilized by the same groups on a seasonal basis.

On the Northwestern Plains there was a shift to intensive procurement of bison that included the use of jumps and corrals that allowed large groups of bison to be killed *en masse* (Frison 1978; Reeves 1983). Communal hunting strategies and a clear focus on bison are absent in the Central Rockies and intermontane basins of western Wyoming. It was on the Northwestern Plains during this time that clear and unequivocal use of tepees appears (Reeves 1983). These attributes, along with corner-notched dart points, are defining characteristics of the Pelican Lake cultural complex (Reeves 1983).

The evidence suggests the development of a cultural dichotomy, not unlike that hypothesized for the Late Paleoindian period, between the bison hunting specialists on the Northwestern Plains and foragers who occupied the Central Rockies and basins of southwestern Wyoming during the Late Archaic. The data are as yet too sparse to illuminate any potential cultural interactions between Pelican Lake bison hunters and the Late Archaic foragers of the Central Rockies and surrounding basins. Although not a refugium, in the strict definition of the term, the Central Rockies appear to have supported a larger carrying capacity than the rest of western Wyoming during most of the Late Archaic period. Unlike the surrounding regions that experienced declining or stagnant population growth, human populations appear to have remained relatively high and increased throughout much of the period. After 2000 cal BP populations throughout western Wyoming expanded at a dramatic rate, a trend that may have continued until European contact.

Late Prehistoric and Protohistoric Periods, circa 1400-150 cal BP

Paleoclimatic data show that temperatures and effective moister did not change significantly in the Central Rockies after circa 2000 cal BP. There was a brief arid period between circa 1200-900 cal BP, but it is unclear whether this negatively impacted human populations (Figure 3-25). The radiocarbon record for the Late Prehistoric period is likely biased due to the tendency of archaeologists to forego radiocarbon dating of sites that are believed to date to the period (Kelly et al. 2013; Surovell et al. 2009). Other proxy data, such as the regional frequency of diagnostic projectile points suggests an increase in human occupation of the Central Rockies (Bartholomew 2001).

The beginning of the Late Prehistoric period is rather arbitrarily set at 1500 BP, or roughly 1400 cal BP. There is evidence from numerous sites throughout western North America for the introduction and spread of bow and arrow technology at about this time. It is unlikely that bows were adopted at the same time in all places, and even less likely that atlatl and dart technologies were immediately abandoned. There was probably a period, perhaps as long as several generations, when both atlatl and bows were part of the toolkit. The manufacture and use of pottery is also a trait used to mark the beginning of the Late Prehistoric period. Yet, pottery is rare and entirely absent from many assemblages with arrow points.

Moreover, pottery from at least six different ceramic traditions has been found throughout western Wyoming. The ceramic traditions have differing spatial and temporal distributions, but overlap in time and space in some areas. The scarcity of pottery and the small and fragmentary state of most assemblages has frustrated attempts to identify clear technological and stylistic parameters and ranges of variation for the ceramic traditions.

The Late Prehistoric period was a time of pronounced prosperity for Native American peoples in western Wyoming with a marked increase in human populations and a diversification of toolkits. There are several identifiable Late Prehistoric cultural complexes in the Central Rockies and surrounding regions during the Late Prehistoric period. Some of the complexes have been defined, others have not. Pottery and in some cases carved steatite bowls, as well as perishable items such as basketry and moccasins, have been used to support hypotheses regarding the ethnic identity for some of the Late Prehistoric complexes.

Avonlea- and Promontory, circa 1500- 400 cal BP

Avonlea is one of the earliest Late Prehistoric complexes on the Northwestern Plains where it is appeared circa 1700 cal BP and persisted until circa 950 cal BP. Diagnostic artifacts include arrow points with shallow side or corner-notches placed very the base which is concave or straight (Figure 3-29 a-f) and pottery identical to contemporary Woodland pottery types from Minnesota and Manitoba (Meyer and Walde 2009). Although most Avonlea pots were tall rimless-bowls with pointed bases, some jars with slightly constricted orifices and short curved rims have also been reported (Meyer and Walde 2009). Several sites in western Wyoming, dated to around 1500-900 cal BP, produced side/corner-notched arrow points, some of which are remarkably similar to the Avonlea point type (Frison 1988). Kehoe (1973) hypothesized that the people of the Avonlea complex were Athabaskan and provided archaeological evidence for the southward migration of proto-Apachean people. It has also been suggested that the Avonlea point and by extension the complex were adopted by people of varying ethnic identities (Walde 2006). Although the debate continues, there is growing evidence for the presence of Athabaskan people in western Wyoming during the Late Prehistoric period.

An intensive exploitation of bison, including the use of jumps, corrals and communal hunting efforts, are believed to have characterized the Avonlea complex on the Northwestern Plains. The near absence of manos and metates or grinding slabs at most Avonlea sites in the Northwestern Plains further highlights the narrow diet breadth of Avonlea people on the Northwestern Plains (Reeves 1983). A small number of sites believed to be affiliated with, or in fact represent, Avonlea have been found in western Wyoming (Frison 1988). The Beehive (48BH346) site, dated to 1316±39 cal BP, produced a component that contained a wide variation of arrow point styles many of which were within the range of variation for the Avonlea complex, but others that more closely resemble Prairie, Plains or Desert side-notched (Frison1988; Hall 1998). Several manos and metates were also found at Beehive, which contrasts with

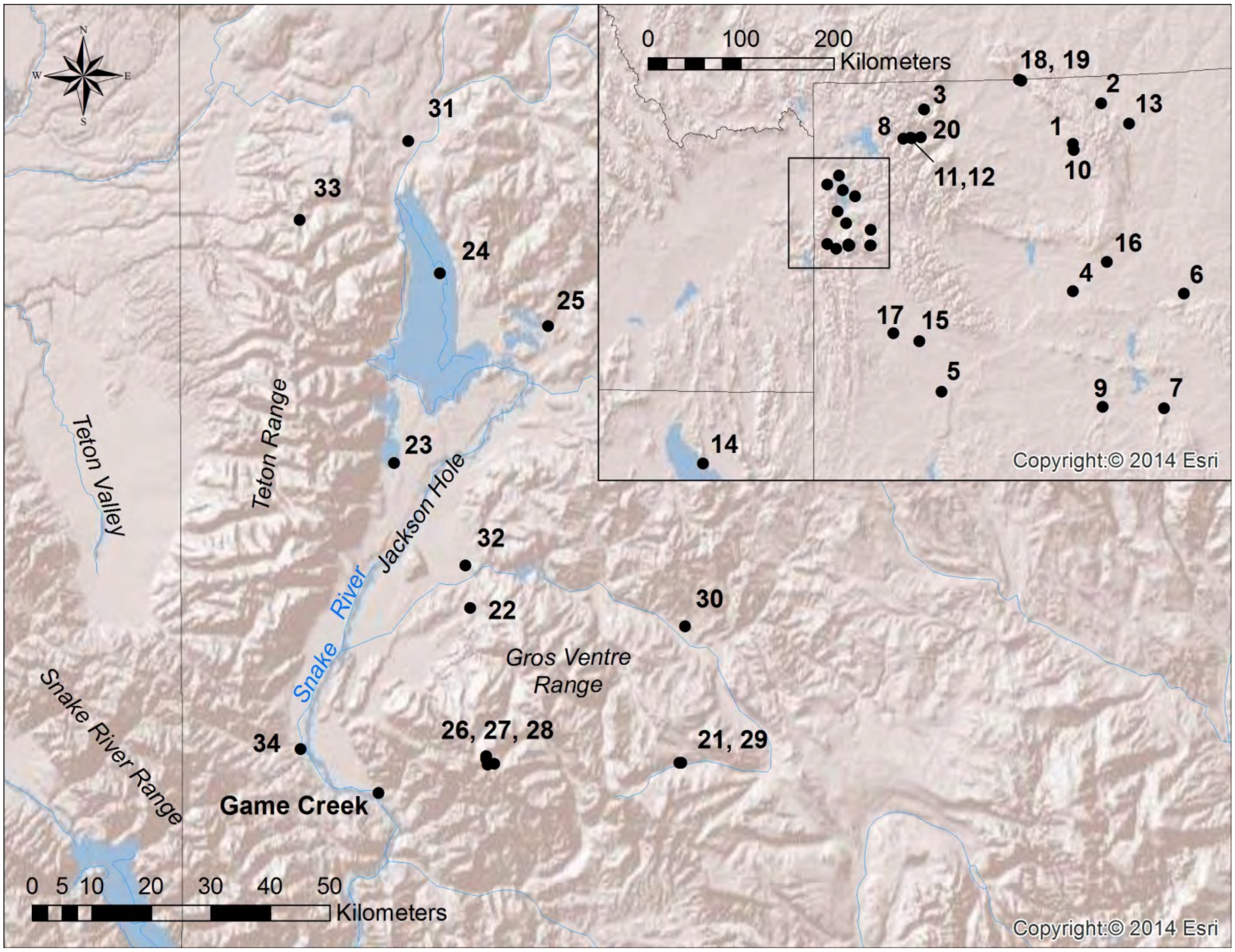


Figure 3-28 Late Prehistoric sites discussed in text: 1. Beehive site (48BH346); 2. Big Goose Creek (48SH313); 3. Bugas-Holding (48PA563); 4. Castle Gardens (48FR108); 5. Eden-Farson (48SW304); 6. EKW (48NA969); 7. Garret Allen (48CR301); 8. Goff Creek (48PA325); 9. John Gale (48CR303); 10. Medicine Lodge Creek (48BH499); 11. Moss Creek (48PA919); 12. Mummy Cave (48PA201); 13. Piney Creek (48JO311/312); 14. Promontory Caves; 15. Raven's Nest (48SU3871); 16. Ross Rock (48NA331); 17. Wardell site (48SU301); 18. Wortham shelter (48BH730); 19. 48BH305; 20. 48PA852; 21. Fraser (48TE487); 22. Goetz (48TE455); 23. Jenny Lake site (48TE414); 24. Lawrence (48TE509); 25. Two Ocean 4 (48TE473); 26. 48TE1386; 27. 48TE1388; 28. 48TE1394; 29. 48TE1817; 30. 48TE1852; 31. 48TE431; 32. 48TE449/450; 33. 48TE601; 34. 48TE1080.

Avonlea sites from the Northwestern Plains (Frison 1988). At Wortham shelter (48BH730), a packrat-turbated, but incredibly well preserved Avonlea component, in the western foothills of the Big Horn Mountains, produced numerous Avonlea points (Figure 3-29) in addition to well-preserved arrow shafts and shaft fragments that shed considerable light on arrow manufacturing and hafting technology.

At least three stratified layers of butchered bison in association with small side-notched points, some of which resemble Avonlea, were found at the Wardell (48SU301) site in the upper Green River Basin (Frison 1988; Frison and Reher 1973). The components, though poorly dated, were occupied several times from circa 1500-900 cal BP. The site is believed to represent a bison corral used to capture

Figure 3-29 Photographs of Late Prehistoric period projectile points from the Central Rockies: (a-f) Avonlea; (g-i) Rose Spring; (m-n) Desert side-notched; (o-r) Desert tri-notched. Specimens are from the following sites: (a-f) Wortham Shelter (Greer 1978); (g) 48PA852 (Eakin and Sutter 1991); (h) Blaine Creek (48PA1070 [Eakin 1988]) (h, m, o) Game Creek (Chapter 6); (i-k) 48TE1516; (i) 48TE1514; (n) Goff Creek (Page 2016); (p-q) Moss Creek (Eakin 2011); (r) 48PA2665 (Eakin 2006). Material from UWAR, Department of Anthropology, University of Wyoming.

small herds of bison. No groundstone tools or other evidence of plant processing were found, but this could be explained by site function. A small pottery assemblage from Wardell contained the remains of about five pots, one of which was partially reconstructed and resembles the curved rim jar form found at some Avonlea sites in Canada and as well as other contemporaneous Late Woodland tradition vessels from the Central Plains (Meyer and Walde 2009). Most of the projectile points from Wardell have side notches that are placed higher on the base than Avonlea and closely resemble the Plains or Desert side-notched types. Frison (1997b:164) believes Wardell represents a "regional variant of (or closely related to) Avonlea."

The pottery and projectile points from Wardell are similar, if not identical, to material culture inventories of the Promontory complex known from investigations at the Promontory Caves north of Salt Lake (Steward 1937). The people of the Promontory complex were big game hunting specialists. Grinding stones are rare and metates entirely absent (Ives 2014; Steward 1937). The once poorly dated complex now has a growing number of radiocarbon dates. A suite of 51 AMS radiocarbon dates, mostly from moccasins, has dated the occupations at the Promontory Caves to 730±25 cal BP 629±39 cal BP (Ives et al. 2014). Perhaps even more significant are the results of the analysis of the moccasins themselves. Ives (2014) found that most of the 250 specimens found in the Promontory Caves were of a distinct style that is common to the Athabaskan people of the Canadian Arctic, where it has been manufactured since at least 1327±22 cal BP. Promontory possesses other material culture attributes that are shared with the Athabaskans of the sub-arctic, such as serrated bone fleshers, D-shaped bifacially retouched tabular scrapers and similar textiles and sewing techniques. One of the Late Prehistoric components from the Raven's Nest (48SU3871) site in the upper Green River Basin produced a small assemblage of Promontory pottery (Figure 3-30) and side-notched arrow points with associated dates of 612±39 cal BP and 512±17 cal BP (Hill and Wolfe 2017). A preserved moccasin from the Ross Rock (48NA331) site has recently been identified as Promontory or Athabaskan and dated to 399±54 cal BP (Ives, personal communication 2017). The Ross Rock site also produced a small assemblage of side-notched points and pottery that was originally identified as Intermountain or Shoshone (Garling 1964).

The data, though sparse, do support some degree of cultural continuity between Avonlea and Promontory complexes and furthermore suggests Athabaskan people resided in western Wyoming for about a millennium. These people appear to have specialized bison hunters who routinely utilized corrals, jumps and communal labor to harvest large numbers of bison (Frison 1998). Manos have been recovered from some sites which indicates that small seeds were a probably an important part of the diet. Rock-lined roasting pits, not otherwise associated with large quantities of bone, are not however reported. According to Connor (1998) Avonlea points have been recovered from Jackson Hole, but unfortunately she fails to say exactly where. Avonlea and Promontory sites are absent or unreported from the Central Rockies, though Avonlea projectile points are occasionally reported throughout western Wyoming (Frison 1988) and eastern Snake River Plain (Holmer 2009). There are reasons to suspect that Promontory sites are more common than reported. First, the side-notched arrow points characteristic of the Promontory complex are nearly identical to the Desert and Plains side-notched types used by throughout western North America. Second, Promontory pottery shares many superficial characteristics with Shoshone or Intermountain ware, which is better known and more widely reported in Western Wyoming. This has, in at least one instance, led to the misidentification of a Promontory component (Hill and Wolfe 2017).

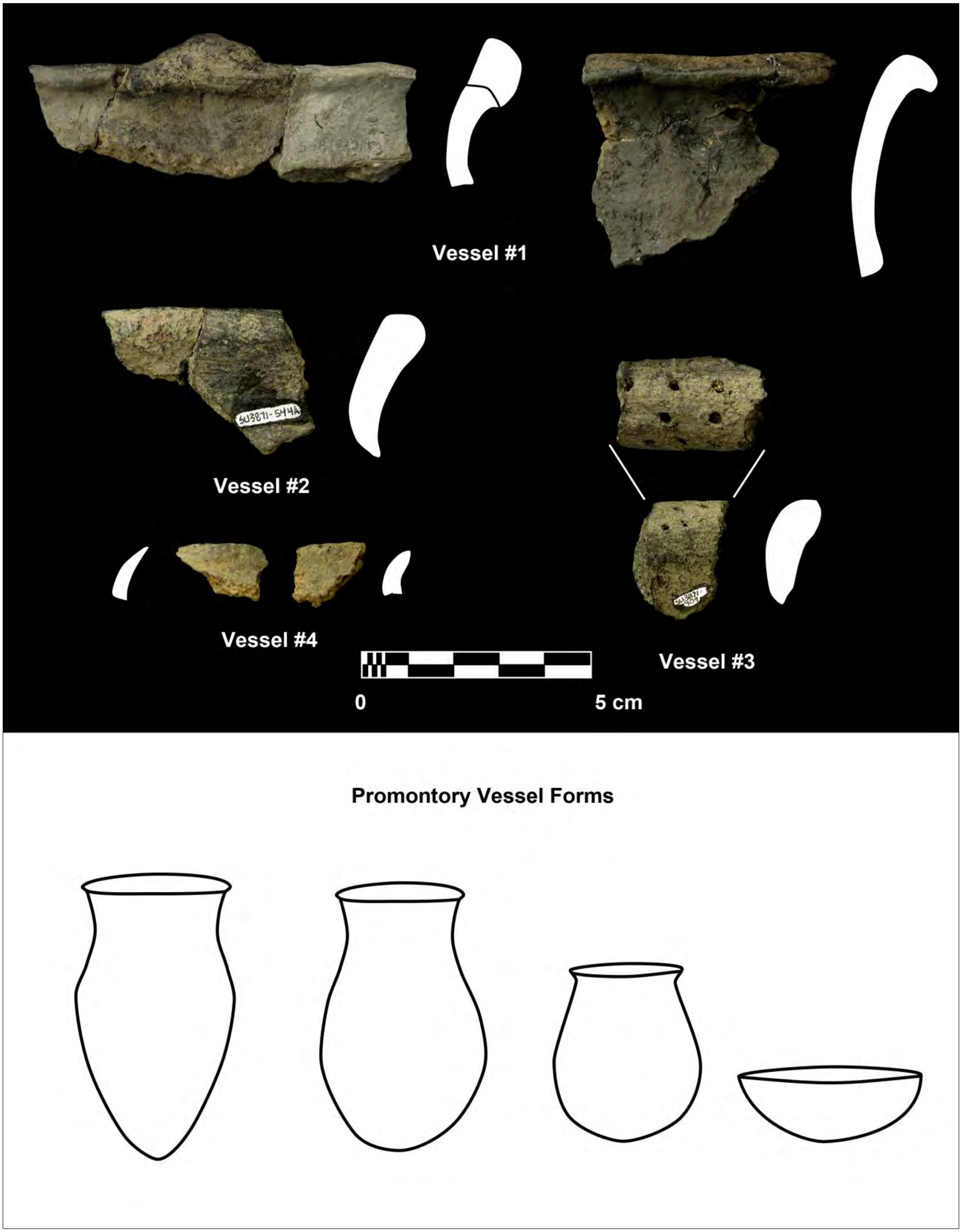


Figure 3-30 Photograph of Promontory pottery from the Raven's Nest (48SU3871) site (upper) and Promontory vessel forms (redrawn from Madsen 1977). Material from UWAR, Department of Anthropology, University of Wyoming.

Bison were probably not numerous or predictable enough in most of the Central Rockies to have drawn Avonlea and Promontory hunters with any regularity. However, Jackson Hole may have supported a sizeable bison herd that was certainly utilized by hunter-gatherers during the Late Prehistoric period (Cannon et al. 2015; Chapter 6). It is therefore plausible if not probable that Jackson Hole was at least occasionally occupied by Avonlea and/or Promontory people.

Early Late Prehistoric Corner-Notched/Fremont complex, circa 1600-700 cal BP

Cultural layer 36 at Mummy Cave, dated to circa 1150 cal BP, produced a large assemblage of stemmed and corner-notched arrow points that are indistinguishable from similarly aged specimens in the Great Basin known as Rose Spring (Holmer 2009; Husted and Edgar 2002; Justice 2002). Although there is considerable variation in size and morphology, Rose Spring points are basically smaller versions of the Late Archaic corner-notched dart (Figures 3-29 g-i). A sizeable groundstone assemblage, a wide range of bone tools, preserved basketry cordage and feather fletching, were also found (Husted and Edgar 2002). Bighorn sheep were the clear target prey, but deer, elk, and a wide variety of smaller mammals and birds were also recovered (Hughes 2003). Three quarters of the features identified in layer 36 were rock filled, which suggests that root crop roasting and/or stone boiling for rendering bone grease were important subsistence activities (Husted and Edgar 2002). Husted and Edgar (2002) found that, apart from the Rose Spring arrow points, the layer 36 chipped stone, groundstone, basketry and wood assemblages are substantially similar in variety and form to earlier Archaic components at Mummy Cave, which they argue is evidence for cultural continuity. Rose Spring points occur with some regularity at sites throughout the Central Rockies including Goff Creek (Page 2016), Moss Creek (Eakin 2011) and 48PA852 (Eakin and Sutter 1991) on the North Fork of the Shoshone River in the Absaroka Mountains, around Yellowstone Lake on the volcanic plateau (Hale and Livers 2013), and at the Lawrence site, Jenny Lake site (48TE414), 48TE431, 48TE1388, 48TE1394, 48TE1817 (Connor 1998; Love 1972; Wright 1984), the Goetz site (Cannon et al. 2015; Love 1972) and Game Creek (Chapter 6) in Jackson Hole.

In southwestern Wyoming and the Snake River Plain, sites with substantially similar material culture inventories as cultural layer 36 at Mummy Cave have also been found in abundance. Some of these sites have also produced small quantities of Fremont pottery in association with Rose Spring corner-notched arrow points, groundstone tools and roasting pits (Hakiel et al. 1986). The core of the Fremont cultural complex was in the eastern Great Basin and Colorado Plateau. Fremont people practiced a semi-sedentary mixed hunting, gathering and horticultural economy from about 1600-850 cal BP (Madsen and Simms 1998). Fremont pottery is rare in western Wyoming and entirely absent from the Central Rockies. The evidence points to little more than an ephemeral occupation of Fremont people concentrated along the lower Green River Basin. However, sites with corner-notched arrow points, grinding tools and roasting pits are fairly common and, apart from the points, mirror assemblages from the Middle and Late Archaic periods.

Shoshone circa 800-150 cal BP

It has been argued that ancestors of the Eastern Shoshone and Comanche arrived in the Central Rockies around AD 1200 after a rather rapid migration or expansion out of a core cultural area in the southwestern Great Basin (Bettinger and Baumhoff 1982; Lamb 1958). Mitochondrial DNA analysis of modern Numic-speaking peoples and a small sample of ancient human remains from the Great Basin do show differing distributions of haplogroups that suggests biological discontinuity (Kaestle and Smith 2001). However, others have argued that continuity in material culture, subsistence and settlement practices is evidence that Numic-speaking speaking people have been in the Central Rockies and Great Basin for millennia (Husted and Edgar 2002; Swanson 1972). Regardless of the timing of their arrival, the Eastern Shoshone were, without question, present in the Central Rockies at the time of historical contact and utilized small side and tri-notched arrow points, Intermountain ware pottery and carved steatite vessels (Eakin 2006; Kornfeld et al. 2010).

Diagnostic artifacts of the Late Prehistoric Shoshone include side and tri-notched arrows, a unique pottery type and carved steatite bowls. These small points have narrow, often deep side-notches and usually straight to slightly concave bases (Figure 3-29 m-n). This style is known as Desert side-notched in the Great Basin and Snake River Plain (Holmer 2009; Justice 2002). The type has more time depth on the Northwestern Plains where it is found in many Avonlea assemblages and is known as Prairie or Plains side-notched (Kehoe 1973). Slightly later, circa 650-550 cal BP, points of this style were modified by the addition of a single notch located in the center of the base (Figure 3-29 o-r), which is known as the Desert tri-notch or “Sierra” type (Holmer 2009; Justice 2002). There is a limited inventory of pottery (Figure 3-31) that has been termed Intermountain ware (Mulloy 1958). The pottery consists of thick flat-bottomed vessels that are either wide-mouthed bowls or jars with slightly constricted orifices, tall curving rims and occasionally wedge-shaped thickened lips (Frison 1971). Vessel surfaces were finished by hand-smoothing, scraping and brushing, but are typically smooth with many striations and undulations (Frison 1971). Decoration of any kind is rare (Haspel 1984; Mulloy 1958).

Desert side and tri-notched points are particularly common throughout the Central Rockies where they have been found in association with Intermountain pottery and steatite vessels. The Bugas-Holding (48PA563) site in the Sunlight Basin of the Absaroka Mountains, believed to have been a winter camp occupied around 390 cal BP (Rapson and Todd 1999), contained a large assemblage of Desert type points, Intermountain pottery ,and evidence of bison bighorn sheep and deer procurement and intensive bone grease processing. Groundstone tools and rock-lined roasting pits present and indicate a broad spectrum foraging strategy that differed little, if at all, from earlier strategies. Other sites in the area, such as Goff Creek (Page 2016), Mummy Cave (Husted and Edgar 2002), and several sites on Boulder Ridge also produced Desert type points, Intermountain pottery and/or steatite vessels. Desert type points are less common in and around Jackson Hole than Rose Spring, but were recovered from Game Creek, Lawrence,

Figure 3-31 Photographs of Intermountain/Shoshone pottery: (a-b) Eden-Farson (Frison 1971), (c) from site in the Bighorn Basin found in association with Crow pottery (Frison 1976). Material from UWAR, Department of Anthropology, University of Wyoming.

Two Ocean 4 (48TE473), Fraser (48TE487), 48TE449/450, 48TE1386 and 48TE1852 (Connor 1998; Love 1972; Wright 1984). Wright (1984) argues that the lower frequency of Desert type points indicates low human populations in the area during the end of the Late Prehistoric period, but this could merely be due to inadequate sampling because sites with Desert Type points are as numerous as those with Rose Spring points on the Yellowstone Plateau (Sanders 2013).

Many sites in the surrounding basins have also produced Desert type points. The Eden-Farson (48SW304) site, located in the Green River Basin and dated to circa 250 cal BP is perhaps the best documented Late Prehistoric site in the area (Frison 1971). The evidence suggests that the site represents a single late fall occupation by the Eastern Shoshone. The faunal assemblage contained the remains of 212 pronghorn that are believed to have been harvested in one or more mass kill events utilizing traps or corrals and the communal efforts of a small band (Frison 1971). Groundstone tools were recovered from most areas of the site, which again indicates that intensive plant processing was an important facet of a specialized bison hunting economy, perhaps as early as 450 cal BP when they are believed to have gradually begun moving to the east-southeast. Evidence of their eastward migration has come from the Shirley Basin site (48AB301) in southeastern Wyoming, where relatively large assemblages of Intermountain pottery, side and tri-notched arrow points were found, but no grinding tools (Zeimens 1975).

Crow, circa 600-150 cal BP

If, as the evidence suggests, the recent dates from Medicine Lodge Creek are in fact associated with the "Postulated Crow Component" (Frison 2007b) then the ancestors of the Crow entered the Northwestern Plains by at least 600 cal BP (Page 2015). Although well-dated components are rare, the component at EKW (48NA969) was dated to 274±34 cal BP (Eckles et al. 2008). At the time of contact, circa AD 1800, the Crow inhabited a large territory bounded by the Sweetwater and North Platte rivers in the south, the Milk River in the north, the foothills of the Central and Northern Rockies in the west and the Black hills in the east (Voget 2001). Crow territory was likely more constricted prior to the adoption of the horse around AD 1730. Numerous Late Prehistoric and Protohistoric Crow sites have been found in the Northwestern Plains and foothills of the Big Horn Mountains (Frison 1976; Francis and Loendorf 2001). These sites display an unmistakable subsistence focus on bison procurement that included communal drives resulting in the harvest of small herds (Frison 1978). Groundstone and roasting pits are uncommon, but plant resources also likely contributed to the daily subsistence needs (Frison 1978). Side and tri-notched projectile points are virtually identical to those used by the neighboring Shoshone as well as every other cultural group in the Central Rockies, Great Basin, Northwestern and Central Plains. The most distinctive item of the Crow toolkit is the pottery (Figure 3-32). The ceramic tradition has display clear connections with contemporaneous traditions along the upper Missouri River and Eastern North Dakota (Frison 1976; Page 2007). Pots were constructed using the paddle and anvil method (Page 2007).

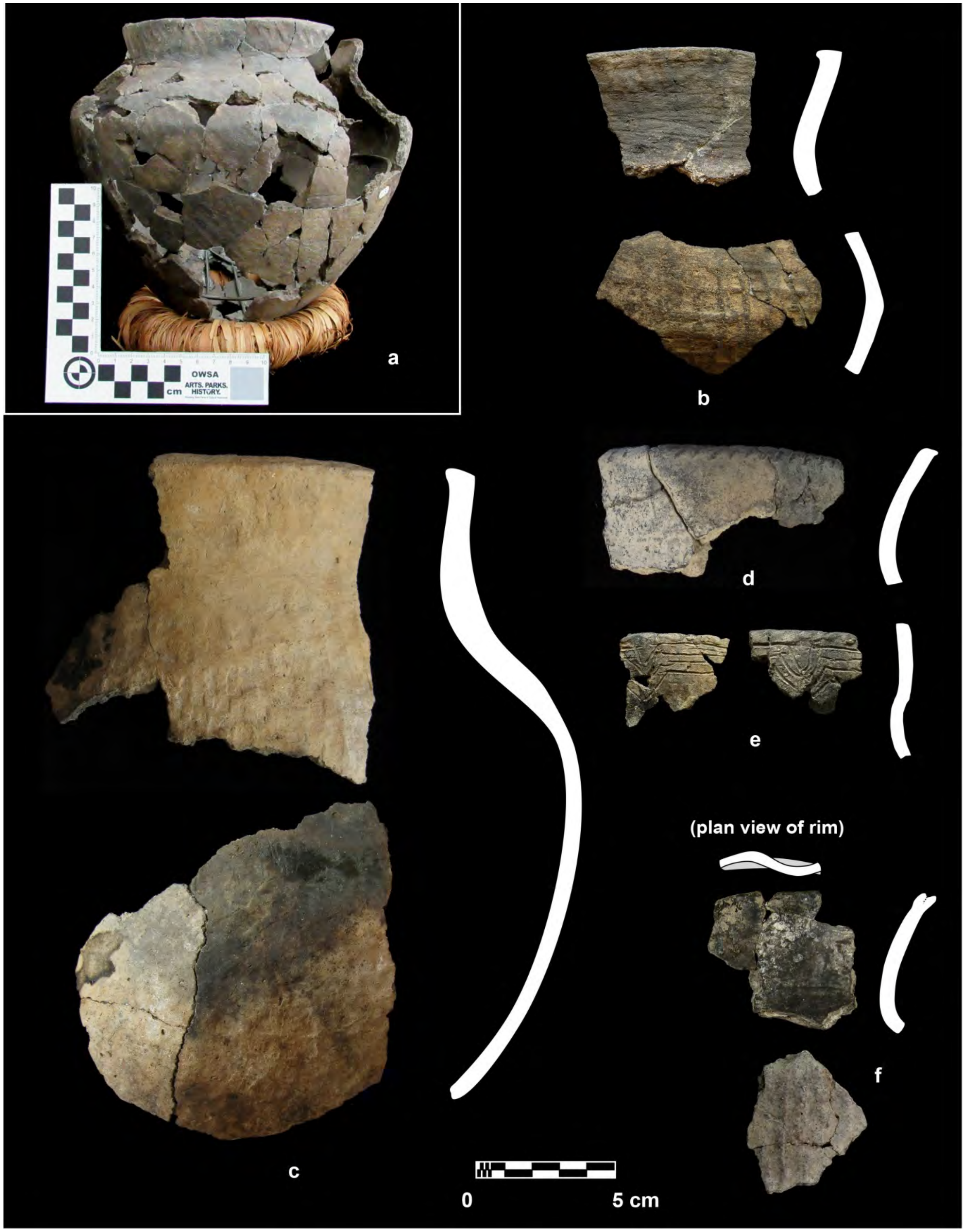


Figure 3-32 Photographs of Crow pottery: (a) Tensleep Canyon Vessel; (b) check-stamped vessel with brushed rim from Medicine Lodge Creek; (c) check-stamped vessel from 48BH305; (d) incised rim sherd from Piney Creek; (e) incised rim from Big Goose Creek; (f) modeled rim from EKW (Eckles et al. 2008; Frison 1976; Page 2007). Material from UWAR, Department of Anthropology, University of Wyoming.

Both constricted orifice jars and small bowls are present, but the former predominates in all assemblages. Jars are globular, slightly wider than they are tall, with rounded to slightly conical bases, clearly demarcated shoulders, often marked by an angular ridge, and straight, curved or recurved rim forms. Check-stamped surface finishes are exceptionally common, but simple stamped and plain smoothed, or occasionally burnished surfaces are also present in considerable numbers. Vessels are frequently decorated by incising/impressing near the exterior edge of lip, top of the lip and on the rim exterior, but is rare on other portions of the vessel (Frison 1976).

Crow pottery shares a number of characteristics, most notably check-stamping, with the Northeastern Plains Village tradition (Toom 2004). This variety of pottery first appears circa 600-350 cal BP at sites in eastern North Dakota and western Minnesota. Toom (2004) argues that the NEPV is the prehistoric manifestation of the Awaxawi and Hidatsa-proper, two of the three tribal divisions of the people collectively known as the Hidatsa, a hypothesis that is further supported by the oral traditions. According to the Crow, they separated from the Hidatsa-proper in the distant past. The sites in western Wyoming likely evidence the arrival of the Crow roughly 600 years ago (Frison 1976).

Crow sites have been identified at Big Goose Creek (48SH313), Piney Creek (48JO311/312) in the Powder River Basin, 48BH305 and Medicine Lodge Creek on the western edge of the Big Horn Mountains, Garrett Allen (48CR301), John Gale (48CR303) and EKW (48NA969) along the North Platte River (Frison 1967, 1976). No sites have been identified west of the Continental Divide, but in the absence of pottery, small assemblages could easily be misidentified as Shoshone. High elevation sites are fairly common in the Big Horn Mountains (Frison 1976). There is evidence in the ceramic assemblages from several sites of interaction between the Crow and Shoshone, such as a Shoshone pot with a single stamp from a grooved paddle, and the intermixing of Crow and Shoshone pottery in single components (Frison 1976).

Uncompahgre/Ute circa 850-150 cal BP

There are a number of sites in the basins of southwestern Wyoming that have produced a distinctive pottery type, known as Uncompahgre, that is believed to have been produced by the Ute. The Ute, a Numic-speaking people, who like their distant relations the Eastern Shoshone, are believed to have arrived in the Colorado Basin and Southern Rockies circa 850 cal BP (Middleton et al. 2007). Dated components from several sites show a temporal range of circa 800-150 cal BP (Loendorf 2002; Middleton et al. 2007). The ceramic tradition includes a single vessel jar form that has a constricted neck, tall curved rim and pointed or round base (Figure 3-33).Vessels were constructed by coil building, unlike Intermountain, Crow and Promontory. Exterior surface are either covered in rows of vertical fingernail impressions or are smoothed. Decoration, apart from the fingernail impressed exterior surfaces, is exceedingly rare (Loendorf 2002; Martin 2000; Middleton eta al. 2007; Reed 1995). Projectile points include side and tri-notched forms as well as unnotched triangular points (Miller 2000; Reed 1995).

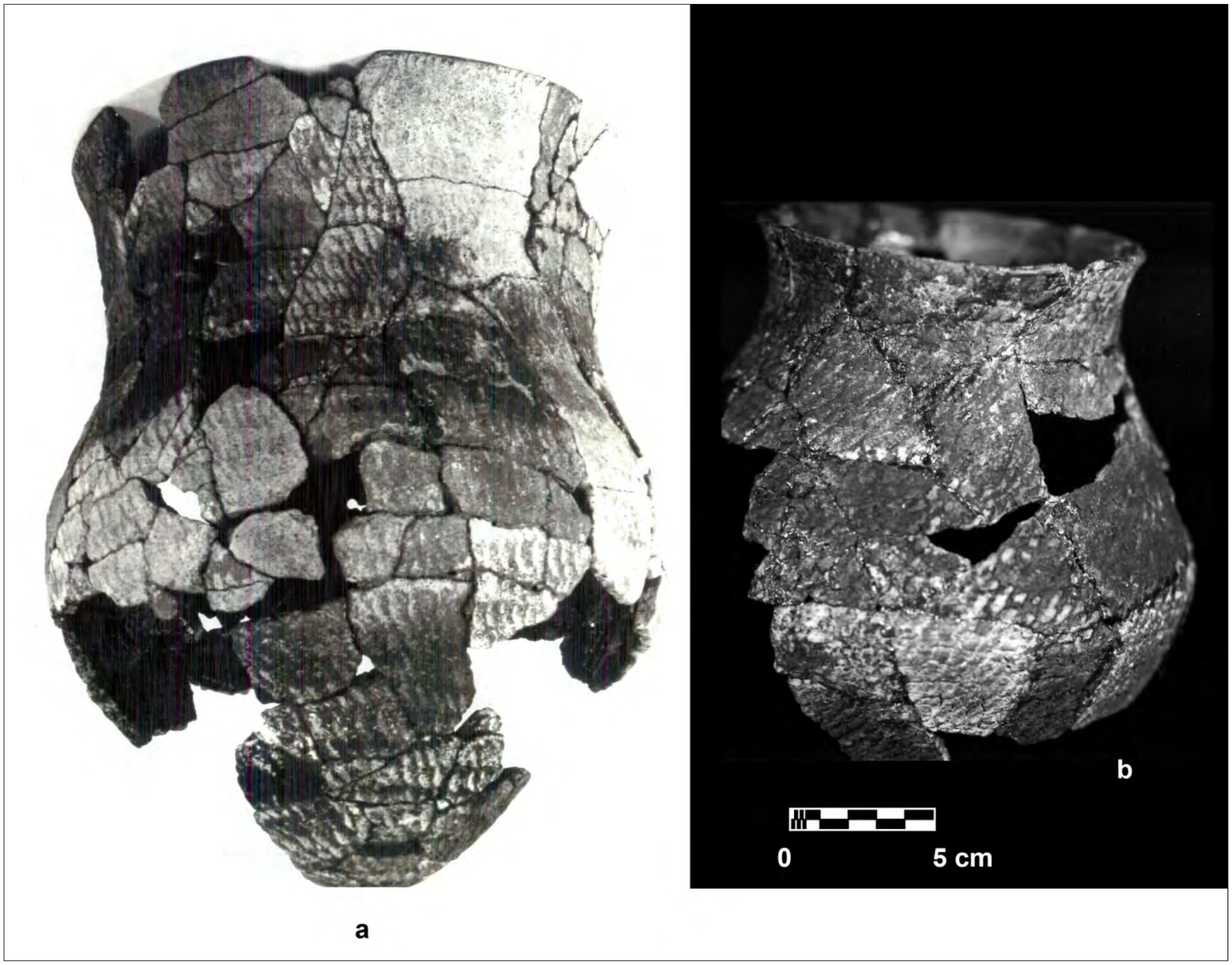


Figure 3-33 Uncompahgre vessels found in southwestern Wyoming: (a) Castle Gardens (48FR108) site (Loendorf 2002); (b) provenience unknown, likely southwestern Wyoming.

Sites with Ute pottery are relatively rare, but widespread, in the intermontane basins of southern Wyoming (Middleton et al. 2007: Miller 2000) and occur as far north as the upper Green River Basin (Frison and Reher 1973). They are however absent in the Central Rockies. The Ute were foragers and hunters who were specifically adapted to the mountains and surrounding basins of the Southern Rockies. It is therefore surprising that there is no evidence that they occupied the Central Rockies.

Summary and Discussion

There was a continuation of a subsistence dichotomy during the Late Prehistoric period. In the Central Rockies, like earlier periods, hunting was focused on bighorn sheep and deer, but faunal assemblages are diverse. There may have been an increase in bison procurement (Rapson and Todd 1999), likely due to higher populations, but there is no evidence for specialized communal bison hunting in the Central Rockies. Groundstone tools and rock-filled roasting pits remain common and reflect a continued reliance on small seeds, roots and tubers. On the Northwestern Plains and to a lesser extent in the Intermontane basins of western Wyoming, people such as the proto-Crow, Apachean (Avonlea and Promontory) and probably Kiowa and Arapaho focused on big game hunting, utilizing communal hunting strategies, jumps and corrals. Ancestors of the Comanche, close relatives of the Eastern Shoshone, apparently transitioned from a high country foraging adaptation to specialized bison hunters. The evidence shows that ethnically diverse groups of Native Americans prospered throughout western Wyoming during the Late Prehistoric period.

According to both early historical accounts and the oral histories of Native American tribes, numerous distinct cultural groups occupied western Wyoming in the Late Prehistoric, Protohistoric and early Historic periods (Fowler 2001; Levy 2001; Parks 2001; Wright 1984). The Flathead, Blackfeet and Bannock, in addition to the Eastern Shoshone and Crow, are known to have hunted and at least occasionally lived in the Central Rockies (Wright 1984). The Kiowa and Arapaho are also believed to have lived in adjacent parts of the Northwestern Plains during the Late Prehistoric and Protohistoric periods (Fowler 2001; Levy 2001). Yet, the nonperishable material culture of these diverse peoples was so similar that, in the absence of pottery, it is impossible to identify sites to ethnic groups.

Historic Period, circa AD 1700-1876

There were profound changes to Native American culture and politics during the Early Historic period. European diseases, for which Native Americans had no natural immunity, decimated populations throughout the Americas after 1521. It is unknown when the first of many epidemics struck the people of the Central Rockies, but there is evidence from the Middle Missouri villages of the Hidatsa, Mandan and Arikara, for multiple epidemics in the beginning in the 17th century. The Shoshone living in the Central Rockies may have been largely spared from these early outbreaks due to their small group size, large territory and high mobility. The Shoshone acquired horses by around AD 1720 which resulted in a dramatic and rapid transition to a mounted bison hunting economy for some groups of the Shoshone (Wright 1984). The Shoshone quickly expanded their range to the north and east at the expense of the Crow, Blackfeet, Arapaho and other tribes who had not yet adopted large numbers of horses and who may have been more severely impacted by European disease given their closer proximity and cultural ties to the Plains Village people on the Middle Missouri. Other Shoshone people remained in the high country of the Central Rockies and continued to practice a foraging subsistence strategy that was at least partially focused on bighorn sheep procurement. The remains of numerous large and complex sheep traps, found throughout the Central Rockies attest to the importance of bighorn sheep to the mountain Shoshone during this time. The Shoshone who remained in the mountains came to be known as the Sheepeaters by their mounted bison-hunting cousins (Wright 1984), but it possible that membership in these groups was fluid with bands transitioning to and from a bison hunting strategy (Eakin 2006).

By about AD 1780 the Shoshone reached their greatest territorial extent, which extended north into Canada and east to the Black Hills (Wright 1984). By that time the horse had been successfully incorporated by most if not all tribes on the Northwestern Plains, many of whom had also acquired guns from trade with the British and Americans. Over the next several decades the Shoshone were driven back to the basins of western Wyoming, northeastern Utah and eastern Idaho where they were living when Euro-Americans made first contact in the early 1800s (Ambrose 1996; Rollins 1935; Wright 1984).

The fur trade had a profound effect on Native American tribes in and around the Central Rockies in the early 19th century. After several centuries of intensive overharvesting, beaver populations were depleted throughout the eastern woodlands and Great Lakes. Plains tribes, such as the Crow and Blackfoot, who had become increasingly reliant on European trade goods, began venturing into the Central Rockies to obtain beaver. Euro-Americans arrived for the same purpose by the first decade of the 19th century. The Shoshone quickly allied themselves with Euro-Americans, which may have triggered a roughly 20 year conflict between Euro-Americans and the Shoshone allies and some groups of the Blackfoot Confederacy (Russell 1921).

Euro-American occupation of the Central Rockies waned following the collapse of the fur trade in the early 1840s. The plains Shoshone, led by Chief Washakie agreed to settle on a reservation set aside for them on the Wind River in 1868 (Shimkin 1986). In 1871, Chief Washakie invited the remaining bands of Sheepeaters to settle on the Wind River Indian Reservation, an offer that appears to have been accepted by most bands (Haines 1996). Native American tribes, such as the Shoshone, Bannock, Crow and Nez Perce continued to hunt in the Central Rockies and passed through the region to hunt bison on the plains of Montana until the late 1870s at which time the bison herds were nearly extirpated. In 1876 a band of Nez Perce led by Chief Joseph were pursued by the US Army across the Central Rockies (Eakin 2009, 2015, 2016). Although the Shoshone continued to hunt in the Central Rockies, both within an outside the boundaries of the reservation, their traditional way of life, which had persisted for millennia, came to an end by about 1880.

Summary and Discussion

Paleoindian Periods

The Paleoindian periods in the Central Rockies span nearly 6,000 years and are represented by numerous distinct projectile point styles and at least two distinct ways of life. The Clovis, Goshen and Folsom complexes specialized in the exploitation of big game animals. Site attributed to these complexes have yet to be identified in the Central Rockies, but a few scattered isolated finds of the distinctive projectile points have been recovered in and around Jackson Hole. The evidence indicates that occupations of the Central Rockies by Clovis, Goshen and Folsom people was ephemeral, perhaps reflecting special use of the high country for acquisition of specific resources. Yet, the evidence also indicates that people of the Western Stemmed tradition, characterized by rather large and thick stemmed and lanceolate projectile points, were also present in the region by at least 12,000 cal BP. Unlike the

Clovis, Goshen and Folsom complexes, the people of the WST do not appear to have specialized in the big game hunting. WST faunal assemblages typically contain a mix of medium-sized artiodactyls and wide range of smaller mammals, birds and fish. Unlike Clovis, Goshen and Folsom, WST sites and isolated finds are fairly common throughout the Central Rockies, though these sites are often misidentified (Frison et al 2015; Wimer 2001) or simply ignored (Connor 1998; Johnson et al. 2004) in cultural historical summaries of the region.

There was a continuation of both specialized big game hunting and Paleoarchaic adaptations during the Middle Paleoindian period. However, there may not have been cultural continuity. The Agate Basin, Hell Gap and Alberta complexes, the stereotypical Middle Paleoindian period bison hunters of the plains and basins, do not appear to have originated from earlier bison hunting specialists such as Goshen or Folsom. The bifacial chipped stone technology used to produce Agate Basin, Hell Gap and Alberta projectile points most closely resembles the WST. If this assessment is correct, then it would appear that some WST people, after entering the plains and basins from the west transitioned from Paleoarchaic foragers to specialized big game hunters. Sites for this period in the foothills and mountains, however, reflect a continuation of Paleoarchaic foraging strategies. Stratigraphic evidence from the Medicine Lodge Creek (Frison 2007), Sorenson and Mangus (Husted 1969) sites show that WST occupations were not only present in the region, but that they preceded the Late Paleoindian Cody, Allen and Foothill-Mountain complexes. Several novel point types appear towards the end of the Middle Paleoindian period. On the plains these include the Scottsbluff and Eden point types. In the foothills and mountains the Angostura and unnamed fishtail point types first appear.

The radiocarbon record, though quite limited for the Middle Paleoindian period, reflects population increases in the Bighorn/Wind River Basins from 11,800-11,300 cal BP with stable, but low populations in the rest of western Wyoming. There was an apparent decline in human populations from circa 11,300-10,900 cal BP. This period was followed in the Bighorn/Wind River Basins by a two hundred year period of growth followed by a steady decline from circa 10,700-10,100 cal BP. Human population in the Central Rockies, however, appears to have grown significantly from about 10,900-10,300 cal BP. It was during this period of population growth that the unnamed fishtail, and WST points appear at Medicine Lodge Creek, and perhaps the Sorenson site (Frison 2007a; Husted 1969). Also, towards the end of this interval, parallel oblique flaking techniques emerge eventually leading to the Angostura point type, which remained a part of the toolkit for Foothill-Mountain complex peoples for the next two millennia.

The plains/foothill-mountain subsistence dichotomy persisted into the Late Paleoindian period (Frison 1997). On the plains Cody and Allen complex hunters continued to focus on bison hunting. Yet, the data also suggest these peoples began utilizing the high country on at least a seasonal basis, which may have been in response to increasing temperatures and decreased precipitation that led to reductions in bison populations on the plains and basins. There were two relatively brief intervals of apparent human population increase in the Bighorn/Wind River Basins from 9900-9700 cal BP and 9300-9100 cal BP, the latter increase was also reflected in radiocarbon record from the upper Green River Basin. Population growth was again more dramatic and sustained in the Central Rockies where there is a marked increase in the radiocarbon index from circa 9900-9500 cal BP. In the foothills and mountains the Lovell/Pryor stemmed projectile point type was added to the toolkit during this period of population growth, but did not replace the earlier Angostura type. Early in the period there is evidence from the foothills and mountains for the use of grinding stone technology to process small edible seeds as well as storage features that are believed to have provided some degree of security in the event of food shortages (Frison 1997, 2007; Frison and Grey 1980; Husted 1969). These changes mark the transition to a lifestyle that closely resembles that of later Archaic cultural complexes throughout North America. One could argue that the appearance of grinding tools and storage of edible plants in fact marks the beginning of the Archaic period in the Central Rockies at circa 10,200 cal BP.

Climate change was likely the impetus behind these subsistence changes in the foothills and mountains. Decreases in effective moisture and/or increased variability in precipitation appear to have negatively affected bison populations on the plains to such a degree that the specialized bison hunting strategies employed for millennia on the plains and basins were no longer viable, and bison hunting specialists disappear from the archaeological record. Although the radiocarbon record indicates that human populations in both the plains and foothill-mountain areas crashed at the onset of the Holocene Climatic Optimum, the broad-spectrum hunting and foraging strategy first used by the Foothill-Mountain complex continued to be utilized by hunter-gatherers for the next several thousand years.

Archaic Periods

The data clearly demonstrate that the low elevation basins of western Wyoming were not abandoned at the onset of the Holocene Climatic Optimum. Although populations and/or occupational intensity were very low in the Bighorn/Wind River Basins (Kelly et al. 2013), the people in the rest of western Wyoming appear to have recovered by circa 8400 cal BP and gradually increased throughout the Early Archaic period. There were apparently some regional fluctuations in human population, two of which could evidence immigration into the Central Rockies from surrounding areas. Between 6900-6500 cal BP and again between 6300-6100 cal BP inferred human populations increased in the Central Rockies but decreased in all surrounding regions. Conversely, apparent decreases in human population in the Central Rockies from 6500-6300 cal BP coincided with increases in the upper Green River Basin and the basins of southwestern Wyoming.

The Early Archaic period was marked by a diversification of stemmed and corner-notched projectile point styles. Although the evidence is far from definitive, there is some indication for temporal and perhaps spatial patterning in variation of point styles. A broad stem variety, identified at several sites in the Central Rockies, may represent one of the earliest (ca. 8400 cal BP) Archaic point styles in the region. Elko Eared, or Hanna-like, points also appear early (ca. 7900 cal BP) west of the continental divide and may have been more common there than the stereotypical side-notched forms, which predominate east of the divide. Early Archaic grinding tools, such as manos and metates, become more common and are more carefully crafted than those in use by earlier Foothill-Mountain complex people. Rock-filled roasting pits appear and become widespread during the Early Archaic. These technological changes likely reflect an intensification of the use and processing of small seeds, roots and tubers.

Provenance studies of obsidian and, to a lesser extent other chipped stone raw materials, may evidence group territories in the Central Rockies. East of the continental divide in the Central Rockies and greater Yellowstone River basin, most sampled obsidian came from the Yellowstone Plateau (Page 2016; Scheiber and Finley 2011). West of the divide in Jackson Hole and the Green River Basin, the majority of diagnostic obsidian artifacts were sourced to Jackson Hole. Obsidian artifacts, especially from lower elevation sites, may reflect the seasonal use of the high country with people west of the continental divide inhabiting Jackson Hole and the surrounding mountains during the spring through early winter and the Green River basin in the winter. A similar seasonal use of the Yellowstone Plateau, Absaroka and Washakie Ranges in the warm season, and the foothills and basins in the winter is evident in the lithic Early Archaic assemblage from Goff Creek (Page 2016).

Human populations in western Wyoming increased slightly or were relatively stable throughout most of the Middle Archaic period likely reflecting increased carrying capacity resulting from higher and less variable precipitation and lower temperatures. The McKean complex with its various stemmed, notched and lanceolate points spread rapidly throughout the Northwestern Plains and Intermontane basins or the west. The marked increase in roasting pits and grinding tools indicates that small seeds, roots and tubers were important components of the diet. Apart from this, the subsistence and settlement practices of McKean complex people changed very little from the Early Archaic.

There may have been some changes in mobility patterns during the Middle Archaic period. Obsidian diagnostics from the Green River are predominantly made of Malad and Bear Gulch obsidian from eastern Idaho and southwestern Montana (Scheiber and Finley 2011). In Jackson Hole there is a marked increase in obsidian from the Yellowstone Plateau. This may evidence a shift in settlement for people living in the Green River Basin. Perhaps, there was reduced seasonal movement between the Central Rockies and the Green River Basin, with people traveling west into high country of southeastern Idaho and Northern Utah rather than into Jackson Hole. Yellowstone and Bear Gulch obsidian continue to dominate obsidian assemblages during the Middle Archaic east of the continental divide (Scheiber and Finley 2011).

There was a gradual declining trend in human populations in all the low elevation regions of western Wyoming after circa 4000 cal BP. Although there was a period of increased aridity (ca. 4000-

3000 cal BP), human populations continued to decline following a return to moister conditions. This same trend has been documented throughout North America, which indicates that climate change was an unlikely cause. In the Central Rockies, however, populations continued to increase throughout this period, which may have been in response to immigration and/or increased occupational intensity and/or natural reproductive success and higher recruitment.

Corner-notched dart points replaced the stemmed, corner-notched/concave base and lanceolate stemmed points of the McKean complex. The timing and pace of this transition is not well documented in the Central Rockies. On the Northwestern Plains, there was return to specialized bison procurement, but in the Central Rockies and surrounding basins there is little evidence for changes in subsistence or settlement. Human populations increased dramatically in all regions of western Wyoming between after circa 2000 cal BP.

Late Prehistoric and Protohistoric Periods

The radiocarbon record is believed to be biased for the Late Prehistoric period because, in part, cross-dating of pottery often provides a rough age estimate and is significantly cheaper than a radiocarbon date. Moreover, fluctuations in the atmospheric concentration of ^{14}C during the Late Prehistoric period leads to ambiguous calibrated age ranges, that is, there are multiple possible calendar age ranges for a given date. The uncertainty of calibrated age ranges from this period has led some to forego the expense of radiocarbon dates of Late Prehistoric sites (Kelly et al. 2013; Peros et al. 2010). Thus the radiocarbon record cannot be used to infer human demographic trends during the Late Prehistoric period. The number and cultural variety of Late Prehistoric sites points to a period of rapid growth and population movement. The Avonlea people may have introduced bow and arrow technology to the Central Rockies around 1500 cal BP and appear to have resided at least on the margins of the Central Rockies for the next thousand years. The people of the Avonlea and Promontory complexes as well as the proto-Crow and others were specialized bison hunters, who also occasionally occupied the high country. The timing of the arrival of Numic-speaking peoples such as the Shoshone and Ute, continues to be debated, but they were almost certainly present in the western and southern Wyoming by circa 800 cal BP. Their way of life differed little from that of the Late Archaic foragers who preceded them and stood in contrast to the bison-hunting specialists on the plains and basins. Like the Late Paleoindian period, it appears that there was a real subsistence dichotomy between the people of the Central Rockies and those on the plains and basins. Yet, there is also evidence that this dichotomy lacked cultural boundaries. Some Shoshone stayed in the high country and Intermontane Basins, others (Comanche) moved onto the plains to hunt bison. There is nothing to preclude an opposite transition.

The corner, side and tri-notched arrow points in use during the Late Prehistoric period have large spatial distributions. We know that the same point types were in use by ethnically diverse populations throughout western North America. Pottery allows the identification of sites to ethnic groups, but in its absence, the ethnic identity of site occupants is difficult and in many cases impossible to ascertain. It is likely that earlier periods of prehistory, when projectile points were the only routinely recovered diagnostic, were just as ethnically diverse as the Late Prehistoric.

In closing, people have lived in the Central Rockies for at least the last 12,000 years. The exact history of these people is far from clear, and much more work is needed to flesh-out the nuances of material culture change and the adaptational response of hunter-gatherers to changing climatic conditions. Although the Central Rockies no longer appears to have served as a refugium in the strict sense of the term, there were multiple periods, some of significant duration, when subsistence appears to have been easier in the Central Rockies than in surrounding regions. This may have led to immigration, increased occupational intensity and greater reproductive success and recruitment. Thus, the high country did serve as a bastion for hunter-gathers if not a refuge. The evidence also shows that the Central Rockies and Jackson Hole, rather than a fringe, marginal area, was of central importance to hunter-gather populations throughout prehistory.

CHAPTER 4 GEOARCHAEOLOGY OF THE GAME CREEK SITE

William Eckerle, James Mayer, Orion Rogers, Sasha Taddie, and Michael Page

Project Purpose

Western GeoArch Research LLC (WGR) conducted geoarchaeological field investigations at the Game Creek site, 48TE1573, Teton County, Wyoming, at the request of the Office of the Wyoming State Archaeologist (OWSA). William Eckerle (WGR) conducted field investigations during the periods of July 1-6, 2010; September 7-13, 2010; September 14-16, 2011; and September 20-22, 2012. The objectives of the geoarchaeological investigations are to document the geologic and soils contexts of the site, assess contextual integrity of site artifact zones, and contribute to geoarchaeological knowledge of Jackson Hole, Wyoming. Documentation and description of the stratigraphy and soils at the site allows inference of depositional environment, pedogenic history, and paleoenvironment. Geomorphological analysis provides evidence of the paleotopography during the span of human occupation and gives a landscape context for the prehistoric activities that took place at the site. Archaeological interpretation requires that natural and cultural site formation processes be discerned, and an earth sciences approach helps document these processes.

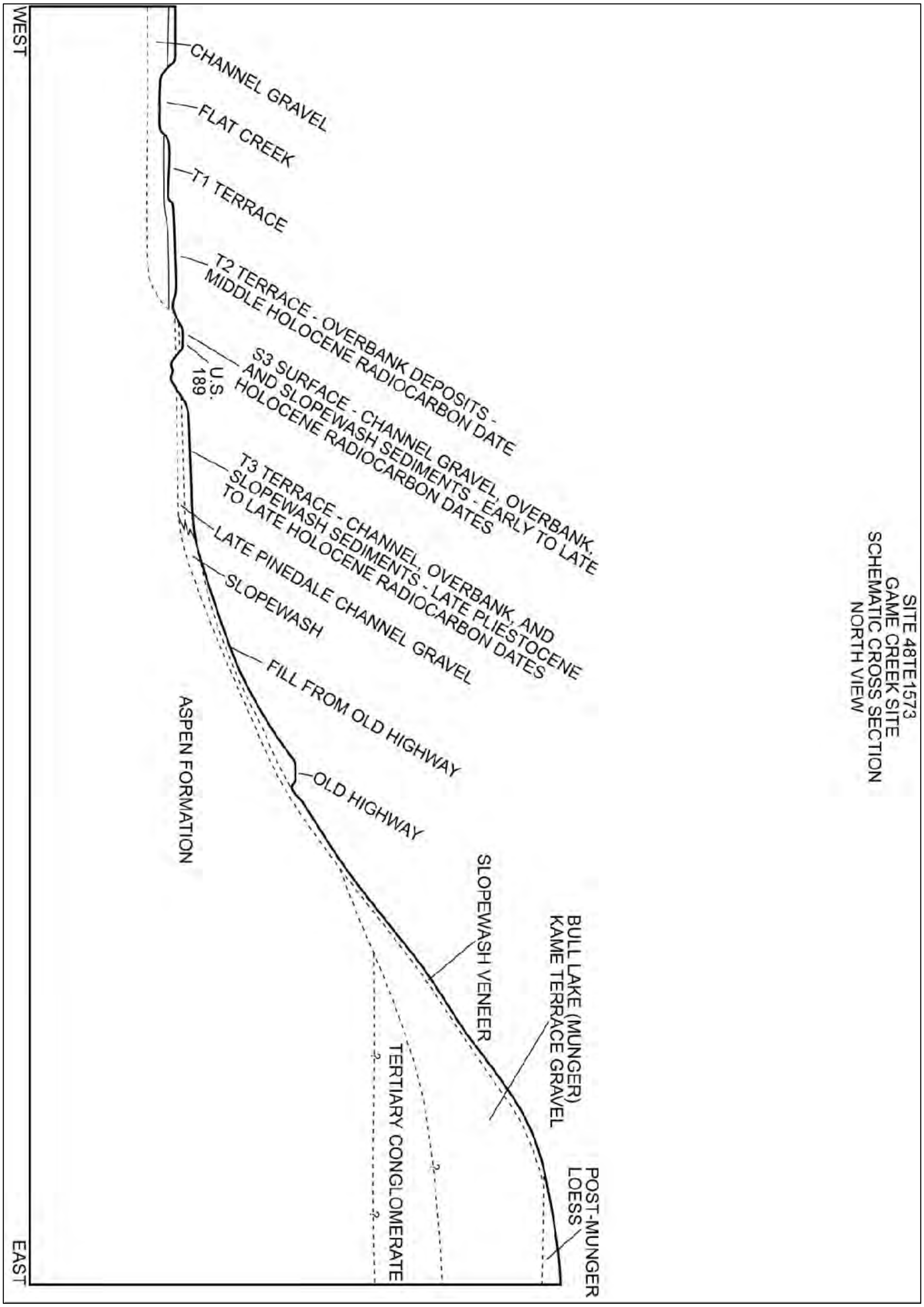
Overview of Site Landforms

Archaeological deposits at the Game Creek site are incorporated into an alluvial fan and terrace sequences at ~1812 m (Figure 4-1). Observations during the 2010-2012 site data recovery excavation phase provide information on the nature and origin of stratigraphic units, and more or less confirm the stratigraphic model developed during the 2002 testing phase (Eakin and Eckerle 2004; Eckerle and Taddie 2003). Preliminary investigations at 48TE1573 in 2002 established that the Game Creek site encompassed four separate landforms including T1, T2, and T3 terraces, and the S3 fan-terrace that contain buried cultural material.

A floodplain and low terrace (T1) covered by a thick growth of wet-meadow vegetation borders the creek and stands at an elevation of ~1814-1817 m. The slightly higher terrace tread of T2 is situated to the east at ~1817-1820 m. Late Archaic and Late Prehistoric cultural material is present in the T1 and T2 terraces. Extensive geoarchaeological investigations were not conducted on the T1/T2 terraces due to very limited exposures and the fact that most of this site area was outside of the project’s area of potential effect.

The slope of the valley wall rises steeply to the east of the site extending to an elevation of 2012 m (Figure 4-1). Above the site glacio-fluvial gravel composing the Munger terrace covers the slope and is, in turn, veneered with loess.

The T1 and T2 terraces contain sediments believed to be Middle/Late Archaic to Late Prehistoric in age. The T3 terrace, a latest Pleistocene through earliest Holocene alluvial-constructional landform is


SITE 48TE1573
GAME CREEK SITE
SCHEMATIC CROSS SECTION
NORTH VIEW
WEST
EAST
CHANNEL GRAVEL
FLAT CREEK
T1 TERRACE
T2 TERRACE - OVERBANK DEPOSITS - MIDDLE HOLOCENE RADIOCARBON DATE
U.S. 189
S3 SURFACE - CHANNEL GRAVEL, OVERBANK, AND SLOPEWASH SEDIMENTS - EARLY TO LATE HOLOCENE RADIOCARBON DATES
T3 TERRACE - CHANNEL, OVERBANK, AND SLOPEWASH SEDIMENTS - LATE PLIESTOCENE TO LATE HOLOCENE RADIOCARBON DATES
LATE PINEDALE CHANNEL GRAVEL
SLOPEWASH
FILL FROM OLD HIGHWAY
OLD HIGHWAY
ASPEN FORMATION
SLOPEWASH VENEER
BULL LAKE (MUNGER) KAME TERRACE GRAVEL
TERTIARY CONGLOMERATE
POST-MUNGER LOESS

situated primarily on the east side of U.S. Highway 26-89-189. This composite landform consists of latest Pleistocene and earliest Holocene axial and overbank alluvium of T3 Strata I-III (note that T3 and S3 have unique strata labeled by Roman numerals) buried by up to 1.5 m of middle Holocene and late Holocene colluvium (slopewash and debris flow) of T3 Strata IV and V. This colluvium is wedge-shaped, becoming both thinner and finer from east to west and convex north to south. Radiocarbon dates reveal that colluvial deposition occurred episodically over the span of up to seven millennia during the middle through late Holocene. The wedge of colluvium is derived from adjacent hillslopes as well as from a steep but shallow gully flowing from the east to west onto the site.

T3 contains Stratum I basal fluvial channel gravel and cobble deposits that date to the era of Pinedale deglaciation. The stratigraphy of T3 includes about 1 m of Stratum I over weathered Aspen Shale. A well-developed calcium carbonate horizon is formed into the upper contact of the T3 Stratum I gravel. T3 Stratum I is overlain in ascending order by T3 Stratum II channel-marginal (point bar, levee, etc.) alluvial sand and T3 Stratum III, a muddy, overbank deposit that contains a buried, humic A horizon with Late Paleoindian cultural material. This A horizon contains no evidence for a high water table suggesting that the Snake River channel had become incised with Strata II and III forming an overbank terrace at the time of this soil formation episode. The soil's humic nature and gradual lower boundary suggest that it probably formed in a grassland environment from root biomass decomposition. The overbank sequence is capped by T3 Strata IV-V colluvium deposits. While the overbank alluvial deposits (T3 Stratum III) contain primarily Paleoindian artifacts, the Stratum IV colluvium contains Foothills-Mountain Paleoindian and Archaic cultural material, and the Stratum V colluvium deposit, that includes a debris flow contains, a few Late Prehistoric cultural remains. A thick and dark colored A horizon with some granular soil structure is formed in the T3 Stratum V and upper half of T3 Stratum IV.

The S3 landform consists of poorly exposed basal fluvial stream channel gravel (S3 Stratum I) overlain by fluvial sands (S3 Stratum II), then overbank alluvial sediment with colluvium interbeds (S3 Stratum III/IV), overlain by colluvium (S3 V-VII) with highway construction fill forming a surface zone of varying thickness (Eakin and Eckerle 2004; Eckerle and Taddie 2003). The basal gravel is undated but is topographically similar to, but slightly lower in elevation than T3 Stratum I, the latest Pleistocene Snake River channel gravel. S3 Stratum II and III alluvial sediments, overlying the channel gravel yielded dates of 7896±40 and 9517 ± 20 cal BP from the upper contact of S3 Stratum III during the 2002 testing suggesting that they are nearly equivalent to T3 Stratum III. Slightly younger, sharp-bounded and organic-rich O and/or fluventic A horizons occur near the upper contact of S3 Stratum III suggesting that the setting was a floodplain, probably within a riparian shrub or riparian forest over-story in contrast to the more diffusely expressed, humic A horizon in T3 Stratum III, the latter of which suggests formation under grassland vegetation. Redoximorphic pedogenesis in S3 Stratum II and III lends support to the interpretation that the S3 area had a more persistent, seasonally high water table than T3 Stratum III.

Sediments in S3 Stratum III-VII, investigated during data recovery, produced Early Archaic through Late Prehistoric-era radiocarbon dates and artifacts. A thick pachic to composite-welded, A horizon biomantle is formed in the S3 Strata IV-VII that contains the occupation zone. There is evidence of substantial vertical mixing of cultural material within S3 Strata IV-VII. A date of 4638±93 cal BP was recovered from a test unit (TU104) on T2 during the 2002 testing (Eakin and Eckerle 2004; Eckerle and Taddie 2003) indicating that lateral aggradation by the Snake River sometime prior to this date back-cut the T3/S3 terrace tread eastward and formed their present valley-facing scarp. This event is probably related to channel diversion of the Snake River from west valley flowing to east valley flowing. This channel migration had the potential to cause the deposition of Crescent H Ranch source obsidian boulders and pebbles on Snake River channel bars at and adjacent to the site at the beginning of the second half of the Holocene.

Methods and Techniques

Strata Descriptions

The deposits at the Game Creek site are divided into strata based primarily on similarities and differences in texture and/or sedimentary structure. The nomenclature that was established during the initial geoarchaeological work at the site (Eckerle and Taddie 2003) is modified in this report. During 2002 investigations, in order to describe strata exhibiting a range of characteristics due to textural changes, lower-case letters were assigned to subdivisions (e.g., Stratum Ia, Ib, Ic), and the type of variability was specified in the field notes. The stratigraphic subdivisions utilized in this report are lithostratigraphic units, with subdivisions based on the amount of gravel (>2 mm) that is present and corresponding with the Folk (1980) terminology (Figure 4-2).

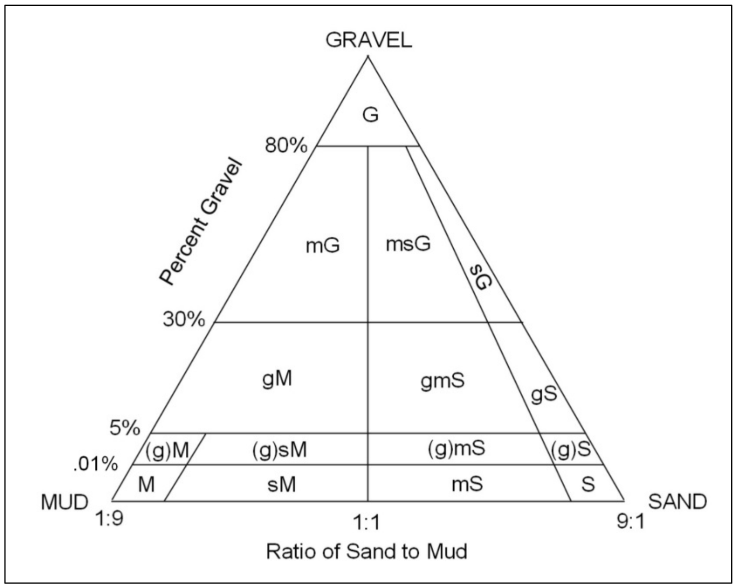


Figure 4-2. Textural classification after Folk (1980).

In addition, differences in lithostratigraphy between the T3 terrace and the S3 fan-terrace resulted in landform specific strata. These landform specific strata are designated by the prefix of T3 versus S3. Although there are parallels, the strata numbering sequence is not necessarily chronostratigraphically-correlatable between the T3 and S3 surfaces.

Geological descriptive methods used for this investigation generally adhere to Compton (1985). The modified Wentworth Scale (Dutro et al. 1982) is used throughout. Color terminology follows the

Munsell system. Roundness descriptions are those presented by the American Geological Institute (Dutro et al. 1982).

Soil Horizon Descriptions

Soil horizons are designated using *Soil Taxonomy* (USDA, NRCS 1999) where master horizons are denoted by capital letters and additional characteristics identified by lowercase suffixes (Table 4-1). The suffix “b”, used for buried horizons, by convention follows all other suffixes (e.g. Bkb) and is not used for C horizons (Schoeneberger et al. 2002). Lithological discontinuities are indicated by numerical prefixes with “1” understood but not shown by convention (Schoeneberger et al. 2002); for example, A, AB, Btk, C, 2Ck, where “2Ck” marks a distinct lithostratigraphic unit. Subdivisions within a master horizon are denoted by numerical suffixes (e.g., A, Btk1, Btk2, 2CK1, 2CK2). The prime “`” symbol is used to indicate the occurrence of identical horizon descriptors within a profile (e.g., 2Ck1, 2Ck2, 2C`k1). Carbonate and gypsum stage descriptions follow Birkeland’s (1984, 1999) six stage classification.

Another of Birkeland's modifications that sometimes has applicability is the ">" symbol, which designates a horizon in a state of major genetic transition. The designation to the left of the > indicates characteristics that formed when the buried soil was a surface soil. On the right of the > is the designation of characteristics that are thought to be the result of post-burial pedogenesis (engulfment) or polygenetic processes (e.g. Ab>Bk).

Table 4-1 Horizon nomenclature used herein (after Schoeneberger et al. 2002).

Master Horizon	Criteria
A	Mineral: organic matter accumulation, loss of Fe, Al, clay
AB	Dominantly A horizon characteristics but also contains some characteristics of the B horizon
A/B	Discrete, intermingled bodies of A and B; majority of horizon is A material
AC	Dominantly A horizon characteristics but also contains some characteristics of C horizon
B	Subsurface accumulation of clay, Fe, Al, Si, humus, $CaCO_3$, $CaSO_4$, or loss of $CaCO_3$, etc.
BC	Dominantly B horizon characteristics but also contains some characteristics of the C horizon
B/C	Discrete, intermingled bodies of B and C material; majority of horizon is B material
C	Little or no pedogenic alteration of parent material
Suffix	Criteria
b	Buried genetic horizon(not used with C horizons)
g	Strong gley
k	Pedogenic carbonate accumulation
p	Artificial disturbance
r	Weathered or soft bedrock
t	Illuvial accumulation of silicate clay
w	Weak color or structure within B

Site Formation Processes

Post-Burial Dispersal and Alteration

A wide range of processes can act to disperse and alter archaeological remains after burial. Erosion and subsequent redeposition can produce a secondary deposit that preserves little or no behavioral context (Butzer 1982; Schiffer 1987). In the event that a site is buried in more or less primary context, archaeological zones may still experience several biogenic and geogenic dispersal processes. The subsurface matrix surrounding artifacts is dynamic and constantly mixed by soil forming processes related to plant growth, animal and insect burrowing, and expansion and contraction due to wet-dry and/or freeze-thaw cycles. These post-burial effects are cumulative and can partly modify or completely alter the original context of archaeological sites (Waters 1992). Post-burial processes are briefly outlined below and more complete discussions can be found in Butzer (1982), Schiffer (1987), Waters (1992), and Wood and Johnson (1978).

Expansion and contraction of the soil and sedimentary matrix are the result of freeze-thaw (cryoturbation) and wet-dry cycles. Cryoturbation is most prominent in fine-grained deposits where freezing temperatures are sustained for long periods, and where soil moisture is abundant (Kessler and Werner 2003). Freeze-thaw cycles may last seasonally or overnight (diurnally). As soils freeze from the surface down, artifacts are “plucked” upward resulting in a void below the artifact. As thawing commences, particles settle into the voids, thus preventing an artifact from returning to its original position. The net effect of this process is upward movement of artifacts, possibly to the point of being ejected onto the ground surface. Work in the Colorado Front Range suggests artifacts with longer axes and larger surface areas are more quickly displaced by cryoturbation than are smaller ones (Benedict and Olson 1978). Cryoturbation may not only destroy archaeological contexts, but it may also damage artifacts through abrasion as they move through the matrix. In areas where colluvial processes occur over frozen substrates (solifluction), stratigraphy can be convoluted by downslope transport.

Depending on the original context of archaeological remains, wet-dry cycles can have similar effects as cryoturbation. Wetting and drying is most prominent in Vertisols (self-swallowing), soils composed of expandable clay minerals (argilliturbation) with pronounced wet and dry seasons (Soil Survey Staff 1999). During dry periods, desiccation cracks penetrate into the subsoil, and artifacts and other material on the surface may fall into the cracks. Likewise, the matrix swells upon wetting, and artifacts in a buried context can be jacked upwards in the matrix, possibly being ejected onto the ground surface. Surface evidence for ongoing shrinking and swelling of clay-rich soils are patterns of mounds and depressions referred to as gilgai. Continued wet-dry cycles can destroy stratigraphy and soil horizonation, and modify or completely alter the spatial relationships among artifacts (Waters 1992:300).

Bioturbation is a broad category of physical mixing processes resulting from plant growth (floralturbation) and burrowing organisms (faunalturbation). Floralturbation is most common in areas of tree and/or shrub growth, and includes disturbances of archaeological sites by root growth and decay, and tree-throw. Displacement by root growth results when artifacts and features are displaced or modified due to the expansion and penetration of root systems. The in-place decay of roots may form voids, into which artifacts can fall as the voids collapse and are filled with younger sediments. Probably the most damage to archaeological sites by floralturbation is caused by tree-throw. As trees are toppled by heavy winds and/or gravity, large hollows form where the root mass is upturned (Gabet et al. 2003). Depending on the size of the tree and root system, the hollows can be several meters across. Archaeological deposits entwined in the root mat are removed from the subsurface. Through time, artifacts and sediments adhering to the root mass fall in and around the margin of the depression. Ongoing tree-throw creates several pits and ridges referred to as cradle-knoll topography. In heavily forested areas, tree-throw can obliterate stratigraphy and modify or destroy the context of even large archaeological sites.

As summarized by Waters (1992:309-310), faunalturbation results from mixing due to burrowing vertebrates (mammals, amphibians, birds, and reptiles) and invertebrates (insects, earthworms, and crustaceans). The degree of faunalturbation at any given site depends on the type and number of burrowing animals present, as well as the nature of deposits. Nevertheless, the end result is partial or total disturbance of archaeological contexts. In deposits that are resistant to collapse, burrows are in-filled with overlying sediments, forming krotovina that are discernable from the surrounding matrix by differences in texture, color, and/or compaction. In less-compact deposits, such as recent dune sands, burrows may collapse and fill with similar surrounding matrix, making them difficult to discern. Several generations of cross cutting burrow systems may move even large artifacts. Burrowing by pocket gophers, for example can concentrate large stones and artifacts at the base of the zone of maximum bioturbation (Johnson 1989). In upland settings in the Midwest, earthworms can play a role not only in disturbing fine-grained matrices, but may be the primary mode of archaeological site burial (Van Nest 2002). In areas of high earthworm activity, artifacts may be slowly translocated to the base of the disturbed zone.

Saturation is an important post-burial process in seasonally or perennially wet settings. As a rule, saturated settings tend to produce remarkably well-preserved organic archaeological materials. Famous examples of well-preserved human remains are the peat bogs in northern Europe producing the “bog bodies” (Coles 1988; Coles and Coles 1989) and the Windover site in Florida (Doran and Dickel 1988), which produced human remains, including brain tissue. Other finds include a wide array of wood and plant remains including art objects, tools, and dwelling structures (Hayen 1987; Zvelebil 1987; Purdy 1991). In a comparison of archaeological materials from sites in Europe, Coles (1987) demonstrated that sites in wetland and dryland settings are characterized by similar preservation of the non-organic zones (i.e., stone, flint, bronze, glass, and pottery), but wetlands contain substantially more organic remains (i.e., dung, antler, wood, skin, basketry, etc.). Nevertheless, preservation or degradation of organic remains in saturated environments is variable (Coles 1987; Caple 2001; Cronyn 2001), and depends largely on the local characteristics of the "burial context", which is characterized by a host of biological, chemical, and physical processes (Raiswell 2001), each of which may vary temporally and spatially.

As mentioned by Holliday (2004:266) draining of wetlands, either as a result of land use or natural environmental change, results in decomposition and oxidation of organic matter. While few studies exist that examine such phenomena, the result is likely detrimental to organic archaeological zones (Van Heeringen and Theunissen 2001). One result of dewatering of organic sediments is compaction. At the Lubbock Lake archaeological site in Lubbock, TX, skeletal remains of an adult *Bison antiquus* from a Paleoindian level in marsh sediments were crushed to ~2 cm thick (Johnson 1987).

Fieldwork Results: T3 Terrace

Stratigraphy and Soils

Five backhoe trenches, 14 test units and 124 1-x-1 meter excavation units were placed on the T3 terrace. Over the course of the investigations, different aspects of the stratigraphic sequence have been observed on T3. The preliminary stratigraphic framework for T3 established during the 2002 testing (Eakin and Eckerle 2004) has since been modified and expanded by additional information gathered during data recovery excavations. Table 4-2 lists and Table 4-3 describes strata documented on the T3 terrace and shows both 2002 and final strata correlations. Table 4-2 presents a master stratigraphic sequence; however in no profile were all substrata observed in sequence. Five major late Quaternary stratigraphic units overlie the Aspen Shale and are designated (from oldest to youngest) as T3 Strata I through V.

Aspen Shale outcrops in at the southern end of the Game Creek. This bedrock forms a strath terrace which is covered by an estimated 1 m of fluvial gravel designated as Stratum I which consists of pale brown, loose, sandy small cobbly gravel. This gravel forms the basal unconsolidated deposit on both T3 and S3 and is a remnant of a former, higher Snake River valley bottom. Clasts currently transported by the Snake River are predominantly quartzite (Table 4-4), and this is the majority lithology of T3 gravels. Minor amounts of igneous (basalt, gneiss, obsidian, granite) rocks occur and are likely derived from the Snake River and from Flat Creek as well as from upslope and up-river Munger-age moraines. Secondary carbonate accumulations (Bk/Ck horizons) at the top of Stratum I are concentrated on the sides and bottom of clasts at and north of Block A but are equally prevalent on tops as well as sides and bottoms of clasts in the vicinity of Blocks D and E. Stratum I underlies and predates the oldest date from the site, which is the 16,300 ± 1500 BP OSL date from Stratum II in Block B. The coarse texture, geomorphic position, and overlying T3 Stratum II dates are interpreted to indicate that T3 Stratum I is late Pleistocene in age. Topographic relief observed in upper T3 Stratum I may indicate that the latest Pleistocene geomorphic context was a braided channel with bar and swale morphology, consistent with Pinedale fluvial contexts in Jackson Hole (Fryxell 1930; Love et al. 2007; Pierce 2004).

ta for the T3 Landform.

	Typical Lithology	Depositional Environment	Approximate (
	trace to slightly gravelly sandy mud	Slopewash	ca. AD 1100 t(
	lenses of gravelly muddy sand	Debris Flow	ca. AD 1100
	lenses of sandy muddy gravel	Debris Flow	ca. AD 1100
	gravelly sandy mud	Slopewash	ca. 6000 BC tc
[	trace to slightly gravelly sandy mud	Slopewash	ca. 7000 BC tc
	gravelly sandy mud	Overbank Alluvium with Slopewash	ca. 9000 to 70(
	carbonate-enriched mud	Overbank Alluvium with Slopewash	ca. 9000 to 70(
:	trace gravelly sandy mud	Overbank Alluvium with Slopewash	ca. 9000 to 70(
	sandy mud	Overbank Alluvium with Slopewash	ca. 9000 to 70(
	muddy sand	Fluvial Channel Marginal	ca. 14,000 to 9
	slightly gravelly muddy sand	Fluvial Channel Marginal	ca. 14,000 to 9
	muddy sandy gravel	Fluvial Channel	ca. >14,000 B(

acteristics for Block A.

Strata	Moist Color (Munsell)	Structure	Texture (Folk 1980)	Soil Horizons	Depos
V(g)m	10YR 5/3	Massive	Slightly Pebbly Sandy Mud	A	Slopewasl
Vmg	10YR 5/3	Discontinuous Massive Lenses	Slightly Muddy Pebbly Gravel	C	Debris Flc
IV(g)m	10YR 2/1 to 3/2	Massive	Slightly Pebbly Sandy Mud	ABb, ABkb	Slopewasl
III(g)m	10YR 4/2	Massive	Slightly Pebbly Sandy Mud	Bkb	Slopewasl Marginal
II	10YR 3/2	Massive	Slightly Pebbly Medium to Very Fine Sand	2Ckb	Fluvial Cł
I	10YR 3.5/3	Massive	Small Cobbly Gravel	2Ckb2	Fluvial Cł

Table 4-4. Simplified lithology of four gravel samples from site vicinity.

Sample	Limestone	Sandstone	Shale	Quartzite	Igneous
Game Cr. Fan Toe	67.9%	8.5%	0.9%	20.8%	1.9%
Snake River	0.0%	5.5%	0.0%	88.3%	6.1%
Game Creek Streambed	94.3%	5.7%	0.0%	0.0%	0.0%
Game Cr. Valley	97.2%	1.9%	0.9%	0.0%	0.0%

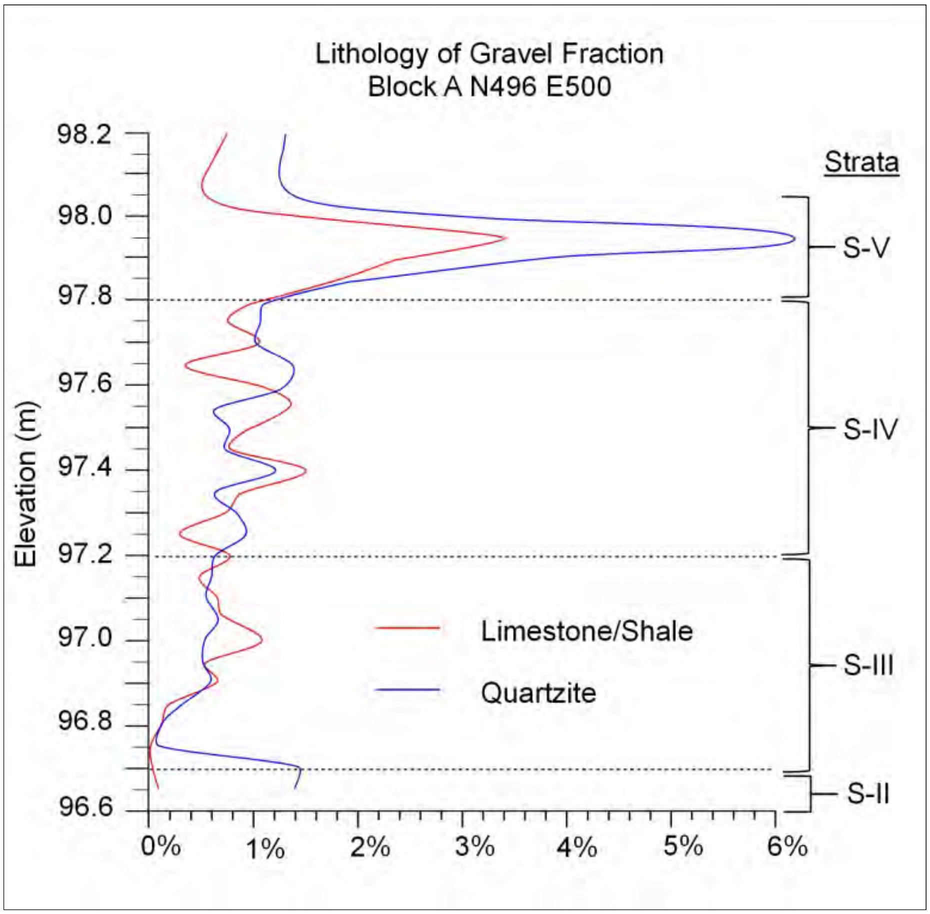


Figure 4-3 Lithology of gravel fraction from Block A N496 E500.

The overlying Stratum II is interpreted as fluvial sand that is generally less than 10-20 cm thick but in some locations is over 30 cm thick. It consists of grayish brown, fining upwards, slightly pebbly silty very fine sand to sandy mud. Stratum II is discontinuous across the T3 terrace, but where present, it exhibits a disconformable-abrupt contact with Stratum I. Its texture and stratigraphic position suggest it is a channel marginal deposit resulting from levee, point bar, or proximal overbank alluvial deposition. The visible contact between Strata II and III corresponds closely with a sharp decrease in the volume of gravel that is composed mostly of rounded quartzite pebbles (Figures 4-3 and 4-6). Stratum II has a single Ck soil horizon composed of grayish brown to brown, massive, silty, very fine sand, with Stage I to I+ calcium carbonate development. An OSL sample was taken from the lower contact of Stratum II dates to 16,300 ± 1500 BP. This suggests that Strata I and II aggraded at the termination of the Jackson Lake (Pinedale) glaciation and represent a shift in stream energy during the transition from glacial to post-glacial flow regimes.

Stratum III covers most of the T3 terrace, but is absent south of the spring and gradually decreases in thickness to the. Stratum III is a 5-80 cm thick wedge-shaped bed of grayish brown, massive, slightly gravelly sandy mud (Substratum III(g)sM) and gravelly mud (Substratum IIIgM). The slightly gravelly sandy mud (Substratum III(g)sM) is the most common substratum. Gravels, mostly in the pebble size (4–64 mm) fraction, occur throughout Stratum III in low percentages overall (.01-2.0%). Many samples show an increase in rounded quartzite pebbles in the lower 5–10 cm of Stratum III that likely come from the underlying Stratum I and II and were incorporated into Stratum III by occupational trampling and/or faunalturbation. The lowest volume of gravel in Stratum III corresponds with the Late Paleoindian occupation and a paleosol. There is a gradual increase in the volume of gravel, mostly subangular to angular limestone and shale, above the paleosol reflecting an increase in the contribution of colluvial (slope wash) deposits (Figure 4-3). Results of granulometry analysis of a column from Block A show that about 45% of Stratum III is composed of clay (Figure 4-6).

The relatively fine-grained muddy texture and low pebble content, as well as the stratigraphic position overlying Stratum II sandy alluvium, suggests that Stratum III is overbank floodplain alluvium deposited when the Snake River migrated westward and/or when its channel became incised into Strata I and II. Interbedding with colluvium occurred throughout the deposition of the stratum along the eastern margin of the terrace, but no clear interfingering of sediments was discernible in excavation profiles.

Reticulated soil pedogenic features were identified in Stratum III during data recovery (Figure 4-4). Reticulated soil structure sometimes occurs when soil experiences intense freezing (Ping et al. 2008). However, a cryogenic origin for these soil features was not confirmed through soil micromorphological assessment by Paul Goldberg, Boston University, who instead suggests that they result from carbonate enrichment along former root voids and desiccation cracks. In any case, these features represent Ck horizon, post-depositional calcium carbonate enrichment and, as such, are illuvial pedogenic rather than sedimentary features.

Soils in Stratum III include one to six carbonaceous C horizons (Eakin and Eckerle 2004). and a buried, carbonaceous, Akb or ABkb horizon. Where present, the paleosol is usually ~20 cm thick, composed of dark grayish brown, clay loam, and is beneath one or more Stratum III Ck horizons that are 10–50 cm thick (Figures 4-6 through 4-15). In most profiles, there is also a Stratum III Ck horizon

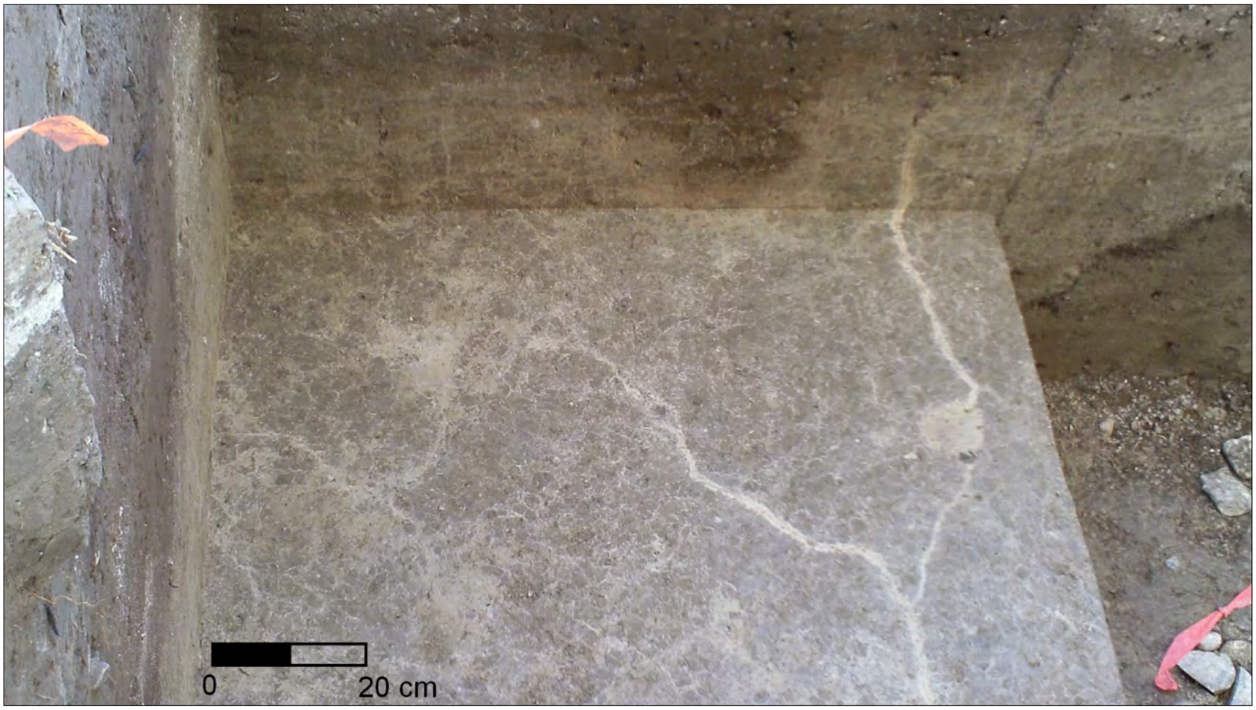
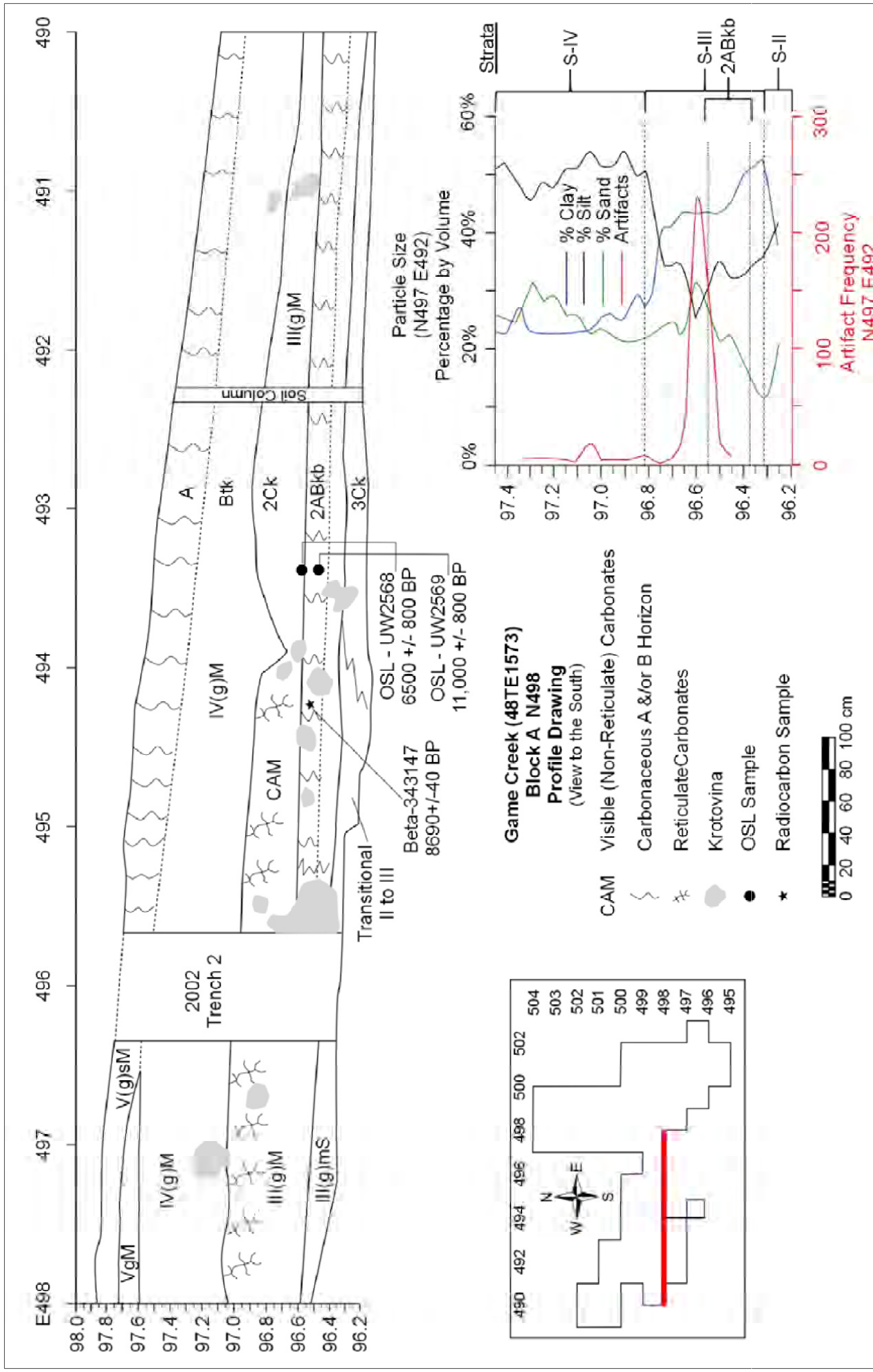
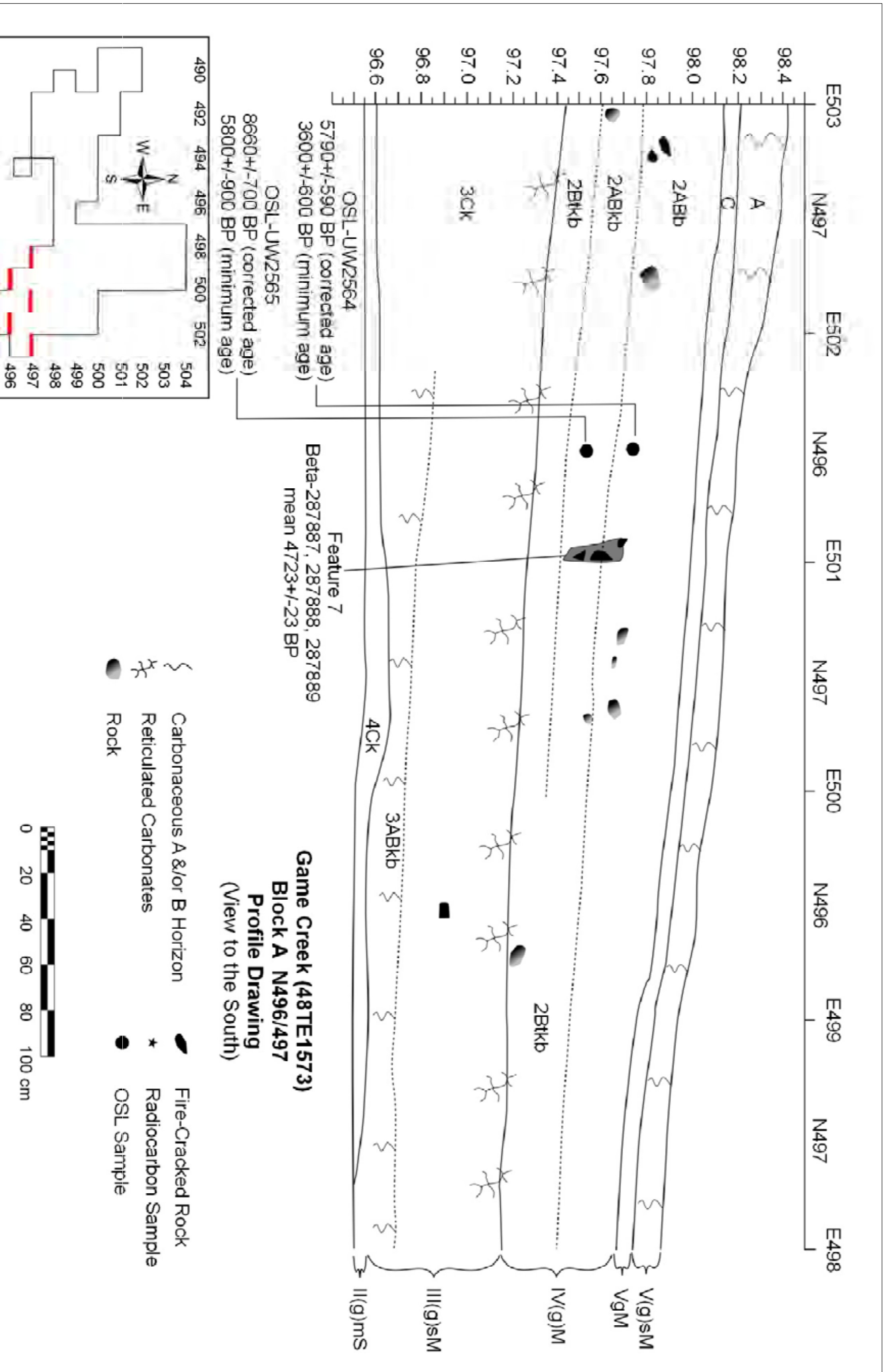
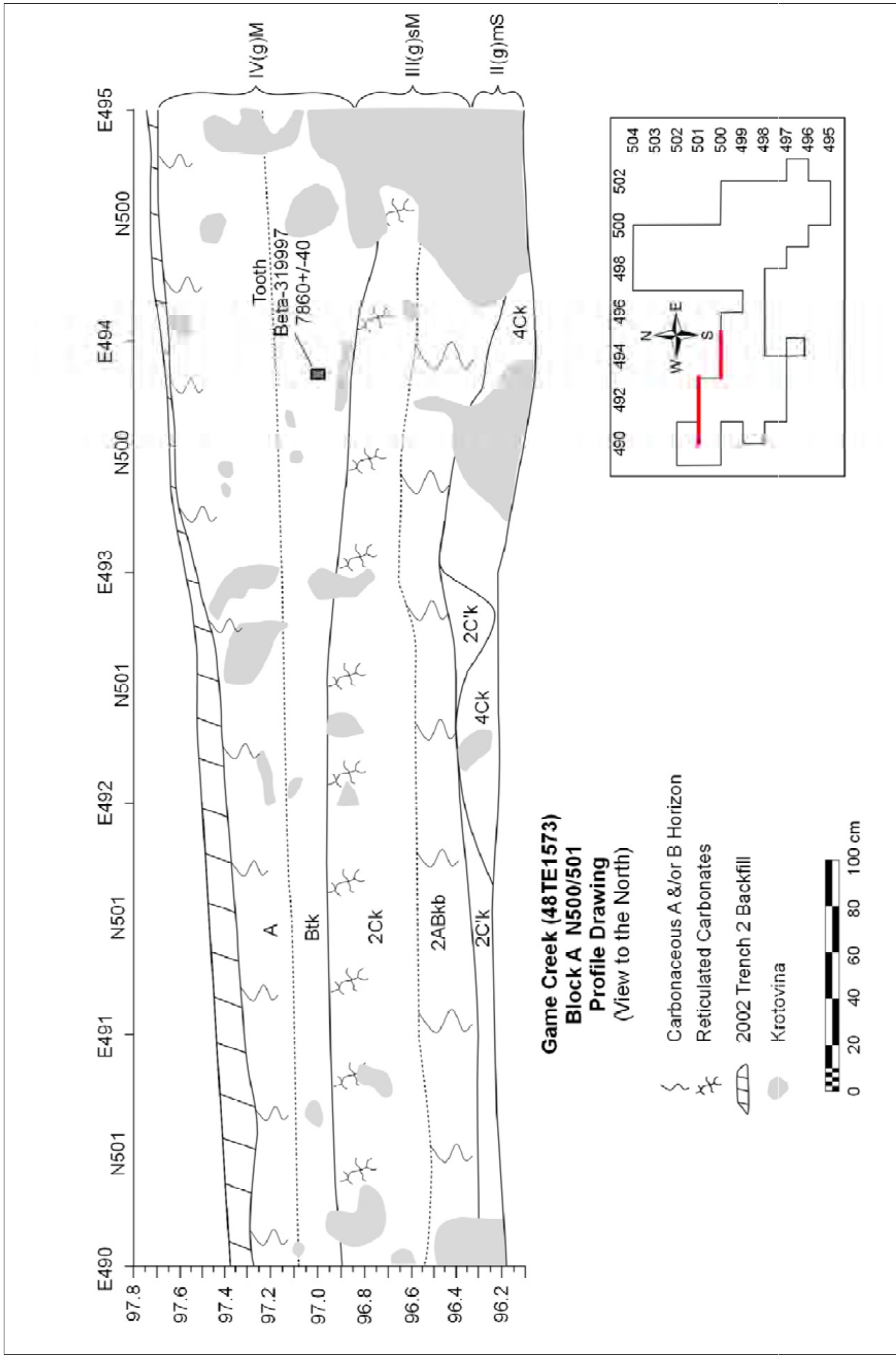


Figure 4-4 Photograph of reticulated carbonate soil features in T3 S-III.

Figure 4-5 Photograph of buried A Horizon near the base of Stratum III. Block A N497 E491-493. View to the south.


Game Creek (48TE1573)
Block A N498
Profile Drawing
(View to the South)
CAM Visible (Non-Reticulate) Carbonates
Carbonaceous A &/or B Horizon
ReticulateCarbonates
Krotovina
OSL Sample
Radiocarbon Sample
0 20 40 60 80 100 cm
OSL - UW2568
6500 +/- 800 BP
OSL - UW2569
11,000 +/- 800 BP
Beta-343147
8690+/-40 BP
Transitional
II to III
2002
Trench 2
Soil Column
A
Btk
2Ck
2ABkb
3Ck
IV(g)M
III(g)M
CAM
V(g)sM
VgM
III(g)mS
Particle Size
(N497 E492)
Percentage by Volume
% Clay
% Silt
% Sand
Artifacts
Artifact Frequency
N497 E492
Strata
S-IV
S-III
2ABkb
S-II


E503
N497
E502
N496
E501
N497
E500
N496
E499
N497
E498
98.4
98.2
98.0
97.8
97.6
97.4
97.2
97.0
96.8
96.6
A
C
2ABb
2ABkb
2Btkb
3Ck
4Ck
3ABkb
2Btkb
V(g)sM
VgM
IV(g)M
III(g)sM
II(g)mS
OSL-UW2564
5790+/-590 BP (corrected age)
3600+/-600 BP (minimum age)
OSL-UW2565
8660+/-700 BP (corrected age)
5800+/-900 BP (minimum age)
Feature 7
Beta-287887, 287888, 287889
mean 4723+/-23 BP
Game Creek (48TE1573)
Block A N496/497
Profile Drawing
(View to the South)
Carbonaceous A &/or B Horizon
Reticulated Carbonates
Rock
Fire-Cracked Rock
Radiocarbon Sample
OSL Sample
0 20 40 60 80 100 cm
N
S
E
W
490 492 494 496 498 500 502
504
503
502
501
500
499
498
497
496


Game Creek (48TE1573)
Block A N500/501
Profile Drawing
(View to the North)
Carbonaceous A &/or B Horizon
Reticulated Carbonates
2002 Trench 2 Backfill
Krotovina
0 20 40 60 80 100 cm
IV(g)M
III(g)sM
II(g)mS
Tooth
Beta-319997
7860+/-40
A
Btk
2Ck
2ABkb
2C'k
4Ck
E490
N501
E491
E492
E493
N500
E494
E495
97.8
97.6
97.4
97.2
97.0
96.8
96.6
96.4
96.2
N
E
S
W
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492
494
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503
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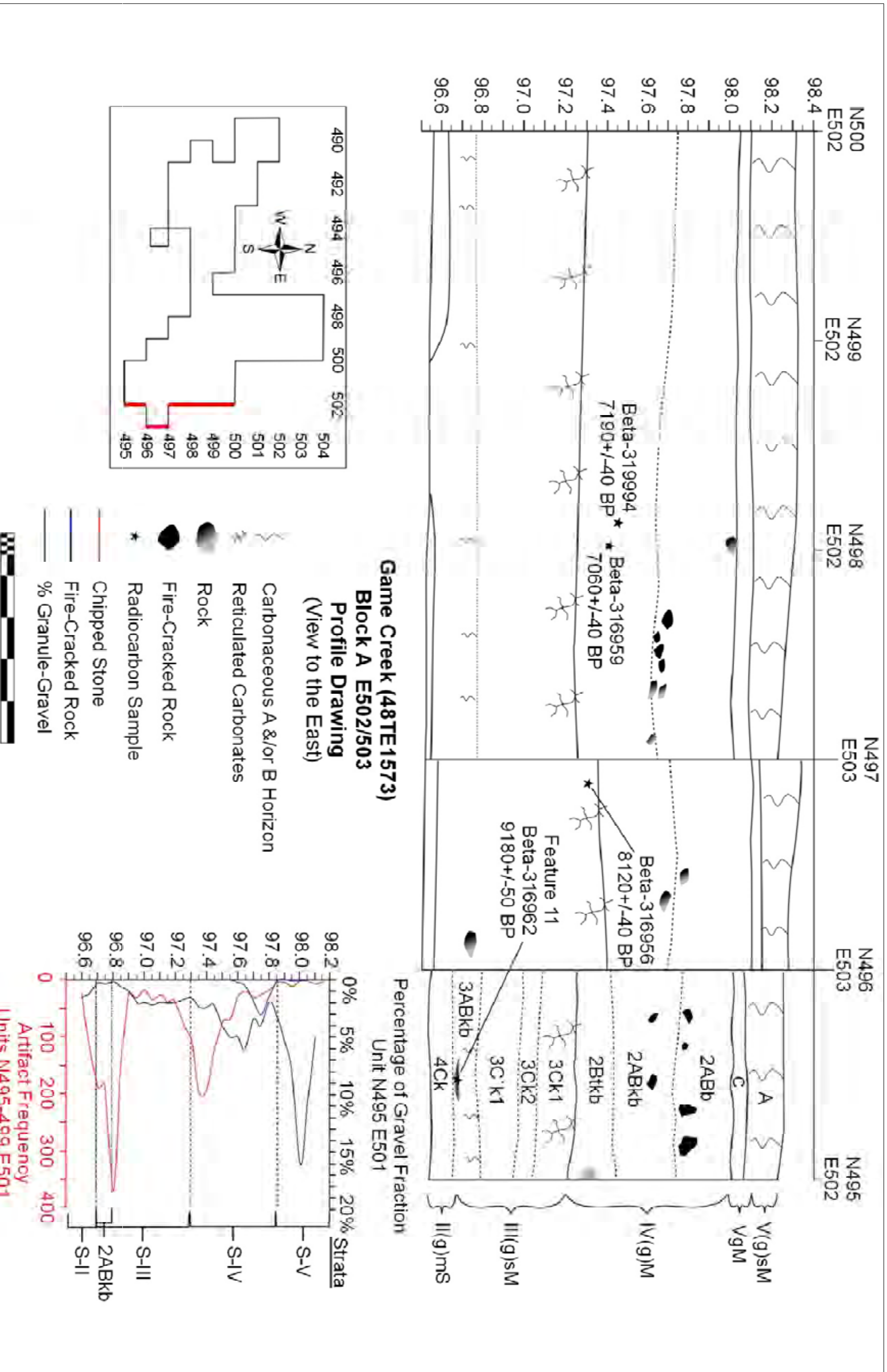
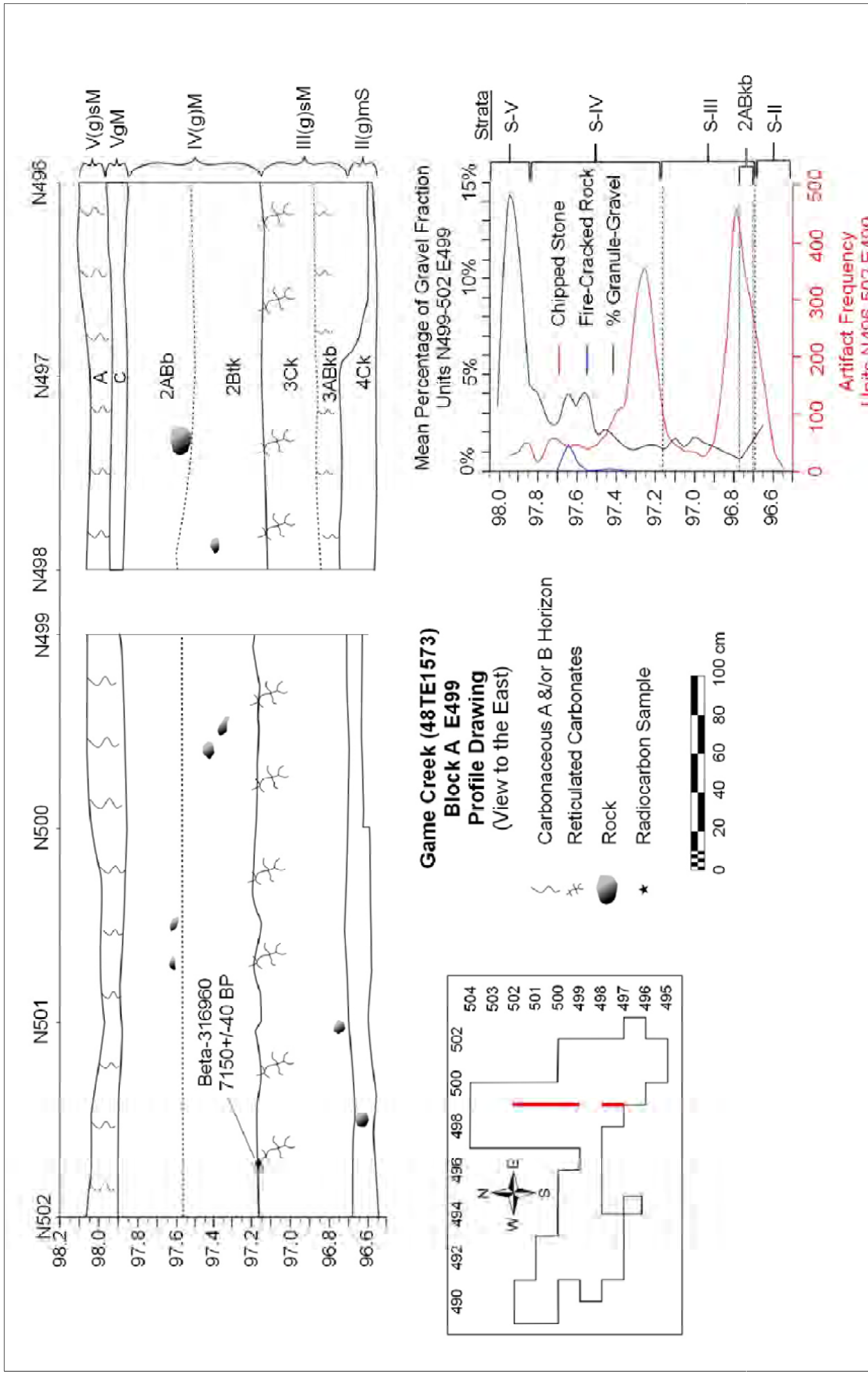
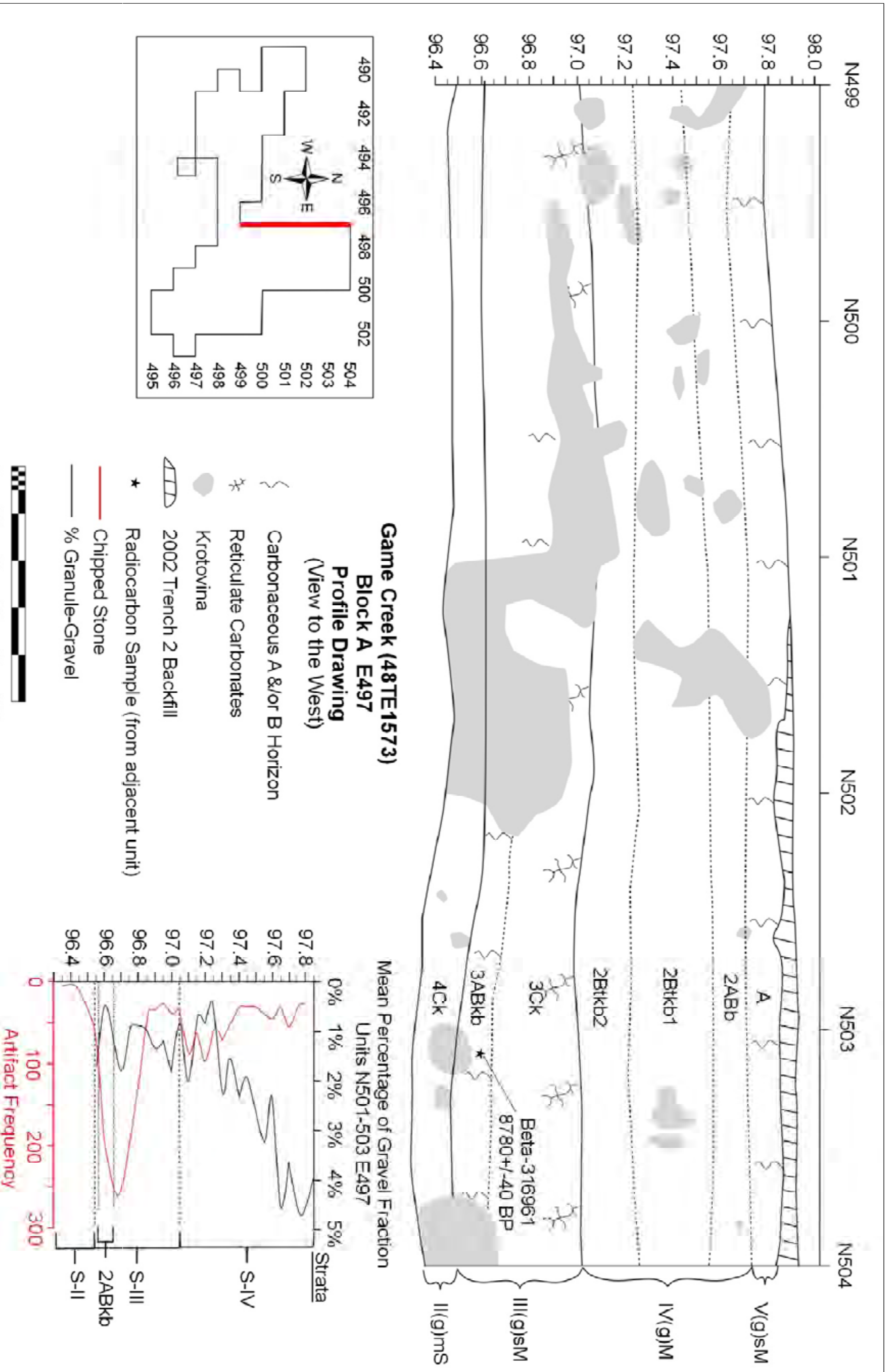
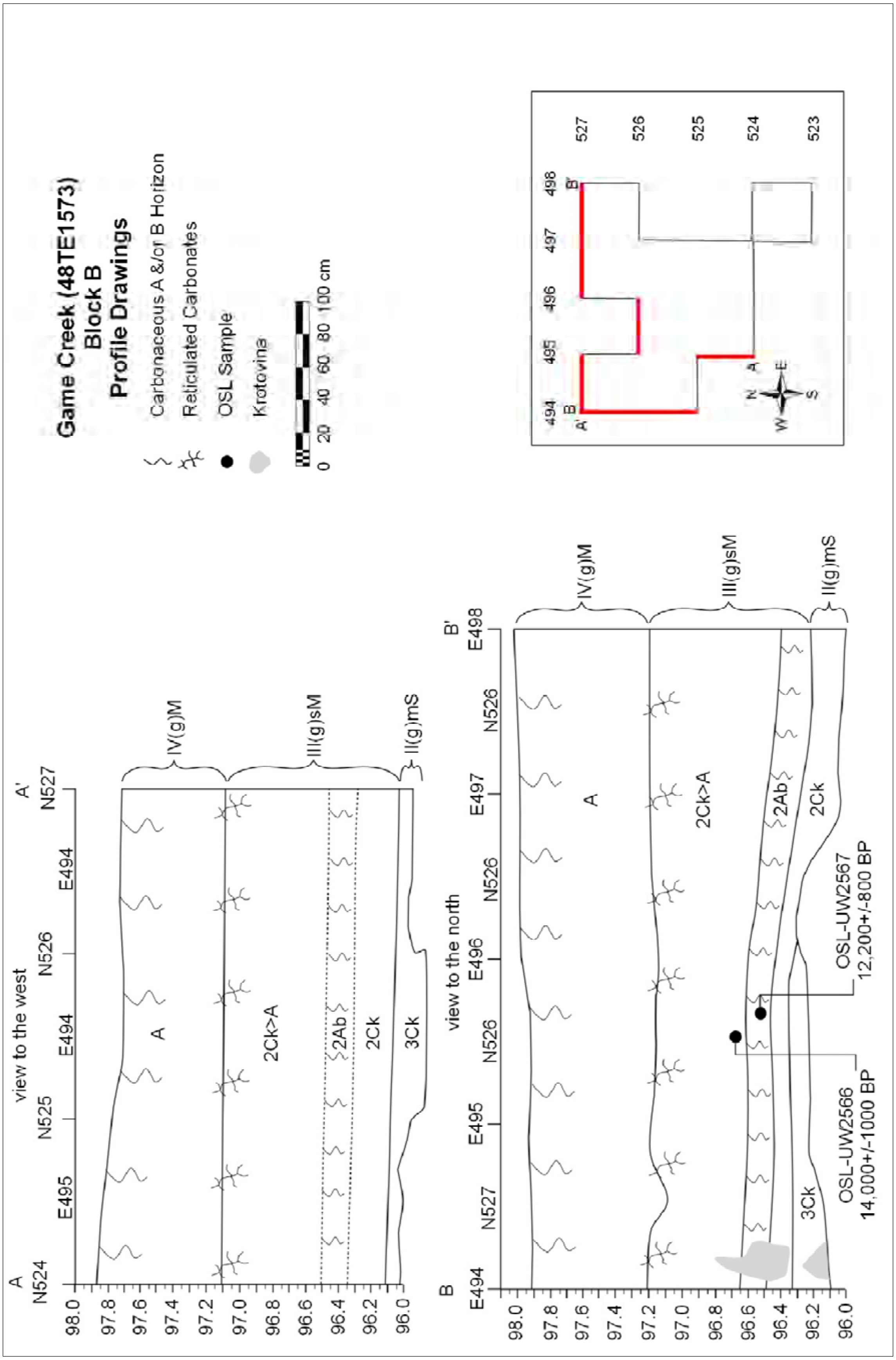
500
499
498
497
496
495

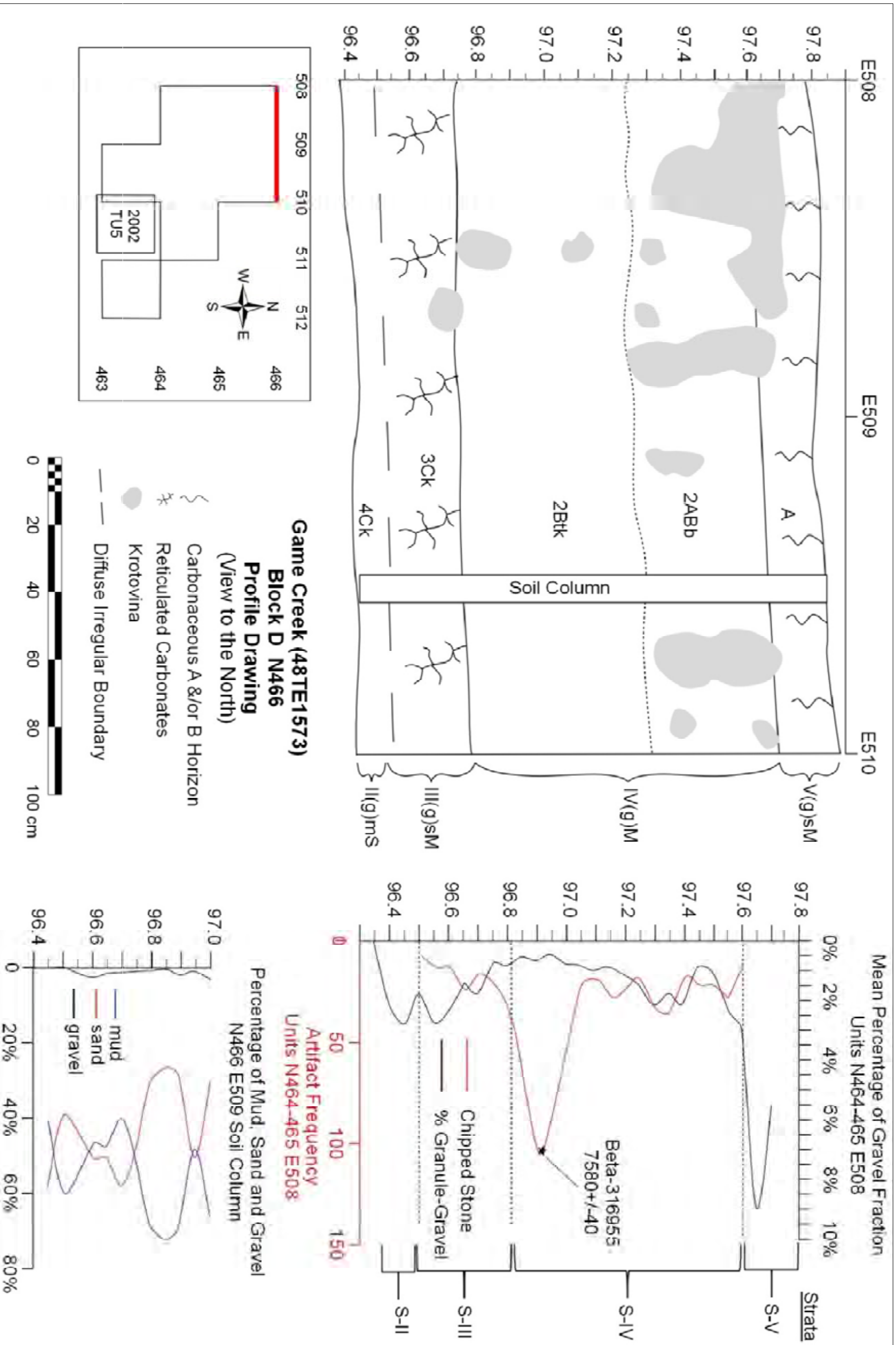

Game Creek (48TE1573)
Block A E502/503
Profile Drawing
(View to the East)
Carbonaceous A &/or B Horizon
Reticulated Carbonates
Rock
Fire-Cracked Rock
Radiocarbon Sample
Chipped Stone
Fire-Cracked Rock
% Granule-Gravel
N500 E502
N499 E502
N498 E502
N497 E503
N496 E503
N495 E502
Beta-319994
7190+/-40 BP
Beta-316959
7060+/-40 BP
Beta-316956
8120+/-40 BP
Feature 11
Beta-316962
9180+/-50 BP
A
C
2ABb
2ABkb
2Btkb
3Ck1
3Ck2
3C k1
3ABkb
4Ck
V(g)sM
VgM
IV(g)M
III(g)sM
III(g)mS
Percentage of Gravel Fraction
Unit N495 E501
Artifact Frequency
Strata
S-V
S-IV
S-III
2ABkb
S-II


Game Creek (48TE1573)
Block A E499
Profile Drawing
(View to the East)
Carbonaceous A &/or B Horizon
Reticulated Carbonates
Rock
Radiocarbon Sample
0 20 40 60 80 100 cm
Beta-316960
7150+/-40 BP
N502
N501
N500
N499
N498
N497
N496
A
C
2ABb
2Btk
3Ck
3ABkb
4Ck
V(g)sM
VgM
IV(g)M
III(g)sM
II(g)mS
Mean Percentage of Gravel Fraction
Units N499-502 E499
Chipped Stone
Fire-Cracked Rock
% Granule-Gravel
Strata
S-V
S-IV
S-III
2ABkb
S-II
Artifact Frequency



Game Creek (48TE1573)
Block A E497
Profile Drawing
(View to the West)
Carbonaceous A &/or B Horizon
Reticulate Carbonates
Krotovina
2002 Trench 2 Backfill
Radiocarbon Sample (from adjacent unit)
Chipped Stone
% Granule-Gravel
N499
N500
N501
N502
N503
N504
98.0
97.8
97.6
97.4
97.2
97.0
96.8
96.6
96.4
A
2ABb
2Btkb1
2Btkb2
3Ck
3ABkb
4Ck
Beta-316961
8780+/-40 BP
V(g)sM
IV(g)M
III(g)sM
II(g)mS
Mean Percentage of Gravel Fraction
Units N501-503 E497
0%
1%
2%
3%
4%
5%
Strata
S-IV
S-III
2ABkb
S-II
0
100
200
300
Artifact Frequency
490
492
494
496
498
500
502
504
503
502
501
500
499
498
497
496
495
N
S
E
W


Game Creek (48TE1573)
Block B
Profile Drawings
Carbonaceous A &/or B Horizon
Reticulated Carbonates
OSL Sample
Krotovina
0 20 40 60 80 100 cm
view to the west
A
N524
E495
N525
E494
N526
E494
N527
A'
IV(g)M
III(g)sM
II(g)mS
A
2Ck>A
2Ab
2Ck
3Ck
view to the north
B
E494
N527
E495
N526
E496
N526
E497
N526
E498
B'
2Ab
2Ck
3Ck
OSL-UW2567
12,200+/-800 BP
OSL-UW2566
14,000+/-1000 BP
98.0
97.8
97.6
97.4
97.2
97.0
96.8
96.6
96.4
96.2
96.0
494
495
496
497
498
527
526
525
524
523
N
E
S
W


Game Creek (48TE1573)
Block D N466
Profile Drawing
(View to the North)
Carbonaceous A &/or B Horizon
Reticulated Carbonates
Krotovina
Diffuse Irregular Boundary
0 20 40 60 80 100 cm
E508
E509
E510
97.8
97.6
97.4
97.2
97.0
96.8
96.6
96.4
A
2ABb
2Btk
3Ck
4Ck
Soil Column
V(g)sM
IV(g)M
III(g)sM
II(g)mS
508 509 510 511 512
466 465 464 463
2002 TU5
N E S W
Mean Percentage of Gravel Fraction
Units N464-465 E508
0% 2% 4% 6% 8% 10%
Chipped Stone
% Granule-Gravel
Beta-316955
7580+/-40
Artifact Frequency
Units N464-465 E508
0 50 100 150
Strata
S-V
S-IV
S-III
S-II
Percentage of Mud, Sand and Gravel
N466 E509 Soil Column
mud
sand
gravel
0 20% 40% 60% 80%

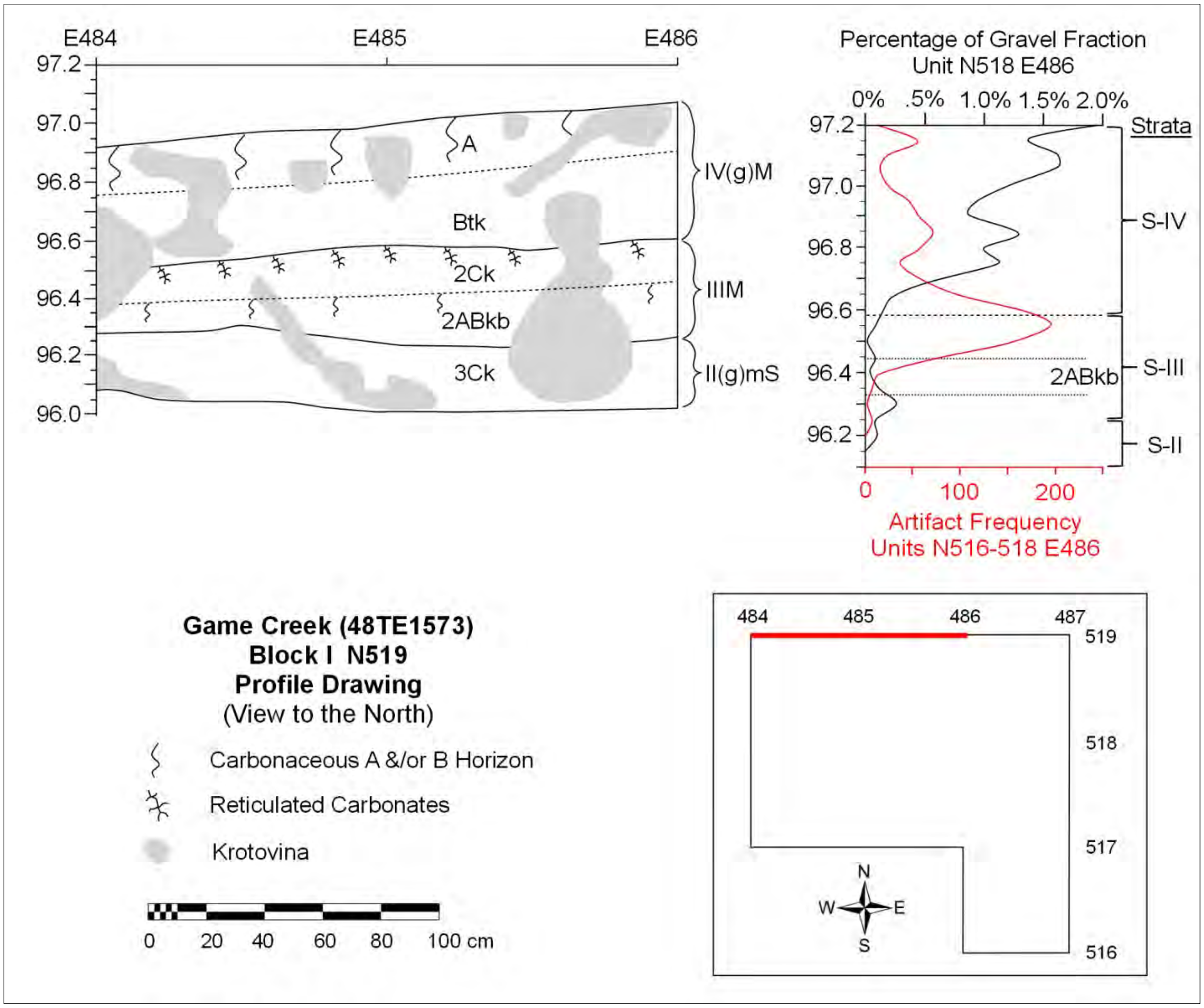


Figure 4-14 Illustrated profile of Block I.

beneath the Akb, but in some places, such as Block I, the Akb rests directly on top of Stratum II (Figure 4-14). The paleosol was absent in exposures south of Block E, perhaps due to masking by massive phreatogenic carbonates. Extensive pocket gopher disturbance in and around Block C likely eradicated any evidence of the Akb horizon there. Given its thickness, color, texture and age the Akb horizon likely formed under a grassland environment. Due to relatively light colored sediment in the Ck horizons it is possible they formed under shrub land cover and/or accumulated relatively quickly impeding pedogenesis.

Based on the radiocarbon dates it appears that the deposition of Stratum III was underway no later than circa 10,400 cal BP. Deposition then slowed or even ceased for a substantial period of time to allow a soil to form. Deposition of alluvium and limited colluvium returned at some point after circa 9630 cal BP and deposited an additional 15 to 50 cm of slightly gravelly sandy mud over the T3 terrace. Three of the four radiocarbon dates obtained from specimens collected at the T3 Strata III/IV boundary range in age from 9061±57 cal BP to 8645±77 cal BP suggesting an early Holocene age of around 9000 cal BP for the final termination of overbank alluvial deposition (Table 4-5). No buried soil is present in upper Stratum III that would indicate a depositional hiatus. An erosional event(s) prior to the onset of T3 Stratum IV deposition may have stripped a soil from upper T3 Stratum III; however, preservation of evidence for a soil would be expected to occur at least locally.

OSL dates from Block A N498 E493 and Block B N526 E497 suggest that initial deposition of Stratum III may have begun earlier than the radiocarbon dates indicate, perhaps as early as 14,000 BP. However, results of the OSL dating revealed that most of the samples had been mixed, and all may have undergone partial bleaching. Consequently, of the four OSL dates from Stratum III, one is far too young (6,500 ± 800 BP), and the remaining dates are stratigraphically out of order. In short, the OSL dates are unreliable.

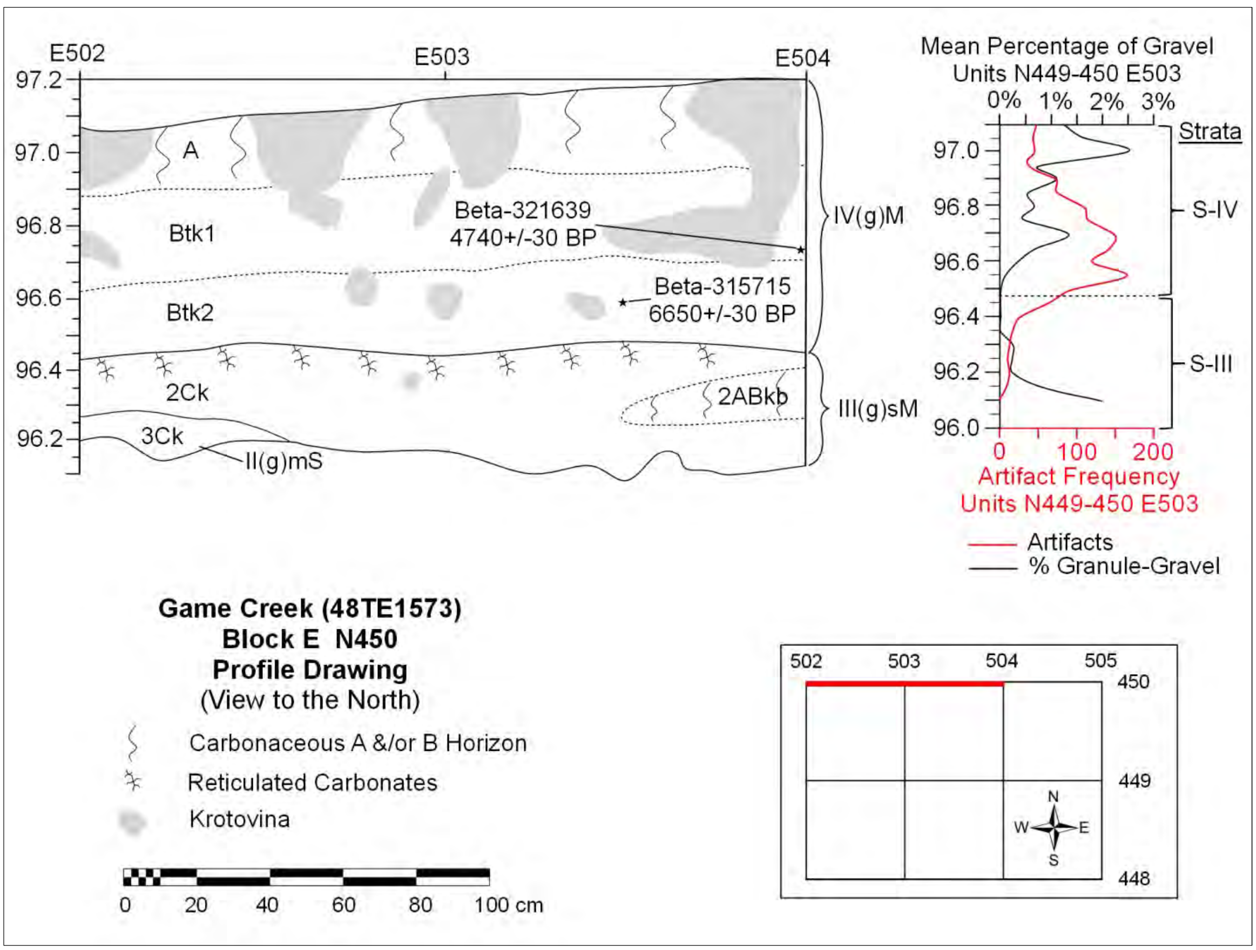


Figure 4-15 Illustrated profile of Block E.

Table 4-5. Radiocarbon dates from the T3 terrace .

Beta #	Blk/Provenience	Elevation(m)/cmbs	Strat.	CL[1]	Material	Conv. RCYBP	*M* cal BP[2]	1 σ cal BP
319995	A/N495.82 E500.84	96.78m/134cmbs	III	1	charcoal	9310±50	10,513	82
171435	A/TU 7	160-170cmbs	III	1	charcoal	9280±50	10,463	83
316958	A/N498.895 E500.74	96.79m/142cmbs	III	1	charcoal	9230±50	10,394	78
316962	A/F.11	96.7m/149cmbs	III	1	charcoal	9180±50	10,343	70
287885	A/F. 4	96.65m/147cmbs	III/II	1	charcoal	9170±40	10,328	61
CL1 pooled mean (319995, 171435, 316958, 316962, 287885)				1		9228±21	10,391	61
171436	B/TU 10	138-142cmbs	III	2	charcoal	9030±50	10,207	68
316961	A/N503.15 E497.74	96.6m/137cmbs	III	2	charcoal	8780±40	9792	100
343147	A/N497.44 E493.85	96.51m/110.5cmbs	III	2	charcoal	8690±40	9631	62
171707	D/TU 5	120-130cmbs	III	2	charcoal	8690±40	9631	62
CL2 pooled mean (316961, 343147, 171707)				2		8720±23	9660	53
287886	A/F. 4	96.65 m/ 147cmbs	III/II	1	charcoal	8290±40	9305	81
316956	A/N496 E502	97.3m	III/IV	4	charcoal	8120±40	9061	57
316957	A/N498 E500	97.2m	III/IV	4	charcoal	8070±40	9002	85
SIII/IV contact pooled mean (316956, 316957)				3/4		8095±28	9020	35
287884	A/F. 4	96.65m/147cmbs	III/II	1	charcoal	8040±40	8912	85
319997	A/N499.99 E493.89	97.0m/70cmbs	IV	4	tooth	7860±40	8645	77
316955	D/N464.37 E510.95	96.91m/98cmbs	IV	4	charcoal	7580±40	8390	28
319994	A/N498.11 E501.31	97.45m/75cmbs	IV	4	charcoal	7190±40	7998	46
316960	A/N501.75 E499.75	97.155m/98cmbs	IV	4	charcoal	7150±40	7973	35
316959	A/N498.04 E501.67	97.395m/92.5cmbs	IV	4	charcoal	7060±40	7892	41
CL4 pooled mean (319994, 316960, 316959)				4		7117±20	7951	23
315714	H/N445.07 E501.98	96.33m/42cmbs	IV	4	bone	6780±30	7629	25
315715	E/N450.04 E503.48	96.59m/51cmbs	IV	4	bone	6650±30	7531	28
321639	E/N449.54 E504	96.73m/37cmbs	IV	5	bone	4740±30	5511	79
287888	A/F. 7	96.65m/50cmbs	IV	5	charcoal	4770±40	5515	65
287887	A/F. 7	96.65m/50cmbs	IV	5	charcoal	4720±40	5460	83
287889	A/F. 7	96.65m/50cmbs	IV	5	charcoal	4680±40	5403	69
Feature 7 pooled mean (287887, 287888, 287889)			IV	5	charcoal	4723±23	5468	89
CL5 pooled mean (321639, 287887, 287888, 287889)			IV	5		4730±18	5519	86
171434	TR1	50cmbs	IV	6	charcoal	3860±40	4288	74
319996	H/N446.93 E501.69	96.335m/53.5cmbs	IV	6	charcoal	3650±40	3970	64
359682	A/N503.38 E499.77	97.96/22cmbs	V	7	bone	900±30	828	51

[1] Cultural Level

[2] Median calibrated ages calculated using OxCal 4.2 (Ramsey 2009), IntCal13 calibration curve (Reimer et al. 2013).

The upper contact of Stratum III is marked by a dramatic decrease in the proportion of clay and corresponding increase in silt and in some instances gravel (Figures 4-6 and 4-15). The change in texture is thought to reflect the transition to a colluvial depositional environment. Stratum IV overlies Stratum III with a clear boundary. This depositional unit is continuous across the T3 surface. Stratum IV is typically black to very dark grayish brown to dark grayish brown, massive, and is interpreted primarily as a colluvial slopewash deposit (Figures 4-6 through 4-15). Stratum IV displays two distinct lithofacies. Substratum IV(g)sM is black to dark grayish brown to very dark grayish brown, massive, slightly gravelly sandy mud and Substratum IVgsM is dark grayish brown to very dark grayish brown, massive, gravelly sandy mud. Both rounded and angular pebble- and cobble-sized clasts are present, but sub-angular to subrounded clasts of limestone, sandstone and shale predominate (Table 4-4). Much of the sediment is probably derived from the steeply sloping reentrant (gully) east (upslope) of the site. Deposition of Stratum IV from this gully has formed a broad-low colluvial apron that is centered approximately in the vicinity of Block A, tapering both to the north and south. Much of the sediment is probably derived from the steeply sloping reentrant (gully) east (upslope) of the site. Deposition of Stratum IV from this gully has formed a broad-low alluvial fan that is centered approximately in the vicinity of Block A, tapering both to the north and south. The lower 10–30 cm of Stratum IV has relatively low and consistent gravel content of ~0.3% in the Block A E489 transect to ~2.5% in the E501 transect. A probable Foothills-Mountain Paleoindian (Pryor) and an Early Archaic component with seven radiocarbon dates ranging from 9061±57 cal BP to 7532±28 cal BP occur within this stratigraphic layer in Blocks A, D and E (Table4-5). At approximately the middle of Stratum IV there is a pronounced increase in the volume of gravel. A well-preserved roasting pit, Feature 7, and a relatively dense scatter of butchered bone and chipped stone were found at the top of this gravelly substratum in Blocks A and E, respectively. Four radiocarbon dates from these cultural levels produced statistically identical dates with a pooled mean date of 5469±89 cal BP (Table 4-5). The volume of gravel decreases above these cultural levels for 10–20 cm then dramatically increases with the deposition of Stratum V.

Soil development in Stratum IV is represented by relatively dark and organic rich buried AB horizons which are often welded together throughout the entire stratum. These AB horizons dominate two-thirds of Stratum IV and extend into the overlying Stratum V. In Stratum IV, the horizons are black to dark grayish brown (moist) where they form a dark-colored humic, biomantle. These horizons are consistent with a geomorphic surface undergoing very slow addition of sediment and soil up-building (cumulic A horizon) under grassland vegetation. Due to relatively non-darkened sediment, it is possible that the lower part of Stratum IV formed under shrub land cover.

A thick horizon sequence occurs in Stratum IV and includes AB and Btk horizons (ABb and Btkb where buried beneath Stratum V). The AB horizon is typically a black, silty clay loam with weak, medium, subangular blocky soil structure. This horizon effervesced weakly in dilute hydrochloric acid (HCL). The AB horizon is underlain in places by an ABkb, which consists of very dark brown, silty clay loam exhibiting moderate, medium, subangular blocky structure. This horizon effervesced strongly in dilute HCL. The final soil horizon to appear in Stratum IV is the Btk horizon. The Btk horizon is a dark to very dark grayish brown, silty clay loam with moderately expressed, fine subangular blocky soil structure. This soil effervesced violently in dilute HCL. A soil micromorphological sample analysis from this zone between 6-7 m in Backhoe Trench 2 suggests the presence of weakly expressed oriented clay in middle to lower Stratum IV (Eakin and Eckerle 2004). Oriented clay along with the prismatic structure is indicative of illuvial accumulation of pedogenic clay (Birkeland 1999). The Btk horizon could easily possess some incipient soil development resulting from low depositional rates that are interpreted for the lower half of

Stratum IV.

Stratigraphic contacts of Stratum IV hold some additional clues as to its origin. The Strata II-III contact is relatively level suggesting deposition on a relatively flat landform, presumably an alluvial terrace. Strata IV and V pinch out to the west (Figures 4-6 through 4-8) towards the edge of the T3 scarp indicating that Strata IV and V assume the form of a colluvial wedge or apron. Available radiocarbon ages indicate deposition of Stratum IV beginning by at least ~9000 cal BP and continuing until sometime after 3970±64 cal BP (Table 4-5).

Stratum V is discontinuous and largely limited to Blocks A and D. Where present, Stratum V forms the surface deposit. Like Stratum IV, Stratum V is derived via colluvial processes. There is evidence for three lithofacies. Black to very dark grayish brown, massive, slightly gravelly sandy mud (Substratum V(g)sM) deposited through slope wash comprises the majority of this unit. However, gravelly mud (Substratum VgM), gravelly muddy sand (Substratum VgmS) and muddy gravel (VmG) lenses were observed in the eastern portion of Block A and in Block D, and are interpreted as debris flow deposits. Gravel content is generally less than 5% in the upper half of Stratum V (substratum V(g)sM) and composed mainly of limestone and sandstone clasts. In several units, approximately 30 cm of Stratum V overlie humic horizons of Stratum IV. A black, humic A horizon is present in the upper 20-30 cm of Stratum V. The lower (C horizon) debris flow is not as dark as the A horizon suggesting the flow is recent enough that humic additions have not yet darkened it. Granular (crumb) A horizon soil structure is present in Stratum V and forms from the binding of fungal hyphae and fine roots, burrowing activities of soil fauna, and organic glues produced by microorganisms (The Cooperative Soil Survey 2014).

Aggradation of T3 Stratum V began sometime after 3970±64 cal BP , and likely formed through similar depositional processes operating during accumulation of T3 Stratum IV (i.e. colluvial). One radiocarbon date from butchered bison bone recovered at the top of the gravelly mud (debris flow) is 828±51 cal BP (Table 4-5) suggesting that prehistoric-era sediment is part of the unit, but a small number of historic-aged artifacts were also recovered from the upper 20 cm of Stratum V. Strata VI and VIII on S3 are chronostratigraphic correlates of T3 Stratum V. The former contains Late Prehistoric diagnostic artifacts and a dated feature from apparently intact stratigraphy in Trench 6 at 30 cmbs yielding an age of 620±71 cal BP (Table 4-5).

Stratum V contains a surficial A horizon comprised of black (moist) silty clay loam that exhibits weak, granular (crumb) structure. This A horizon is underlain by a C horizon. Horizon C is a very dark grayish brown, massive, gravelly mud or gravelly muddy sand. A clear boundary separates the A from the C. Both the A and C horizons are formed in the surface deposit, Stratum V. The surface A-C horizon reflects humic soil formation in the most recent slopewash deposit. A sharp boundary delineates the C horizon from the underlying Stratum IV sediment. The soils in Stratum V appear to have developed under a grassland environment.

Geoarchaeological Discussion: T3 Terrace

In this section we discuss the age and context of cultural material in the T3 strata. First, under the subheading of *Cultural Level Contexts: T3 Terrace* we describe the stratigraphic and pedogenic settings of cultural levels. Emphasis is placed on relating absolute dates to artifact zones within the stratigraphic sequence. Subsequently, under *Integrity of Cultural Levels: T3 Terrace* we expand this discussion within a site formation and destruction process framework by assessing the impacts of faunalturbation on the cultural deposits .

Cultural Level Contexts: T3 Terrace

Artifact, stratigraphic, and radiocarbon data from the 2002 testing and 2010-2012 data recovery investigations established that buried Late Paleoindian through Late Prehistoric artifacts occur on T3 at the Game Creek site. These occupations are separated into seven cultural levels (Figure 4-16). The cultural levels are not occupational levels per se, but rather analytical temporal units delineated by radiocarbon dates, stratigraphic boundaries and textural characteristics within strata. Table 4-6 shows the depositional rates interpreted for Blocks A, D and E calculated from radiocarbon dates and depths of deposits. It is assumed that the age of stratigraphic boundaries was relatively uniform across the landform. Depositional rates varied through time and across the landform.

The most prominent concentration of cultural material on the T3 terrace is within the lower half of Stratum III. There are 11 radiocarbon dates from charcoal recovered in direct association with cultural materials in the lower ~25 cm of Stratum III (Table 4-5). Of these, five dates from the eastern half of Block A ranging from 10,513±82 cal BP to 10,328±61 cal BP, are statistically the same with a pooled mean age of 10,391±61 cal BP. Two of these dates, 10,328±61 cal BP and 10337±63 cal BP, originated from Cultural Level 1 in Features 4 and 11, respectively. Two dates came from the Stratum III Ab soil horizon in Cultural Level 2. The remaining date is from charcoal recovered in TU7 during the 2002 testing (Eakin and Eckerle 2004) and is believed to correspond with Cultural Level 2. Three additional radiocarbon dates (9792±100, 9631±62, 9631±62 cal BP) are also statistically the same with a pooled average date of 9660±53 cal BP. One of these dates came from charcoal recovered in Cultural Level 1, one from Cultural Level 2 in the Stratum III Ab soil horizon in the western half of Block A and the remaining date was from Cultural Level 2 in Block D (Table 4-5). The 10,207±68 cal BP date, obtained from TU10 during the 2002 testing, falls between the two mean dates. Two dates (9305±81 and 8912±85 cal BP) from Feature 4 deviate significantly from all other radiocarbon dates from Stratum III and are interpreted as intrusive.

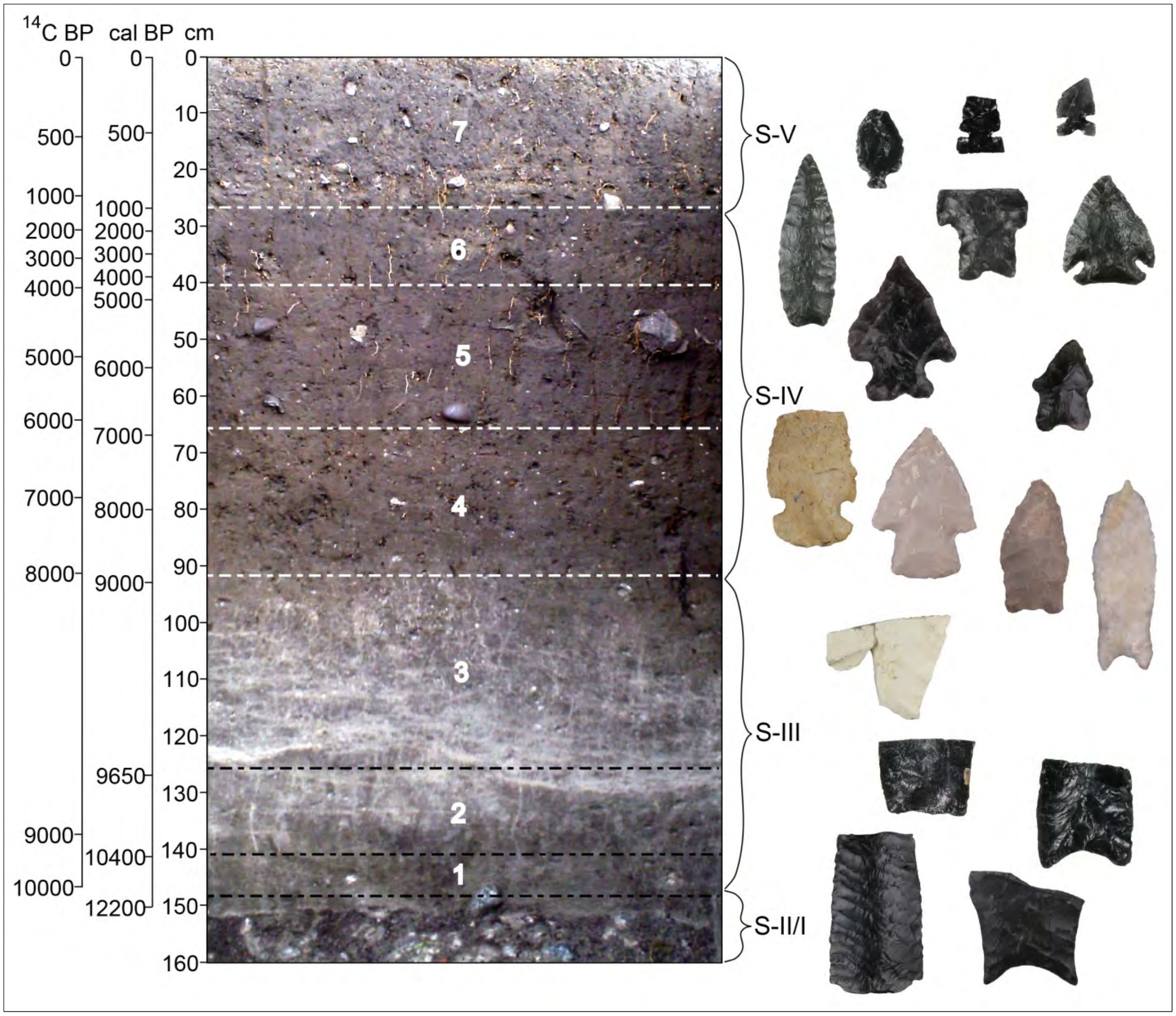


Figure 4-16 Composite chronostratigraphic profile of the T3 terrace.

The stratigraphic position of the dates from Cultural Levels 1 and 2 indicate that there has been some mixing of deposits, which is understandable and even expected given the amount of faunalturbation documented from Stratum III as well as the cumulative effects of occupational trampling (see below). Based on evidence presented in detail below, the mean dates of 10,391±61 cal BP and 9660±53 cal BP are interpreted as representing the approximate ages of Cultural Levels 1 and 2, respectively.

Cultural Level 1 is represented by three carbon-stained features (4, 6, and 11) and a lithic and bone scatter at the contact of Strata II and III (~96.6-96.7 m) in the eastern half of Block A. This level is immediately below the Stratum III Ab soil horizon. One projectile point fragment (two pieces likely from the same point) was found in Cultural Level 1. This point has a plano-convex cross-section with delicately executed parallel oblique flaking and slightly expanding, concave base that has heavily ground margins. This point resembles the point recovered from Cultural Layer 4 at Mummy Cave

Table 4-6 Depositional Rates on the T3 Terrace.

Block/ Elev.	Median Cal BP	Stratum	Cultural Level(s)	Thickness (cm)	Duration (cal yrs)	Depositional Rate (cm/100 cal years)
A (E500-501)						
98.13 (surface)		V	7	28	878	3.11
97.85	**828 (1)**[1]	IV/V	6/7[2]	15	4640	0.32
97.7	5490 (4)	IV	5/6	37	2482	1.49
97.33	7950 (4)	IV	4	13	1059	1.23
97.2	**9009 (3)**	III/IV	3/4	35	650	5.38
96.85	*9659 (3)*	III	2/3	15	732	2.05
96.7	*10,391 (5)*	III	1	10	-	-
D						
97.83 (surface)		V	7	23	2000	1.15
97.6	**828**	IV/V	6/7	69	6390	1.08
96.91	8390 (1)	IV	4	9	619	1.45
96.82	**9009**	III/IV	3/4	24	650	3.69
96.58	*9659 (3)*	III	2/3	-	-	-
E						
97.09		IV	6-7	36	5511	0.65
96.73	5490 (4)	IV	5/6	14	2020	0.69
96.59	7531	IV	4	14	1478	0.95
96.45	**9009**	III/IV	3/4	-	-	-

Dates in **bold** are the inferred ages of stratigraphic boundaries compiled from dates originating in the eastern half of Block A. See text for discussion of dates in *italics*.
[1] Number of radiocarbon dates included in pooled mean.
[2] "/" denotes boundary between strata and cultural levels
Median calibrated ages calculated using OxCal 4.2 (Ramsey 2009).

that is dated to 10,442±103 cal BP (Husted and Edgar 2002). Larson (2013) has recently referred to point of this style as an "unnamed Foothills-Mountain" type.

Cultural Level 2 is directly above Cultural Level 1 at an elevation of ~96.7–96.85 m in the eastern half of Block A and from ~96.5–96.6 m in the western half of Block A and separated from it by several centimeters of culturally sterile sediment along the eastern margin (E500-503) of Block A. Farther to the west (downslope), where depositional rates were lower (Table 4-6), Cultural Levels 1 and 2 merge without a perceptible break in artifact concentrations between the levels. Cultural Level 2 occurs within and immediately above the Stratum III Ab soil horizon in Block A and was documented in Blocks D and E by a diffuse scatter of artifacts approximately 10–20 cm above the Strata II/III contact. Three projectile point fragments and a late stage biface preform were recovered from Cultural Level 2. Similar material from the Lookingbill (48FR308 [Kornfeld et al. 2001]) Barton Gulch (24MA171 [Davis et al. 1989]) and Mummy Cave (48PA201[Husted and Edgar]) sites also have associated dates of circa 9800 cal BP.

Cultural Level 3 is within the upper portion of Stratum III above the Ab horizon. In Block A, artifact frequencies were very low within this level, and no features were identified. In Block I, a fairly discrete concentration of artifacts was documented within this stratigraphic layer. No radiocarbon dates were obtained from Cultural Level 3 due to the absence of dateable material in direct association with artifacts. However, this level postdates the Cultural Level 2 occupation of 9660±53 cal BP and ended by about 9020±35 cal BP when the depositional regime changed from alluvial to colluvial. One projectile point fragment, believed to be of the James Allen type was found in Block A approximately 15 cm above the Cultural Level 2/3 boundary.

Cultural Level 4 occurs in the lower ~20–30 cm of Stratum IV and is marked by a peak in artifact frequency in Blocks A, D and E. The rate of deposition within this level was only ~1.2–1.4 cm per century (Table 4-6), and the deposit contained low volumes of gravel. There are nine radiocarbon dates, six on charcoal and three on bone, ranging from 9061±57 cal BP to 7532±28 cal BP. These dates, combined with the wide array of projectile point styles, indicate that multiple Foothills-Mountain Paleoindian and Early Archaic aged components are present. A projectile point somewhat reminiscent of the Pryor Stemmed type was found in the lower half of the cultural zone in Block A in roughly the same stratigraphic position as a scatter of butchered deer and bison bone. A whole bison tooth from this artifact scatter returned a date of 8645±77 cal BP. A concentration of fire-cracked limestone (Feature 8), a dense lithic scatter and a broad stemmed projectile point were found in Block D at ~96.9 m, about 10 cm above the Strata III/IV contact. A piece of wood charcoal from this level was dated to 8390±28 cal BP. Two radiocarbon dates, 7998±46 cal BP and 7892±41 cal BP were also run on charcoal from ~15 cm above the Strata III/IV boundary in the E501 transect of Block A; at the peak of artifact frequency. Several projectile points typed as Elko Corner-Notched or Elko Eared as well as a small amount of FCR were found in association with the dated charcoal. Two radiocarbon dates on bone recovered from ~12 cm above the Strata III/IV contact in Blocks H and E returned dates of 7629±25 cal BP and 7532±28 cal BP, respectively. These dates also correspond with peaks in artifact frequency and low volume of gravels. A barb from a corner-notched dart point was found at the same elevation as the dated bone in Block E. In short, there is evidence for one or two Foothill-Mountain Paleoindian components (9061±57 Cal BP and 8645±77 cal BP) and two to four Early Archaic components. The top boundary of Cultural Level 4 is marked by an increase in the volume of gravel and a decrease in artifact.

Cultural Level 5 is a ~20-25 cm thick layer that correlates with the mid Stratum IV increase in the volume of gravel that coincides with an increase in the inferred rate of deposition. The frequency of chipped stone and bone in Blocks A and D was very low, but Blocks E, H and I showed a peak in the frequency of these artifacts. An intact roasting pit (Feature 7) approximately 110 cm in diameter and 35 cm in depth containing 126 kg of FCR within a dark carbon stained matrix was discovered at the top of Cultural Level 5. A dense scatter of FCR surrounds the feature indicating repeated reuse. The FCR scatter is confined to a discrete layer that represents the living surface at the time of occupation. Three pieces of wood charcoal from Feature 7 produced dates that are statistically the same, and when pooled with a bone date from Block E that is also statistically the same, have a mean date of 5511±87 cal BP. Two Elko Eared dart points and two barbs from corner-notched points were also found in the cultural level. The upper boundary of Cultural Level 5 is demarcated by a sharp decrease in the volume of gravel.

Cultural Level 6 on the T3 terrace consists of little more than a diffuse lithic scatter. Depositional rates during the accumulation of this level were less than one-half of a centimeter per century, and the volume of gravel was as low as that recorded for most of Stratum III. Consequently, it took nearly 5,000 years for only 15 cm of sediment to accumulate at Block A E500-501 (Table 4-6). Thus, most of the Middle Archaic period and all of the Late Archaic period on the T3 is compressed into a thin layer. Feature 1, a small concentration of FCR and charcoal discovered in the wall of Trench 1 during the 2002 testing, was dated to 4288±74 cal BP (Eakin and Eckerle 2004) and was presumably within Cultural Level 6. One corner-notched dart point fragment was found within this level in Block A. The upper boundary of Cultural Level 6 is delimited by the debris flow that marks the Strata IV/V contact. Although Stratum V is not present over much of the T3 terrace, there is a significant increase in the volume of gravel noted in all sampled excavation units within the upper ~10–20 cm of the landform.

Cultural Level 7 represents the Late Prehistoric period, and like Cultural Level 6, had very low artifact frequencies on the T3. A piece of butchered bone from a large artiodactyl recovered immediately above the debris flow deposit in Block A N503 E499 returned a date of 828±51 cal BP. No features and no artifacts diagnostic of the Late Prehistoric period were found in Cultural Level 7 on the T3 terrace. A small quantity of Historic period artifacts was found exclusively within the sod layer just below the modern surface.

Integrity of Cultural Levels: T3 Terrace

The degree of faunalturbation is dependent on the species present, their population density, texture of sediments, size of artifact clasts and time (Johnson et al. 1987; Johnson and Watson-Stegner 1987). Given the broad geographic distribution and wide range in habitat tolerated by Uinta Ground Squirrels, Northern Pocket Gophers and voles it is likely that these species have been present in the area since the initial formation of the landform over 10,000 years ago. None of the sediments within the T3 terrace stratigraphic sequence, with the possible exception of the debris flow in Stratum V, posed any obstacle to burrowing rodents. Moreover, soil characteristics of the T3 terrace indicate that a grassland habitat, the kind preferred by ground squirrels and pocket gophers, probably covered the surface for much of the last 10,400 years. There are no data on the population densities of these rodents throughout the Holocene of Jackson Hole. If we assume, however, that the populations were relatively constant, then the amount of faunalturbation should be positively correlated with the age of the deposits. Thus, the lower strata should be more disturbed than the upper strata for the simple fact that they have been subjected to burrowing rodents for a longer period of time.

Results of excavation confirm the expectations of the degree of faunalturbation on the T3 terrace. The volume of krotovina (i.e. filled rodent burrows) were recorded by level for 81of the 124 excavation units on the T3 terrace (Table 4-7). Results show that the distribution and amount of disturbance varied greatly across the terrace. However, the data indicate that Strata IV and V had the lowest cumulative volume of disturbance of the four strata (Table 4-7). Blocks D and E and some of the excavation units at the southern and eastern edges of the T3 terrace do show increased levels of bioturbation in Stratum IV compared to Stratum III. Nevertheless, Strata III and II appear to have experienced the highest rates of faunalturbation on the T3 terrace.

Non-cultural rodent bone was recovered from all strata in all portions of the T3 terrace. However, over 70% of the rodent bone collected from seemingly intact deposits came from strata III and II (Tables 4-8 and 4-9). Similarly, 84.4% of the rodent bone found in excavated krotovina also came from strata III and II. This disparity is even more striking when one considers the overall thickness of each stratum. Combined strata V and IV are on average 89 cm thick, over twice as thick as Stratum III and eight times as thick as Stratum II, yet only 29.4% of the rodent bones recovered in standard excavation came from strata IV and V.

Additional evidence for the impacts of fossorial rodents can be gleaned from the specific burrowing behavior of the animals identified in the non-cultural faunal assemblage. Both Uinta Ground Squirrels and Northern Pocket Gophers habitually dig burrows to a depth exceeding 1m below surface. The mean thickness of Stratum IV is only 65 cm. Therefore many if not most ground squirrel and pocket gopher burrows dug on the T3 terrace extend into Stratum III. Ground squirrel burrows consist of one or more tunnels that lead to larger nest chambers. Fill from burrows is deposited at the burrow entrance, leading to horizontal and vertical transfer of sediment and artifacts <~7 cm in diameter. The excavation of the larger nest would cause comparatively more disturbance at the base of the burrow (within Strata III or II) than along the tunnel leading to it. Unlike ground squirrels, pocket gophers continually burrow in order to feed and also fill old burrows with newly excavated soil causing extensive horizontal as well as vertical displacement of sediment and artifacts <~7 cm. Again, chambers excavated in the lower burrow systems (within Strata III and II) are larger than tunnels and therefore have the potential to cause greater disturbance. Vole burrows are less extensive and shallower than ground squirrel or pocket gopher burrows, so those excavated in recent millennia would be restricted to the upper strata. However, over half of the vole elements were recovered from Strata III and II suggesting that voles may have been present and burrowing on site throughout the deposition of the lower strata.

According to Bocek (1986) extensive pocket gopher burrowing at archaeological sites will result in systematic size sorting of artifacts and naturally occurring clasts (i.e. gravel and cobbles). Prolonged periods of intensive and extensive pocket gopher burrowing will result in a homogenization of smaller clasts (<5.0 cm), those too large for pocket gophers to transport, resulting in similar and correlated

Table 4-7 Mean Percentage by Volume of krotovina by Stratum and Excavation Unit on the T3 terrace

Stratum	BLK A	BLK D	BLK E	BLK I	Misc.	Total
V	11.3%	3.1%	NA	NA	4.1%	7.6%
IV	13.5%	2.8%	12.1%	1.5%	8.6%	10.2%
III	14.1%	1.9%	6.4%	8.2%	19.7%	14.8%
II	19.6%	NA	NA	22.9%	29.3%	25.3%
Total	14.0%	2.6%	10.8%	9.1%	15.2%	13.1%

Table 4-8 Non-cultural rodent bone recovered from deposits not identified as krotovina (1/8” screen).

	NISP						
Stratum	Ground Squirrel	Pocket Gopher	Vole	Unidentified	Total	%	Mean Thickness of Stratum
V	0	4	1	0	5	2.2%	24 cm
IV	13	27	4	17	61	27.2%	65 cm
III	28	41	3	18	90	40.2%	44 cm
II	13	50	1	4	68	30.4%	12 cm
Total	54	122	9	39	224		

Table 4-9 Non-cultural fossorial rodent bone recovered from excavated krotovina (1/4” screen).

	NISP						
Stratum	Ground Squirrel	Pocket Gopher	Vole	Unidentified	Total	%	Mean Thickness of Stratum
V	0	2	0	0	2	1.2%	24 cm
IV	18	6	1	0	25	14.5%	65 cm
III	88	20	0	1	109	63%	44 cm
II	28	5	3	1	37	21.4%	12 cm
Total	134	33	4	2	173		

distributions of artifacts and naturally occurring gravels (Bocek 1986; Johnson 1989). The smaller clasts, including artifacts and gravel “should be disproportionately numerous near the surface. Larger clasts (> 5.0 cm) should cluster slightly below” heavily turbated zones in stone lines (Bocek 1986:592).

In order to assess whether pocket gopher burrowing has caused homogenization of smaller and larger clasts, samples were selected from Blocks A, D, E and I. The total number of artifacts <5.0 cm in size, which accounts for over 99% of the artifacts from the samples, were summed by 5 cm excavation level. The total volume (ml) of gravel was also calculated for each 5 cm excavation level. These columns were then tested using the Correlation Table in *Past*, a free statistical software package (Hammer and Ryan 2001). Results of the statistical test show a weak and statistically insignificant negative correlation

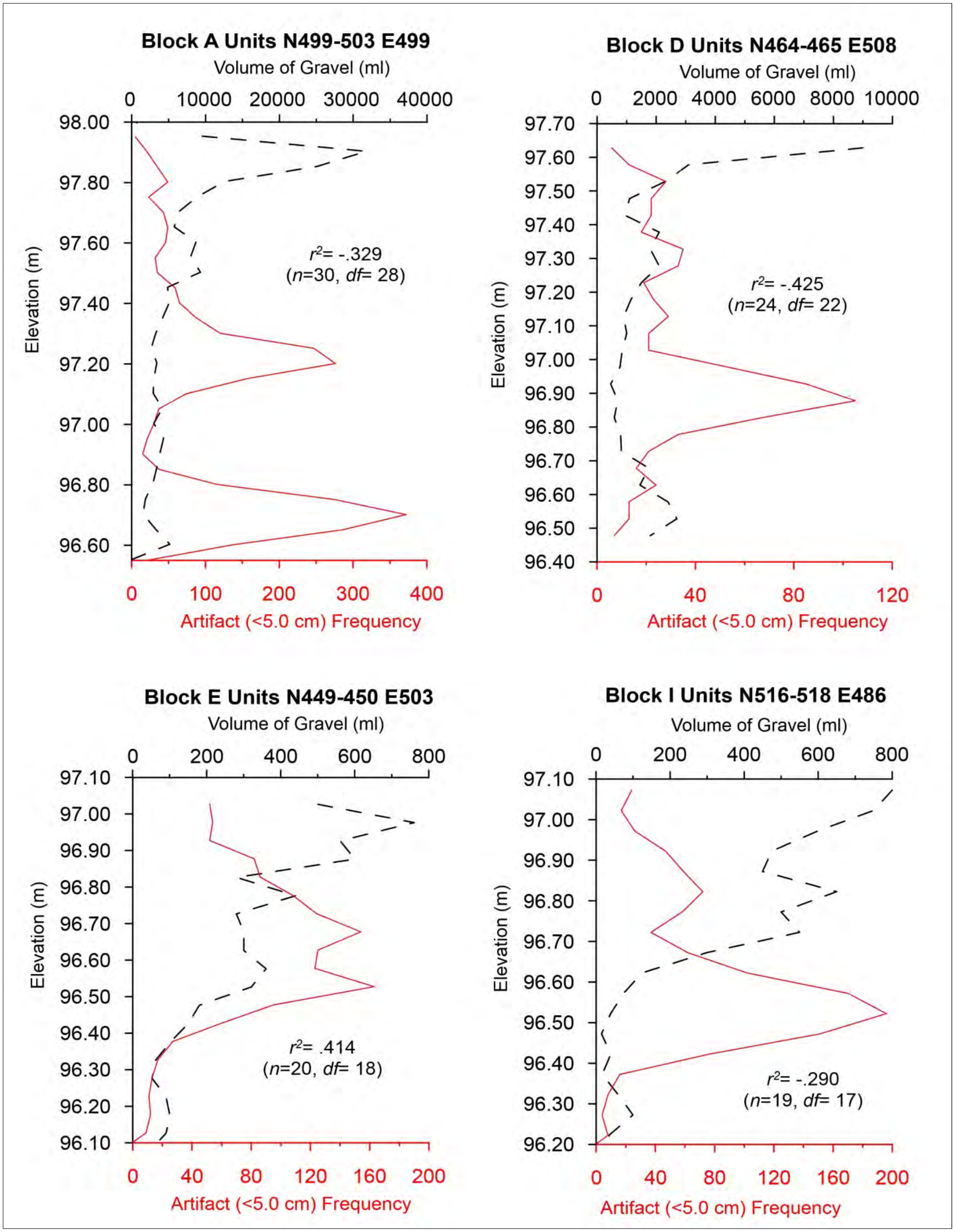


Figure 4-17 Distribution of artifacts (<5.0 cm) and gravels by depth and results of correlation analysis for samples from Blocks A, D, E and I.

Figure 4-18 Photograph of south wall profile of Unit N480 E491 showing homogenized soil profile caused by severe faunalturbation.

between artifact frequency and volume of gravel in the tested samples from Blocks A, D and I. There is a weak and statistically insignificant positive correlation of artifact frequency and volume of gravel in Block E that may reflect the high rates of faunalturbation that were documented during excavation. Too few artifacts or rocks >5.0 cm were recovered from the sampled units to allow for a statistical comparison. The results indicate that faunalturbation has not significantly altered the contextual integrity of the cultural levels on the T3 terrace.

Severe faunalturbation by fossorial rodents results in the homogenization of soil profiles as well as the eradication of sedimentary structures and cultural horizons (Johnson and Watson-Stegner 1987). As discussed above, stratigraphic boundaries of the T3 terrace sequence are fairly clear and contain well-developed soil horizons (Figures 4-6 through 4-15). Furthermore, the vertical distribution in the volume of gravel shows relatively clear and consistent variation across much of the T3terrace. Lastly, several stratigraphically discrete and reasonably well dated cultural horizons were documented in Blocks A, D and E.

Examples of extensive faunalturbation were encountered in four locations, two along the western margin of the terrace (Figure 4-18), one in the center of Block A adjacent to the 2002 Trench 2

Figure 4-19 Photograph of Block B, view to the northeast, showing severe impacts to Stratum IV by burrowing rodents.

and one in Block B. The volume of krotovina was not recorded for Block B because all of Stratum IV had been stripped prior to implementation of the krotovina recording procedures. Nevertheless, Stratum IV within Block B lacked clear soil horizonation and had numerous visible rodent burrows (Figure 4-19) suggesting that it was severely turbated. The majority of the units sampled contained less than 30% krotovina by volume and over one-half had less than 10%. Overall, the mean percentage of krotovina by volume in the sampled excavation units was only 12%.

Fieldwork Results: S3 Landform

Geomorphological Discussion: S3 Landform

The S3 landform was designated during the testing phase (Eakin and Eckerle 2004). The area of interest on S3 within the site is an area of low slope (tread) situated south of Game Creek, east of the T2 terrace, and west of U.S. 191. The ditch bounding the west side of the highway was an obvious area of construction disturbance. This disturbance extended westward onto the blocks, but intact sediment is present below the disturbance. The low sloping area is about 17 m wide (from TU101 to N696 E426) with its long axis azimuth oriented about 355°. Length of the relatively low slope area along the long axis is 40 m from the north end of Trench 6 to the south wall of Block J/K. The slope normal to the long axis is approximately 3.5°. The relatively flat portion of S3 slopes 0.7° (~0.5 m in 40 m) along an azimuth oriented at 175°. The surface of the basal gravel in T3 and S3 slopes southward at 1° to 2° respectively, which is in the direction of the Snake River valley gradient. Since the Tetons and Jackson Hole are seismically active and were heavily glaciated, it is unknown how much tectonic or isostatic tilting contribute to this slope.

Aspen Shale underlies the S3 and is overlain from bottom to top by a basal channel gravel, alluvial overbank sediment, and slopewash colluvium as illustrated in the Trench 6 profile (Eakin and Eckerle 2004). During testing, late Paleoindian, Archaic, and Late Prehistoric-era radiocarbon dates along with *in situ* Archaic and Late Prehistoric cultural materials were documented on the S3 landform in TU101 and Trench 6 (Eakin and Eckerle 2004). Work in 2011 and 2012 focused on better understanding the geology exposed in the archaeological blocks.

S3 Stratigraphy

Over the course of the investigations, different aspects of the S3 stratigraphic sequence were observed. Year 2002 testing at TU101 and investigation of Trench 6 in 2003 provided a preliminary stratigraphic framework (Eakin and Eckerle 2004). Master strata for the S3 surface are presented in Table 4-10. Like the T3 terrace, strata from the S3 are designated from oldest to youngest with Roman numerals followed by an abbreviation for their modal texture. The T3 versus S3 designations are specific to each landform and cannot be directly correlated.

Six unconsolidated stratigraphic units overlie the Aspen Shale on S3 and are designated (from oldest to youngest) as channel gravel S3 Stratum I, fluvial channel marginal sand S3 Stratum II, lower overbank (alluvium)/slopewash S3 Stratum III, upper overbank (alluvium)/slopewash S3 Stratum IV, lower slopewash/overbank deposit S3 Stratum V, debris flow S3 Stratum VI, upper slopewash S3 Stratum VII, construction fill S3 Stratum VIII (Table 4-10). Stratigraphic details were documented during the 2011-2012 field seasons in Blocks G, J/K, and L (Tables 4-11 through 4-15; Figures 4-20 through 4-25).

Aspen Shale regolith was observed on the south end of Trench 6 situated below basal gravel on the S3-T2 scarp (Eakin and Eckerle 2004). The Aspen Shale is disconformably overlain by at least 0.6 m of Stratum I channel gravel (we omit the S3 strata prefix here and below). This gravel was best exposed in Trench 6 and consists of strong brown, oxidized, sandy small cobbly gravel (Eakin and Eckerle 2004). The upper portion of the gravel exhibited oxidized iron redoximorphic concentrations caused by a high water table present today and likely in the past. Calcium carbonate accumulation is present in the lower portion of the Stratum I gravel. No radiocarbon or OSL ages are available for Stratum I but a date from the overlying strata in Trench 6 suggests Stratum I is older than 7896±40 cal BP. Based on correlation with T3 Stratum I, the channel gravel on S3 likely dates in excess of 15,500 cal BP.

Table 4-10 Master strata for the S3 landform.

Stratum	Folk Texture	Soil Horizons(s)	Color	USDA Texture	Depositional Environment	Age
IX	NA	A	highly variable	NA	highway construction	Late Holocene
VIII	gsM	Ab	very dark brown, black	silt loam	slopewash	Late Holocene
	(g)M	ABkb		silty clay loam		
	(g)sM	Ab		silt loam		
VII	sG	C	Brown	sand	channel	Late Holocene
VI	mG	Ab	dark brown	silty clay loam	debris flow	Late Holocene
	(g)sM	C	reddish brown	silty clay loam		
V	gM	Ab	light brown	silty clay loam	slopewash/ overbank	Late Holocene
	(g)M	Ab		silty clay loam/loam		
	(g)sM	Ab		silt loam		
IV	(g)sM	A/C	dark brown	silt loam	overbank/ slopewash	Middle – Late Holocene
	(g)M	C	yellowish red	silty clay loam		
III	(g)M	Akb	dark gray, black	silty clay loam	overbank	Early – Middle Holocene
	(g)sM	Akb		silt loam		
	(g)sM	Ab	dark gray	silt loam		
	(g)sM	Bb	dark brown	silt loam		
	M	Akb	dark gray	silty clay loam		
	M	Ck	light gray	silty clay loam		
	M	Ckg	dark gray	silty clay loam		
II	(g)sM	Cg	light olive brown	silty clay loam	channel marginal	Late Pleistocene

Stratum II is a fluvial channel marginal (levee, bar, or proximal overbank setting) alluvium deposit fining upward to an overbank silty clay loam unit (Stratum III). Based on an auger probe in Block G N696 E420, this stratum is 65 cm thick and composed of trace gravelly (.17%), mottled light gray to brownish yellow, silty fine sand to silty very fine sand with discontinuous lenses of gray silty clay. Its colors indicate redoximorphic alterations (concentrations/depletions) that formed under an aerobic, saturated moisture regime. Much of Stratum II is presently below the water table. No radiocarbon or OSL dates were taken from Stratum II, and no cultural material was recovered.

Strata III through V and VIII which overly Stratum II are composed of slightly gravelly muds and sandy muds with silt predominating, generally more clay than sand, and less than 5% gravel. The dominance of silt is due to the presence of loess deposits upslope (east) from the site. In addition to slightly gravelly muds, some sediment was mud, slightly gravelly mud, very fine sandy mud, and very fine sandy silt (Table 4-10). Units that lack gravel generally also lack coarse and very coarse sand and are clearly overbank alluvial deposits. Gravel volume in some units is transitional between overbank and slopewash transport. Unfortunately, the effects of prolonged and intensive burrowing by fossorial rodents has resulted in systematic size sorting of clasts, including gravel and artifacts (see below),

Table 4-11 Strata and soil characteristics for Block G N697 E419-425 (Figures 4-20 and 4-21).

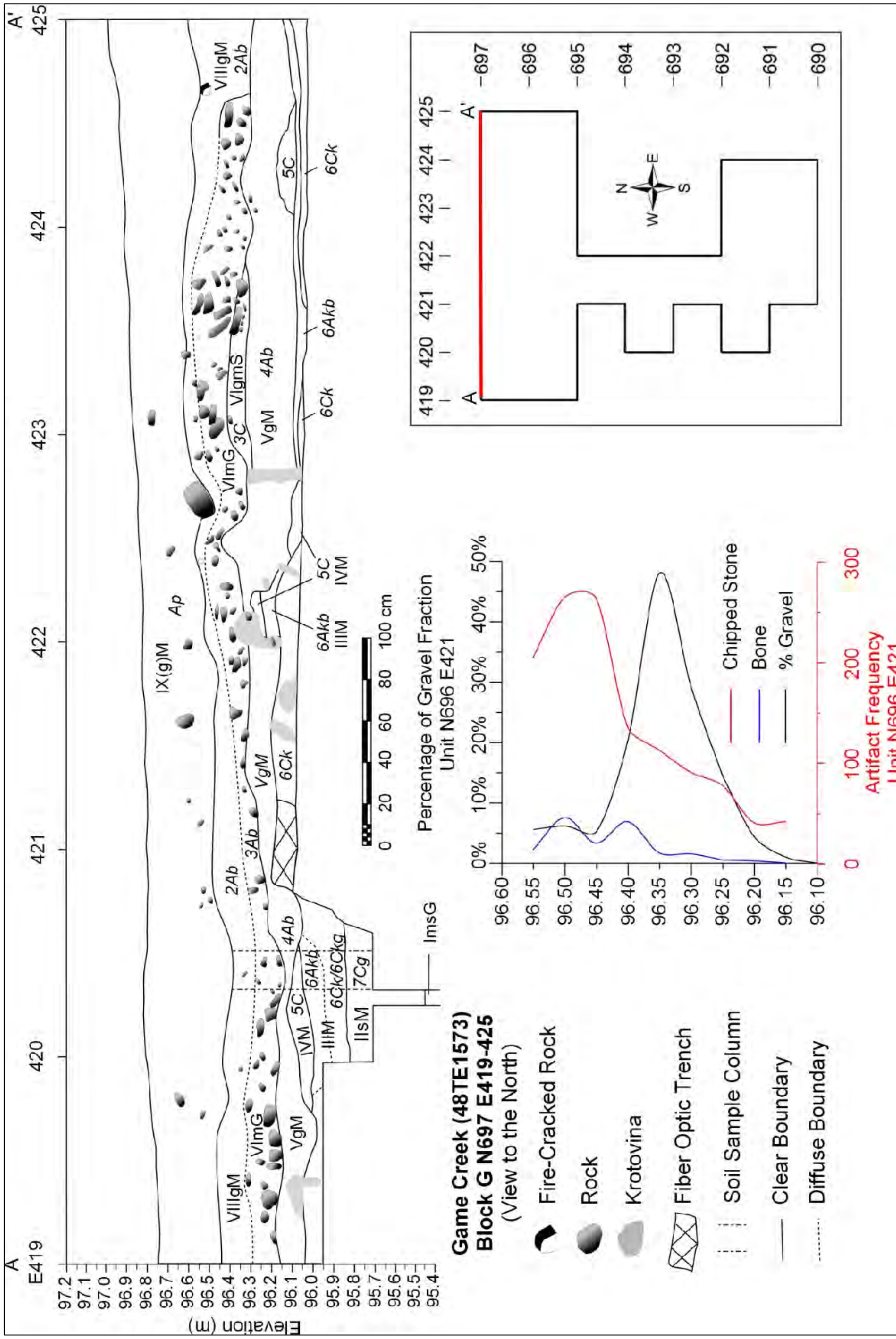
Stratum	Soil Horizons	Moist Color (Munsell)	USDA Texture	%Gravel	Structure	Depositional Environment
VIIIgM	2Ab	black (7.5YR 2.5/2)	silt loam	6	massive	Slopewash
VImG	3Ab	dark brown (7.5YR 3/2)	silty clay loam	33	massive	debris flow
VIgmS	3C	reddish brown (5YR4/4)	silty clay loam	28	massive	debris flow
VgM	4Ab	light brown (7.5YR 6/4)	silty clay loam	14	massive	Slopewash
IVM	5A/Cb	dark brown (7.5YR3/4)	silty clay loam	NA	massive	overbank/slopewash
IVM	5C	yellowish red (5YR 5/6)	silty clay loam	.01	massive	overbank/slopewash
IIIM	6Akb	dark gray (2.5Y 4/1)	silty clay loam	0	massive	Overbank
IIIM	6Ck, 6Ckg	light gray (2.5Y 7/1)	silty clay loam	0	massive	Overbank
IIsM	7Cg	dark gray (2.5Y 4/1)	silty clay loam	0	massive	channel marginal

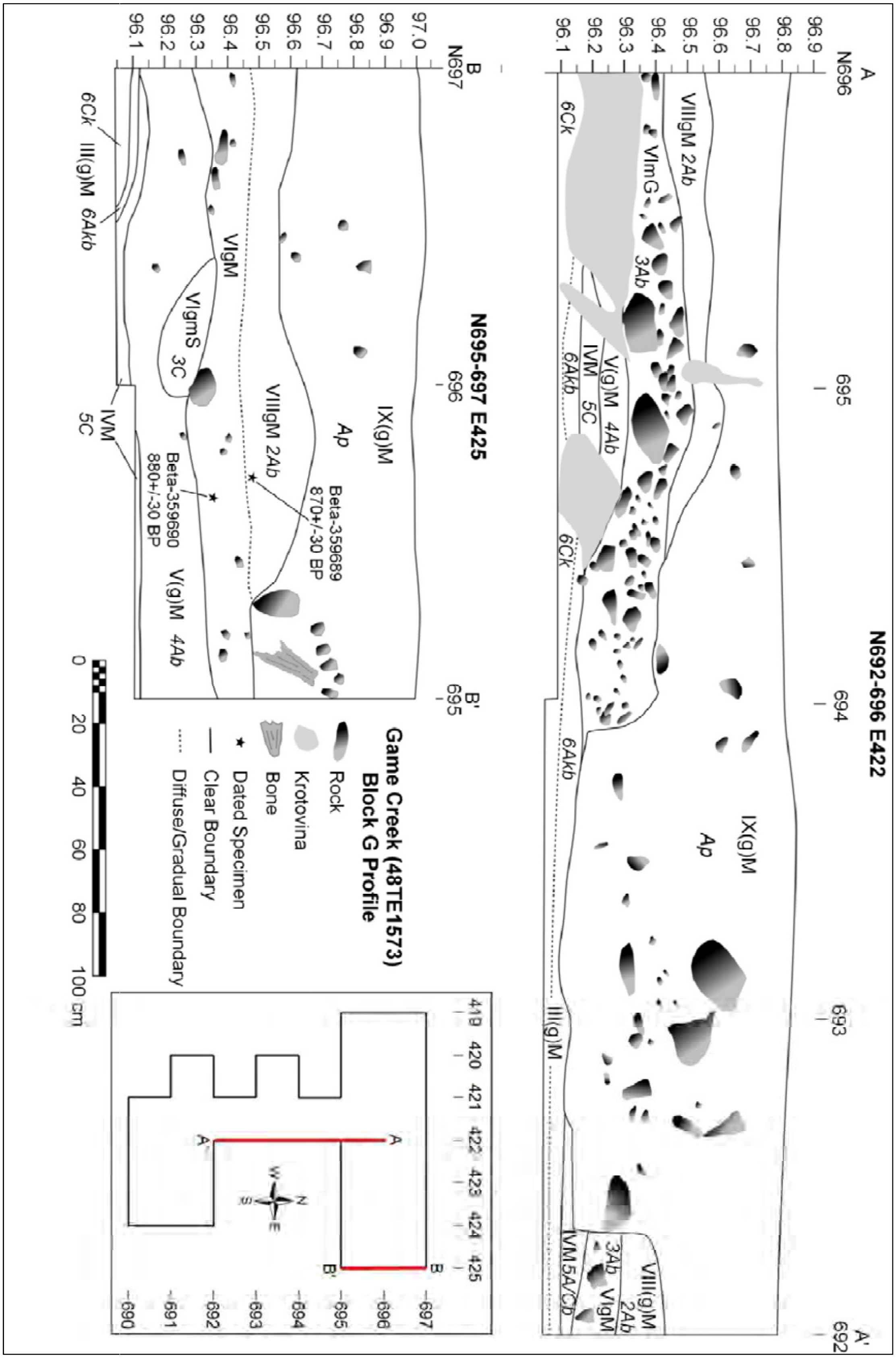
Table 4-12 Strata and soil characteristics for Block G N690 E421-424 (Figure 4-22).

Stratum	Soil Horizons	Moist Color (Munsell)	USDA Texture	%Gravel	Structure	Depositional Environment
VIII(g)M	2Ab	v-dark brown (10YR2/2)	silt loam	4	massive	Slopewash
	2ABkb	black (7.5YR 2.5/2)	silty clay loam	4	massive	Slopewash
V(g)M	4Ab	light brown (7.5YR 6/4)	silty clay loam	2.5	massive	Slopewash
IVM	5C	yellowish red (5YR 5/6)	silty clay loam	NA	massive	overbank/slopewash
III(g)M	6Akb	dark gray (2.5Y 4/1)	silty clay loam	1.1	massive	Overbank
III(g)sM	6Ck	light gray (2.5Y 7/1)	silty clay loam	.2	massive	Overbank

leading to a concentration of smaller clasts (<6.3 cm) near the surface of the landform. Consequently, the proportion of gravel in the strata on the S3 cannot be used to interpret depositional environment. However, the presence of gravels, particularly at the north end of the S3 in Block G, indicates that colluvial processes contributed to the formation of the landform.

Stratum III overlies Stratum II with a gradational boundary. This stratum is approximately 20 cm thick at N697 E420-421 (Figure 4-20). Stratum III is light to dark gray mud to slightly gravelly mud with slightly gravelly very fine sandy mud interbeds. The gravel content of Stratum III is typically less than 0.5%, although one sample from the column at Block G N697 E420 contained 2.68% which could be accounted for by the small (100 ml) sample subjected to laser granulometry. The low volume of gravel is consistent with an overbank alluvium or slackwater depositional environment. As mentioned in the soils section (below), a calcium carbonate enriched horizon (Ck/Ckg) is formed at the upper contact of Stratum III. The texture of this boundary varies from slightly gravelly very fine sandy mud (Figure 4-20), very fine sandy silt to very fine sandy mud all of which are representative of textural variation in Stratum III (Table 4-10).


Game Creek (48TE1573)
Block G N697 E419-425
(View to the North)
Fire-Cracked Rock
Rock
Krotovina
Fiber Optic Trench
Soil Sample Column
Clear Boundary
Diffuse Boundary
Elevation (m)
Percentage of Gravel Fraction
Unit N696 E421
Artifact Frequency
Unit N696 E421
Chipped Stone
Bone
% Gravel
100 cm


N692-696 E422
N695-697 E425
Game Creek (48TE1573)
Block G Profile
Rock
Krotovina
Bone
Dated Specimen
Clear Boundary
Diffuse/Gradual Boundary
0 20 40 60 80 100 cm
IX(g)M
Ap
VIIIgM 2Ab
VImG
3Ab
V(g)M 4Ab
IVM 5C
6AKb
6Ck
III(g)M
VIgM
VIgmS 3C
Beta-359689
870+/-30 BP
Beta-359690
880+/-30 BP

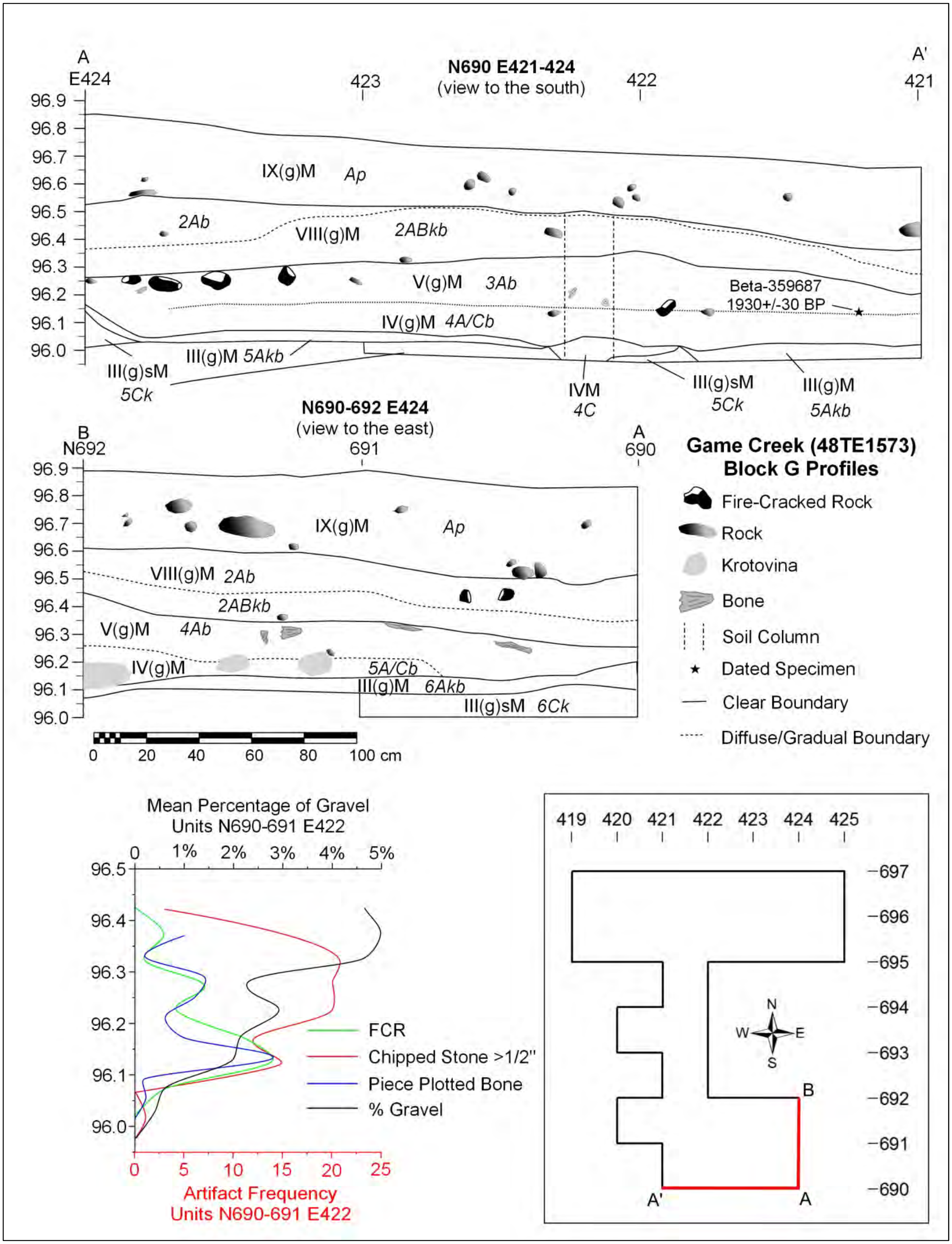


Figure 4-22 Illustrated profile of Block G N690 E421-424 and N690-692 E424.

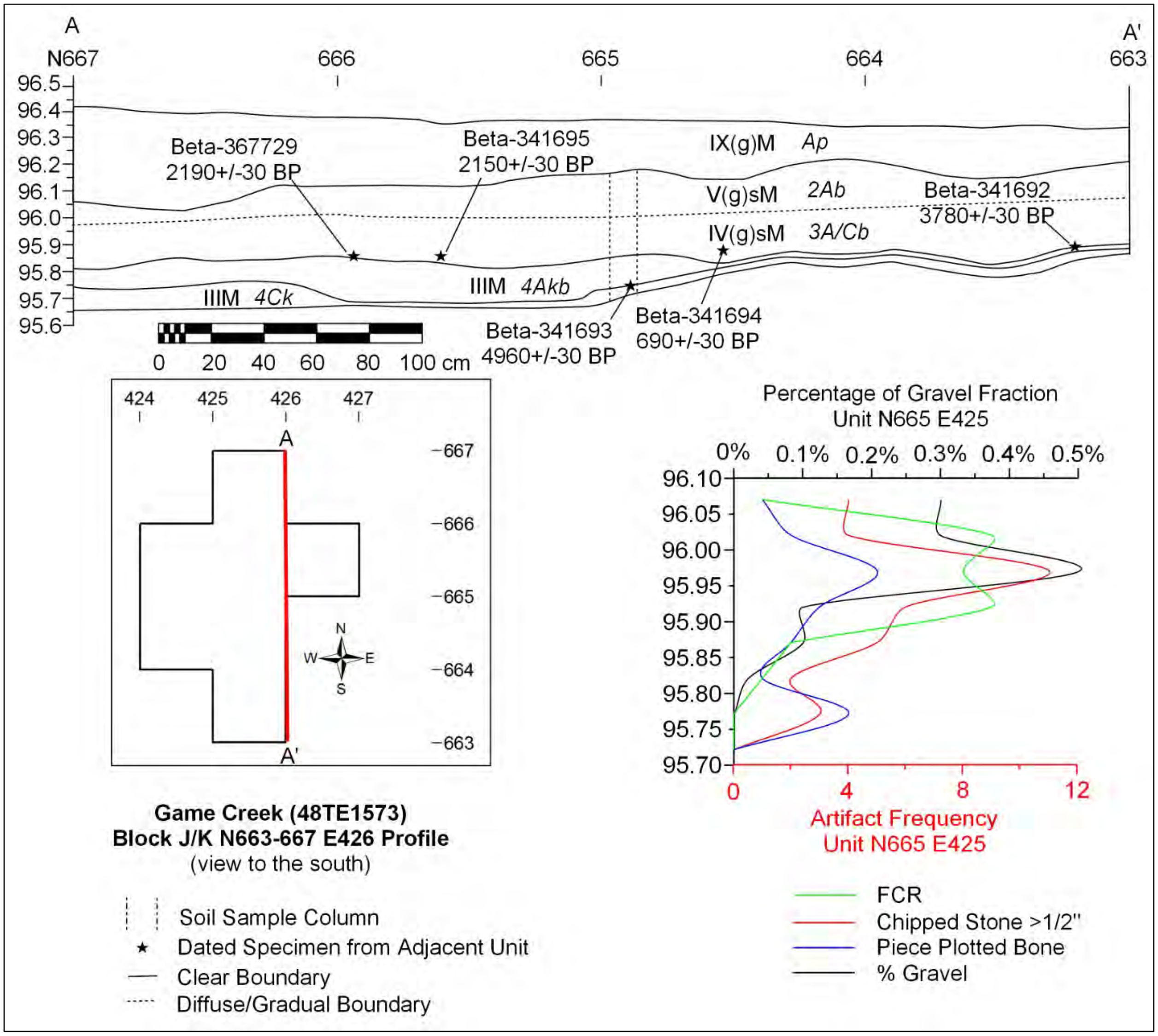


Figure 4-23 Illustrated profile of Block J/K N663-667 E426.

Table 4-13 Strata and soil characteristics for Block J/K N663-667 E426 (Figure 4-23).

Stratum	Soil Horizons	Moist Color (Munsell)	USDA Texture	%Gravel	Structure	Depositional Environment
V(g)sM	2Ab	v. dark brown (7.5YR2.5/2)	silt loam	0.25	massive	Slopewash
IV(g)sM	3A/C	dark brown (7.5YR3/3) strong brown (7.5YR 5/6)	silt loam – loam silty clay loam	0.13 0.02	massive	slopewash/overbank
IIIM	4Akb	dark gray (2.5Y 4/1)	silt loam	0	massive	Overbank
IIIsM	4Ck	light gray (2.5Y 7/1)	silt loam	0	massive	Overbank

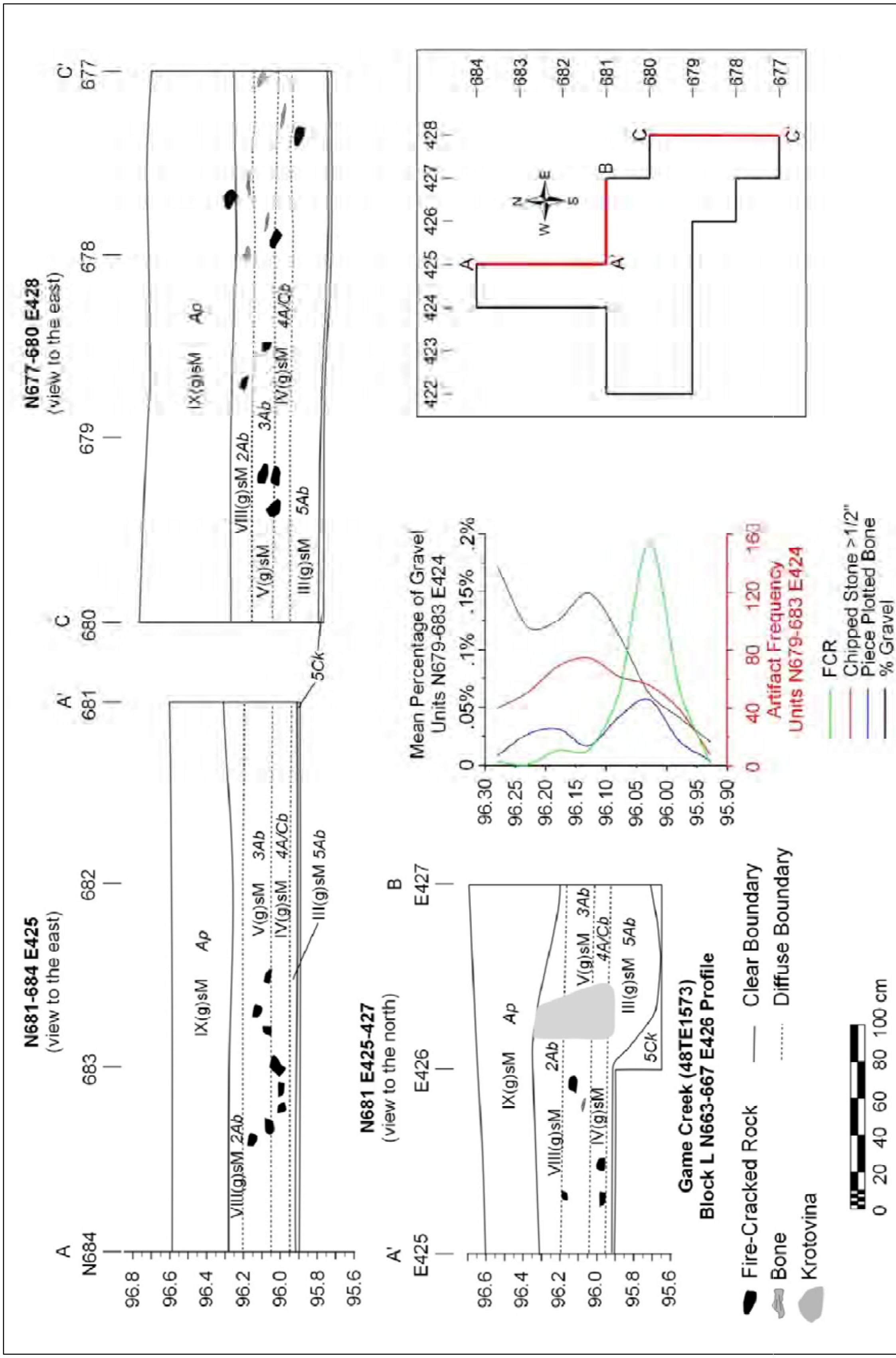

N681-684 E425
(view to the east)
N677-680 E428
(view to the east)
N681 E425-427
(view to the north)
IX(g)sM Ap
VIII(g)sM 2Ab
V(g)sM 3Ab
IV(g)sM 4A/Cb
III(g)sM 5Ab
5Ck
Mean Percentage of Gravel
Units N679-683 E424
Artifact Frequency
Units N679-683 E424
FCR
Chipped Stone >1/2"
Piece Plotted Bone
% Gravel
Fire-Cracked Rock
Bone
Krotovina
Clear Boundary
Diffuse Boundary
0 20 40 60 80 100 cm
Game Creek (48TE1573)
Block L N663-667 E426 Profile

Table 4-14 Strata and soil characteristics for Block L (Figure 4-24).

Stratum	Soil Horizons	Moist Color (Munsell)	USDA Texture	%Gravel	Structure	Depositional Environment
VIII(g)sM	2Ab	v-dark brown (10YR2/2)	silt loam	1.7	massive	Slopewash
V(g)sM	3Ab	light brown (7.5YR 6/4)	silt loam	1.5	massive	Slopewash
III(g)sM	4Ab	dark gray (2.5Y 4/1)	silt loam	0.5	massive	Overbank
	4Ck	light gray (2.5Y 7/1)	silt loam	0.01	massive	Overbank

Table 4-15 Radiocarbon dates from the S3 landform.

Beta #	Block/Provenience	Elevation(m)/cmbs	Strat.	CL	Material	Conv. RCYBP	*M* cal BP	1 σ cal BP
171708	TU101 F. 1	57cmbgs	III	?	charcoal	8530±40	9517	20
182053	TR6 N46.5m	80cmbs	III	?	charcoal	7070±40	7896	40
341693	JK/N664.89 E424.53	95.77m/53cmbs	III	5/6	charcoal	4960±30	5685	42
182052	TR6 N50.2	70cmbs	IV	?	charcoal	4080±40	4583	102
341692	JK/N663.2 E425.185	95.9m/38.5cmbs	III/IV	5/6	charcoal	3780±30	4154	56
367723	L/N679.44 E424.55	96.04	IV	6	bone	2340±30	2350	39
367729	JK/N665.94 E425.36	95.846m	IV	6	bone	2190±30	2236	57
341695	JK/N665.6 E425.06	95.86m/47cmbs	IV	6	charcoal	2150±30	2144	80
367728	JK/F. 12	95.945m	IV	6	bone	2070±30	2039	45
359687	G/N690.69 E421.26	96.135m/51.5cmbs	V	6	charcoal	1930±30	1878	36
359690	G/N695.67 E424.195	96.351m/56.4cmbs	VI	NA	charcoal	880±30	787	54
359689	G/N695.76 E424.315	96.485m/43cmbs	VI/VIII	NA	charcoal	870±30	775	52
359688	G/N691.54 E421.86	96.255m/48.5cmbs	V	7	charcoal	820±30	727	30
359685	L/N680.77 E422.68	96.075m/48.5cmbs	V	6	charcoal	730±30	676	22
341694	JK/N664.53 E425.06	95.88m/42cmbs	IV	6	charcoal	690±30	658	40
182051	TR6 N54	30cmbs	?	?	sediment	650±100	619	71
359683	L/N679.27 E422.88	96.02m/52cmbs	IV	6	charcoal	570±30	601	36
359686	L/N680.46 E423.1	96.14m42cmbs	V	7	charcoal	540±30	546	38
359684	L/N679.76 E423.74	96.22m/35cmbs	VIII	NA	charcoal	30±30	58	73

Stratum IV overlies Stratum III. As documented in Blocks G, J/K and L (Tables 4-10 through 4-14, Figures 4-20 through 4-25), this unit is yellowish red to brown, massive, mud to very fine sandy mud with little to no gravel indicative of overbank alluvium, although there may have been some contribution from slopewash along the eastern and northern boundaries of the landform. The "redness" of this unit varies across the blocks with dark organic (humic) A horizon formation partly masking the underlying red-yellow hue. In many places discrete bodies of red to yellow parent material (C horizon) are encased within a humic A horizon creating an A/C horizon (Figures 4-28 and 4-29). The provenance for this sediment is believed to be the Game Creek drainage. Various Paleozoic through Cenozoic red-beds crop out in the Game Creek hydrological basin including large areas of Chugwater and Amsden Formations that might have been the provenance for the reddish sediment. It is possible that Stratum IV interbeds with Stratum V, but stratigraphic contacts have likely been eradicated by faunalturbation and/or masked by post-depositional humic darkening.

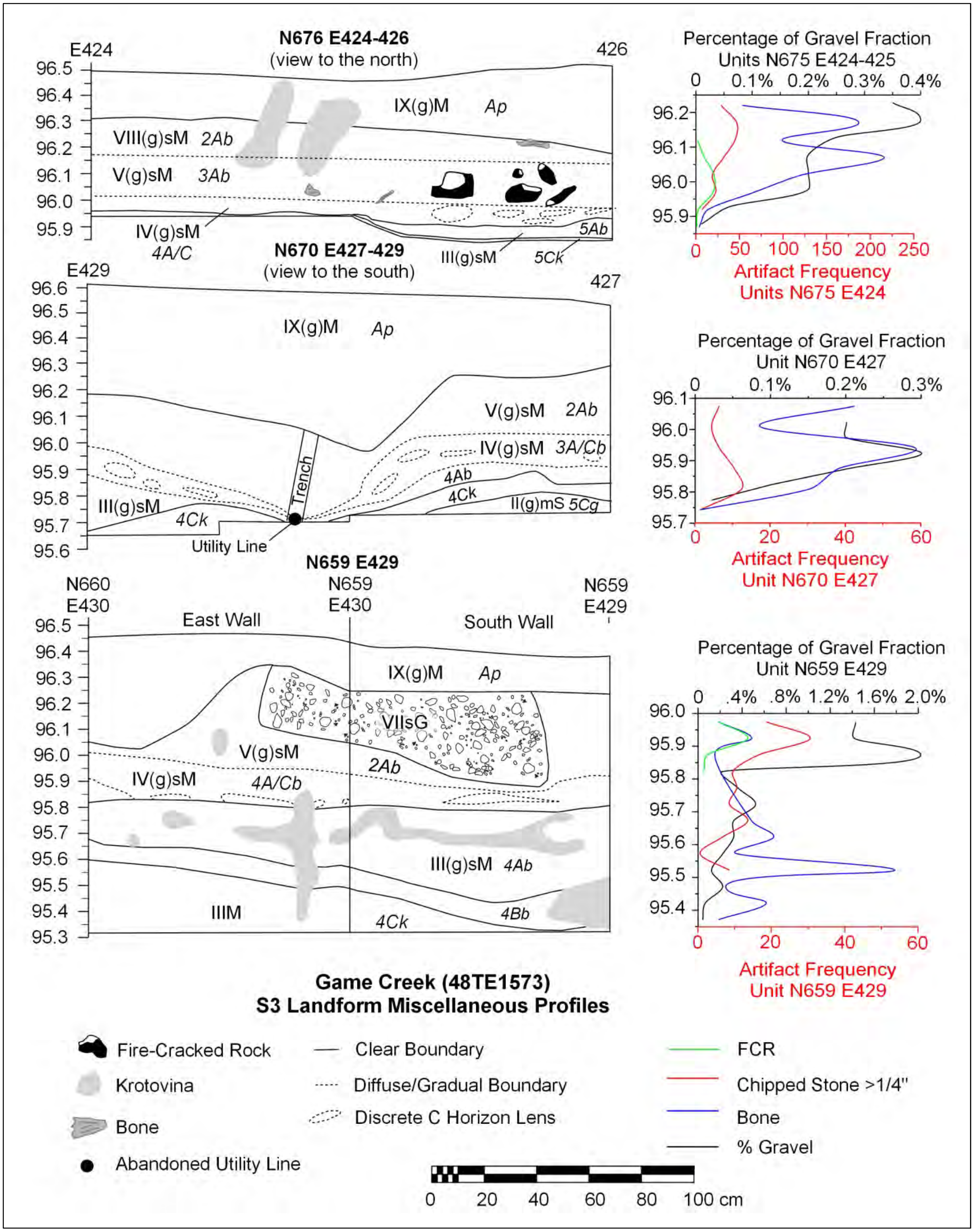


Figure 4-25 Illustrated profile of units N659 E429, N670 E427-429 and N676 E424-426.

Table 4-16 Strata and soil characteristics for Units N676 E424-425, N670 E427-428, N659 E429.

Stratum	Soil Horizons	Moist Color (Munsell)	USDA Texture	%Gravel	Structure	Depositional Environment
N676 E424-426						
VIII(g)sM	2Ab	v-dark brown (7.5YR2.5/2)	silt loam	.38	massive	Slopewash
V(g)sM	3Ab	light brown (7.5YR 6/4)	silt loam	.28	massive	Slopewash
IV(g)sM	4A/Cb	black (7.5YR2.5/1) brown (7.5YR4/4)	silt loam	.20	massive	Overbank
III(g)sM	5Ab	dark gray (2.5Y 4/1)	silt loam	.01	massive	Overbank
	5Ck	light gray (2.5Y 7/1)	silt loam	0.01	massive	Overbank
N670 E427-429						
V(g)sM	2Ab	dark brown (7.5YR3/2)	silt loam	.23	massive	Slopewash
IV(g)sM	3A/Cb	black (7.5YR2.5/1) brown (7.5YR4/4)	silt loam	.15	massive	Overbank
III(g)sM	4Ab	black (7.5YR2.5/1)	silty clay loam	.06	massive	Overbank
	4Ck	gray (2.5Y6/1)	silty clay loam	.02	massive	Overbank
II(g)mS	5Cg	grayish brown	sandy loam	.02	massive	Channel margin
N659 E429						
VIIsG	C	brown (10YR5/3)	sandy gravel	~50.0	massive	Channel
V(g)sM	2Ab	dark brown (7.5YR3/2)	silt loam	1.6	massive	Slopewash
IV(g)sM	3A/Cb	dark brown (7.5YR3/2) reddish brown (5YR4/4)	silt loam	.27	massive	Overbank
III(g)sM	4Ab	black (7.5YR2.5/1)	silt loam	.33	massive	Overbank
	4Bb	dark brown(7.5YR3/2)	silt loam	.11	massive	Overbank
	4Ck	gray (2.5Y6/1)	silty clay loam	.02	massive	Overbank

Six radiocarbon dates were run from specimens recovered in Stratum IV. The dates varied in age from 2350±39 cal BP to 601±36 cal BP (Table 4-15). There is even a wider range of diagnostic artifacts recovered from Stratum IV on the S3 including Early, Middle and Late Archaic, as well as Late Prehistoric projectile points. In short, post-depositional mixing of the deposit precludes a reliable assessment of the age of Stratum IV.

Slightly gravelly mud zones situated both above and below a debris flow (discussed below) at the north end of Block G are documented by both visual and laboratory assessments. The lower zone is designated Stratum V. At Block G, N697 E421-422 this unit is a light brown (7.5YR6/4), massive, slightly gravelly mud containing 14% gravel (Table 4-10, Figures 4-20 and 4-21). The volume of gravel within Stratum V decreases to the south with 2.5% recorded at Block G N690, 1.5% at Block L N681-683 and only 0.25% in Block J/K N664 (Tables 4-11 through 4-13, Figures 4-22 through 4-25). The increase in gravels may mark a shift from overbank to slopewash deposition on the S3. However, it is likely that the volume of gravels in Stratum V has been altered by post-depositional sorting of clasts caused by faunalturbation (see below).

Stratum VI is a debris flow that disconformably overlies Strata IV and V in the northern half of Block G. The gravel content of this zone approaches 50% in the N696 transect of Block G (Table 4-11, Figures 4-20 and 4-21). Stratum VI is dark brown, gravelly mud to muddy gravel. This unit was documented in the northern part of Trench 6 (at 55-57 m) where it was labeled “stone line with small to medium cobbles” (Eakin and Eckerle 2004). This deposit formed from flash flood style deposition as opposed to snowmelt runoff which is thought to have produced Strata II-IV. The gravel and cobbles are predominantly limestone and sandstone similar to the present lithology of the Game Creek streambed (Table 4-4, Figure 4-26). It is unclear how much of the underlying strata were impacted by the debris flow, but portions of Strata IV and V were partially to entirely truncated by the flow in Block G (Figures 4-20 and 4-21). The flow does not appear to be present south of ~N692. Low frequencies of cultural material were recovered from within Stratum VI and appear to have been entrained in the debris flow (Figure 4-26). Two charcoal samples, one from the base and one immediately above the debris flow were dated to 775±52 cal BP and 787±54 cal BP and are statistically the same as the 828±51 cal BP date from the top of the debris flow (Stratum V) on the T3 terrace. Whether the two flows were related to the same event is difficult to address.

Stratum VII is a stream channel deposit documented in unit N659 E429 (Table 4-16, Figures 4-25 and 4-27). The channel is incised into and disconformably overlies Stratum V. This unit consists of brown sandy cobbly gravel about 30 cm thick, but an unknown amount of the unit was stripped during highway construction. The width of the channel is unknown. It may have cut in a southwesterly direction across the T2 terrace toward Flat Creek because gravel and cobbles cap the S3/T2 scarp in this area. Yet, the gravel could also be from Stratum I, or both. The gravel and cobbles from Stratum VII appear to be mostly quartzite (Figure 4-27), similar to the Snake River bedload and markedly dissimilar to the modern Game Creek streambed that is composed almost entirely of limestone and sandstone (Table 4-4). Nevertheless, Game Creek is the likely source of the channel. Unfortunately, construction of the present alignment of US Highway 189/191/89/26 appears to have destroyed most of Stratum VII precluding an assessment of original stream course.

Stratum VIII overlies Stratum VI in the northern portion of S3 and Stratum V south of ~N692. This unit appears to be absent south of Block L. At Block G, N697 E421-422 (Figure 4-20 and 4-21), this upper stratum consists of black, massive, slightly gravelly mud. In the southern portion of Block G, where Stratum VIII is best preserved, the unit has a 4% gravel content, almost twice that of Stratum V (Table 4-11). Yet, it is unclear whether this increase in gravel is due to increased rates of deposition or to size sorting caused by faunalturbation. Stratum VIII is overlain by highway construction fill. Some of the original surface appears to have been stripped and/or severely disturbed by heavy equipment. A small quantity of historic-aged artifacts were found in the upper portion of Stratum VIII, but it is unclear whether these were deposited with the construction fill or were on an intact surface.

Figure 4-26 Photograph of Stratum VI debris flow in Block G N696 E419 at 96.2 m. Note angular limestone cobbles and bison rib (Page 2012).

Figure 4-27 Photograph of Stratum VII channel deposit in unit N659 E429. Note the well-rounded quartzite gravel and cobbles (Page 2012).

S3 Soils

As documented in Blocks G, J/K, and L, Strata II through VIII on S3 exhibit soil profiles dominated by an overthickened A horizon formed in slopewash and overbank alluvium overlying a buried calcium carbonate enriched Ck horizon (in Stratum III) and basal gleyed Cg horizon formed into the lower overbank and channel margin units. There is no evidence of pedogenic clay enrichment with soil horizon textures reflecting parent material grain size distribution. The absence or poor expression of normal A and B physicochemical horizonation likely indicates that there has been significant mixing of the deposit (Johnson 1989). The profile from N697 E420-421, at the north end of Block G exhibits a horizon sequence consisting of the following (Figure 4-20): Ap-2Ab-3Ab-3C-4Ab-5C-6Akb-6Ck-6Ckg-7Cg. The first paleosol is a buried humic Ab sequence consisting of an Ab formed in Stratum VIII and an Ab formed in the Stratum VI debris flow. A small lens of lighter colored sediment at N697 E423 appears to be unaltered parent material, or a C horizon. The 2Ab and 3Ab differ mostly in color with the upper being darker.

Along with evidence for high water table in this zone, these A to Oa horizons likely resulted from organic surface litter decomposition under a non-grassland setting, possibly under a forest canopy or under riparian shrubs. In contrast the A horizons in Strata IV and above have gradational lower boundaries with lower estimated organic content are interpreted as grassland soils that formed primarily from below ground organic input from the decomposition of grass rootlets. Additional redoximorphic features are present but lacking overprinting by calcium carbonate in the Stratum II Cg horizon (Figures 4-20 and 4-28).

The fact that primary sedimentary colors can be transformed as a result of redoximorphic processes (Birkeland 1999) presents the possibility that Stratum III, the lower overbank/slopewash deposit, might have originally been deposited with a 7.5YR hue (7.5YR 6/4, light brown) similar to Stratum IV, but its hue might have been gleyed to 2.5Y (2.5Y 7/1) by redoximorphic processes. If true, the Strata III-IV boundary is not a true stratigraphic contact but represents a soil horizon boundary. This seems likely based on the variation in the texture and gravel content of the top of the light gray (2.5Y 7/1) zone. However, as mentioned above, thin A grading to O horizons below the plotted Strata III-IV boundary signal a shift from forest to grassland environment, but whether it also marks a depositional environment shift is not clear.

The topography of horizon boundaries is controlled by soil formation processes which, on the S3, include primarily organic additions, changes in water table level, and for the carbonates. Thus, the topography of what we have defined as carbonate enriched upper contact of Stratum III is more a function of water table variation than post-depositional erosion.

Figure 4-28 Photograph of profile from Unit N670 E427 showing the mottled colors of Stratum IV A/Cb horizon (Page 2012).

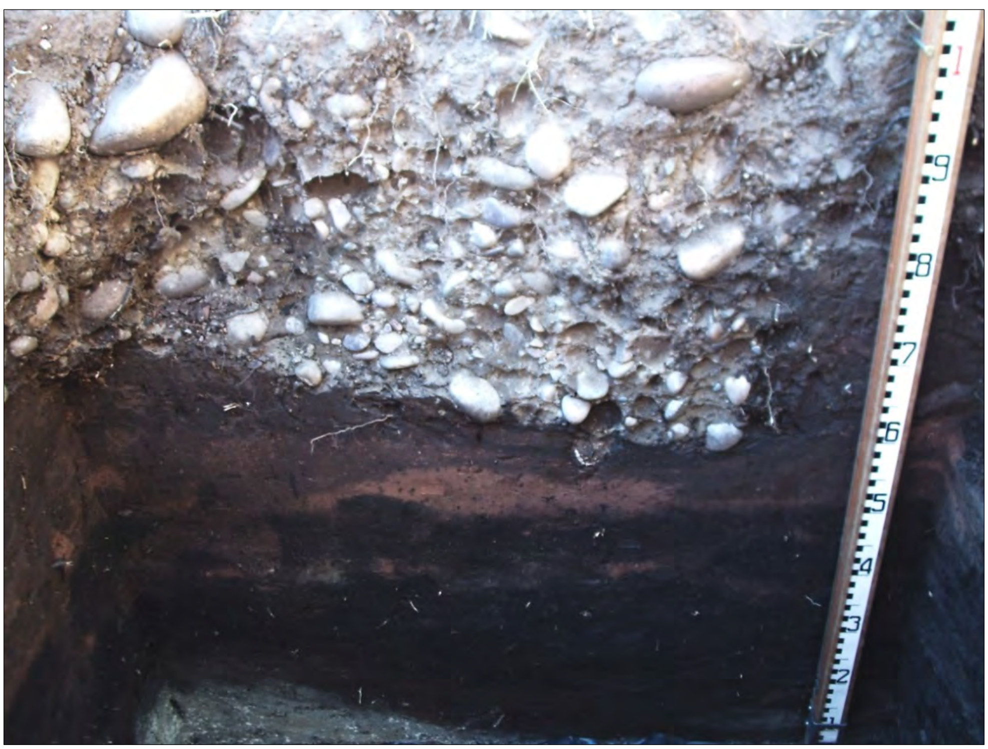


Figure 4-29 Photograph of unit N659 E429 south wall showing the Stratum IV A/C horizon and Stratum III Ab and Ck horizons (Page 2012).

Integrity of Cultural Levels: S3

Artifact frequencies on the S3 were significantly higher than on the T3. Unfortunately, faunalturbation and impacts from hydrologic events have profoundly affected the archaeological integrity of the S3 landform. These post-depositional processes have reduced most of the S3 to a palimpsest containing an unknown mixture of artifacts attributable to at least 10 occupations dating from circa 5700 cal BP to 550 cal BP (Table 4-15). However, the northern half of Block G may retain some level of contextual integrity.

A Late Prehistoric component was identified in the northern half of Block G. The flood event that created the Stratum VI debris flow deposit stripped most of strata V and IV from that portion of the S3 landform around 828±51 cal BP. The subsequent Late Prehistoric components identified in Stratum VIII, above Stratum VI, are believed to be relatively unmixed with earlier Archaic-aged artifacts because those materials were removed along with strata V and IV. Contextual integrity was still poor, with no clear chronostratigraphic boundaries. No radiocarbon dates are available, but diagnostic artifacts recovered from excavations indicate at least two Late Prehistoric components that are assigned to Cultural Level 7 (Chapter 5).

Assessment of Faunalturbation

Unlike the T3 terrace, very few krotovina were identified during excavation on the S3 due to the dark humic soils and lack of clear horizonation. Moreover these deposits have been capped by a thick layer of rubble deposited during highway construction. The coarse fabric of the construction debris appears to have deterred burrowing rodents, since no evidence of recent burrowing was observed during excavation. Discernable krotovina were very common at the contact of the Stratum III Ck horizon where the burrows stood in sharp contrast to the light gray soil (Figures 4-30 and 4-31). However, the frequency of intrusive rodent bones on the S3 is much higher than on the T3, with nearly five times as many identifiable specimens per cubic meter overall (Table 4-17). Block J/K had an unusually high number of rodent bones and was one of the thinnest deposits excavated at the site. Since most burrowing rodents routinely dig in excess of a meter it is likely that the entire landform has been impacted.

Table 4-17 Intrusive rodent bone by block.

Landform	Block	NISP	NISP/m^3
	G	78	4.5
S3	JK	84	20.4
	L	37	2.8
S3 mean			9.3
	A	137	2.1
T3	D	15	1.6
	E	18	2.7
	I	8	1.2
T3 Mean			1.9

Extensive burrowing can result in systematic sorting of artifacts and naturally occurring gravel and rock by size. Overtime the deposition of excavated material on the surface by fossorial rodents causes smaller artifacts and gravel to become concentrated near the surface (Bocek 1986; Johnson 1989). Clasts

Figure 4-30 Photograph of Block L unit N679 E423 at 95.90 m elevation, at contact with Stratum III, showing krotovina (Page 2012).

Figure 4-31 Photograph of Block G unit N695 E423 at 96.1 m elevation, at contact with Stratum III, showing krotovina

larger than 6.3 cm, those too big to be transported by pocket gophers, eventually subside to near the base of the biomantle by falling into collapsed burrows (Bocek 1986; Johnson 1989). Given enough time and/or intensity of burrowing a stone/artifact line will often form at the base of a deposit.

In order to test whether burrowing by fossorial rodents has significantly altered the contextual integrity of the archaeological deposits, the frequency distribution of artifacts smaller than 6.3 cm and the volume distribution of gravel were calculated and compared. If burrowing has significantly altered the integrity of the deposit then both small artifacts and gravel should display similar vertical distributions. As shown in Figure 4-32, there are nearly identical vertical distributions of small artifacts and gravel in all sampled blocks. The distributions of small artifacts and gravel show high and statistically significant positive correlations for all sample units (Table 4-18). Both small artifacts and gravel are most numerous near the surface and decline in frequency with depth (Figure 4-32). The distribution is linear and statistically significant in each sampled block (Table 4-19).

In the same manner, the vertical distributions of artifacts and rocks larger than 6.3 cm were plotted and tested. Results show that the distributions of large (>6.3 cm) artifacts and rocks are positively correlated at a statistically significant level (Figure 4-32, Table 4-18). However the distribution of large artifacts and rocks differs from the smaller clasts in that there is no linear relationship with depth (Figure 4-32, Table 4-19). In Block L, 90% of the large artifacts and rocks were found in the lower half of the excavated sample. Most (87%) of the large artifacts and rocks found in the Block G sample were concentrated between 96.3 m and 96.2 m. Although this concentration is not at the bottom of the biomantle, it is below 63% of the smaller artifacts and ecofacts, which suggests some degree of subsidence of large clasts. In Block J/K the larger artifacts have the same distribution as the smaller artifacts, likely due to truncation of the landform during highway construction in and around Block J/K.

A large linear disturbance in the E426 transect of Block L is the same width and depth as a beaver canal (Figure 4-33). The possible beaver canal was first identified at the top of intact deposits and was filled with 10–20 cm of highway construction fill. The lower 10–20 cm contained slightly gravelly (slopewash) deposits similar to Stratum VIII. Thus, it appears the feature was dug into Strata VIII and V, abandoned and partially filled and then completely filled during highway construction. Periodic flooding associated with beaver dams and dam failure during spring runoff is less obvious, but perhaps more destructive than the occasional canal.

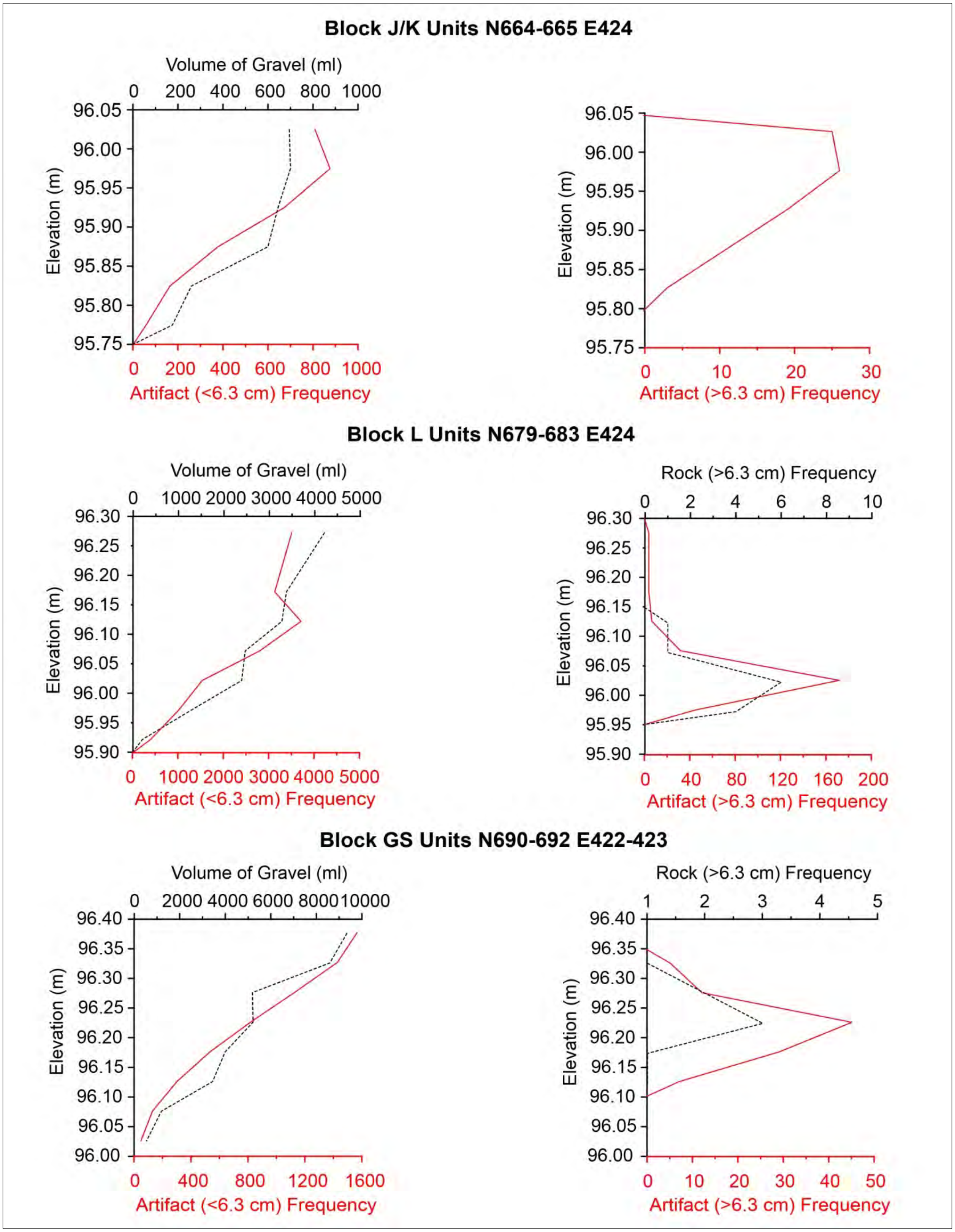


Figure 4-32 Vertical distribution of large and small artifacts and ecofacts (gravel and rock) from samples taken from Blocks J/K, L and G on the S3 landform.

Table 4-18 Results of correlation analysis of artifacts and ecofacts from the S3.

Sample Provenience	r^2	*n*=	*df*	Critical Value (One-Tailed *p* [.05])
Block J/K N664-665 E424				
Artifacts and Gravel (<6.3 cm)	0.945	7	5	0.669
Block L N679-683 E424				
Artifacts and Gravel (<6.3 cm)	0.952	8	6	0.621
Artifacts and Rocks (>6.3 cm)	0.92	8	6	0.621
Block G N690-692 E422-423				
Artifacts and Gravel (<6.3 cm)	0.969	8	6	0.621
Artifacts and Rocks (>6.3 cm)	0.862	8	6	0.621

Calculated using *PAST* (Hammer and Ryan 2001)
H_0 = there is no correlation between sampled items. The null hypothesis is rejected when r^2 meets or exceeds the critical value. Level of significance .05, one-tailed.

Table 4-19 Results of linear regression analysis (Coefficient of Determination R^2).

Sample Provenience	R^2	Equation	Critical Value (One-Tailed p [.05])
Block J/K N664-665 E424			
Artifacts <6.3 cm	0.934	y=0.0003x+95.778	0.669
Gravel (.3-5 cm)	0.891	y=0.0004x+95.731	0.669
Artifacts >6.3 cm	0.914	y=0.0077x+95.82	0.669
Block L N679-683 E424			
Artifacts <6.3 cm	0.946	y=8E-05x+95.897	0.621
Gravel (.3-5 cm)	0.861	y=8E-05x+95.909	0.621
Artifacts >6.3 cm	0.015	y=-0.0004x+96.09	0.621
Rock >6.3 cm	0.04	y=0188x+96.099	0.621
Block G N690-692 E422-423			
Artifacts <6.3 cm	0.981	y=0.0002x+96.07	0.621
Gravel (.3-5 cm)	0.954	y=4E-05x+96.046	0.621
Artifacts >6.3 cm	0.009	y=0.0133x+96.215	0.621
Rock >6.3 cm	0.013	y=0.0133x+96.215	0.621

Calculated using *PAST* (Hammer and Ryan 2001)
H_0 = there is no linear correlation between sampled items. The null hypothesis is rejected when r^2 meets or exceeds the critical value. Level of significance .05, one-tailed.

Figure 4-33 Possible beaver canal exposed in Block L E426.

Geoarchaeological Conclusions

Geoarchaeological investigations of the Game Creek site provide an assessment of geomorphology, stratigraphy, pedology site formation history and taphonomy. The Game Creek site geologic history begins with glaciofluvial deposition of channel and overbank deposits (T3/S3 Strata I-II) on a bedrock strath. Midway during Stratum III overbank sediment aggradation a major Paleoindian occupation event occurred on T3 from 10,391±61 cal BP to 9660±53 cal BP, which was subsequently overprinted by a humic, now-buried A horizon (Ab). 3-D visualization of point-plotted artifacts occurring in the T3-Stratum III Ab horizon reveals a lower vertically-constrained occupation zone with the artifact zone somewhat thicker than a predicted occupant trampled zone for this texture of sediment (see Eckerle et al. 2011), but nonetheless forming a distinct cultural level. Despite some visible krotovina in this occupation, the evidence suggests that post-occupation mixing was moderate, and the zone represents an important archaeological manifestation within Jackson Hole.

Based on climate modeling presented in Chapter 2, Cultural Levels 1 and 2, below and within the T3 Stratum III Ab horizon, respectively, are modeled (at 100 year class-intervals) to have accumulated during a time of highly variable winter and summer effective moisture. A dry event from approximately 10,200 cal BP to 9550 cal BP is retrodicted in the MCM model and further reflected in the proxy data from Lake of the Woods. During this time, there was a decrease in winter precipitation and increase in summer precipitation that likely caused a reduction in spring runoff and decreased stream competency leading to a pause in overbank flooding and alluvial deposition. The concurrent increase in summer precipitation would have promoted the growth of grasses that in turn led to the formation of the A horizon.

The intervals of high annual but low summer effective moisture probably resulted in forage production and game animal densities much like present day conditions, which support relatively abundant big game populations. Climatic models and proxy data from the GYE suggest the potential for a balanced hunting and gathering adaptation with abundant big game and plant resources during the late Paleoindian occupation interval.

By about 9000 cal BP, the T3 Stratum IV colluvial wedge of slopewash with minor debris flows began to accumulate. The cessation of overbank flooding coincided with the Early Holocene decrease in effective moisture documented in local proxy records. The MCM retrodicts a trend towards increasing summer effective moisture between 9000 cal BP and 7850 cal BP despite an overall marked decline in annual effective moisture. Evidence for this trend can be found in the decreased depositional rates and the low volume of gravel on the T3. An increase in summer precipitation would have benefited grasses whose roots would have stabilized slopes and decreased erosion. After 7850 cal BP and until 5600 cal BP there were increases in depositional rates and gravel in T3 Stratum IV suggesting a decrease in slope stability. The MCM retrodicts a decline in both summer and annual effective moisture during this period.

Low modeled effective precipitation between ~9025-5600 cal BP, supported by regional studies, would have lowered the water table on the Snake River-Flat Creek bottomland and reduced plant food resource production for several high-value species, but increased production of summer moisture-dependent upland plants. Overall, game animal populations were probably lower than present.

Annual effective moisture increased to near modern levels after 5600 cal BP resulting in dramatic reductions in depositional rates and gravel in T3 Stratum IV. Deposition of T3 Stratum IV continued until sometime after ~4300 cal BP but before 828±51 cal BP. Overbank flooding of Game Creek likely caused by increased spring runoff during this time led to the accumulation of S3 Stratum IV. Overbank alluvial deposition on the S3 continued until sometime after ~2000 cal BP and was probably followed by a transition to a colluvial slopewash dominated depositional regime.

A date from T2 suggests that the Snake River trimmed back T3 and S3 prior to 4638±93 cal BP. At one time it was thought that Quaternary movement had occurred on the Hoback Fault to the east of the site (Love and Montagne 1956). Any such movement could have resulted in east valley-tilting and caused the Snake River channel to shift from west-valley-flowing upstream of Game Creek to east-valley downstream. However, Kenneth Pierce, USGS, has searched for evidence of Quaternary offset and cautions that evidence for movement along the Hoback fault is weak. A more likely possibility is that floodwater from the Devil's Elbow slide dated to 4194±339 cal BP to 4637±283 cal BP (Love and Love 1988) trimmed back the T3 terrace and S3 alluvial fan.

Significant soil formation and landscape stability (non-deposition) occurred in upper T3 Stratum IV and perhaps S3 Stratum V until approximately 1125 cal BP to 825 cal BP when there is evidence for destabilization of hillsides and increased slopewash deposition. This interval coincides with a decrease in effective moisture inferred from paleoshorelines at Lake of the Woods. On the T3, there was a sharp increase in the volume of gravel over the entire landform that marks the T3 Strata IV/V boundary. The debris flow, described as T3 Stratum V (C horizon), was deposited along the eastern margin of the T3 sometime prior to 828±51 cal BP. S3 Stratum VI was deposited shortly thereafter at about 787±54 cal BP, but was caused by a flash flood event within the Game Creek drainage. The steep Game Creek valley is flanked by unconsolidated glacial deposits that are prone to landslides. It is possible that the slope instability that led to the deposition of the T3 Stratum V debris flow also caused a landslide in the Game Creek valley creating a natural dam, similar to the Devil's Elbow slide on the Gros Ventre River. When wet conditions returned at approximately 825 cal BP, the dam ruptured causing a large flood that resulted in the deposition of the S3 Stratum VI debris flow. This event may also have altered the course of Game Creek that appears to have previously flowed south as it exited the valley as suggested by the stream channel deposit (S3 Stratum VII) observed in unit N659 E429.

The period ~5600-825 cal BP (until T3 Stratum V times) is modeled as a time of high annual precipitation that would have enhanced plant food resource production from lowland adapted species, as well as early-season moisture-dependent root and tuber-producing plants. However, upland species would not have been as available during this time. Big game animal densities were probably much like present day.

Colluvial slopewash deposition continued the T3 and S3 after 825 cal BP until the present. The volume of gravel in S3 Stratum VIII (North half of Block G) and T3 Stratum V is significantly higher than underlying slopewash deposits (T3 Stratum IV and S3 Stratum V) suggesting lower summer effective moisture. However, MCM simulated effective moisture during this time is close to modern conditions. The proxy data from Lake of the Woods likewise shows fairly stable, near modern, effective moisture. At Crevice Lake in the northern GYE there is evidence for alternating extreme wet and dry conditions from 825 cal BP to 525 cal BP. Dendro-climatological studies in the region also show at least one severe drought occurred in AD 1304 (646 BP). Thus, the higher depositional rates and gravel volume may reflect high frequency and amplitude variation in effective moisture rather than a prolonged dry period.

CHAPTER 5 RESULTS OF EXCAVATION

Michael K. Page

The excavations at Game Creek resulted in the identification of seven cultural levels. The geomorphology and stratigraphy of each cultural level is thoroughly discussed in the previous chapter and will not be repeated in detail. To briefly summarize Cultural Levels 1 through 3 are found within fine-grained alluvium in Stratum III on the T3 terrace. The deposition of Stratum III began sometime before 10,391±61 cal BP and ended at about 9000 cal BP. No unambiguous evidence of occupations dating to this period was found on the S3 landform (Game Creek alluvial fan). Cultural Levels 4 through 6 were found within the T3 Terrace Stratum IV, a slopewash deposit that accumulated between 9000 cal BP and about 1000 cal BP. On the S3 landform, Cultural Levels 4 and 5 occur within overbank alluvium in Stratum III but contained sparse cultural material. Cultural Level 6 was limited to the upper part of Stratum IV on the T3 terrace. Cultural Level 7 was found within Stratum V, where present, or within the upper limits of Stratum IV. Both Cultural Level 6 and 7 contained low artifact frequencies on the T3 terrace. On the S3, Cultural Levels 6 and 7 produced impressive assemblages that were poorly preserved and severely mixed, precluding detailed separation and description of individual components.

Table 5-1 Cultural Levels and dated components at the Game Creek site.

Cultural Level	Landform & Stratum	cal BP Range	Dated Components cal BP ± 1σ (Block)	Diagnostic Artifacts
1	T3 S-II/III	?-10,391	10,391±61 (A)	Unnamed Fishtail
2	T3 S-III	10,391-9660	10,207±68 (B) 9660±53 (A)	Angostura/Ruby Valley
3	T3 S-III	9660-9000	NA	Allen, Lovell/Pryor
4	T3 S-IV S3 S-III	9000-6900	9009±28 (A) 8645±77 (A)? 8390±28 (D) 7951±23 (A) 7629±25 (H)? 7531±28 (E)?	Lovell/Pryor Elko Eared Elko CN
5	T3 S-IV S3 S-III	6900-5290	5685±42 (J/K) 5519±86 (A, E)	Elko Eared, Bitterroot SN Elko CN
6	T3 S-IV S3 S-IV	5290-1000	4583±102 (TR6) 4288±74 (TR1) 4154±56 (J/K) 3970±64 (H) 2350±39 (L) 2249±66 (J/K) 2039±45 (J/K) 1878±36 (G)	 Bitterroot/Northern SN Gate Cliff/Duncan Stemmed Pelican Lake/Elko CN
7	T3 S-V S3 S-V S3 S-VIII	1000-550	767±26 (A, G) 668±21 (L, J/K) 554±36 (L)	 Desert TN

Calibrated at 2σ using CALIB 7.0.4, Intcal13 calibration curve (Stuiver and Reimer 1993; Reimer et al. 2013).

The cultural levels do not represent individual components but rather are analytical units that are demarcated by sedimentary and/or soil characteristics (Chapter 4). There is evidence for multiple occupations within some of the cultural levels. Based on the 47 AMS radiocarbon dates run on either charcoal recovered in direct association with cultural material or butchered bone, there are at least 19 components in evidence at the Game Creek site (Table 5-1). Dated components were determined by creating pooled means of all radiocarbon dates that were statistically the same. The standard deviation (lab error) of even the most precise AMS date is 30 years. Therefore, it is likely that some components were lumped together. In some instances it is possible to differentiate components within a cultural level, but for the most part post-depositional processes have led to the mixing of artifacts preventing precise separation of components. Consequently, the following discussion will focus on cultural levels rather than components except in the few cases where the occupational surface of a component can be identified with a reasonable degree of confidence.

Artifact density was not uniform across the T3 terrace. Many units contained few artifacts and others were so badly disturbed by faunalturbation that no reasonable conclusions can be drawn from the artifacts recovered. Included in the list of unproductive and/or heavily disturbed units are Blocks B, C and H and all but three of the single excavation units. The following descriptions are based on the material recovered from Blocks A, D, E, F and I and units N436 E503, N440 E504 and N440 E520.

Cultural Levels 1 and 2 – Block A

One of the most persistently difficult issues in the archaeological interpretations of the Game Creek site is whether and where to separate Cultural Levels 1 and 2. On the one hand Cultural Levels 1 and 2 showed no clear stratigraphic demarcation in the western (E497-499) and northern (N500-504) parts of Block A or in any of the other excavation blocks. Even where Cultural Level 1 is best preserved mixing from bioturbation and occupational trampling make it nearly impossible to say with any certainty where any one artifact originated. These factors led Meyer et al. (2014) to conclude that the entire deposit was a palimpsest.

On the other hand, in the eastern five meters of Block A, Cultural Level 1 was clearly separated from Cultural Level 2 by one to three centimeters of deposit. The lower boundary was clearly demarcated by the contact of Strata II and III, and the upper boundary was marked by a buried soil horizon. Thus, in this relatively small part of the excavations, Cultural Levels 1 and 2 were stratigraphically distinct. Furthermore, Features 4, 6 and 11 were found stratigraphically within Cultural Level 1 and butchered bone and tools show spatial distributions indicative of hearth-centered activity. The distribution of analytical nodules enabled and facilitated the identification of episodes of tool production and provided some means to assess the horizontal extent of occupations. The lithic raw material composition of Cultural Levels 1 and 2 also differ significantly as do the types of reduction strategies inferred from a mass lithic analysis. For these reason it seems justified to divide Cultural Levels 1 and 2 in Block A.

Artifacts were recovered from the lower portion of Stratum III in Blocks D, E and I, but for the most part little data was found that clearly establishes a connection between these assemblages and those from Block A. Blocks D, E and I will therefore be addressed separately from Block A. Discussions of the spatial patterning of artifacts, lithic raw material composition, minimum analytical nodule analysis, results of the mass lithic analysis and radiocarbon dating are discussed following brief descriptions of Cultural Levels 1 and 2.

Cultural Level 1

Cultural Level 1 is approximately 10 cm thick and found immediately above the Strata II/III contact approximately 140 cmbs in Block A. The majority of the artifacts from Cultural Level 1 were found in and around Features 4, 6 and 11 (Table 5-2, Figure 5-1). Bone preservation was poor, but a small faunal assemblage that included a diverse array of identifiable large and small mammals and one freshwater bivalve shell fragment was also recovered. The integrity of the cultural deposits has been degraded by faunalturbation and occupational trampling. Figure 5-1 shows the mapped distribution of piece plotted artifacts and krotovina. Piece plotted artifacts that are mapped within krotovina in Figure 5-1 were actually found either above or below the burrows. Most of the disturbance occurred within, and west of, the E497 transect of Block A where most of the krotovina and 74 non-cultural fossorial rodent bones were recovered. Fortunately, the eastern half of Block A, where Cultural Level 1 is most prominently expressed, was largely spared from recent rodent burrowing.

Feature 4

Feature 4 was identified by a dark (10YR3/1) organic stain that contained abundant flecks of charcoal at an elevation of 96.67 m, or directly on the Strata II/III boundary in the southwestern corner of unit N498 E499 (Figures 5-1 and 5-2). A thin and diffuse lens of oxidized soil was uncovered at the base of the feature in Unit N497 E500 (Figure 5-3). The boundaries of the feature were diffuse and particularly difficult to discern in the southwestern quadrant. This feature was roughly spherical, at least 120-135 cm in diameter and 1cm to 5 cm in thickness (Figures 5-1 and 5-4). The integrity of the deposit appeared good with no visible disturbances. The feature fill (54.8 liters) was collected for flotation and fine-screen recovery. One small retouched obsidian flake fragment, hundreds of flakes, a small number of faunal remains and charred macrofloral remains were recovered from Feature 4 (Table 5-3). Twenty-three pieces of debitage and the retouched flake were found *in situ*. All of the bone and most of the debitage was recovered from the heavy fraction of the feature fill that was screened through a 1 mm geologic sieve. Two unidentifiable intrusive rodent bones were found in the feature fill, which suggests that the feature had suffered some post-depositional disturbance.

Table 5-2 Artifacts from Block A Cultural Level 1.

Artifact Description Chipped Stone	Obsidian	Chert	Other	O-QTZ	M-QTZ	Basalt	Sil. Wood	Total
Projectile Point	2							2
Biface	3	1						4
Graver	1							1
Retouched Flake	6	3	1					10
Utilized Flake	17	2	3	34				56
Primary Flake	3	1						4
Secondary Flake	8	5	2					15
Tertiary Flake	153	67	27	4		1		252
BF Thin. Flake	3							3
Flake Fragment	1691	202	70	29	3	1	1	1,997
Shatter	368	8	8	1	1			386
Total	2,255	289	111	68	4	2	1	2,730

Faunal Remains	NISP
Bison	2
Lg. Artiodactyl	1
Porcupine	1
Unidentified Mammal Bone	29
Freshwater Bivalve Shell	1

Macrofloral	Piece Plotted Items
Charcoal	42
Carbonized Seed	1

Feature 11

Feature 11 was mostly confined to unit N495 E501 (Figure 5-1). Like Feature 4, this feature consisted of a concentration of very dark brown to very dark grayish brown organically stained sediment with abundant flecks of charcoal at the contact of Strata II and III (Figures 5-5 and 5-6). No oxidation of sediment was observed. The stain was roughly oval measuring approximately 120 cm by 100 cm and was 1-5 cm in thickness. It was on average thinner (~2 cm) than Feature 4. The boundaries of Feature 11 were fairly clear. A small part of the feature likely extended into unit N496 E501, but it was not recognized during excavation. No evidence of disturbances was noted. All but a small portion of the feature that extends to the east of E502 was excavated. In all, 18 liters of fill was collected and floated for advanced recovery of macrobotanical remains. A small number of artifacts were found in the feature. Point plotted artifacts include five pieces of debitage, three of which were heat-altered chert from analytical nodule

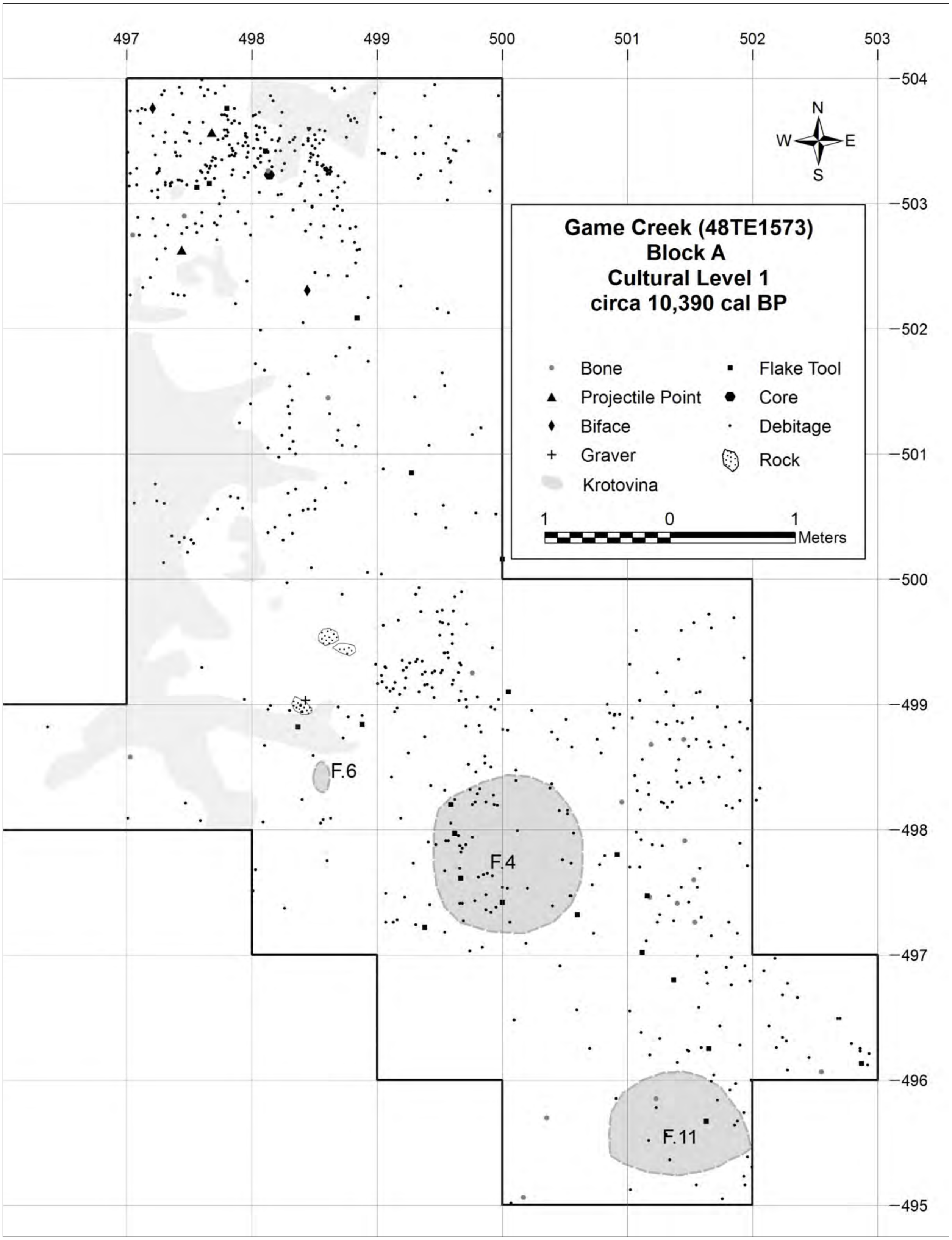


Figure 5-1 Plan view of Cultural Level 1 Block A.

Figure 5-2 Photograph of Feature 4 (upper right) in unit N498 E499 at 96.68 m.

Figure 5-3 Photograph of Feature 4 in unit N497 E500 showing oxidation of sediment.

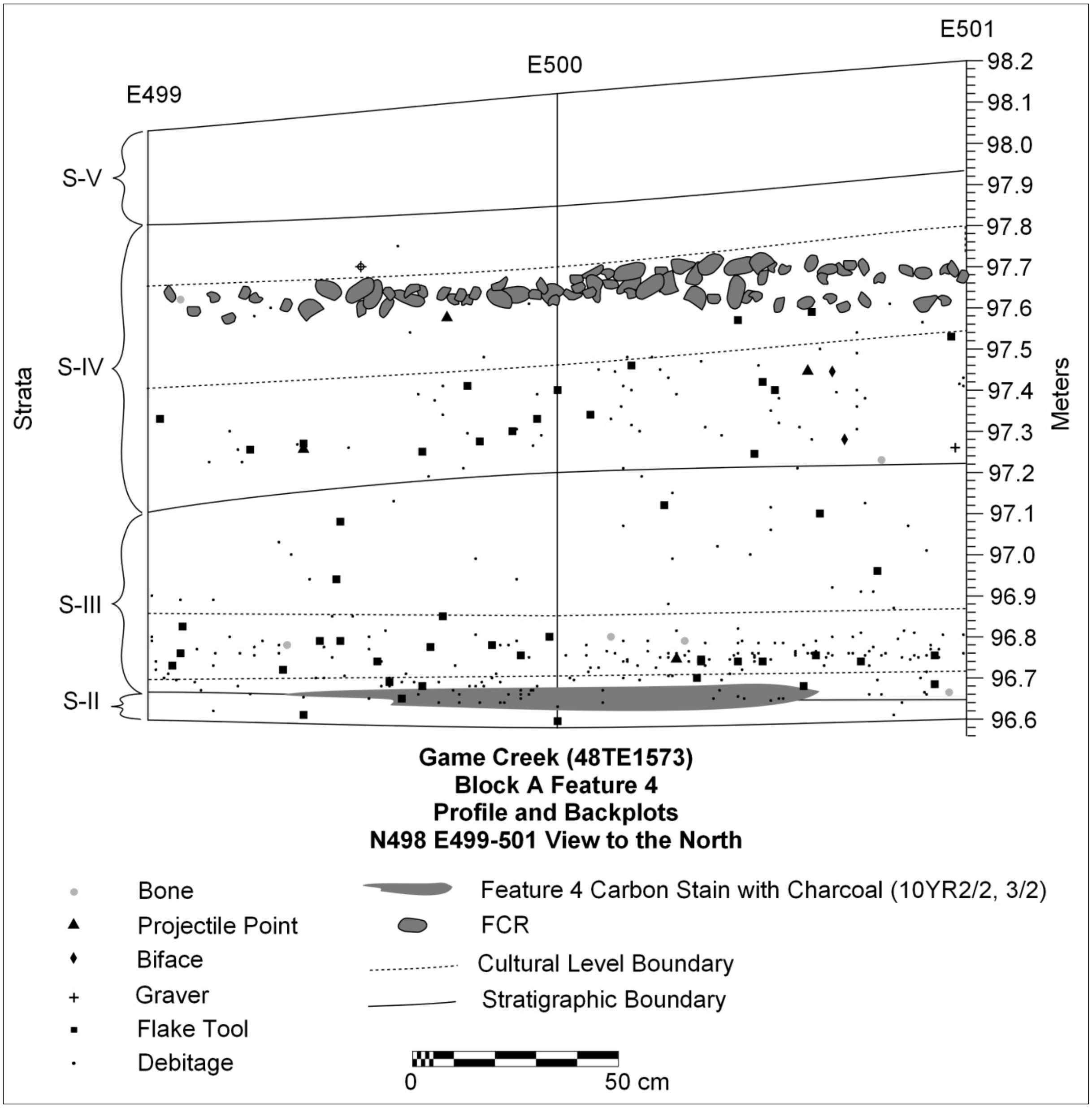


Figure 5-4 Profile of Feature 4 with backplots of artifacts.

A/B, and seven pieces of charcoal (Table 5-4). Several pieces of pine and birch charcoal greater than 1 mm were recovered from the light fraction of the feature fill (Table 5-4). The heavy fraction of the floated feature fill contained microdebitage and unidentifiable faunal remains, four of which were calcined or partially calcined (Table 5-4).

Table 5-3 Artifacts recovered from Feature 4.

Chipped Stone	Obsidian	Chert	Quartzite	Other	Total
Retouched Flake	1				
Tertiary Flake	3		1		4
Flake Fragment	14			1	15
Shatter	4			1	5
Debitage <1/8"	267	42	11	2	322
Total	288	42	12	4	346

Faunal Remains	Count	Burned
Unidentified mammal tooth enamel	4	0
Unidentified mammal bone	11	7
Unidentified Rodent calcaneus	1	1
Intrusive rodent bone	2	0
Total	18	8

Macrofloral Remains	grams	Count
Pine charcoal >1mm	.12	
Unidentified charcoal (point plotted)	.43	4
Charred goosefoot seed		1

Table 5-4 Artifacts recovered from Feature 11.

Chipped Stone	Obsidian	Chert	Quartzite	Total
Tertiary Flake	1	1		2
Flake Fragment		3		3
Debitage <1/8"	40	33	11	84
Total	41	37	11	89

Faunal Remains	Count	Burned
Unidentified mammal tooth enamel	4	
Unidentified mammal bone	2	4
Total	6	4

Macrofloral Remains	grams	Count
Pine/Birch charcoal >1mm	2.07	
Unidentified charcoal (point plotted)		5
Pine charcoal (point plotted)		1
Birch charcoal (point plotted)		1

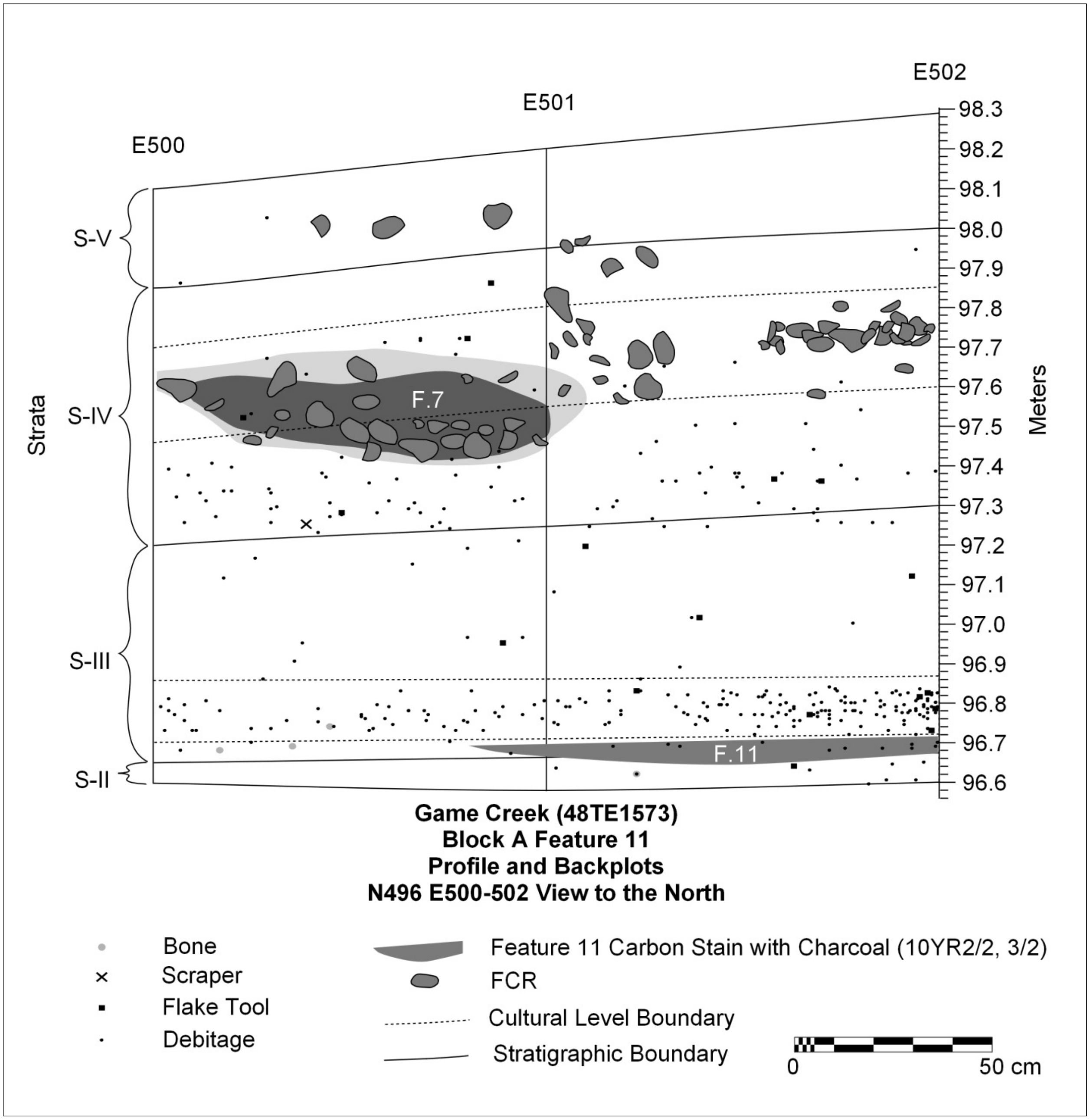


Figure 5-5 Profile and backplots of Features 11 and 7 at N496 E500-502.

Feature 6

Feature 6 was a small (25x12 cm), thin (1-4.5 cm) black to very dark grayish brown stain that contained charcoal flecks (Figures 5-1 and 5-7). This feature was found in unit N498 E498 at 96.67 m near the contact of Strata II and III. The feature boundaries were somewhat amorphous and gradual. The entire feature (~2 liters) was collected for flotation. A small amount of charcoal was recovered, but none of the pieces were large enough for identification. The only other cultural material found within the feature consisted of 14 pieces of obsidian and three pieces of chert microdebitage collected

Figure 5-6 Photograph of Feature 11 in Unit N495 E501 at 96.69 m.

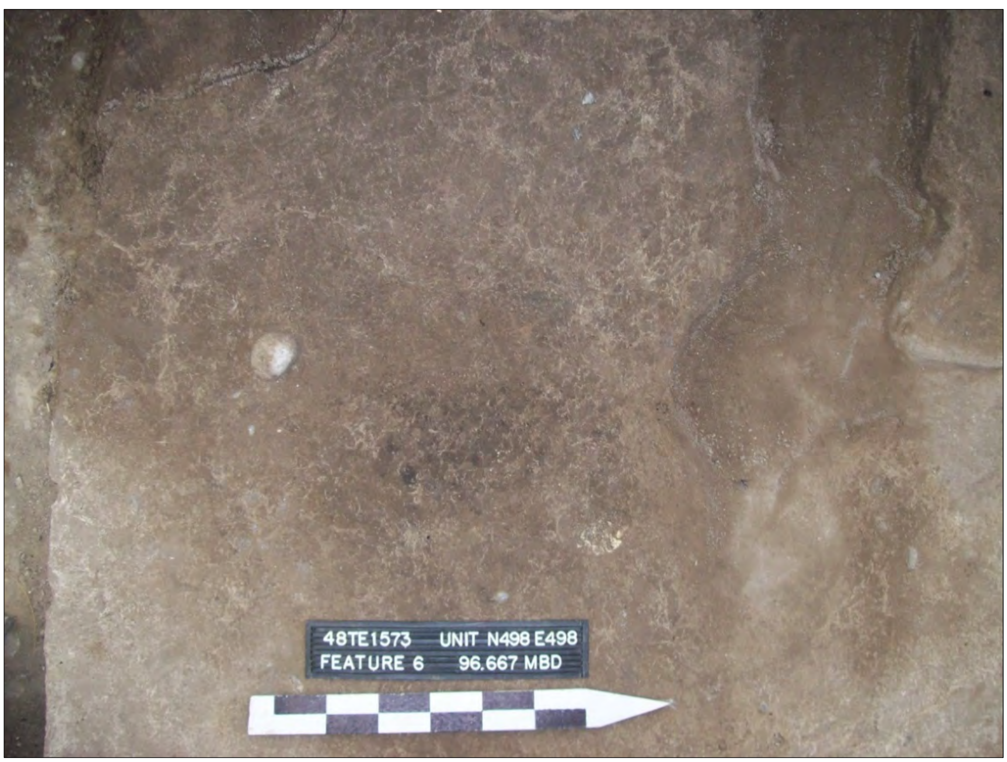


Figure 5-7 Photograph of Feature 6 in unit N498 E498 at 96.667 m.

from the 1 mm heavy fraction screen. A large krotovina was found about 10 cm north of Feature 6 (Figures 5-1 and 5-7), and there was extensive disturbance farther west. Given its size and close proximity to Feature 4, Feature 6 may represent a secondary deposit of charcoal that washed into a small depression. Alternatively, Feature 6 could be the remnant of a small surface hearth that was largely eroded away.

Cultural Level 2

Cultural Level 2 is approximately 15 cm thick, and where present, is found within and immediately above a buried soil horizon near the base of Stratum III. This level contained the highest artifact frequencies on the T3 terrace (Table 5-5). Over 11,000 artifacts, including 97 stone tools and 82 pieces of culturally modified bone, are attributed to Cultural Level 2. Most of the artifacts from this level came from Block A, but sizeable assemblages were also recovered from Blocks D and I. No features were identified in Cultural Level 2, but several horizontally distinct artifact concentrations were found in Block A (Figures 5-9 through 5-11). The *in situ* recovery of artifacts was rather high with 27% of all artifacts >1/8" piece plotted (Figure 5-8). Integrity of the deposits in Block A was fair, but rodent burrowing was extensive in the E497 transect and farther west. Yet, only 10 intrusive rodent bones were found in Cultural Level 2 in Block A, far fewer than the 74 recovered from Cultural Level 1.

Cultural Levels 1 and 2 Activity Areas

Features 4 and 11 are interpreted as unlined surface hearths. Mayer et al. (2014) expressed some doubt as to whether these features were in fact hearths. There is cause for skepticism. Neither of the features was particularly well defined, and there has certainly been considerable mixing of the deposit. However, several lines of evidence support the interpretation that Features 4 and 11 were hearths. Since Cultural Levels 1 and 2 are not entirely stratigraphically distinct it is necessary to include some low frequency artifacts from both levels to identify horizontally discrete occupations. Of the 22 pieces of burned bone found in Cultural Levels 1 and 2, 12 were found directly within Features 4 and 11 (Tables 5-3 through 5-5), and five more pieces were recovered within a one meter radius of Feature 4. Heat altered lithics and charcoal from Cultural Levels 1 and 2 are concentrated within and immediately adjacent to Features 4 and 11. The distribution of burned artifacts is fairly conclusive evidence of fire in and around Features 4 and 11. Nevertheless, it is conceivable that a natural fire could have caused the burning of bone and lithics. Yet, the distribution of bone and stone tools (Figure 5-10) from Cultural Levels 1 and 2 are also concentrated in and around Features 4 and 11. Figure 5-11 shows the distribution of debitage for Cultural Level 1 and 2. The interpolated debitage contours lend further support to the interpretation that Features 4 and 11 were in fact hearths with clear spatial clustering of artifacts.

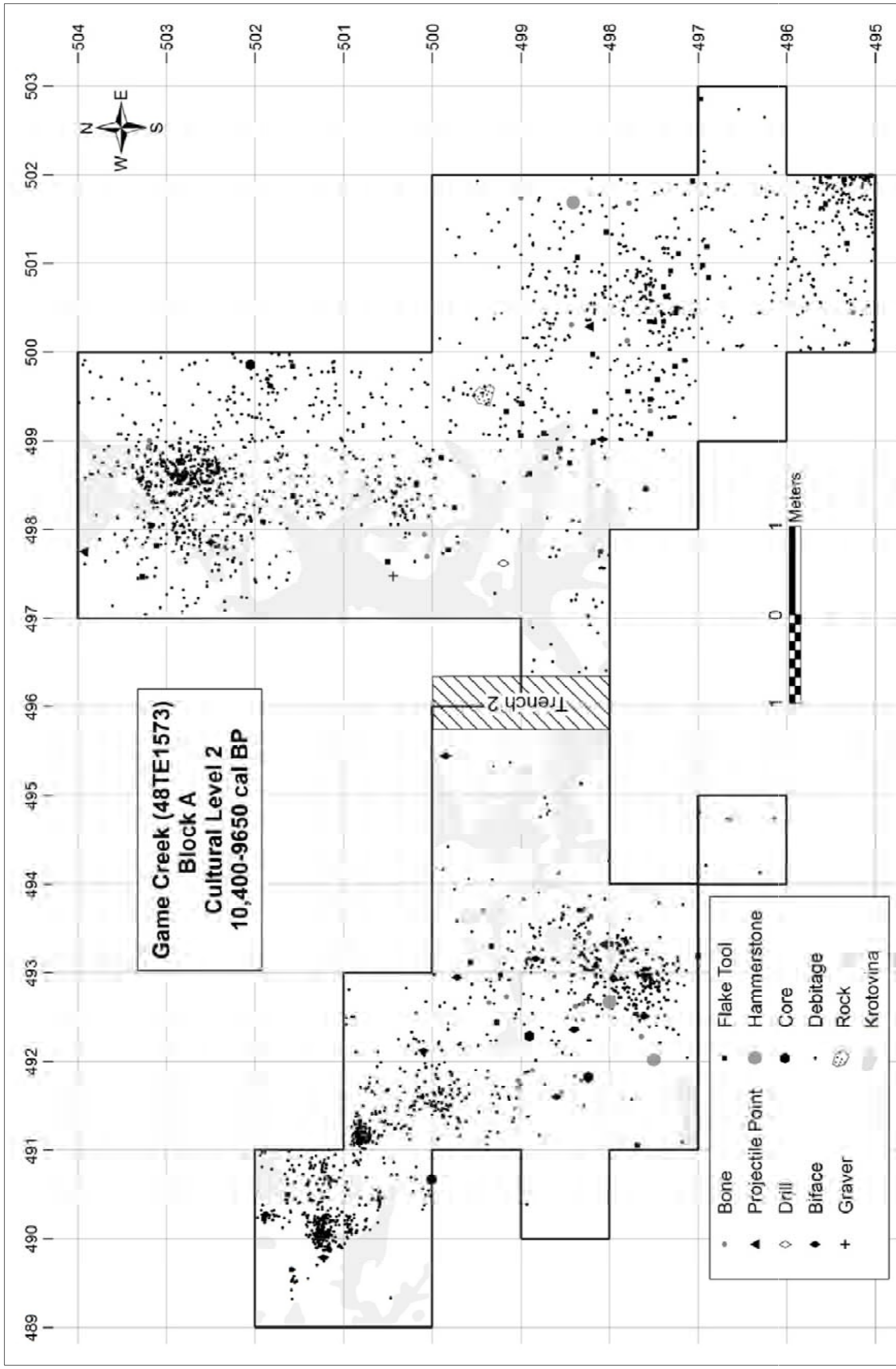

Game Creek (48TE1573)
Block A
Cultural Level 2
10,400-9650 cal BP
Trench 2
Meters
0
1
Bone
Projectile Point
Drill
Biface
Graver
Flake Tool
Hammerstone
Core
Debitage
Rock
Krotovina
N
E
S
W

Table 5-5 Artifacts recovered from Block A Cultural Level 2.

Artifact Description	Obsidian	Chert	Other	O-QTZ	M-QTZ	Basalt	Sil. Wood	Total
Projectile Point	3							3
Biface	10	2						12
Drill	1	1						2
Graver	1	1						2
Retouched Flake	17	1						18
Utilized Flake	44	2		1		44	2	93
Hammerstone								
Core	2	2				1		5
Primary Flake	4	1		2				7
Secondary Flake	43	13			2	1		59
Tertiary Flake	791	64		44	1	3	4	907
Blade	10							10
BF Thin. Flake	20							20
Flake Fragment	7,032	390	4	207	10	24	16	7,683
Shatter	1,399	139	1	3		16	5	1,563
Total	9,377	616	5	257	13	89	27	10,384

Faunal Remains	count	burned
L. Artiodactyl	3	
M. Artiodactyl	3	
UID Artiodactyl	7	
Beaver	1	
Unidentified	49	
Total	63	

Macrofloral (point plotted)	count
Charcoal	91
Carbonized Seed	3
Total	94

Clustering of artifacts in and around Features 4 and 11 is consistent with the interpretation that these features were hearths. Even in the absence of a definable feature, the distribution of burned artifacts, bone and tools have been used to locate eroded or otherwise degraded hearths (Surovell and Waguespack 2007). In this case the data clearly suggest that Features 4 and 11 were surface fires around which people performed a variety of tasks such as the preparation of food and tool production.

The artifact contours also reveal the horizontal separation of components in Cultural Levels 1 and 2. Most of the artifacts from Block A Cultural Level 1 were either found in close proximity to the features or in a small cluster in and around units N503 E497 and N503 E498 (Figure 5-11). In Cultural Level 2

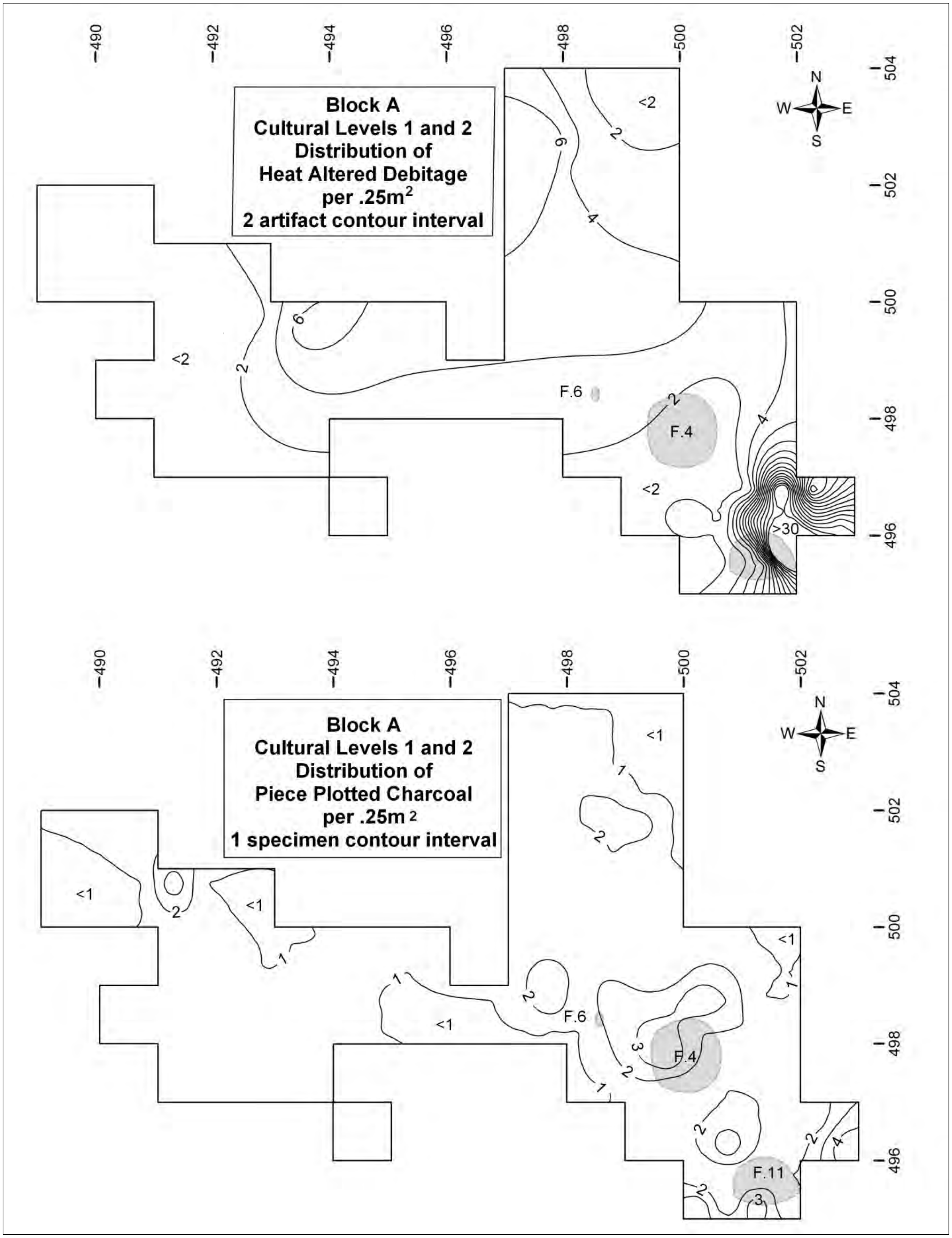


Figure 5-9 Density and distribution of heat altered debitage (above) and piece plotted charcoal (>3mm) from Cultural Levels 1 and 2.

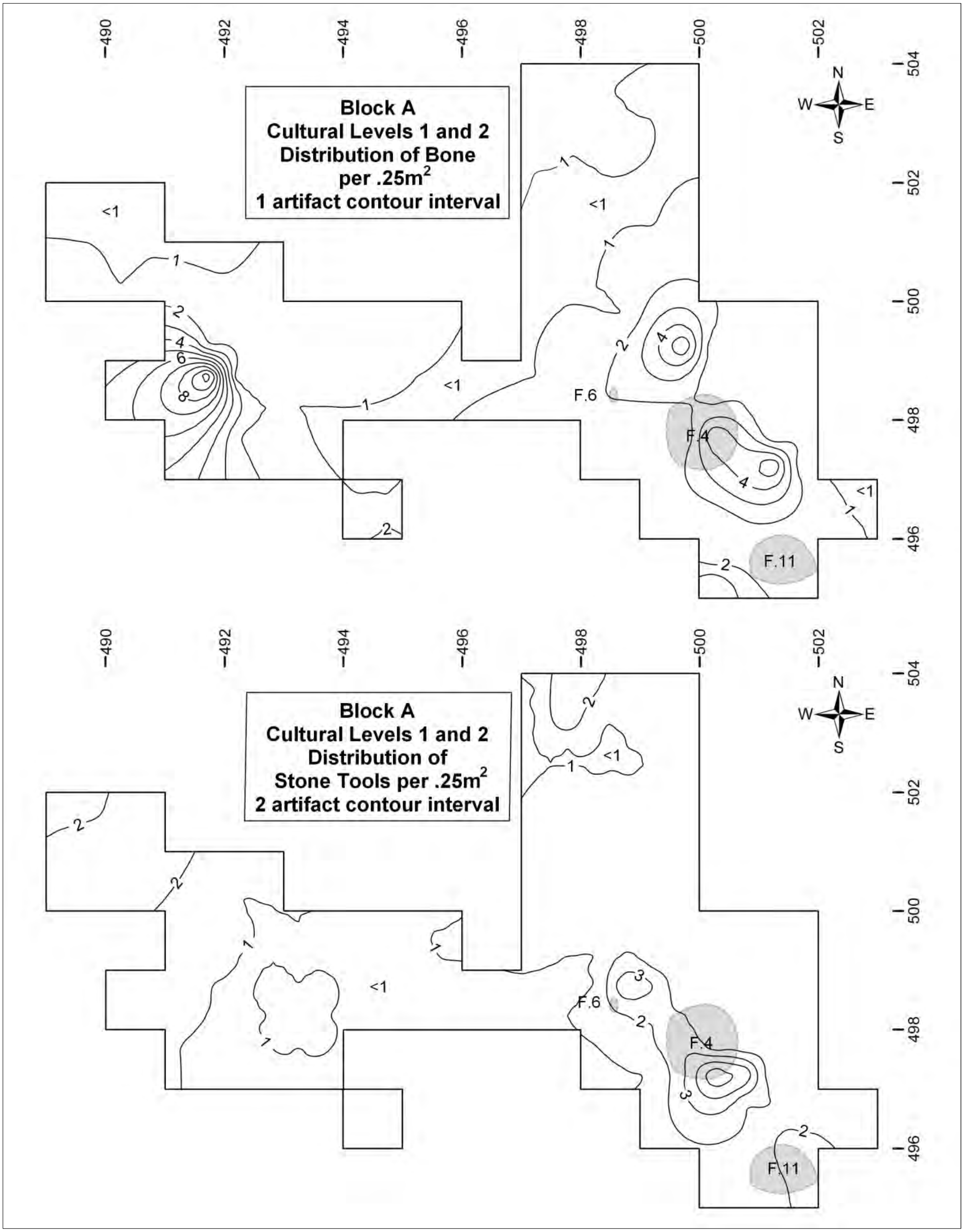


Figure 5-10 Density and Distribution of bone (above) and stone tools (below) from Cultural Levels 1 and 2 in Block A

four dense clusters of artifacts were found, two in the eastern half and two in the western half of Block A (Figures 5-8 and 5-11). The Cultural Level 2 artifact concentrations differ from the Cultural Level 1 clusters in several ways. First, the Cultural Level 2 assemblage contained a relatively small proportion of stone tools (Figure 5-10). The ratio of tools to debitage in Cultural Level 1 was 1:84 whereas in Cultural Level 2 the proportion was 1:115. This suggests that considerably more time and effort was expended in tool production than tool use in Cultural Level 2 as compared to Cultural Level 1. Second, almost all of the bone recovered from Cultural Levels 1 and 2 was found adjacent to Features 4 and 11 and likely represents food preparation around the hearths (Figure 5-10). Identifiable faunal remains associated with the Cultural Level 1 hearths included porcupine and bison. Conversely, the only bone concentration directly associated with Cultural Level 2 consisted of a scatter of heavily fragmented medium artiodactyl (deer, pronghorn or sheep) bone in and around unit N498 E491 in the western half of Block A (Figure 5-10). Third, most of the charcoal and heat altered lithics were found in direct association with the Cultural Level 1 features. The absence of charcoal and burned lithics within artifact concentrations associated with Cultural Level 2 may suggest that the activity areas were not hearth-centered. These spatial data support the interpretation that Cultural Levels 1 and 2 represent distinct occupations that reflect different sets of activities. Another line of spatial evidence that further buttresses these interpretations is found in the analytical nodules identified in Cultural Levels 1 and 2.

Minimum Analytical Nodule Analysis

Analytical nodules are collections of macroscopically distinct lithic material, and/or refitted and conjoined pieces of debitage. Minimum analytical nodule analysis, or MANA, is a technique developed by Larson (1990, 1992, 1994), Larson and Kornfeld (1997) and Larson and Ingbar (1992), as a useful supplement to lithic refitting studies. Both refitting and MANA have been successfully used to track tool production sequences, use and discard of tools across sites (Byrnes 2009). There are two basic types of analytical nodules - single item nodules, and multiple item nodules (Sellet 1999). Single item nodules are typically exhausted or broken tools that were produced and maintained off-site and deposited as refuse at the site. Single item nodules, in particular those of extralocal materials, potentially provide valuable information on mobility and territory of hunter-gatherer groups, but are not pertinent to the present topic. A discussion of the single item nodules and the inferences drawn from them is provided below. Multiple item nodules are collections of debitage and in some cases finished or broken tools. Although MANA was developed to assess raw material flow and tool production sequences, it also provides a practical means of identifying activity areas in situations where multiple occupations cannot be confidently segregated by stratigraphy alone.

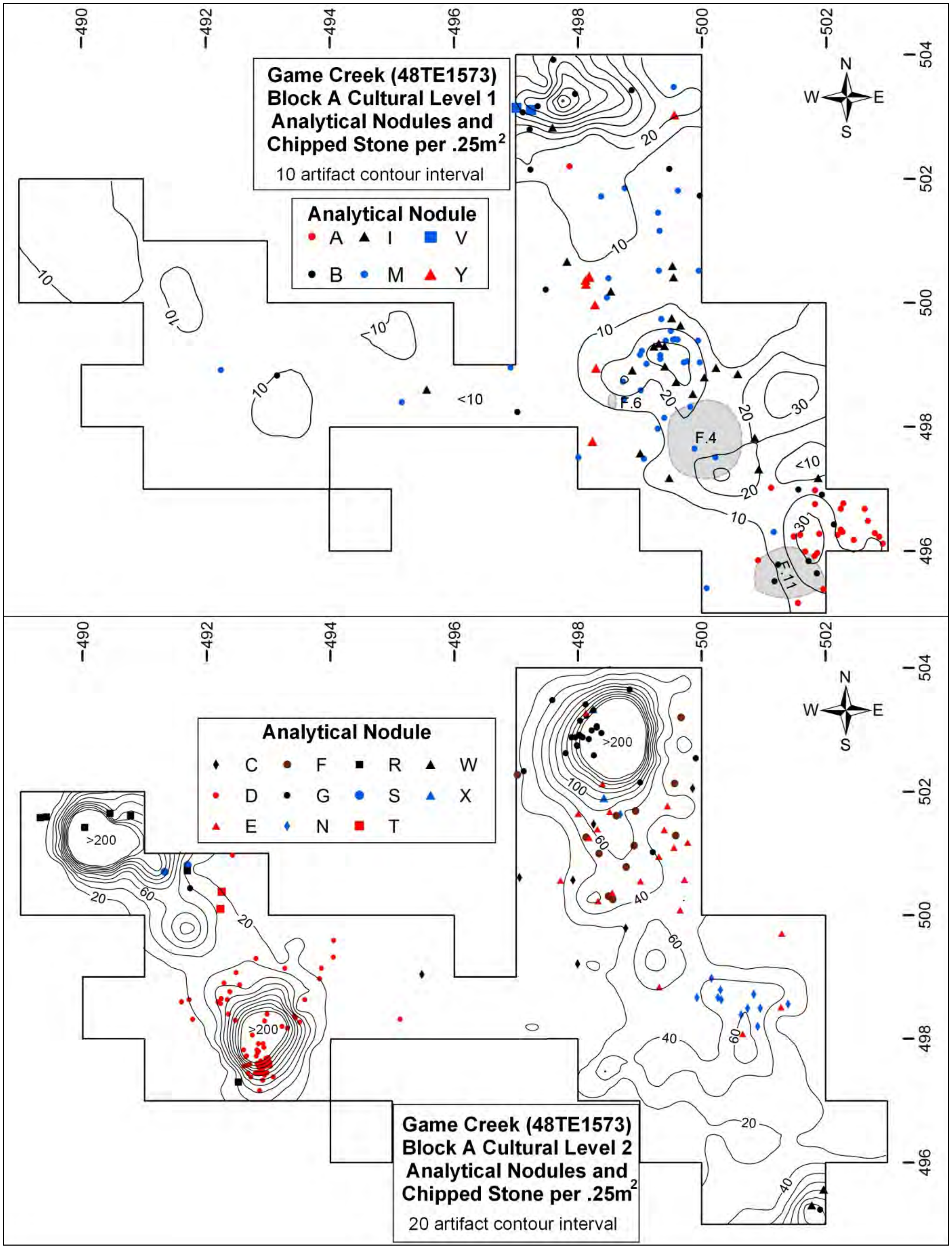


Figure 5-11 Distribution of debitage (≥ 1/8") and analytical nodules in Block A Cultural Levels 1 (above) and 2 (below).

Table 5-6 Descriptive statistics and refits of analytical nodules from Cultural Levels 1 and 2.

Analytical Nodule	Material Type*	CL	Elevation (m) Descriptive Statistics					Piece Plots	Total	Refits
			mean	median	mode	SD	range			
A/B	C2	1	96.66	96.66	96.64	0.05	96.55-97.6	40	171	0
I	C6	1	96.69	96.69	96.7	0.05	96.6-96.97	14	32	3
M	O1	1	96.75	96.7	96.67	0.22	96.5-97.3	41	110	2
V	OB	1	96.63	96.63	N/A	0.01	96.62-96.64	2	2	2
Y	OB	1	96.68	96.68	96.7	0.06	96.6-96.8	8	8	8
G	B2	2	96.74	96.71	96.66	0.15	96.65-97.38	27	38	8
F	C9	2	96.72	96.72	96.71	0.05	96.5-97.95	10	35	2
C	C4	2	96.76	96.75	N/A	0.03	96.45-97.05	7	22	5
E	C24	2	96.81	96.76	96.8	0.24	96.5-97.9	21	49	2
N	Q1	2	96.77	96.77	96.76	0.02	96.65-97.25	12	26	0
W	OB	2	96.79	96.79	N/A	0.01	96.78-96.79	2	2	2
X	OB	2	96.72	96.72	96.72	0.00	96.72	2	2	2
R	C28	2	96.52	96.53	#N/A	0.02	96.35-97.05	7	27	2
D	C1	2	96.56	96.56	96.57	0.03	96.3-97.4	85	357	0
S	OB	2	96.52	96.52	N/A	0.01	96.51-96.53	2	2	2
T	OB	2	96.56	96.56	N/A	0.01	96.55-96.57	2	2	2

* C=chert, O=other, B=basalt, Q=orthoquartzite, OB=obsidian.

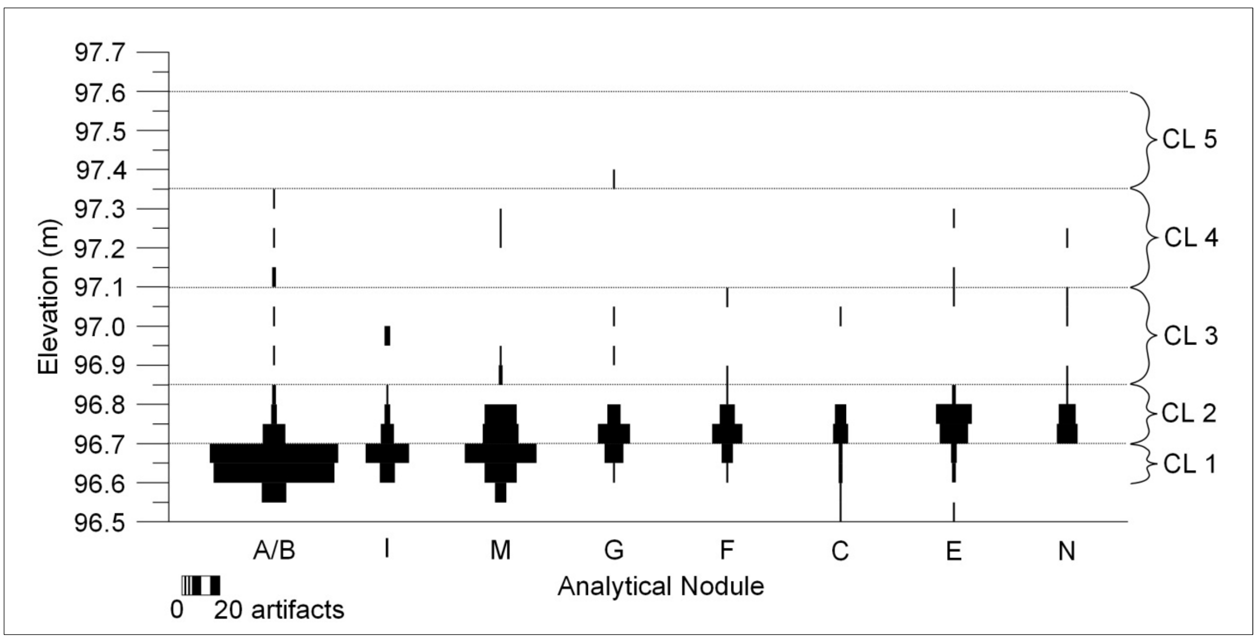


Figure 5-12 Vertical distribution of analytical nodules from Cultural Levels 1 and 2 in the eastern half of Block A.

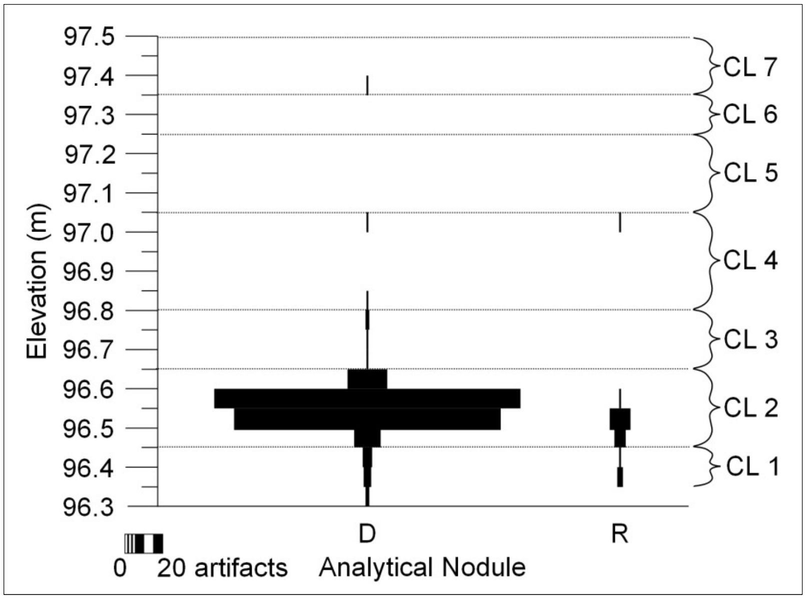


Figure 5-13 Vertical distribution of analytical nodules from the western half of Block A.

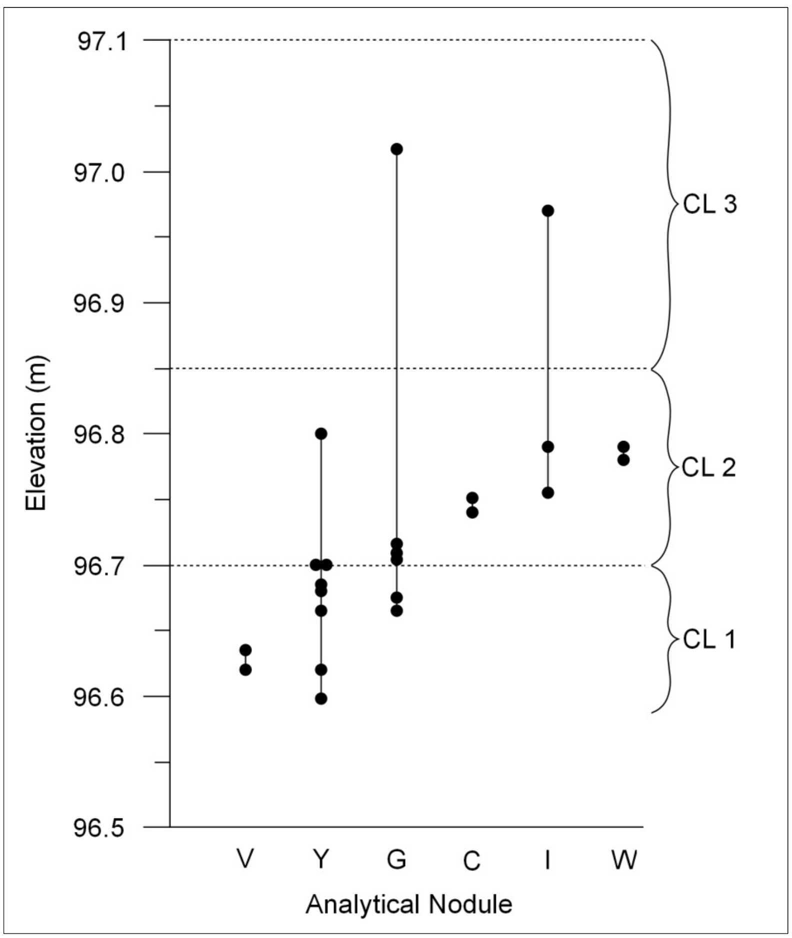


Figure 5-14 Vertical distribution of refitted pieces from obsidian analytical nodules.

The majority of the lithic assemblage from Game Creek is composed of obsidian that was probably obtained locally. There is a wide range of variation in color, translucency, banding and inclusions of locally derived obsidians even within a single nodule. It is therefore difficult, if not futile, to attempt a MANA using obsidian artifacts. Consequently, 10 of the 16 analytical nodules from Cultural Levels 1 and 2 consist of cryptocrystalline silicates such as chert and orthoquartzite. The remaining six nodules, all obsidian, were identified by refitting of flakes (Table 5-6). Five of the analytical nodules, A/B, I, M, V and Y are associated with Cultural Level 1 and the other 11 appear to have originated from Cultural Level 2 (Table 5-6, Figures 5-11 through 5-14).

Only 33 refits were identified during analysis (Table 5-6). The vertical distribution of refitted pieces closely mirrors that of the analytical nodules as a whole (Figure 5-14). Again it is clear that there has been some post-depositional mixing of artifacts, but most of the artifacts within each analytical nodule are stratigraphically restricted to a cultural level (Table 5-6, Figures 5-12 and 5-13).

The horizontal distribution of the analytical nodules adds further support to the interpretation that artifact clusters represent fairly discreet activity areas. Analytical nodule A consists of burned debitage from nodule B and was spatially associated with Feature 11. The unburned debitage, nodule B, was also recovered from in and around Feature 11 but also in the northern part of Block A (Figure 5-11). The analytical nodules from Cultural Level 2 are distributed among the various debitage concentrations, but few were found in and around Features 4 and 11 (Figure 5-11). The one exception, analytical nodule N, is concentrated near Feature 4, but most of the pieces of this nodule were found five or more centimeters above Cultural Level 1.

There were several more noteworthy associations of nodules within Cultural Levels 1 and 2. Two pieces of nodule M and one each of nodules C and D were recovered from Block I at approximately the same stratigraphic position as in Block A. These artifacts provided contextual details about the Block I deposits that could not have otherwise been gained due to the homogenous and generally lackluster composition of the assemblage. Based on the presence of nodule M in Block I it would appear that the occupation that produced the Feature 4 hearth extended about 20 m to the north. The same inference can be drawn regarding the Cultural Level 2 occupations. In Block A, nodules D and R are entirely confined to the western half of the block, and nodules F, G, E and N were found only in the eastern half of the block. The disjunct and relatively confined distributions of nodules A/B, D, F, G, N and R suggests relatively brief tool production episodes. Conversely, nodules I, M and Y display a more dispersed spatial pattern and included larger, and in several cases utilized and/or retouched flakes, indicating flake tool production.

Lithic Raw Material Composition

Table 5-7 Percentages of raw material types in Cultural Levels 1 and 2.

Material Type	Cultural Level 1	Cultural Level 2
Obsidian	85.3%	91.1%
Chert	9.5%	5.7%
Orthoquartzite	1.2%	2.3%
Other (AN-O)	3.7%	.0%
Metaquartzite	.3%	.2%
Basalt	.1%	.4%
Silicified Wood	.0%	.3%

The lithic raw material composition of Cultural Levels 1 and 2 differ. Cultural Level 1 has nearly twice as much chert and half the orthoquartzite of Cultural Level 2. A Chi^2 test reveals that these differences are statistically significant ($Chi^2 = 149.08$, $df=5$, $p<.0000$).

Most of the chipped stone assemblages from Cultural Levels 1 and 2 are obsidian (Table 5-7). There are at least four known obsidian sources in southern Jackson Hole (Schoen 1997) and several more on the Yellowstone Plateau, in southwestern Montana and scattered across the Snake River Plain (Figure 5-15 [Harvey 2012; Homer 1997; Scheiber and Finley 2011]). Five pieces of obsidian, including the four diagnostic obsidian artifacts, were submitted for source analysis. All of the specimens were sourced to either Teton Pass or Crescent H Ranch, both of which are locally available.

Chert was the next most common material type (Figure 5-15). Determining the provenance of chert is not as simple as obsidian. There is wide variation in macroscopic characteristics of chert within any one geological source making accurate identification problematic. According to Love (1972) high quality chert is relatively rare in Jackson Hole. The Madison and Amsden formations in the Gros Ventre range do contain yellowish brown and red nodular chert (Love 1972). Black, gray and translucent white cherts are also reported from a conglomerate outcrop in northern Jackson Hole, near Conant Pass (Love 1972). According to Clayton (1999), green opaque chert can be found in the Camp Davis and Teewinot formations that both outcrop in Jackson Hole. Orthoquartzites are also available in and around Jackson Hole including a multicolored type from the Tensleep formation (Love 1972) and a lustrous white variety from the Morrison formation (Clayton 1999). However, no chert quarries and only a few small orthoquartzite quarries have been documented in Jackson Hole (Love 1972). Utilized chert nodules appear to have come from secondary glacial or fluvial deposits. The majority of the chert from Cultural Levels 1 and 2 generally match the descriptions of locally available material and most appear to have originated from secondary cobble sources.

Evidence for the use of locally obtained lithics can be found in the proportion of cortical flakes. Previous studies have shown that initial reduction involving the removal of cortex usually occurs near the raw material source, be that source primary (Ahler 1989) or secondary (Francis 1997). In part this is a consequence of material testing since even at quarries where high quality materials are abundant, a substantial proportion of the stone is unsuitable for tool production (Francis 1997; Kornfeld et al. 2010). Furthermore, raw materials were often reduced to prepared cores, tool blanks or finished tools at lithic workshops at or near the quarry for efficiency of transport (Francis 1997). The lithic assemblages from quarry workshops typically contain a high proportion of cortical flakes.

Of the 10 non-obsidian analytical nodules from Cultural Levels 1 and 2, eight contained relatively high proportions of cortical debitage (Table 5-8). This is particularly true for the nodules from Cultural Level 2. Moreover, the cortex present on these nodules is invariably smooth which is indicative of secondary, glacially and/or fluvially transported cobbles. The overall percentage of cortical chert debitage, including those specimens not assigned to analytical nodules, is roughly the same as the locally available obsidian (Table 5-9). Therefore, it is likely that most of the chert was procured locally. There are, however, several notable exceptions.

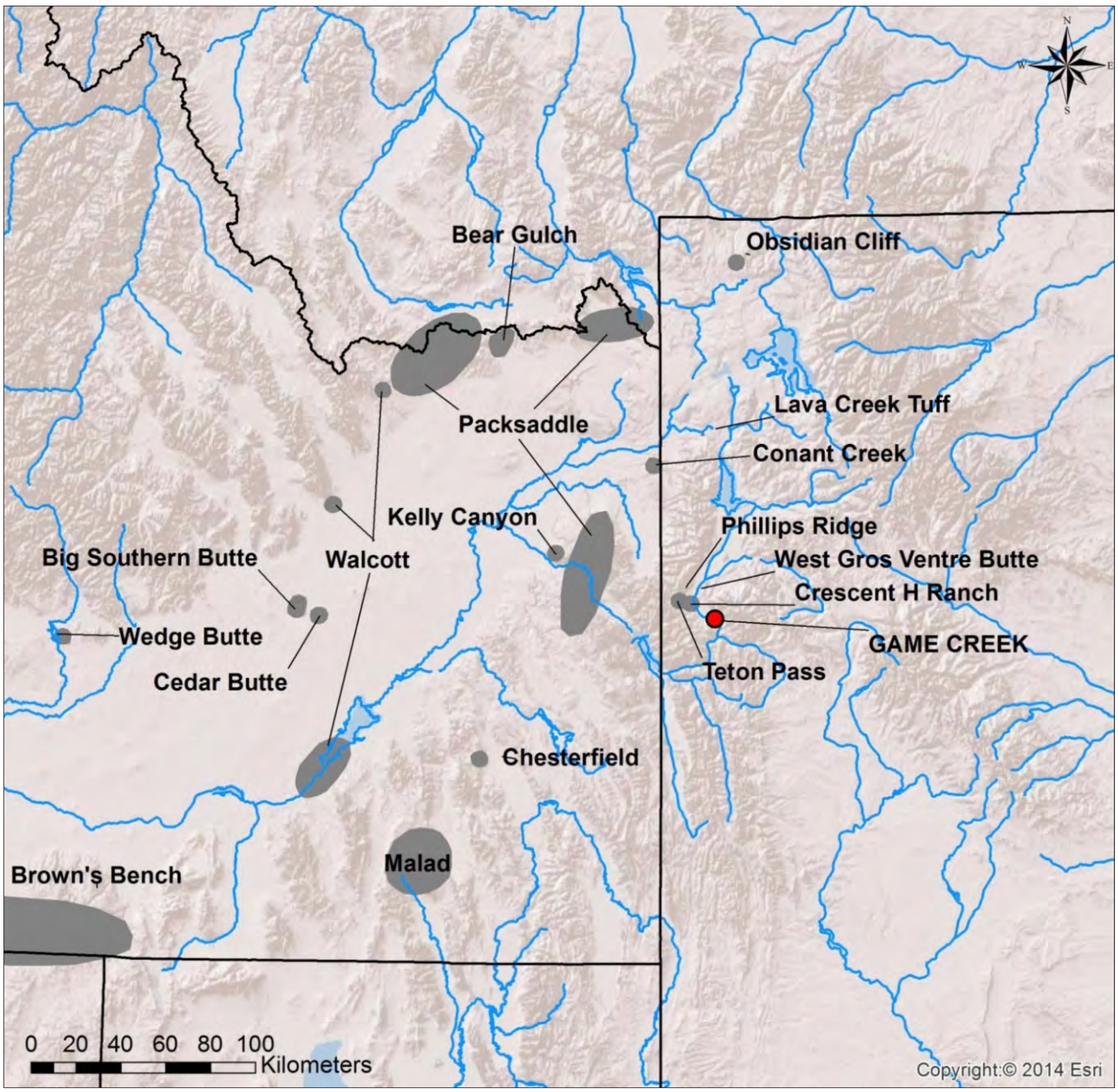


Figure 5-15 Obsidian sources of the Central and Northern Rockies and Snake River Plain (Holmer 2009).

Table 5-8 Percentage of cortical debitage for analytical nodules.

Cultural Level	Analytical Nodule	Material Type	Material Code	% Cortical Flakes
1	A/B	Chert	C2	2%
1	M	Orthoquartzite?	O1	16%
1	I	Chert	C6	12%
2	N	Orthoquartzite	Q1	0%
2	G	Basalt	B2	8%
2	E	Chert	C24	7%
2	R	Chert	C28	40%
2	C	Chert	C4	64%
2	F	Chert	C9	30%
2	D	Chert	C1	12%

Analytical nodule A/B from Cultural Level 1 is similar to some Bridger formation cherts that commonly occur in primary and secondary deposits in the upper Green River Basin about 130 kilometers south of Game Creek (Clayton 1999). This nodule contained mostly small non-cortical, SG1 debitage, but a fragment of either an early stage biface or an exhausted bifacial core was also found. Therefore, analytical nodule A/B appears to have been brought to the site as a prepared core or tool blank. The minimum analytical nodule analysis resulted in the identification of four single item nodules from Cultural Level 2, including the tip and base of a well-made bifacial drill, a graver and two flake tools. The absence of corresponding debitage indicates that these tools were brought to the site in a toolkit and discarded after use. Yet, it is unclear whether these artifacts were made of local stone.

The small orthoquartzite assemblages from Cultural Levels 1 and 2 contained a very low percentage of cortical flakes. Analytical nodule N contained no cortical pieces, and all the debitage consisted of small flakes indicative of late stage bifacial thinning (Ahler 1989), probably of a finished tool or tool blank that was brought to the site. Surprisingly few pieces of Tensleep orthoquartzite were found in Cultural Levels 1 and 2 despite that fact that several known quarries are located on Blacktail Butte in Teton National Park (Love 1972). The relatively infrequent occurrence of orthoquartzite in the Cultural Level 1 and 2 assemblages at Game Creek is unusual because there was an apparent preference for this material during Late Paleoindian times at other sites in the region (Bradley 2013; Kornfeld et al. 2001).

Table 5-9 Percentage of cortical debitage from Cultural Levels 1 and 2.

Material Type	CL1	CL2
Obsidian	11%	10%
Chert	8%	16%
Orthoquartzite	3%	2%

Lithic Reduction Strategies as Inferred from Mass Analysis

The chipped stone assemblages from each cultural level and each excavation block were subjected to a Mass Analysis in order to assess the type of lithic reduction strategies used through time at Game Creek (Phillips and Francis 2017). Mass analysis is a technique developed by Ahler (1989) as an alternative to individual flake analysis. The Mass Analysis employed 97 lithic reduction experiments conducted on obsidian and produced by two knappers. The experiments included the use of five reduction groups; bipolar reduction, freehand core reduction (flake tool production), biface edging (early stage biface reduction), bifacial thinning (late stage biface reduction) and pressure flaking. The resulting experimental assemblages were size-graded through 1/8", 1/4", 1/2" and 1" standard geologic sieves, with each size grade weighed and the presence/absence of cortex recorded. These data were then subjected to a discriminant function analysis. Bipolar, freehand core and bifacial thinning were well discriminated, with between 81% and 100% correct classification rate. The bifacial edging category was not particularly well discriminated, however, with only a 57.1% correct classification rate. Nevertheless, the analysis reveals that assemblages composed predominantly of debitage produced from bifacial reduction can be reliably segregated from assemblages created from both bipolar core and freehand core reduction.

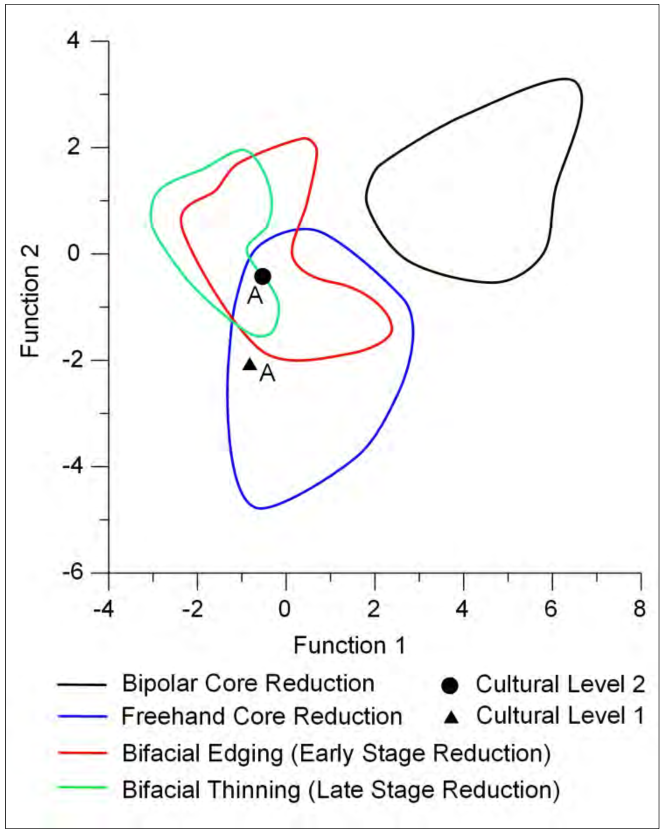


Figure 5-16 Results of the discriminant function analysis of obsidian chipped stone from Cultural Levels 1 and 2, Blocks A, D, E and I.

The results of the discriminant function analysis reveal that the obsidian debitage from Block A Cultural Level 1 most closely resembles an assemblage created through freehand core reduction, i.e. the production of flake tools. In contrast, the debitage from Block A Cultural Level 2 was classified as bifacial thinning, suggesting late stage bifacial tool production (Figure 5-16).

Two conclusions can be drawn from the discriminant function analysis. First, the chipped stone assemblages from Cultural Levels 1 and 2 are different. If the two levels were a palimpsest, then it is unlikely that the two assemblages would be classified as different reduction strategies. Second, the different reduction strategies reflected in the obsidian debitage show that the people who occupied the site during Cultural Level 1 were less concerned with replenishing their toolkits than they were with expediently producing flake tools for immediate use during a relatively short term occupation. This would account for the lower density of debitage and the dearth of bifaces, biface fragments and bifacial thinning flakes in Cultural Level 1. The absence of hearths, sparse faunal remains and dense lithic concentration in Cultural Level 2 are more consistent with the interpretation of a lithic workshop than a hunting camp.

Radiocarbon Dates

There are 11 AMS radiocarbon dates, all run on wood charcoal recovered from the lower portion of Stratum III (Table 5-10). These dates are not all stratigraphically in order, but are nonetheless horizontally associated with activity areas that correspond with a particular cultural level. The five earliest dates are statistically the same with a pooled mean calibrated age of 10,391±61 cal BP. Two of these dates, 10,328±61 cal BP and 10,343±70 cal BP were obtained on charcoal collected from Features 4 and 11, respectively. Two of the early dates, 10,513±82 cal BP and 10,394±78 cal BP, were recovered from Cultural Level 2, 8-9 cm above the Cultural Level 1/2 boundary. However, the pieces of charcoal that produced these two dates were horizontally associated with Features 4 and 11. The final early date came from charcoal found in TU7 during the 2002 testing (Eakin and Eckerle 2004). Unfortunately, it is unclear whether the level from which this charcoal came corresponds to Cultural Level 1 or 2 because the precise elevation of the charcoal was not recorded and excavation levels during testing were 10 cm thick and may have straddled the cultural level boundary. Regardless, TU7 was located approximately two meters east of Feature 4 in an area where most of the artifacts were found within Cultural Level 1. Based on the spatial associations of the five earliest dates and the fact that two of these dates were run on charcoal taken directly from Features 4 and 11, it would appear reasonable to conclude that all of the dated charcoal originated in Cultural Level 1. Thus, the approximate date of the occupation(s) in Cultural Level 1 is 10,391±61 cal BP.

Following the 2002 testing, a piece of charcoal from Stratum III in TU10 was dated to 10,207±68 cal BP. This date is not statistically the same as any other date from Game Creek. Block B was placed next to TU10 in order to recover more of the cultural deposit from which the dated charcoal came. Yet, the results of the Block B excavation were disappointing. The 11 units in and around Block B contained only sparse scatters of debitage, 17 flake tools and 10 piece of bone. No features or discrete artifact concentrations were found. In short, the Block B assemblage added little to our understanding of the occupation. The elevation from which the dated charcoal came corresponds stratigraphically with Cultural Level 2 in Block A.

Three dates, two from Block A and one from Block D, are statistically the same with a mean calibrated age of 9660±53 cal BP. One of the dates, 9631±62 cal BP, came from charcoal recovered from the southwest activity area in Block A Cultural Level 2. An identical date was obtained from charcoal found in Stratum III of TU5 during the 2002 testing (Eakin and Eckerle 2004). Block D was placed

Table 5-10 AMS radiocarbon dates on charcoal from Cultural Levels 1 and 2.

Beta #	Provenience	Stratum	Cultural Level	Conv. RCYBP	*M* cal BP ± 1σ
319995	Blk A, N495.82 E500.84, 96.78m	III	2	9310±50	10,513±82
171435	Blk A, TU 7, 160-170cmbs	III	?	9280±50	10,463±83
316958	Blk A, N498.895 E500.74, 96.79m	III	2	9230±50	10,394±78
316962	Blk A, Feature 11, 96.7m	III/II	1	9180±50	10,343±70
287885	Blk A, Feature 4, 96.65m	III/II	1	9170±40	10,328±61
Pooled Mean	(171435, 287885, 316958, 316962, 319995)			9228±21	10,391±61
171436	Blk B, TU10, 138-142cmbs	III	?	9030±50	10,207±68
316961	Blk A, N503.15 E497.74, 96.6m	III	1	8780±40	9792±100
343147	Blk A, N497.44 E493.85, 96.51m	III	2	8690±40	9631±62
171707	Blk D, TU 5, 120-130cmbs	III	1/2	8690±40	9631±62
Pooled Mean	(171707, 316961, 343147)			8720±23	9660±53
287886	Blk A, Feature 4, 96.65 m	III/II	1	8290±40	9305±81
287884	Blk A, Feature 4, 96.65m	III/II	1	8040±40	8912±85

Calibrated at 2σ using CALIB 7.0.4, Intcal13 calibration curve (Stuiver and Reimer 1993; Reimer et al. 2013).

around TU5 and produced a small assemblage or debitage, stone tools and bone. Stratum III in Block D was much thinner (25 cm) than in Block A (30-85 cm) resulting in compressed stratigraphy, but the level from which the dated charcoal came was several centimeters above the Stratum II/III boundary (Eakin and Eckerle 2004:Figure 5.23) and therefore probably correlates with Cultural Level 2. The third date in this group, 9792±100 cal BP, came from a piece of charcoal recovered stratigraphically in Cultural Level 1, but horizontally within the northern Cultural Level 2 activity area in Block A. Based on these data Cultural Level 2 appears to date to approximately 9660±62 cal BP, or about 730 years after the Cultural Level 1 occupation(s).

Temporally Diagnostic Artifacts

Thorough description of the diagnostic artifacts recovered from Cultural Levels 1 and 2 is contained in Chapter 6 and an overview of projectile point styles and associated dates from the Central Rockies and surrounding regions is covered in Chapter 3. For the sake of brevity this discussion will focus on the specific context in which the diagnostics were found and what they add to the interpretation of site use. Two fragments, a lateral base (Cat# 8,664) and a midsection (Cat# 6,873), likely from the same obsidian projectile point (Figure 5-17), were found in the northern artifact concentration in Cultural Level 1 (Figure 5-1). The small base fragment exhibits heavily ground, concave lateral and basal margins resulting in a slightly expanding, fishtail base. The midsection is relatively thick (~8 mm), plano-convex in cross-section, with carefully executed serial, parallel-oblique flaking. The two fragments were found less than a meter apart, but the base was about 12 cm below the midsection. The midsection was submitted for sourcing and found to be from the locally available Teton Pass source. The northern part of Block A contained a dense artifact concentration that was not well-differentiated stratigraphically. However, both fragments were found within centimeters, both vertically and horizontally, of several pieces of debitage from analytical nodules B, I and M believed to have been deposited during the Cultural

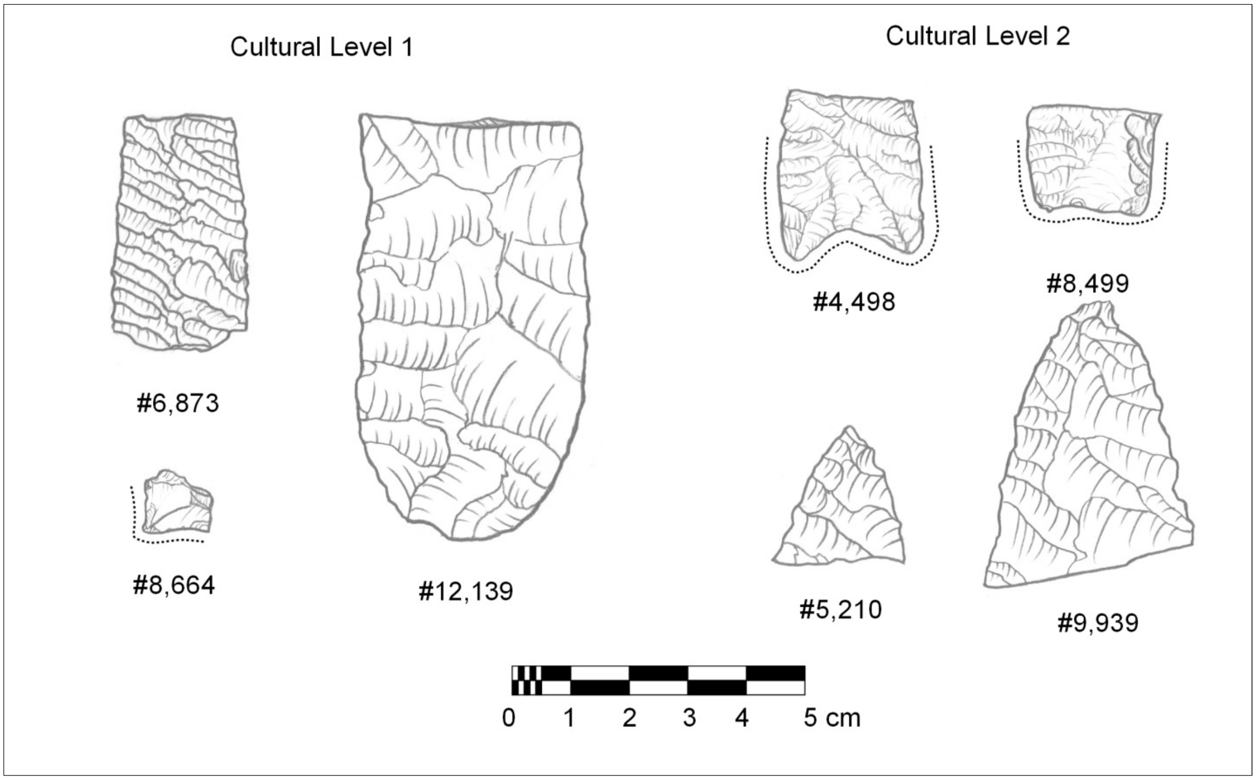


Figure 5-17 Diagnostic artifacts from Cultural Levels 1 and 2.

Level 1 occupation. Furthermore, several pieces of analytical nodules G, E and F from Cultural Level 2 were also found in this concentration, but were recovered from at least 5 cm above both point fragments. Given the depth of these fragments and their spatial association with analytical nodules it appears that these point fragments were discarded during the occupation(s) in Cultural Level 1. A similar projectile point was recovered from Layer 4 at Mummy Cave, that has been dated to 10,422±103 cal BP (Husted and Edgar 2002), and is statistically the same as the five dates that comprise the Cultural Level 1 mean. This point style has not been given a name (Larson 2012), but may be technologically derived from earlier "Fishtail" points (Frison 2007a).

One base-midsection fragment of a projectile point preform made of metaquartzite (Figure 5-17, #12,139) was found directly at the Strata II/III contact, or at the base of Cultural Level 1, in unit N464 E504. This thick (11 mm) lanceolate has a convex base and pronounced collateral percussion flake scars, characteristics commonly associated with the Haskett point type (Butler 1965; Holmer 2009). A small base fragment of a Haskett point was found in disturbed context during the 2002 testing at Game Creek (Eakin and Eckerle 2004). Haskett points, part of the Western Stemmed tradition (Chatters et al. 2012), have poorly defined temporal boundaries, but a component from the Helen Lookingbill site was dated to 12,277±165 cal BP (Kornfeld 2001). According to Holmer (2009:49), the Haskett type was produced until circa 10,100 cal BP or just slightly after the Cultural Level 1 occupation(s). Thus, it is possible that

Cultural Level 1 contains a Haskett component.

Three projectile point fragments and a preform, all obsidian, were found in Block A Cultural Level 2 (Figure 5-17). The projectile point fragments were all sourced to the locally available Teton Pass or Crescent H Ranch sources. One of these (Cat#4,498) is a rather thick (8.2 mm) base-midsection fragment with ground, slightly constricted basal margins, a concave base and parallel-oblique pressure flaking pattern. The attributes of this point are within the range of variation recorded for the Angostura type (Bradley 2013; Pitblado 2003). This specimen was recovered from unit N498 E500 in the eastern part of Block A, five centimeters above the Cultural Level 1/2 boundary. It is possible that this point fragment has been displaced from Cultural Level 1 because it was found just above Feature 4 and several pieces of analytical nodules M and I were piece plotted at the same elevation and in close proximity. However, the analytical nodule N cluster, as well as several pieces of nodule E, are closely associated at about the same elevation. Thus, it is unclear with which cultural level this point belongs. A base fragment (Cat#8,499) with ground parallel lateral margins, a straight base and a random pressure flaking pattern was found in unit N503 E497 near the top of Cultural Level 2 in close association with analytical nodule G. This point is similar to the Birch Creek type (Holmer 2009). A point tip fragment with finely executed parallel oblique pressure flaking was recovered from unit N498 E493 in the western half of Block A in direct association with analytical nodule D. The tip of a projectile point preform (Cat#9,939) with a parallel-oblique pressure flaking pattern was found less than a meter from the point tip in unit N497 E492 also in direct association nodule D.

Relatively thick lanceolate points with constricting to parallel margins and parallel-oblique or random pressure flaking patterns variously known as Angostura, Ruby Valley and Birch Creek have been recovered at numerous sites in the Central Rockies and surrounding regions and dated to circa 10,600-8700 cal BP (Chapter 3). The projectile points from Cultural Level 2 are technologically and temporally consistent with these defined point types.

Cultural Level 1/2 - Blocks D, E and I

In Blocks D, E and I the lower part of Stratum III produced a small artifact assemblage composed mostly of debitage (Table 5-11). Unlike the Block A deposits, there were no clear concentrations of artifacts that could be inferred as discrete activity areas or hearths (Figures 5-18 and 5-19). Stratum III in Block D was much thinner (~25 cm) than in Block A, and buried soil was absent. It is therefore not possible to stratigraphically differentiate cultural levels in Block D. Stratum III in Block E did present evidence of the buried soil along its eastern edge, but contained few artifacts. The buried soil that separates Cultural Level 1 and 2 in Block A was also present in Block I, but post-depositional mixing appears to have blurred any clear boundaries.

Table 5-11 Artifact recovered from Cultural Level 1/2 in Blocks D, E and I

Artifact Description	Block			Total
	D	E	I	
Biface	1		1	2
Utilized Flake	1		3	4
Secondary Flake	3	2	3	8
Tertiary Flake	23	10	34	67
Flake Fragment	204	89	691	984
Shatter	28	11	187	226
Tooth	0	1	0	1
Bone	11	2	1	14
Charcoal			1	1
Total	271	115	921	1,307

Chi^2 tests comparing the frequency of obsidian, chert and orthoquartzite, the three material types representing 96%-99% of each assemblage, revealed that the raw material composition in Blocks E and I were significantly the same (Chi^2=1.9269, *df*=2, *p*=.382), but differed significantly from all other blocks. Unlike the Block A cultural level assemblages, those from Blocks E and I had a much higher percentage of obsidian and correspondingly lower percentages of chert and orthoquartzite (Table 5-12). Overall, these proportions of raw materials more closely resemble the assemblages from Cultural levels 3 and 4. Thus, it is possible that much of the lithic material recovered from these lower deposits in Blocks E and I was displaced from overlying deposits. Yet, the presence of flakes from analytical nodules C, D and I in Block I suggests that both the Cultural Level 1 and 2 occupations extended into the area.

Table 5-12 Percentages of raw material in Blocks D, E and I, Cultural Levels ½.

Material Type	Block		
	D	E	I
Obsidian	88.5%	97.3%	97.6%
Chert	6.2%	0.9%	1.6%
Orthoquartzite	1.5%	0.9%	0.2%
Metaquartzite	3.1%	0.0%	0.1%
Basalt	0.8%	0.0%	0.3%
Silic. Wood	0.0%	0.9%	0.1%

The lithic assemblage from Block D was similar Block A Cultural Level 2 (Chi^2=.94988, *df*=2, *p*=.622). There are other associations between Blocks D and A such as the remains of medium artiodactyl and beaver bone. The most convincing similarity, however, is the 9631±62 cal BP date from TU5 that is precisely the same as a date from Cultural Level 2 in Block A. It would appear that the Cultural Level 1/2 occupation in Block D is likely associated with the Cultural Level 2 component in Block A.

Summary

Cultural Level 1 contained the remains of at least two unprepared hearths and relatively small lithic and faunal assemblages. Most of the artifacts associated with the level were concentrated in fairly discrete hearth-centered activity areas. The mass analysis of debitage indicates that core reduction for the

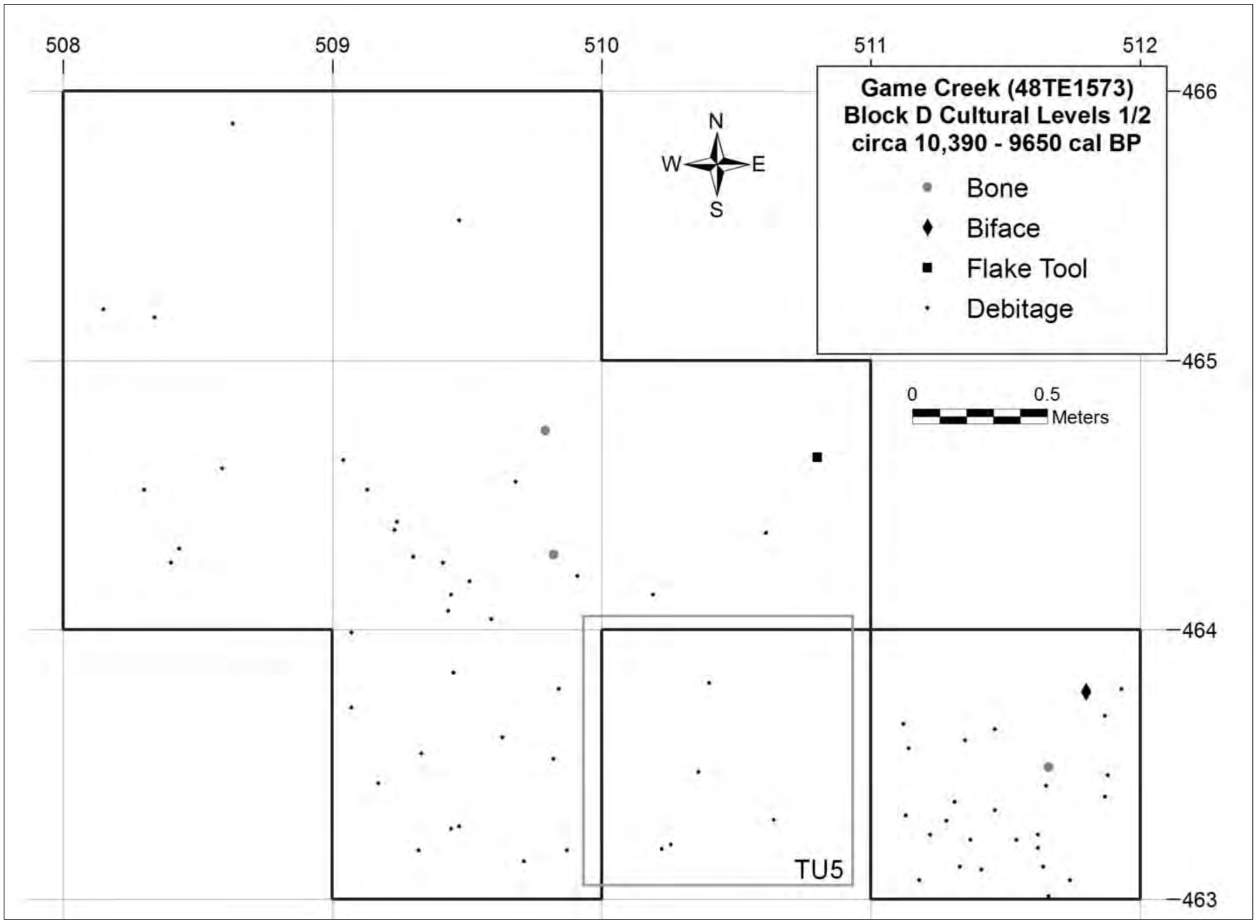


Figure 5-18 Plan view map of Block D, Cultural Level 1/2 showing piece plotted artifacts and the boundaries of TU5.

production of flake tools was the predominate lithic reduction strategy employed. However, the presence of three or four biface fragments in various stages of production also indicates that some amount of bifacial tool production also occurred. The minimum analytical nodule and raw material type analyses show that most of the stone used on site was probably obtained locally, though one nodule may have been transported to the site from the upper Green River Basin. These data point to the conclusion that Cultural Level 1 represents one or more short-term hunting camps used by small groups of people approximately 10,400 years ago. The lightly used hearths and presence of beaver, an animal particularly difficult to harvest in the winter, suggest a warm weather occupation. The only diagnostic artifact recovered from this level is of an unnamed type affiliated with the early part of the Foothills-Mountain Paleoindian tradition.

Cultural Level 2 differed from the earlier level in several ways. First, the composition of the lithic assemblages was markedly different. Second, no hearths or even evidence from which a hearth could be inferred was found. Yet, given the presence of charcoal, butchered pronghorn, beaver and large artiodactyl, it is likely that one or more hearths are or were present at the site. Third, results of the lithic

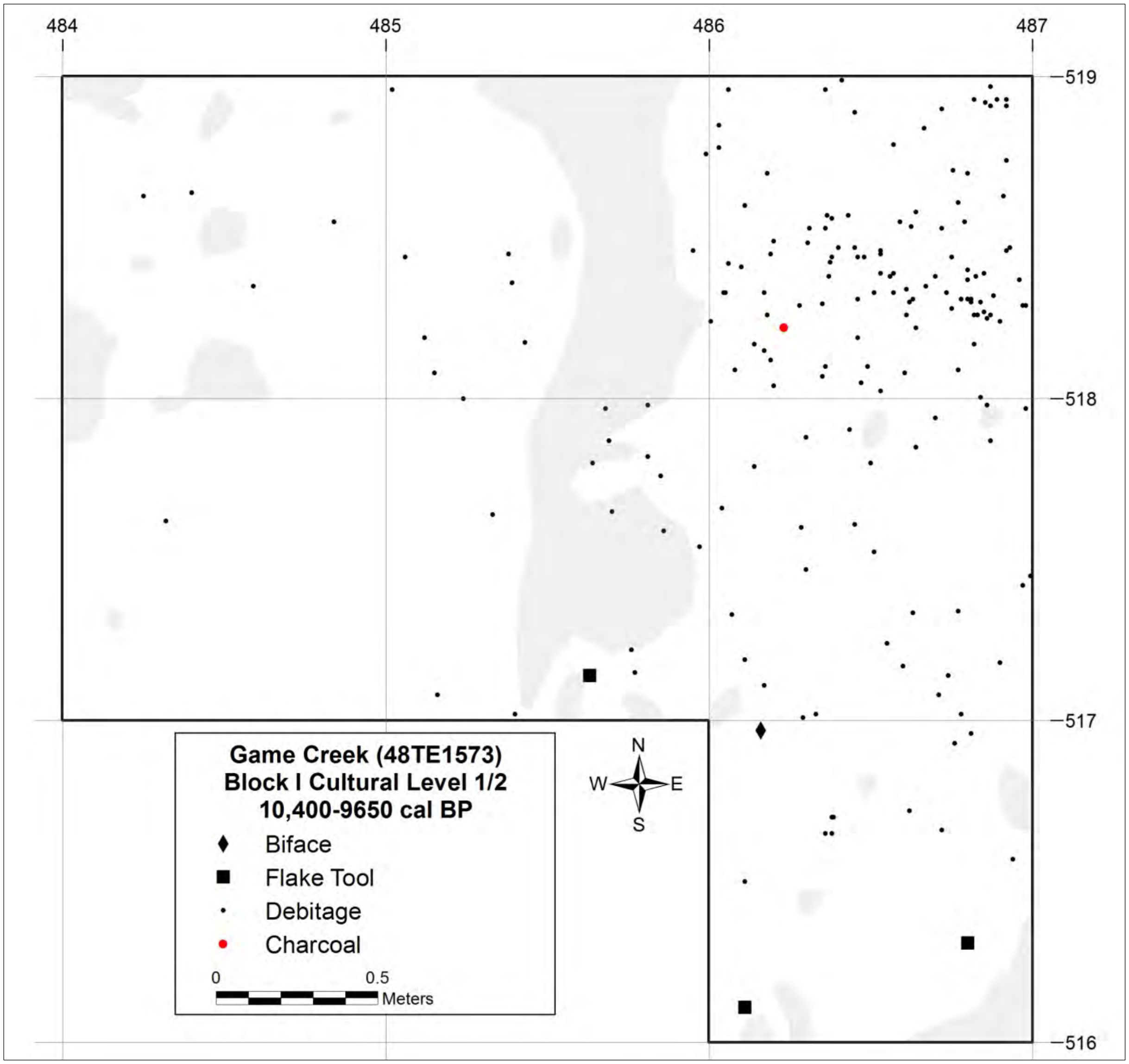


Figure 5-19 Plan view map of Block I, Cultural Level1/2 showing piece plotted artifacts.

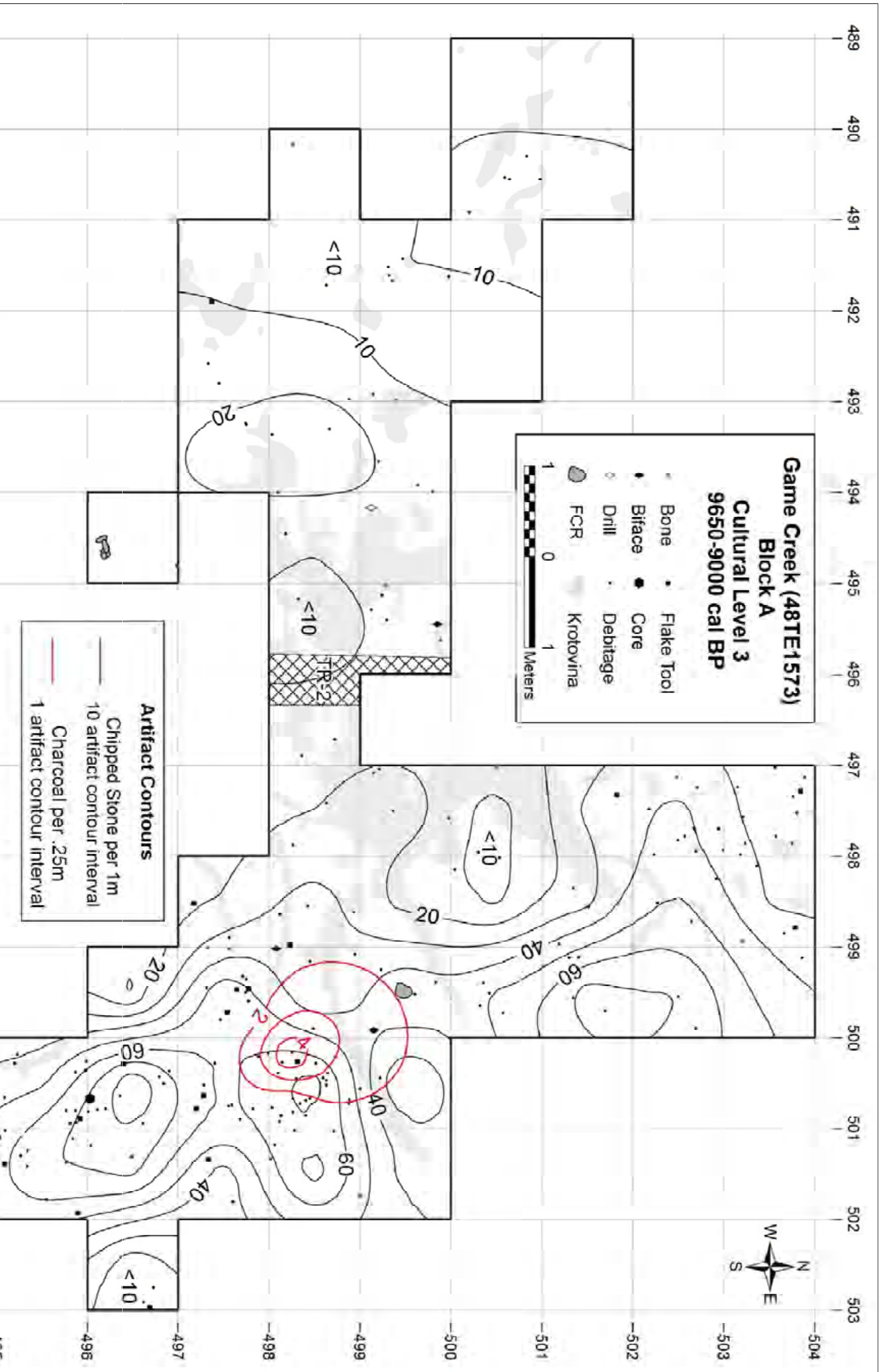
mass analysis show that the late stage bifacial tool production was probably the primary task performed (Phillips and Francis 2017). These bifacial reduction episodes are reflected in several dense and highly concentrated activity areas. There is some evidence that several secondary chert cobbles were procured locally and reduced to form tool blanks or cores. One small stage I biface, was recovered. The remaining 12 bifaces are all fragments that appear to have broken during manufacturing. The evidence points predominantly to tool production and maintenance activities. The fourth difference between Cultural Level 1 and 2, is that the former appears to represent a single component and latter probably consists of a artifacts deposited intermittently over an extended period of time circa 9,650 years ago.

Cultural Level 3

Cultural Level 3 is stratigraphically defined to include all artifacts found above the buried soil horizon and Cultural Level 2 and below the Strata III/IV boundary. In Block A, the depth below surface of Cultural Level 3 varied from about 50 cmbs in the west edge of Block A and in Blocks E and I to about 100 cmbs at the eastern end of Block A and in Block D. This stratigraphic horizon is relatively thick, ranging from about 20-45 cm, but based on bracketing radiocarbon dates, it accumulated over a period of only about 700 years, between about 9650 and 9000 cal BP. Although no radiocarbon dates were obtained directly from Cultural Level 3, one of the discordant dates from Feature 4, Cultural Level 1 may have originated in this level. Artifact frequency was low compared to earlier and later levels (Table 5-13). There was extensive visible bioturbation, particularly in and around Block E, between Blocks E and A, and in the E494-E497 transects of Block A. In the eastern half of Block A there was few discernible krotovina, but artifacts were dispersed in almost precisely the same spatial pattern as in the overlying Cultural Level 4, which strongly suggesting post-depositional mixing of the deposit. Only two potentially diagnostic artifacts were recovered. The faunal assemblage was sparse with only nine pieces of bone found mostly in Block A (Table 5-13). No features were identified. However, a concentration of charcoal and bone in Block A may mark the location of an ephemeral hearth.

Although artifacts assigned to this cultural level were found in all block excavations and many individual units, the only concentrations that could be inferred as activity areas were in Blocks A and I. The eastern three meters of Block A contained a fairly dense concentration of debitage, one core fragment, a biface fragment and several flake tools (Figure 5-17). There is some indication of two occupations within Block A, Cultural Level 3 based on the stratigraphic distribution of cultural material (Figure 5-21). Yet, the low frequency of artifacts precludes comprehensive spatial analysis. A concentration of charcoal was identified in and around unit N498 E500 (Figure 5-21). One piece of fire-cracked rock and five of the six bones from Block A, two of which were charred, were recovered from within a two meter radius of the charcoal concentration. If the charcoal concentration was in fact a feature then it is a likely source of the 9305±81 cal BP date from Feature 4 that was so markedly discordant with all the other dates from Cultural Levels 1 and 2. The two krotovina recorded within or adjacent to the charcoal concentration are possible avenues by which the charcoal was displaced to Cultural Level 1.

There was an even denser concentration in the northwestern units of Block I where several hundred pieces of debitage, several flake tools, a biface fragment, a complete chert drill and an end scraper were found (Figure 5-22). No evidence of thermal features and no faunal remains were found in this deposit. However, the relatively diverse assortment of tools reflects a variety of tasks that is consistent with a short-term hunting or secondary base camp (Bender and Wright 1988).


Game Creek (48TE1573)
Block A
Cultural Level 3
9650-9000 cal BP
Bone
Flake Tool
Biface
Core
Drill
Debitage
FCR
Krotovina
1 0 1
Meters
TR-2
Artifact Contours
Chipped Stone per 1m
10 artifact contour interval
Charcoal per .25m
1 artifact contour interval
N
S
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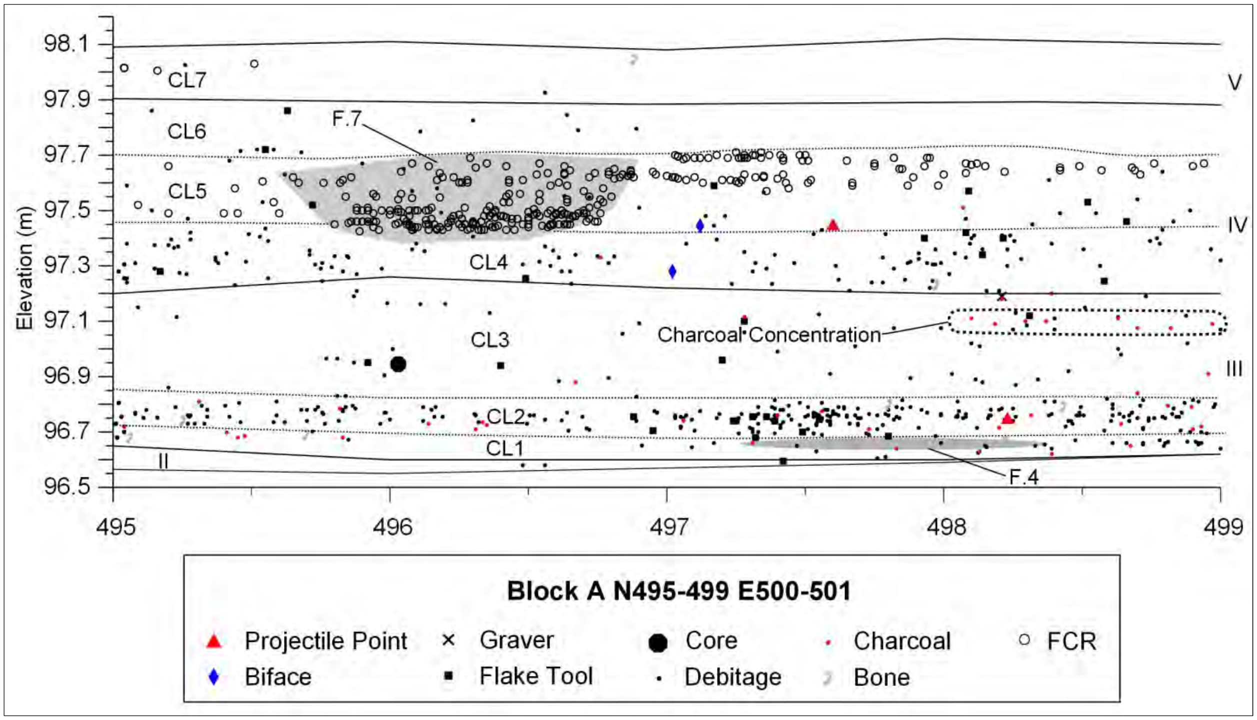


Figure 5-21 Backplots of artifacts from Block A N495-499 E500-501 showing charcoal concentration in Cultural Level 3.

Table 5-13 Artifacts recovered from Cultural Level 3.

Description	Block				Total
	A	D	E	I	
Projectile Point	1				1
Biface	1			1	2
Drill	1			1	2
End Scraper				1	1
Retouched Flake	9				9
Utilized Flake	20	1	1	8	30
Core	1				1
Primary Flake		1	1	1	3
Secondary Flake	5	1	2	2	10
Tertiary Flake	172	24	24	104	324
BF Thinning Flake	4			2	6
Flake Fragment	1,199	167	314	1,405	3,085
Shatter	193	23	41	454	711
L. Artiodactyl bone	4				4
unidentified bone	2		3		5
Charcoal	31	4		1	36
Total	1,649	221	386	1,980	4,236

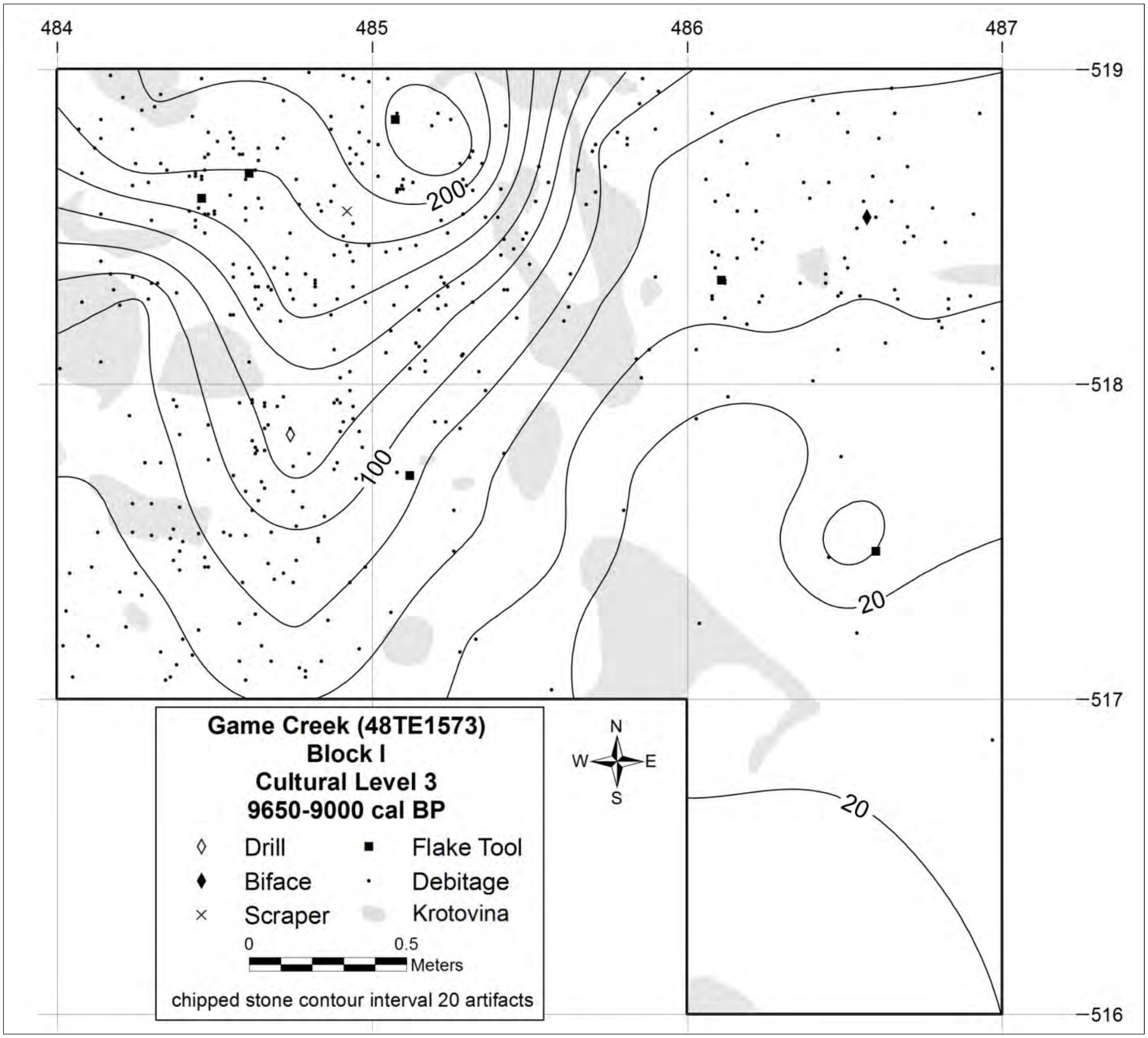


Figure 5-22 Plan view map of Block I, Cultural Level 3 showing piece plotted artifacts and shipped stone artifact contours.

The lithic raw material composition of Cultural Level 3 differed significantly from Cultural Level 2 (Chi^2=36.677, *df*=2, *p*<0.000). The percentage of obsidian (94.9%) was higher and the percentages of chert (2.7%) and orthoquartzite (1.5%) were much lower. Since most of the chert from Cultural Level 2 appears to have been obtained locally, it is unlikely that the decrease in chert reflects changes in mobility or territory of the site's inhabitants. It is possible that the chert cobbles utilized in Cultural Levels 1 and 2 were procured from Pleistocene-aged channel deposits (Stratum I) that were exposed on or near the site surface. The increase in overbank deposition during the Cultural Level 3 occupation(s) may have buried these previously available sources resulting in a reduction of chert utilization. Yet, the changes in material use could have been merely idiosyncratic.

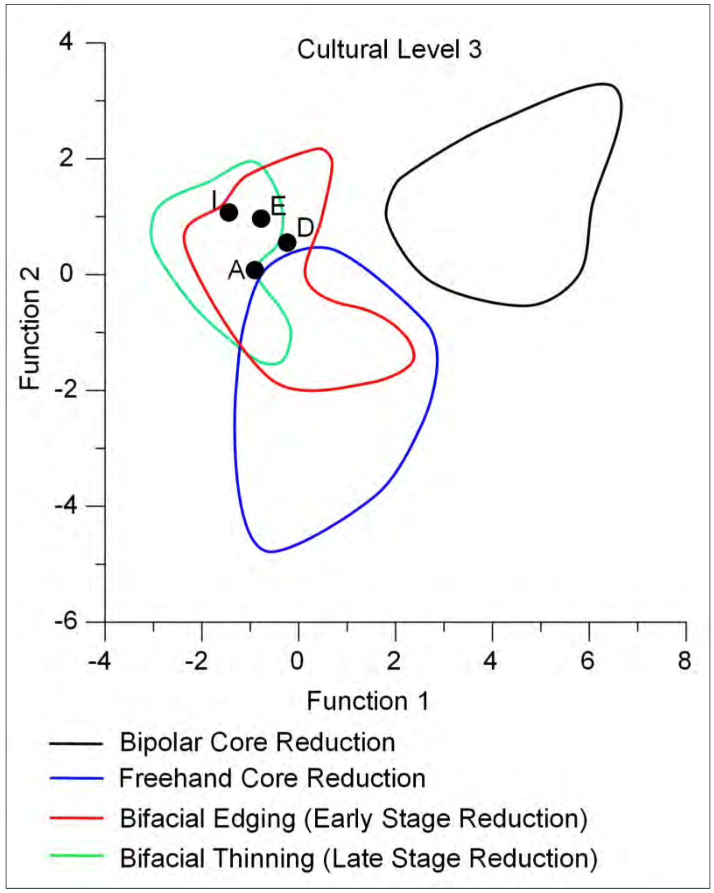


Figure 5-23 Results of the lithic mass analysis using discriminant function analysis.

No multiple-item analytical nodules were identified in Cultural Level 3. However, two single-item nodules, a projectile point fragment and a drill, were found. The projectile point was found in two pieces. One piece was found in a rodent burrow in unit N499 E498 in Block A during the 2010 excavations. The following year another fragment that conjoins with the previous piece was recovered from the screen in unit N501 E497 between 97.0-96.95 m, about 10 cm below the Strata IV/III contact. This specimen is made of a high quality lustrous, opaque, white chert. Possible sources of this material include the Miocene-aged cherts from Green River Basin and meta-volcanics from the Absaroka Range (Clayton 1999; Dan Wolf 2015, personal communication). The second single-item nodule is a complete drill found in Block I. The material is opaque, mottled grayish-brown, gray and yellowish brown in color and is very similar to cherts from the Laney Member of the Green River Formation. Thus, both specimens appear to have originated outside Jackson Hole and were brought to Game Creek as finished tools.

The obsidian debitage from Cultural Level 3 was noticeably homogenous across the site. The low percentage of cortical debitage and high proportion of small flakes indicate that most of the flint knapping involved late stage bifacial tool production. The discriminant function analysis classified the lithic assemblages from all four sampled blocks within the bifacial thinning reduction group (Figure 5-23). No complete obsidian bifacial tools were found. However, two small lateral biface fragments were recovered. Similar lateral fragments are often created during bifacial thinning, and several nearly identical specimens were present in the knapping experiments conducted by Denoyer and Sanders. It would appear that most of the bifacial tools produced on site were removed from the site as finished tools or tool blanks.

The projectile point fragment (Cat#4,895, 8,348) is from a thin (5.4 mm), wide (36.1 mm) lanceolate with converging, unground, lateral margins and a concave base (Figure 5-24). The flaking pattern is parallel horizontal on one face, slightly oblique on the other and is finely executed. This specimen does not closely resemble any named projectile point type. Its width, thickness and flaking pattern most closely corresponds with the James Allen point type (Bradley 2009, 2010, 2013; Pitblado 2003).

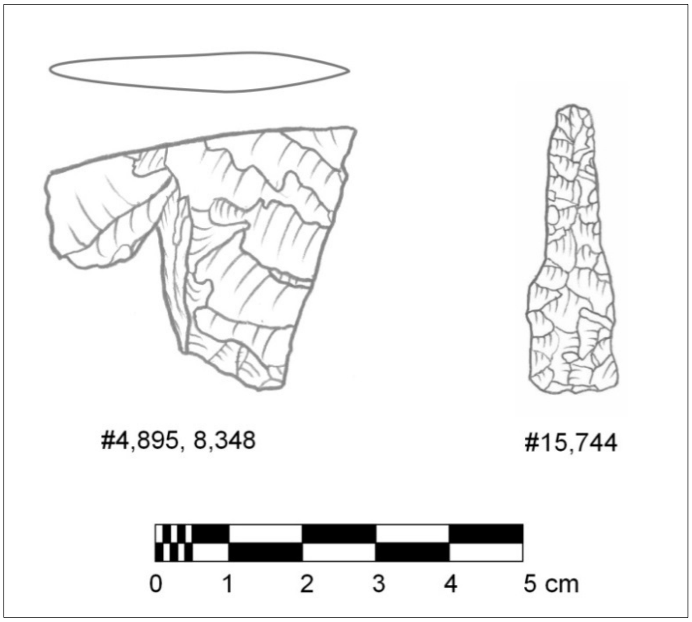


Figure 5-24 Projectile point and drill recovered from Cultural Level 3.

The drill recovered from Block I appears to be made from a projectile point. The base of the drill is 10.5 mm wide with a straight, slightly ground base that is very similar to Lovell Constricted or Pryor Stemmed projectile points (Figure 5-24). As discussed in Chapter 3, the Lovell and Pryor types differ only in the method of resharpening, with alternately beveled resharpening being the norm and defining characteristic of the Pryor Stemmed type (Husted 1969). Lovell/Pryor points were often repurposed into drills (Davis 1990). The drill from Block I appears to fit this pattern. The temporal boundaries of Cultural Level 3 fall within the period of time that Lovell Constricted and Pryor Stemmed points are known to have been produced (10,000 to 8500 cal BP).

In summary, Cultural Level 3 produced relatively low artifact frequencies overall, but there were concentrations within Blocks A and I that appear to represent activity areas. In Block A the artifacts are clustered around what may have been an ephemeral hearth. There is some evidence for an earlier occupation in Block A, but this remains equivocal due to the low artifact frequencies and absence of unique artifact classes, such as analytical nodules, with which to conduct a more detailed spatial analysis. Bracketing radiocarbon dates place the occupation period at sometime between 9650 and 9000 cal BP. The 9305±81 cal BP date from Feature 4 may have originated from Cultural Level 3. Such a date is consistent with the Lovell Constricted or Pryor Stemmed occupation. This is further supported by the point reworked into a drill from Block I. The faunal assemblage, though sparse, contains large artiodactyl (bison or elk) and small mammal or bird remains. In this respect it is similar to Cultural Levels 1 and 2 where no clear emphasis on large or small game was in evidence. Despite the low numbers of artifacts, it would appear that Cultural Level 3 represents a short-term hunting or secondary base camp given the diversity of tools and a rather low tool to debitage ratio (1:92).

Cultural Level 4

Cultural Level 4 was the second most productive level on the T3 terrace. The level is within the lower 20-40 cm of Stratum VI at 30-50 cmbs. There is firm evidence for multiple occupations, some of which are spatially discrete. Most of artifacts from Cultural Level 4 were found in Blocks A, D and E, but nearly 10% of the total assemblage was recovered from three units at the south end of the T2 terrace. Depositional rates during the Cultural Level 4 occupations were only about 1 cm per century, resulting in compressed stratigraphy. Moreover, bioturbation and occupational trampling have caused some degree of mixing of these components. Consequently, stratigraphic separation of components in Cultural Level 4, especially in Block E and the eastern part of Block A, was not possible.

Block A

In the eastern and northern portions of Block A, Cultural Level 4 is about 25 cm thick. Based on two radiocarbon dates from the contact of Strata III and IV, the earliest occupation occurred around 9020±35 cal BP (Table 5-14). One of the aberrant dates from Feature 4 in Cultural Level 1 (8912±85 cal BP) is also statistically the same as these dates and may have been moved to Cultural Level 1 from Cultural Level 4 through bioturbation. The 7973±35 cal BP age also came from a piece of charcoal recovered from the stratigraphic contact. This date is a thousand years younger than the other two, but is very close to two dates from charcoal collected 10-20 cm above the Strata III/IV boundary. Relatively few artifacts were found at the contact of Strata III and IV indicating that the earlier occupation was brief.

Evidence for a slightly later component came from a sparse but diverse artifact scatter in the western part of Block A. A whole bison tooth from unit N499 E493 returned an AMS date of 8645±77 cal BP. Nine utilized or retouched flakes, a metate fragment and the tip of a projectile point were found in association with the dated bison remains. Previous studies have shown that bone, under certain conditions, can be more susceptible to contamination than wood charcoal and produce younger than expected age estimations (Potter and Reuther 2012). Therefore, it is possible that the dated tooth from the western part of Block A and the early dated charcoal from farther east were deposited during the same occupation.

Most of the artifacts from the northern and eastern parts of Block A came from a 15 cm thick zone, the base of which was about 10 cm above the Strata III/IV boundary and the two earliest dates. Two pieces of charcoal recovered from this zone returned dates of 7998±46 cal BP and 7892±41 cal BP. The earlier date is statistically the same as the discordant date from the Strata III/IV boundary. When pooled these two dates produce a mean age estimate of 7984±21 cal BP. This occupation contained a wide array of stone tools, including five projectile points, nine bifaces, a drill, several scrapers and numerous utilized and retouched flakes. The faunal assemblage contained three large artiodactyl bones, two small (rabbit)-medium (porcupine) sized mammal bones and 15 unidentifiable specimens, five of which were burned.

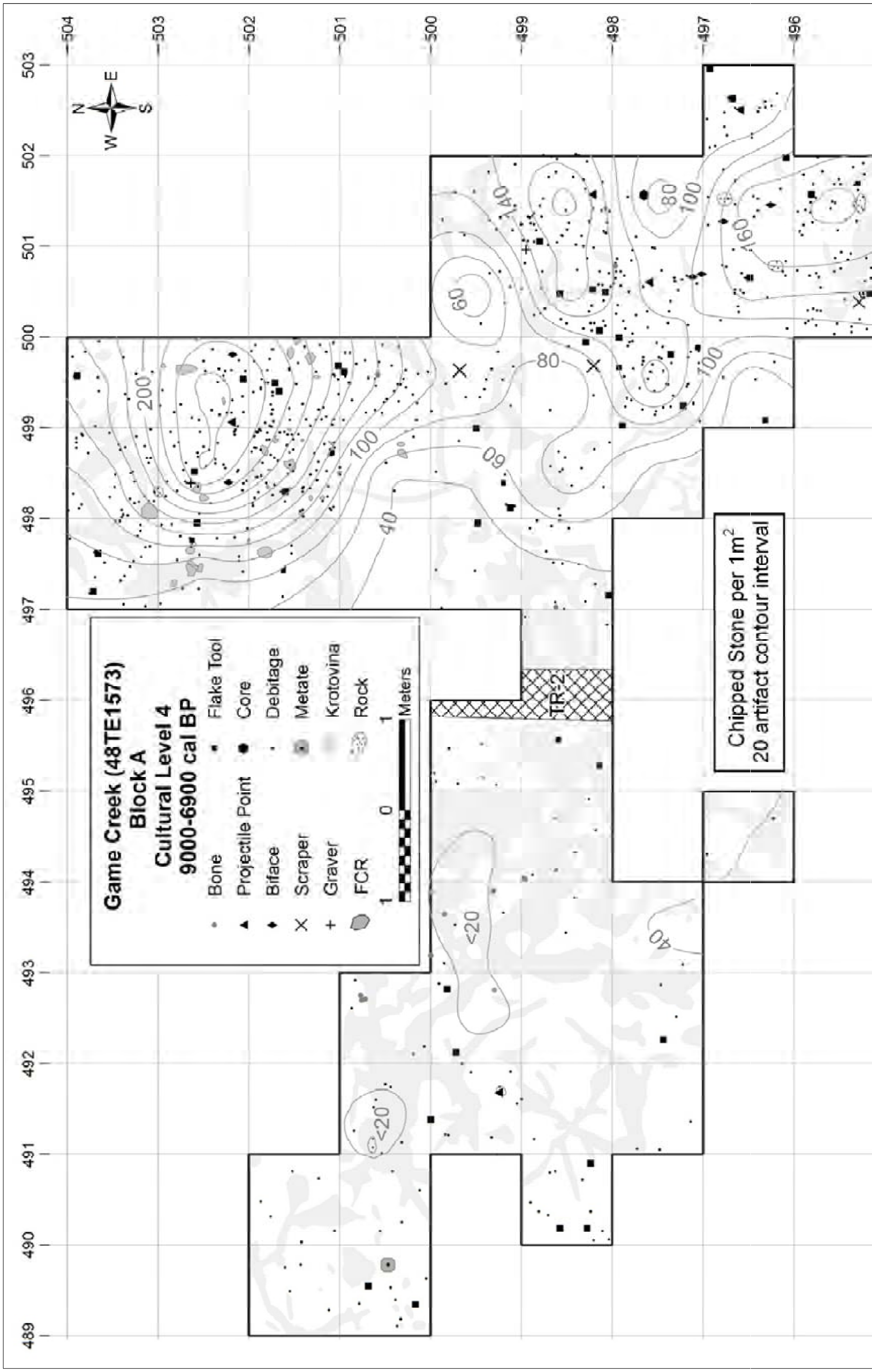
Table 5-14 Artifacts Recovered from Cultural Level 4

Description	Block					N436 E503	N440 E504	N440 E520	Total
	A	D	E	I	H				
Projectile Point	6	1	1		1				9
Biface	9	2	1	2					14
Drill	1								1
End Scraper	1								1
Side Scraper	1								1
Graver	2								2
Retouched Flake	12		3	2			2	1	20
Utilized Flake	58	4	6	3			3	3	77
Mano								1	1
Metate Frag	1								1
Core	1		1	1					3
Primary Flake	4		3	1	1			2	11
Secondary Flake	23	18	13	9	2	2		4	71
Tertiary Flake	377	133	107	44	39	30	36	117	883
BF Thinning Flake	10	1	1	1		1			14
Flake Fragment	3,341	1,047	1,155	449	540	178	150	229	7,089
Shatter	551	131	146	118	26	41	52	43	1,108
Tooth	2		1						3
Tooth Enamel	9					4			13
Bone	49	4	65	1	8	6	3		136
Charcoal	14	7	1	2	1		1		26
Total	4,472	1,348	1,504	633	618	262	247	400	9,484

Table 5-15 AMS radiocarbon dates from Cultural Level 4.

Beta #	Provenience	Stratum	Cultural Level	Dated Material	Conv. RCYBP	*M* cal BP ± 1σ
316956	Blk A, N496 E502, 97.3m	III/IV	4	charcoal	8120±40	9061±57
316957	Blk A, N498 E500, 97.2m	III/IV	4	charcoal	8070±40	9002±85
Pooled Mean (316956, 316957)					8095±28	9020±35
319997	Blk A, N499.99 E493.89, 97.0m	IV	4	bison tooth	7860±40	8645±77
316955	Blk D, F.8, N464.37 E510.95, 96.91m	IV	4	charcoal	7580±40	8390±28
319994	Blk A, N498.11 E501.31, 97.45m	IV	4	charcoal	7190±40	7998±46
316960	Blk A, N501.75 E499.75, 97.155m	IV	4	charcoal	7150±40	7973±35
Pooled Mean (319994, 316960)					7170±28	7984±21
316959	Blk A, N498.04 E501.67, 97.395m	IV	4	charcoal	7060±40	7892±41
315714	Blk H, N445.07 E501.98, 96.33m	IV	4	bone	6780±30	7629±25
315715	Blk E, N450.04 E503.48, 96.59m	IV	4	bone	6650±30	7531±28
319996	Blk H, N446.93 E501.69, 96.335m	IV	4	charcoal	3650±40	3970±64

Calibrated at 2σ using CALIB 7.0.4, Intcal13 calibration curve (Stuiver and Reimer 1993; Reimer et al. 2013).


Game Creek (48TE1573)
Block A
Cultural Level 4
9000-6900 cal BP
Bone
Projectile Point
Biface
Scraper
Graver
FCR
Flake Tool
Core
Debitage
Metate
Krotovina
Rock
Meters
TR-2
Chipped Stone per 1m2
20 artifact contour interval

In the northern portion of block a diffuse scatter of fire-cracked rock was found, but little charcoal and no heat-altered chipped stone was recovered. Spatial analysis of burned items failed to reveal any concentrations that could be inferred as eroded thermal features.

Block D, Feature 8

Cultural Level 4 in Block D consisted of a roughly 15 cm thick artifact horizon that contained a dense debitage concentration, three flake tools, two biface fragments and a complete projectile point and the only feature in Cultural Level 4 (Figure 5-26). Feature 8 was a cluster of 16 pieces of fire-cracked limestone weighing approximately 3 kg. The fire-cracked rock was within an area measuring 65 x 48 cm at an elevation of 96.8-96.86 m (Figures 5-26 through 5-28). No carbon staining or oxidation of sediment was observed, but a few flecks of charcoal were scattered in and around the fire-cracked rock. The largest piece of charcoal returned an age estimate of 8390±28 cal BP. Most of the artifacts from Cultural Level 4 were found slightly above the rocks, which provide some indication that the rocks were placed into an excavated basin.

Blocks E and H

The Cultural Level 4 assemblage from Blocks E and H was found within a 15-20 cm thick zone Bioturbation was more extensive in and around Blocks E and H than Blocks A and D resulting in more mixing of cultural material. Block H was particularly disturbed, with approximately 50% of Cultural Level 4 recorded as krotovina. Nevertheless, a concentration of butchered elk, bison, deer and unidentifiable mammal bone was recovered mostly from a 10 cm thick horizon. Large quantities of debitage, several flake tools, a biface fragment, a small projectile point fragment and three pieces of fire-cracked rock were also found scattered across Block E (Figure 5-29). Block H, however, had far lower artifact diversity with one tool, a complete projectile point, recovered.

The faunal assemblage from Blocks E and H is the largest recovered from the T3 terrace excavations. Identifiable specimens included 10 bison, 12 elk and one deer. Most of the bone had been heavily processed for marrow and bone grease with several specimens showing evidence of impacts and many bearing green bone spiral fracturing. Cut marks were also found on several bones. One cluster of butchered bone in Block E that contained both bison and elk appears to have been dumped, perhaps following stone boiling.

Two pieces of large artiodactyl bone from Blocks E and H were submitted for radiocarbon dating and returned dates of 7531±28 cal BP and 7629±25 cal BP, respectively. Although the two dates are not statistically the same, they are close enough that they may represent the same event especially if the risks of contamination are taken into account. A small piece of charcoal from Block H was also submitted for dating, but the date, 3970±64 cal BP is discordant from all other Cultural Level 4 dates. Given the amount

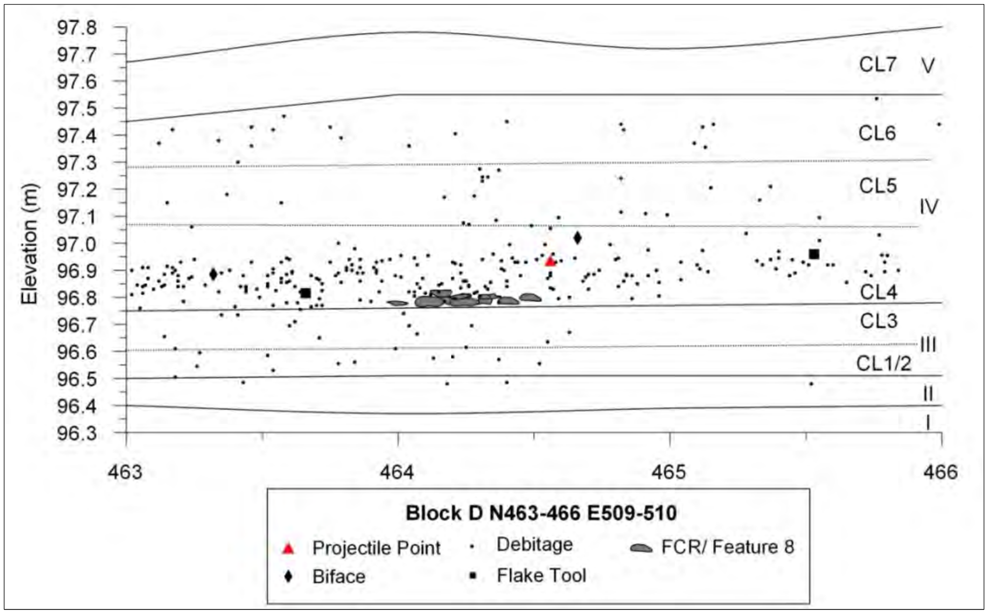


Figure 5-26 Profile drawing of Feature 8, Block D Cultural Level 4.

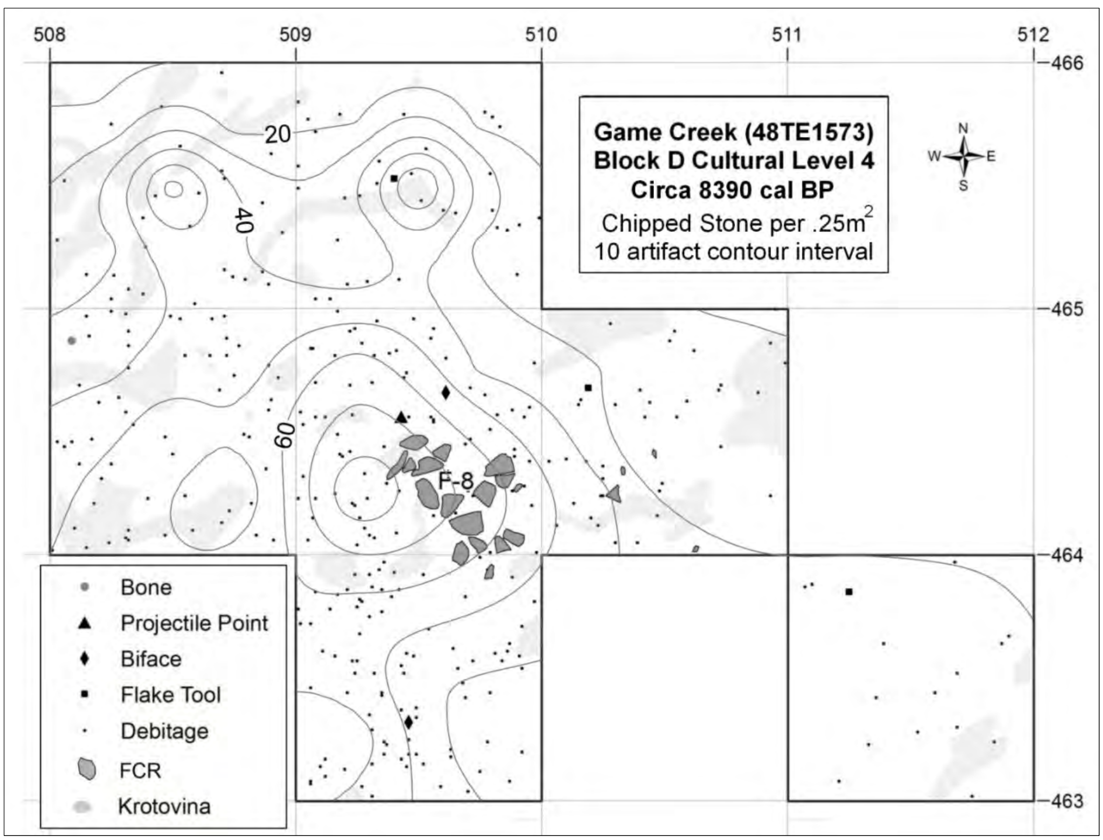


Figure 5-27 Plan view map of Block D Cultural Level 4 showing piece plotted artifacts, Feature 8 and a chipped stone artifact contour.

Figure 5-28 Photograph of Feature 8, Block D Cultural Level 4 at 96.8 m.

of bioturbation in Block H it is likely the charcoal that produced the date was out of context. A similarly aged sample, was recovered from a badly eroded hearth in Trench 1 during the 2002 testing (Eakin and Eckerle 2004)

South Units

Three excavation units, N436 E503, N440 E504 and N440 E520, contained nearly 10% of the artifacts from Cultural Level 4. Each of these units produced large quantities of debitage, a small faunal assemblage, and several flake tools (Table 5-14, Figures 5-30 and 5-31). Unit N440 E520 was excavated during the 2010 season prior to the modifications of field methods. Consequently this unit was excavated by shovel and 1/4" dry-screened. Had 1/8” water-screening been used it is likely that this unit would have produced the densest concentration of artifacts in Cultural Level 4. Faunalturbation in these southern units was severe in places with between 5% and 15% krotovina recorded in the various 5 cm thick excavation levels. No features, evidence of features or diagnostic artifacts were found. However, a mano was recovered from unit N440 E520. Faunal remains included two butchered and burned black bear bones, two large artiodactyl bones and several unidentifiable mammal bones. It is highly likely that extensive

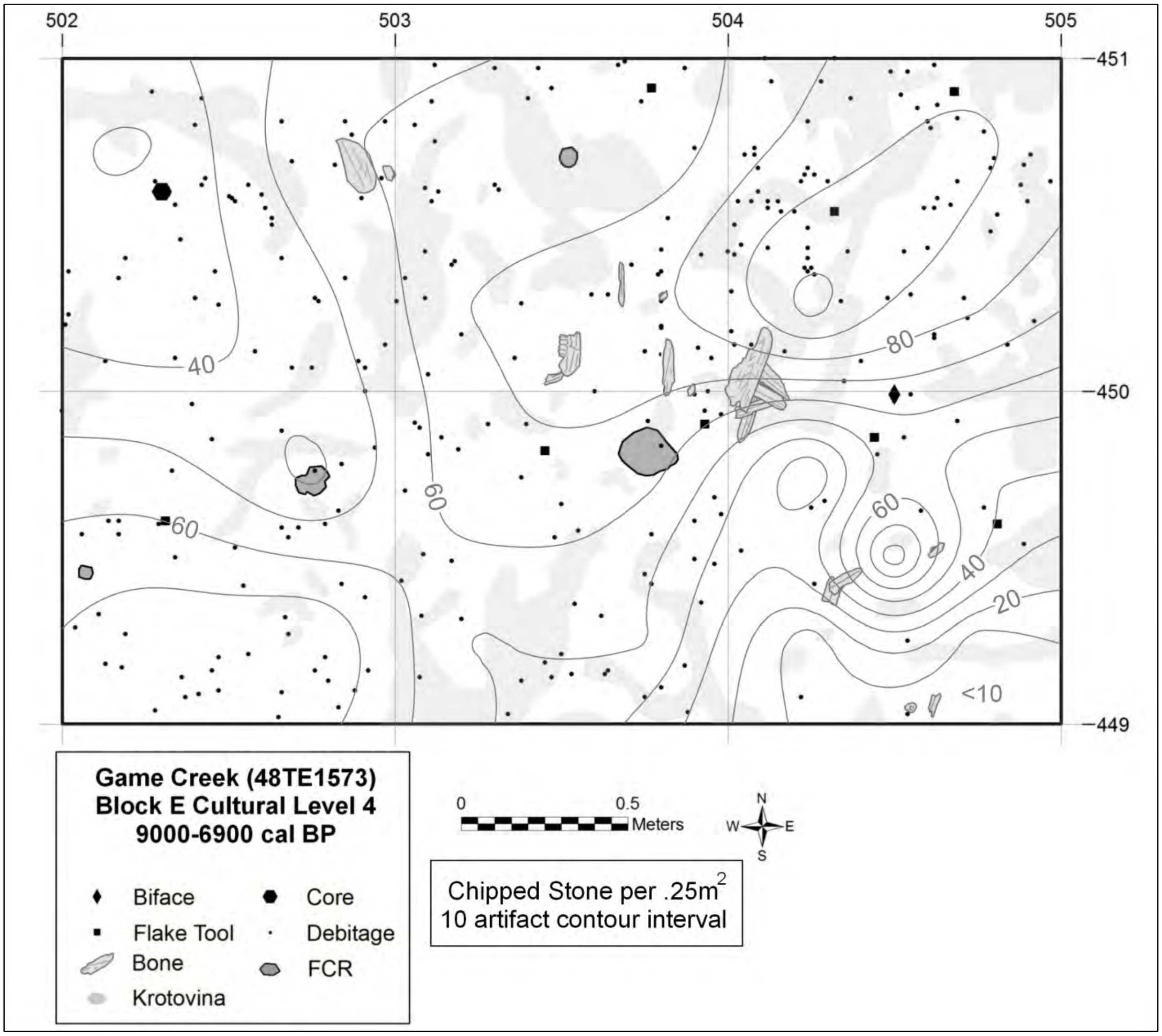


Figure 5-29 Plan view map of Block E Cultural Level 4 showing piece plotted artifacts and a chipped stone artifact contour.

cultural deposits dating to Cultural Level 4 times are present in the vicinity of these three units at the south end of the T3 terrace. Additional excavations were not conducted because this area will not be impacted by the proposed highway construction.

Lithic Raw Material and Minimum Analytical Nodule Analysis

The raw material composition of Cultural Level 4 was not statistically different from the Cultural Level 3 assemblage (Chi^2=2.094, *df*=3, *p*=.5531). Obsidian was again the dominant material, representing 95.1% of the assemblage, followed by chert (2%) and orthoquartzite (1.6%). There were increases in the percentages of metaquartzite and silicified wood. Three obsidian projectile points and three flakes were

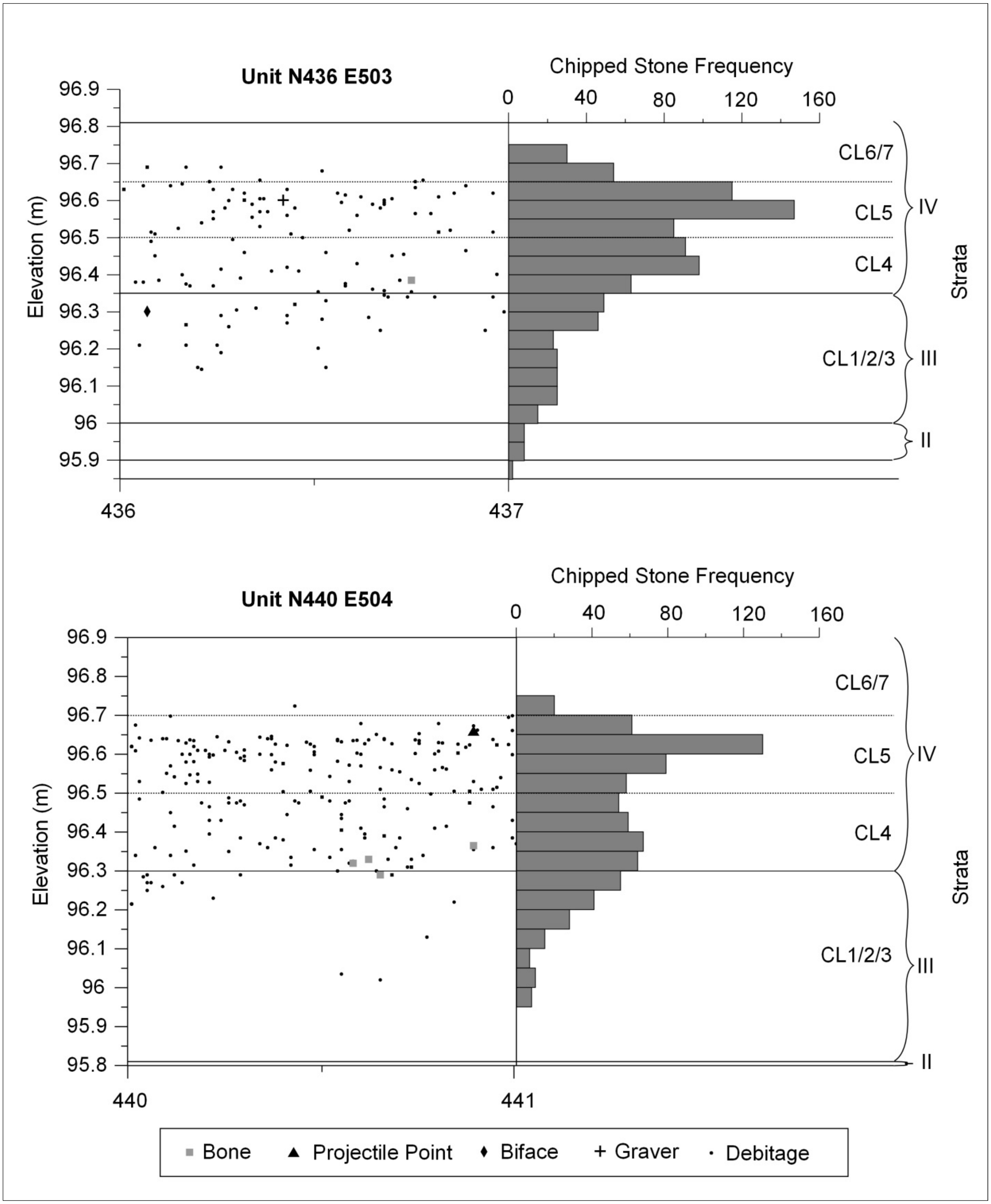


Figure 5-30 Backplots and artifact frequency histograms for units N436 E503 and N440 E504.

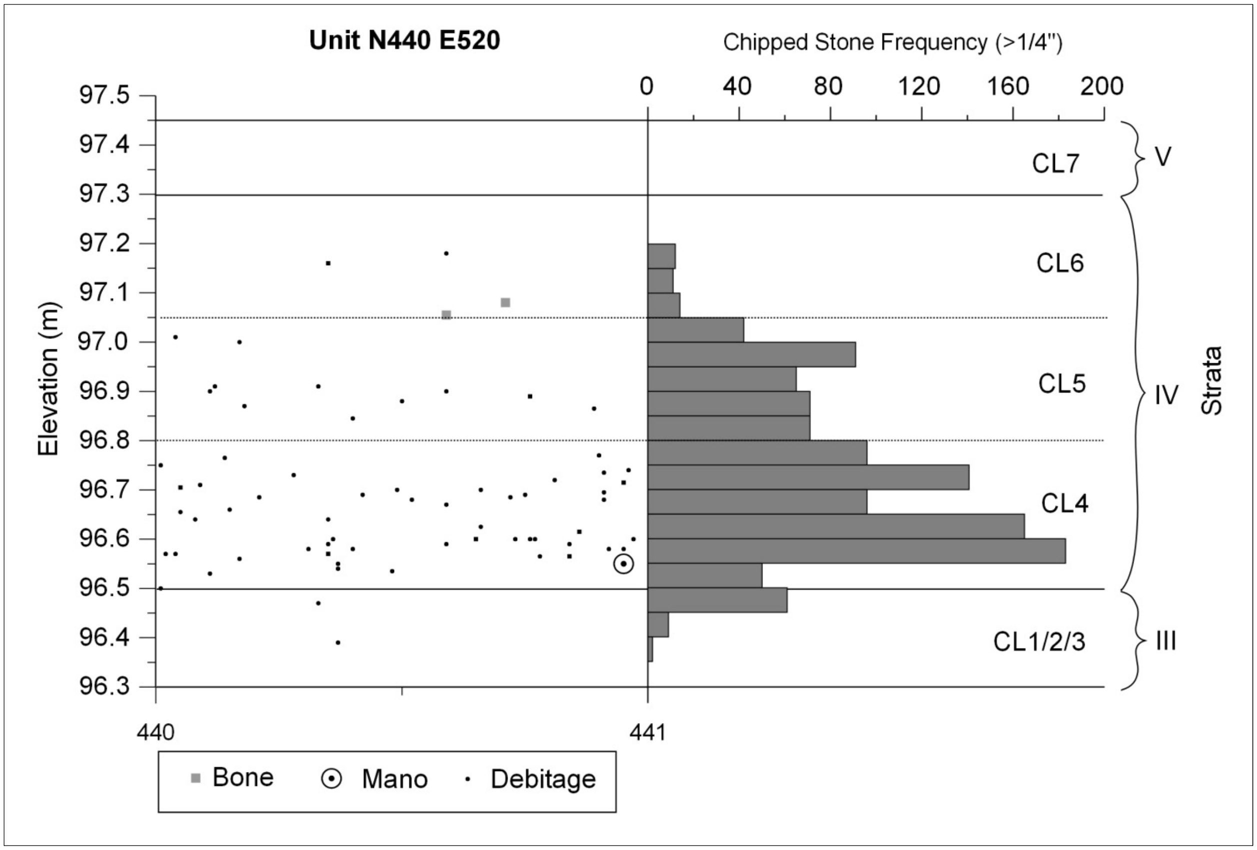


Figure 5-31 Backplots and artifact frequency histogram for unit N440 E520.

sourced using ed-xrf. Four of the specimens produced elemental signatures from Teton Pass, Crescent H Ranch and West Gros Ventre Butte, all of which are locally available. One flake from Block A came from the Bear Gulch source in southwestern Montana and one projectile point fragment from Block A came from the Malad source in eastern Idaho. Six pieces of chert that appear to be from the Laney Member of the Green River Formation were recovered from Cultural Level 4, one of which was a Pryor Stemmed projectile point.

Two multiple item analytical nodules were identified in the Cultural Level 4 assemblage. Analytical nodule J is a distinctive piece of silicified wood that was found only in Block D between 96.95 and 96.8 m. The vertical distribution of the specimens in this nodule provides part of the basis for the identification of the stratigraphic boundaries of Cultural Level 4 in Block D. All of the debitage from nodule J was non-cortical and within the smaller SG1 and SG2 sizes. Although the small sample precludes statistical analysis, it would appear that the pieces were produced during late stage bifacial thinning of a tool or tool blank that was brought to the site in a partial state of completion. Similar pieces of silicified wood are available in the Gros Ventre Range, and a cobble with nearly identical characteristics was collected from the shore of Lower Slide Lake. Thus, nodule J was probably obtained locally.

Analytical Nodule P consisted of 33 pieces of chert debitage scattered throughout Cultural Level 4 in Block A. The living surface of Cultural Level 4 in Block A was sloped, and the pieces of nodule P were spread from the E492 transect to the E501 transect complicating attempts to compare the vertical distribution. Most of the pieces, however, were recovered from the eastern half of Block A between E498 and E501 within a 15 cm thick zone. Nodule P was probably obtained locally because there is a high proportion of cortical debitage (24.2%). The broad distribution of the debitage is difficult to explain. If the nodule was a chert cobble picked out of the channel gravels in the area and reduced to a biface or prepared core then one would expect the debitage to be clustered within a relatively small area much like the nodules from Cultural Levels 1 and 2. If the nodule was a flake core used sporadically as needed throughout the duration of an occupation, then flakes should be distributed over a broader area and at least some of those flakes should have shown some use wear. Yet, no utilized or retouched flakes were found.

Three single item nodules were identified in the Cultural Level 4 assemblage. One of these is a complete projectile point made from what appears to be a mottled semi-translucent, gray Miocene chert. Similar material is available in the Green River Basin (Clayton 1999). A bifacially retouched flake made from a mottled brown, opaque chert was recovered from Block E (Figure 5-32 #1,954). The material is similar to Bridger formation cherts from the Green River Basin. A nearly identical tool, made from obsidian, was found in Block I (Figure 5-32 #11,795). Both tools have numerous fine abrasions on the dorsal and ventral surfaces indicative of bag wear. A very similar specimen was found at the Goff Creek site (48PA325) on the North Fork of the Shoshone River in Early Archaic-aged contexts (Page 2016). The marked morphological similarities between these tools suggest that this is a formal tool type. The last single item nodule is a utilized flake made from a mottled reddish brown, coarse, opaque chert that does not closely resemble any described material type.

Diagnostic Projectile Points

A total of nine projectile points or point fragments were recovered from Cultural level 4 (Figure 5-32). Three of the points (#9,409, #6,958 and #5,643) fall within the range of variation for the Pryor Stemmed type. All three have a parallel-oblique pressure flaking pattern. Two of the points have alternately beveled resharpening, and one has serrated edges. Point #9,409 was recovered from Block H approximately 5 cm above the Strata III/IV boundary. About 50% of the Cultural Level 4 deposits in Block H were krotovina. Therefore any stratigraphic relationship within the block is tenuous at best. Point #6,958 was found in the northern artifact concentration of Block A approximately 4 cm above the Strata III/IV boundary and may have been associated with the earlier, circa 9000 cal BP occupation. The same can be said for point fragment #5,643 that was found in unit N499 E491 directly on the stratigraphic boundary. A date of about 9000 cal BP for a Pryor Stemmed occupation in the lower half of Cultural Level 4 would be temporally consistent with the findings of Husted (1969) and Frison and Grey (1980) for sites in the Bighorn Mountains.

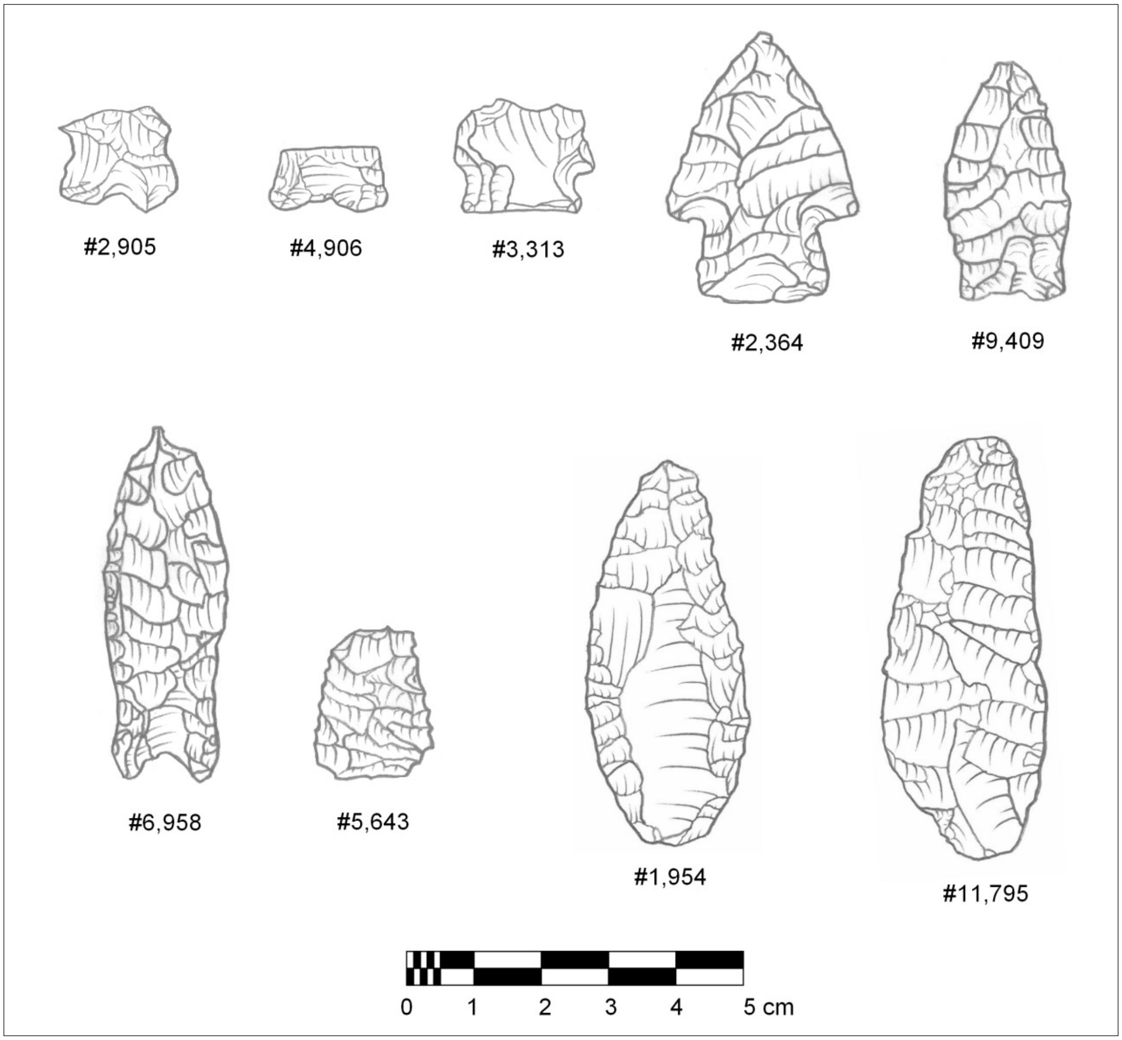


Figure 5-32 Projectile points and knives recovered from Cultural Level 4.

Point #2,364 was found in Block D, slightly above Feature 8 and at the same elevation as the charcoal that returned the age estimate of 8390±28 cal BP. This point is of an unnamed type that occurs infrequently in the Central Rockies. Several similar specimens were found in Strata II and III at the Trappers Point site. A hearth feature in Stratum III at Trappers Point was dated to 8707±116 cal BP. However, the evidence from Stratum III at Trappers Point indicated that the occupational surface was exposed for a long period of time and witnessed numerous occupations over perhaps two thousand years (Francis and Sanders 1999). Thus, the temporal boundaries of this unnamed point type are uncertain. Nevertheless, the circa 8400 cal BP date from Game Creek does not conflict with the findings of Francis and Sanders (1999).

Two point base fragments (#2,905 and #4,906) were found in the upper Cultural Level 4 deposits in the eastern half of Block A. By any measure, these points look like the Hanna Type of the McKean Complex, and when first discovered it was assumed that they were in fact Hanna points. However, the dates from Cultural Level 4 are at least two thousand years older than the earliest McKean Complex date.

Moreover, numerous points of this type were also found in Strata III and IV at the Trappers Point site dating from circa 8700 cal BP to 6500 cal BP (Francis and Widman 1999). To the west in the Snake River Plain and Great Basin, points of this style are typed as Elko Eared (Aikens 1970; Justice 2002; Holmer 1985, 2009; Swanson 1972) and have been found in contexts as old as about 7000 cal BP (Swanson 1972). The points from Game Creek are the best dated and earliest examples of this type documented anywhere in the Central Rockies and surrounding regions.

Point #3,313 is a crudely made corner-notched point that may have been used as a hafted scraper. This point was found in the upper Cultural Level 4 deposits of Block A near the two Elko Eared points. Barb fragments of corner-notched, or perhaps Elko Eared, points were found in Block E and the western half of Block A. Similar corner-notched points, often lumped into the Elko Corner-Notched type, occur throughout the Central Rockies, Great Basin and Snake River Plain and may have been produced for several thousand years. A study by Holmer (1986) found that corner-notched points began to be made in the eastern Great Basin perhaps as early as 10,000 cal BP and continued to be made until Euro-American contact. However, the style is rare from contexts dating from 5800 cal BP to about 3200 cal BP. At Trappers Point corner notched points are the most common type in Stratum III, are absent from Stratum IV and then comprise a minority in Strata V, VI and VII (Francis and Widman 1999). Based on these data, corner-notched darts first appear in the Central Rockies by circa 8300 cal BP and continued to be made throughout most of the Early Archaic period gradually being supplanted by side-notched dart forms.

One of the more surprising findings regarding projectile points is the almost complete absence of side-notched dart forms in the Cultural Level 4 assemblage. Side-notched dart points are the dominant type at all other reported Early Archaic sites in the Central Rockies and surrounding regions (Francis and Widman 1999; Kornfeld et al. 2001; Husted and Edgar 2002; Miller 1988; Swanson 1972). Only one side-notched dart point was found on the T3 terrace. The lone specimen is a fire-cracked base fragment that was recovered from a krotovina below Cultural Level 4 in Unit N440 E520. The point probably came from the dense Cultural Level 4 deposit, but this is only conjecture. Several side-notched darts were found on the S3 landform, but again the context of those points leaves much to be desired. According to Peterson (1991), there are numerous side-notched darts in the Lawrence site assemblage. Yet, Bartholomew (2002) reported that the type was one of the least common in the same collection.

Lithic Reduction Strategies

The Cultural Level 4 obsidian debitage from all four sampled blocks were assigned to the biface thinning reduction group by the discriminant function analysis (Figure 5-33). However, it is clear that early stage bifacial reduction and core reduction also contributed to the assemblage. Three stage I bifaces, two of which were complete and appear to have been discarded due to imperfections of the material or unsuitable width to thickness ratios, were found in blocks A and I. Similarly, five stage II bifaces including one complete and four fragmentary items, were recovered from Blocks A, D and E. Only one

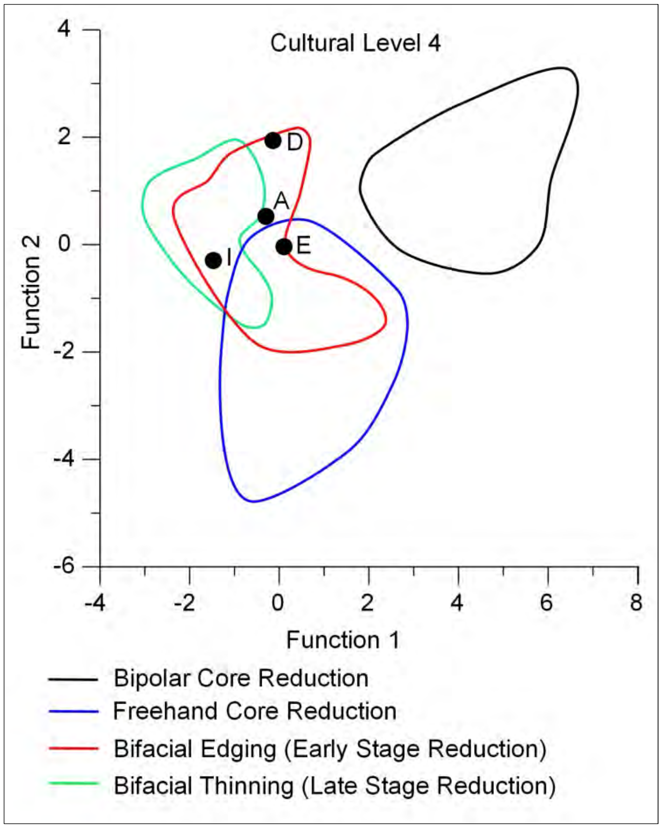


Figure 5-33 Results of the discriminant function analysis.

stage III biface, a complete point preform, was found. Thus, early stage biface production (edging) was certainly conducted during the Cultural Level 4 occupations. Most of the finished bifaces would have been taken from the site when the inhabitants moved on, but if bifacial thinning was the primary activity performed at the site then one would expect to find more late stage biface fragments.

The small core assemblage also indicates that more than just bifacial thinning was performed on site. One bipolar, one bifacial, one amorphous multidirectional and one unifacial core were found. The bipolar, multidirectional and unifacial items were all apparently used for flake tool production. Some of these items may have been brought to the site as prepared cores and discarded when exhausted, but apart from the bifacial core, all had large amounts of cortex, a characteristic generally inconsistent with cores prepared for transport (Francis 1997).

Summary

Based on the radiocarbon dates, there were seven identifiable components in Cultural Level 4. However, there are reasons to question the accuracy of some of these dates. Potter and Reuther (2012) conducted a study to compare age estimates based on charcoal and bone. The results showed that age estimates based on bone collagen samples treated with standard protocols were substantially younger than associated dates from wood charcoal. On average the bone dates from their sample were 4.9% younger than the paired charcoal samples from the same context. The radiocarbon dating results from Cultural Level 4 closely mirror those of Potter and Reuther (2012). The bone dates from Cultural Level 4 are on average 4.8% younger than the charcoal dates with an average age offset of 342 years (Figure 5-34). Given the systematic discrepancy shown to exist between charcoal and standard processed bone collagen dates, there would appear to be firm evidence for only three components in Cultural Level 4.

The earliest component occurred around 9020±35 cal BP in Block A and is associated with a Pryor Stemmed occupation. The remains of at least one bison, one medium artiodactyl, one porcupine/beaver-sized animal and one small mammal or bird were found in association with the early

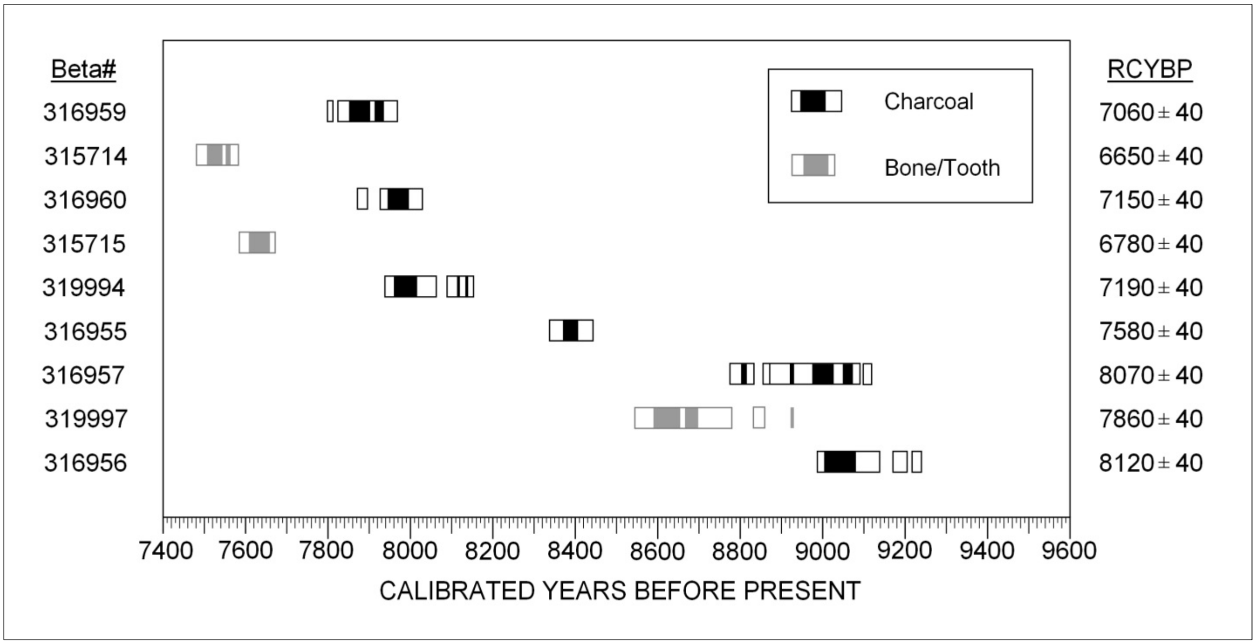


Figure 5-34 Probability block plots of calibrated radiocarbon dates from Cultural Level 4. Calibrated at 2σ using CALIB 7.0.4, Intcal13 calibration curve (Stuiver and Reimer 1993; Reimer et al. 2013).

dates and Pryor Stemmed projectile points from Block A. One piece of groundstone, a metate fragment, was also found in association with the earliest occupation, which further substantiates the findings of Husted (1969) and Frison and Gray (1980) regarding the increased reliance on seeds by Foothills-Mountain Paleoindian people. There is no evidence for occupation at the site between circa 9020 cal BP and 8400 cal BP. This is not entirely surprising because there is no evidence for any human occupation in western Wyoming between about 8700 cal BP and 8400 cal BP (Chapter 3). The cause of this apparent large-scale reduction in human population was likely climatic, but if a severe drought was the culprit then there should have been some evidence. As discussed in the previous chapter, other periods of documented aridity correspond with increased deposition of gravels on the T3 terrace caused by slope denudation. Yet, the sediment from the base of Stratum IV consistently contained some of the lowest percentages of gravel fraction on the T3 terrace. In the end, there are no site specific data that sheds any light on the apparent post Paleoindian population crash in the Central Rockies.

After a several hundred year hiatus there was another occupation in and around Block D dated to 8390±28 cal BP. Feature 8 provides some evidence for roasting or stone boiling. The projectile point found in this component is of an unnamed type that has also been recovered from similarly aged contexts in the upper Green River Basin. The occupation may have extended into Blocks A and E, but post-depositional mixing and low depositional rates have eradicated any clear stratigraphic separation.

At around 7984±21 cal BP there was another occupation that was exposed in Blocks A and E. Several Elko Eared and Corner-notched points were found. A large assemblage of bison, elk, deer, black bear and small mammal bone, mostly from the southern half of the T3 terrace, may also be directly associated with this occupation. A well-made mano and scatters of fire-cracked rock attest to the increase exploitation of plant foods that require mechanical or thermal processing. There is evidence for a slightly later occupation, but it could be due to random error or contamination. Either way, another component cannot be spatially isolated in the Cultural Level 4 deposits.

Cultural Level 5

Cultural Level 5 had fewer artifacts than the previous cultural level. Blocks D and I contained only a diffuse scatter of debitage with a few tools. Most of the cultural material was found in Blocks A and E, but the densest deposits occurred at the south end of the T3 terrace with disproportionately larger assemblages from Block E and units N436 E503 and N440 E504 (Table 5-16). Three features, 2, 3 and 7, were identified in the eastern half of Block A. All features are spatially and temporally related. Bioturbation was most prevalent in the western half of Block A and in the southern units where the volume of krotovina ranged from 5% to 36%, with an average of around 12%. Four radiocarbon dates, all statistically the same, with a pooled mean age of 5519±86 cal BP, were run on charcoal and bone from Blocks A and E.

Table 5-16 Artifacts recovered from Cultural Level 5

Artifact Description	Block				N436 E503	N440 E504	Total
	A	D	E	I			
Projectile Point	2	1				1	4
Biface	2						2
Drill	1	1	1				3
Retouched Flake	8			1		2	11
Utilized Flake	29	1	5	1		3	39
Hammerstone	1						1
Core	2						2
Primary Flake	4		2				6
Secondary Flake	20	2	11	1	1	1	36
Tertiary Flake	170	22	92	25	29	36	374
BF Thinning Flake	7	1	1		1		10
Flake Fragment	1,336	255	999	195	176	150	3,111
Shatter	224	30	144	36	41	51	526
Tooth Enamel	7	1	2		1	2	13
Bone	16	6	26	1	1	1	51
Charcoal	6					1	7
Total	1,835	320	1,283	260	250	247	4,196

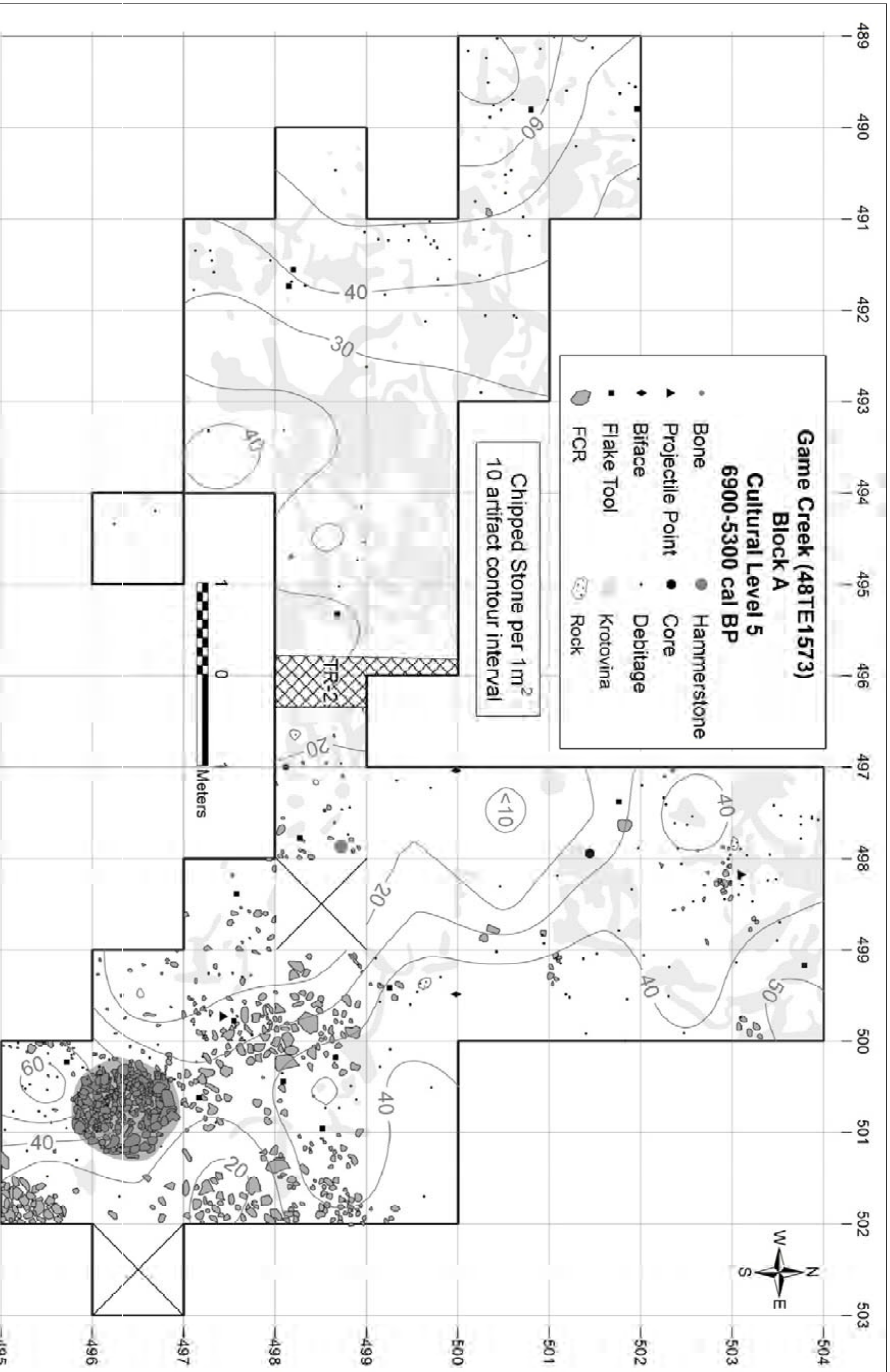

Game Creek (48TE1573)
Block A
Cultural Level 5
6900-5300 cal BP
Bone
Projectile Point
Biface
Flake Tool
FCR
Hammerstone
Core
Debitage
Krotovina
Rock
Chipped Stone per 1m²
10 artifact contour interval
TR-2
Meters
N
S
E
W

Table 5-17 Artifacts recovered from Features 2, 3 and 7

Chipped Stone (F.7)	Obsidian	Chert	Quartzite	Other	Total
Flake Fragment	1				1
Shatter	2				2
Tertiary Flake	2				2
Debitage <1/8"	236	61	1	46	344

Fire-Cracked Rock	Count	Weight (kg)
Feature 7	906	127
Feature 2/3	794	149
Total	1,700	276

Faunal Remains	Count	Burned
Unidentified mammal Bone	41	11
Mouse-sized rodent bones and teeth	336	0

Macrofloral Remains	Count	Weight (g)
Charcoal >1mm	45	15.9

Block A, Features 2, 3 and 7

Cultural Level 5 in Block A consisted mostly of a dense fire-cracked rock scatter associated with Feature 7. There were two chipped stone concentrations, one southwest of Feature 7 and another in the far western corner of the block. This level was identified during the first session of the 2010 investigations when dense concentrations of fire-cracked rock were encountered in units N497 E501 and N498 E499 and designated Features 2 and 3, respectively (Figures 5-36 and 5-37). Subsequent excavation revealed that Features 2 and 3 were clean-outs from a large roasting pit, Feature 7. Another apparent clean-out was found southeast of Feature 7 in unit N495 E501, but it was not assigned a feature number.

Feature 7 is a large, well-preserved, roasting pit located mostly in units N496 E500 and N496 E501. The feature was identified at 97.75 cm elevation by a dense concentration of Fire-cracked rock and carbon stained soil. It measured approximately 110 cm in diameter (Figures 5-35 and 5-38 and 5-40) and was about 35 cm thick from the top of the highest rock to the base of staining. Boundaries were clear, lined by rock and stained black. The maximum depth of the feature was 96.4 m. The feature intrudes into the underlying Cultural Level 4 deposits, which undoubtedly caused some mixing of artifacts. The small concentration of chipped stone southwest of the feature may actually be from Cultural Level 4.

In all, 906 pieces of fire-cracked rock weighing 127 kg was recovered from the feature. All of the fine-grained feature fill (166.5 liters) was floated resulting in the recovery of 15.9 g of wood charcoal, some of which was identified as pine (Table 5-17). The three radiocarbon dates run on charcoal from Feature 7 were statistically the same. The heavy fraction was screened through a 1 mm diameter geologic sieve. Five flakes >1/8” and several hundred pieces of microdebitage were recovered from the feature fill (Table 5-17). The Feature 7 roasting pit appears to have been reused at least once judging from

Figure 5-36 Photograph of Feature 2 at 97.76 m in unit N497 E501.

Figure 5-37 Photograph of Feature 3 at 97.66 in unit N498 E499.

Figure 5-38 Photograph of Feature 7 at 97.6 m elevation.

Figure 5-39 Photograph of Feature 7 at 96.5 m elevation.

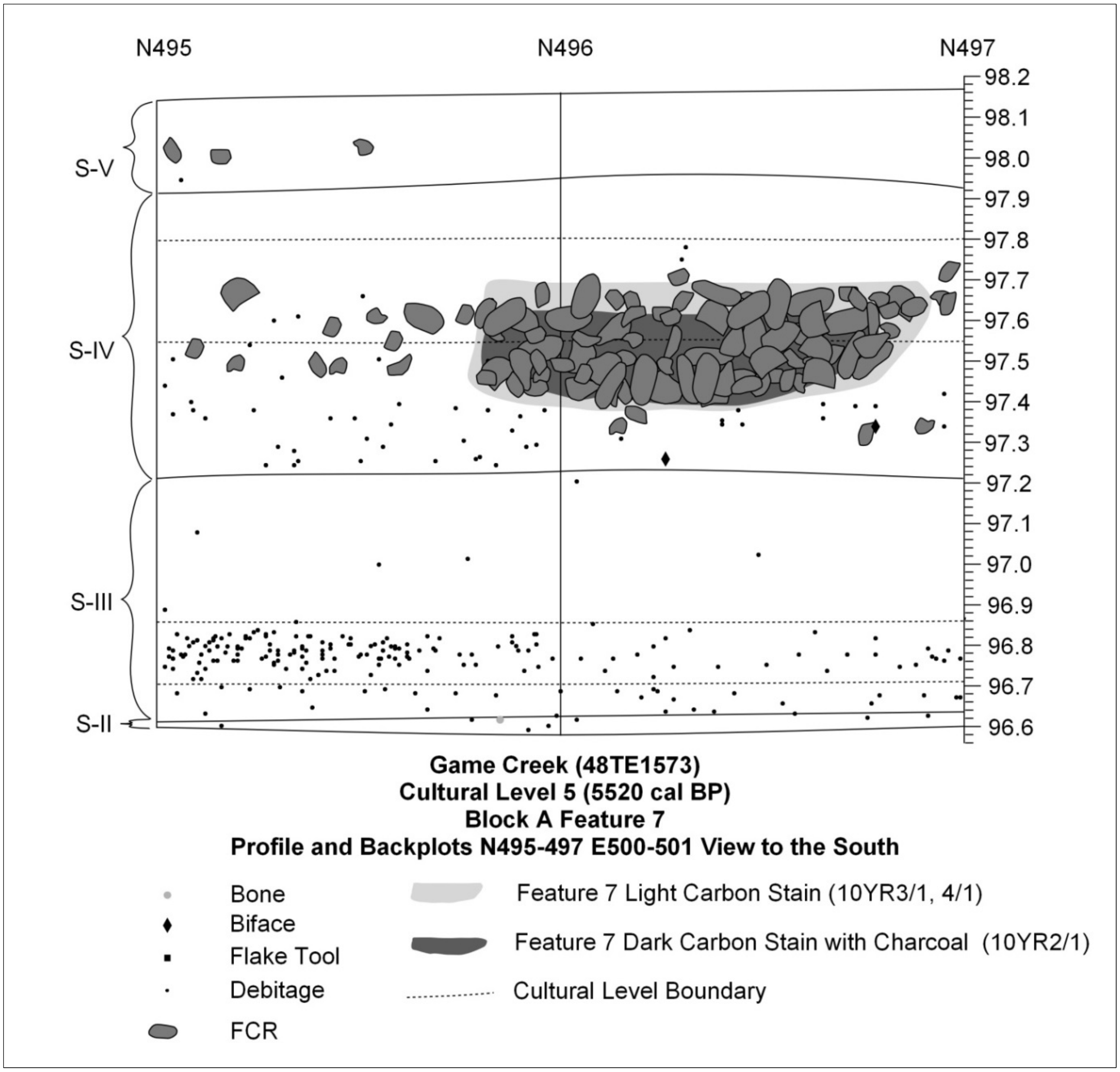


Figure 5-40 Profile drawing of Feature 7.

the nearly 800 pieces of fire-cracked rock found around it. It is possible that each of the clean-out concentrations represents a separate episode of use, but these clusters could have resulted from neighboring as yet undiscovered features being cleaned for reuse.

Apart from the fire-cracked rock, artifact density was low in the eastern half of Block A around Feature 7. On the western edge of Block A a concentration of debitage, stone tools and butchered bone was uncovered. The small and badly weathered faunal assemblage was surprisingly diverse with eight large artiodactyl, two medium artiodactyl and one beaver element identified.

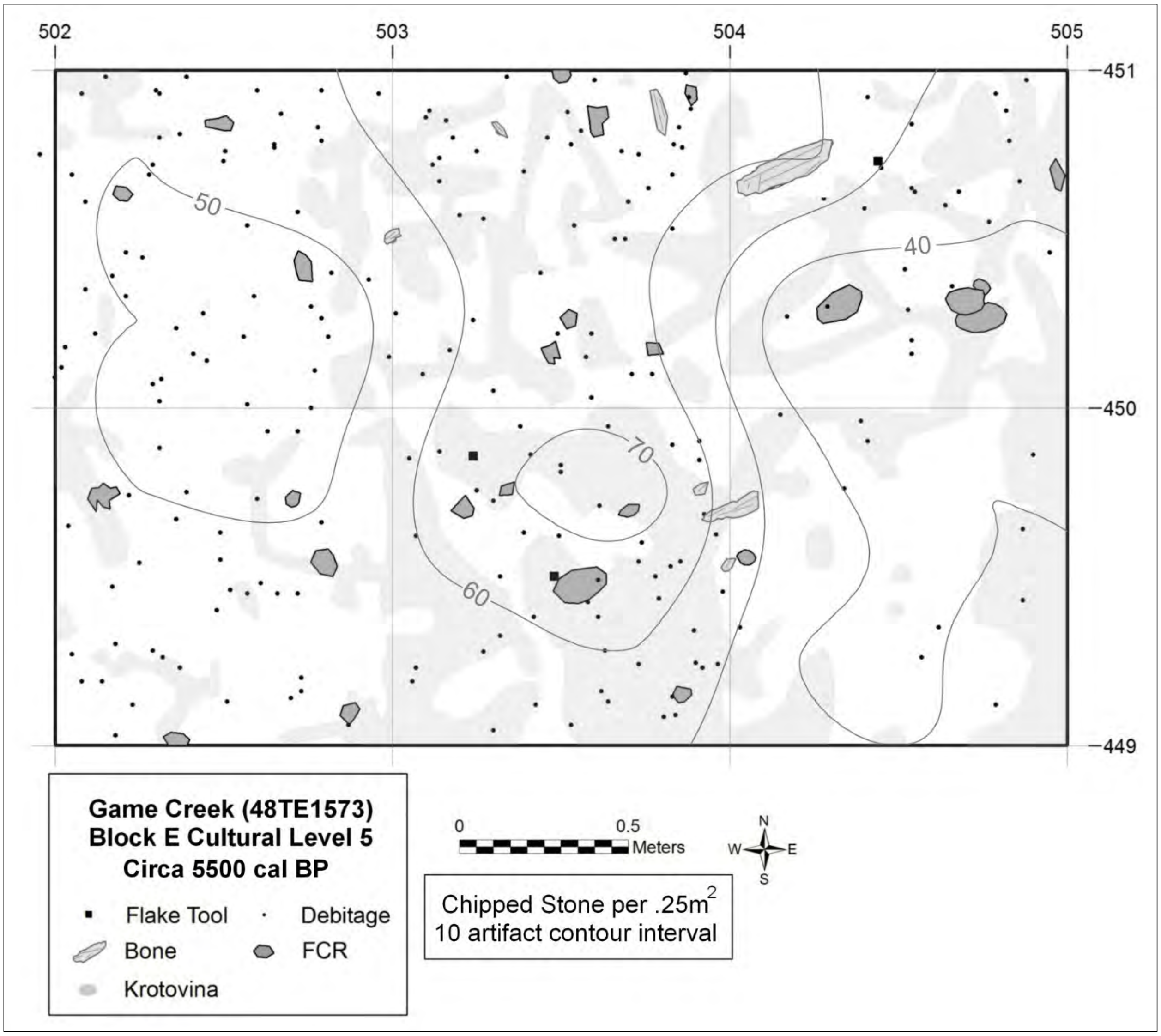


Figure 5-41 Plan view map of Block E Cultural Level 5 showing piece plotted items and a chipped stone frequency contour.

Block E and the South Units N436 E503 and N440 E504

Cultural Level 5 in Block E was found within a 15 cm thick zone. There were decreases in the amount of chipped stone and bone in Block E from the previous cultural level, but an increase in the frequency of fire-cracked rock (Table 5-16 and Figure 5-41). The spatial distribution of chipped stone is markedly different from the previous level with the densest concentration recovered from unit N449 E 503 (Figures 5-29 and 5-41). The stratigraphically isolated clusters of chipped stone show that the Cultural Levels 4 and 5 are not entirely mixed. No diagnostic artifacts were recovered, but a drill fragment and several flake tools were found. The faunal assemblage contained three bison bones, one elk bone, seven large artiodactyl bone fragments and seven unidentified mammal bone fragments. The elk bone may have been displaced from Cultural Level 4 where a larger sample of elk bone was found. A long bone fragment from a large artiodactyl was radiocarbon dated and produced an age estimate that was statistically the same as the three charcoal dates from Feature 7. Fire-cracked rock in this level was scattered throughout the block and appears to be from roasting pit cleanouts much like Features 2 and 3 in Block A. Another scatter of fire-cracked was identified five meters north of Block E in unit N455 E499 at the same elevation. It would appear that there is another roasting pit somewhere in the vicinity of Block E that was repeatedly used similar to Feature 7 in Block A.

A relatively large sample of debitage was found in units N436 E503 and N440 E504 (Table 5-16, Figure 5-30). Several stone tools were also recovered from N440 E504 including one complete, though heavily resharpened, projectile point. Only a few small unidentifiable bone and tooth fragments were found, one of which may be from a small mammal.

Lithic Raw Material

The raw material composition of Cultural Level 5 differed significantly from the Cultural Level 4 assemblage (Chi^2=8.4528, *df*=3, *p*=.038). Obsidian was still by far the most common material (94.2%). Two obsidian projectile points and a flake fragment were submitted for provenance determination. Both of the points were sourced to Teton Pass, and the flake was sourced to Bear Gulch. Most of the chert flakes were too small to allow identification of type, but seven pieces of Green River Formation-Laney Member chert were recovered from Blocks A, D and E. Only 6% of the chert artifacts retained cortex, compared with 11.9% of obsidian flakes, which may indicate that much of the chert arrived at the site as finished tools, tool blanks or prepared cores. Four flakes of a high quality chert that resembles Madison Formation material was also found in Blocks A and D and could be from the same nodule. However, given the limited sample size and the internal range of variation no multiple analytical nodules were identified in the Cultural Level 5 assemblage. Again, the assemblage shows the predominant use of locally available stone with some extralocal material coming from the Green River basin and southwestern Montana.

Diagnostic Artifacts

Three obsidian projectile points were found in Cultural Level 5. Two of the points came from Block A and one from unit N440 E504. All three points are of the same style, with broad corner notches and bifurcated bases (Figure 5-42). These points most closely resemble the Elko Eared type from the Great Basin and Snake River Plain, but many Hanna points are similar enough to be easily misidentified. These points are similar to the two specimens found in Block A Cultural Level 4, although the ears are more pronounced on the Cultural Level 5 points. No side-notched darts were found in Cultural Level 5 on the T3 terrace, which is surprising given the association of the type with similarly aged deposits at Trappers Point (Francis and Widman 1999) and Mummy Cave (Husted and Edgar 2002).

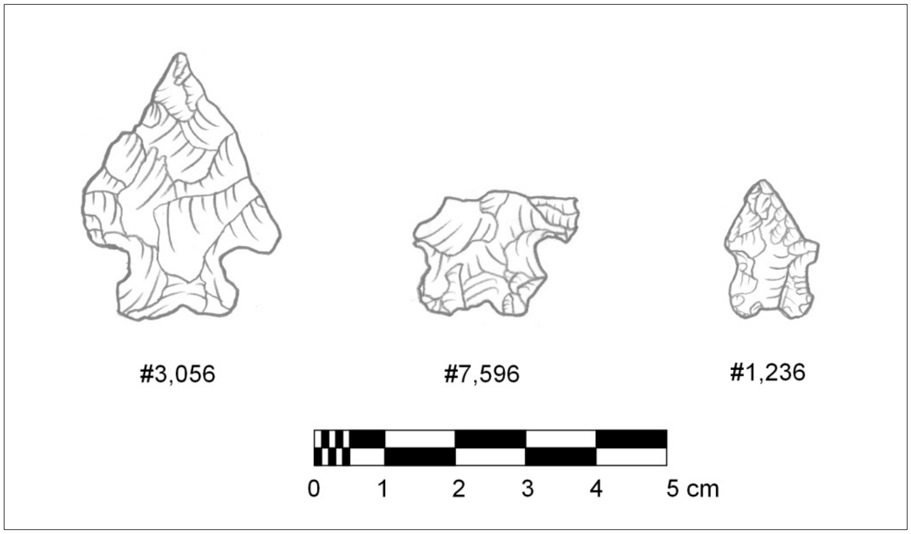


Figure 5-42 Diagnostic projectile points recovered from Cultural Level 5.

Lithic Reduction Strategies

Results of the Mass Analysis of obsidian debitage indicate that late stage biface production was the dominant lithic reduction strategy reflected in the Cultural Level 5 assemblage (Figure 5-43). Some bipolar reduction of obsidian cobbles was also performed since two bipolar cores were found in Block A. Two stage I bifaces were also found. Thus, like the previous level, even though late stage bifacial reduction predominated, other reduction strategies were also used.

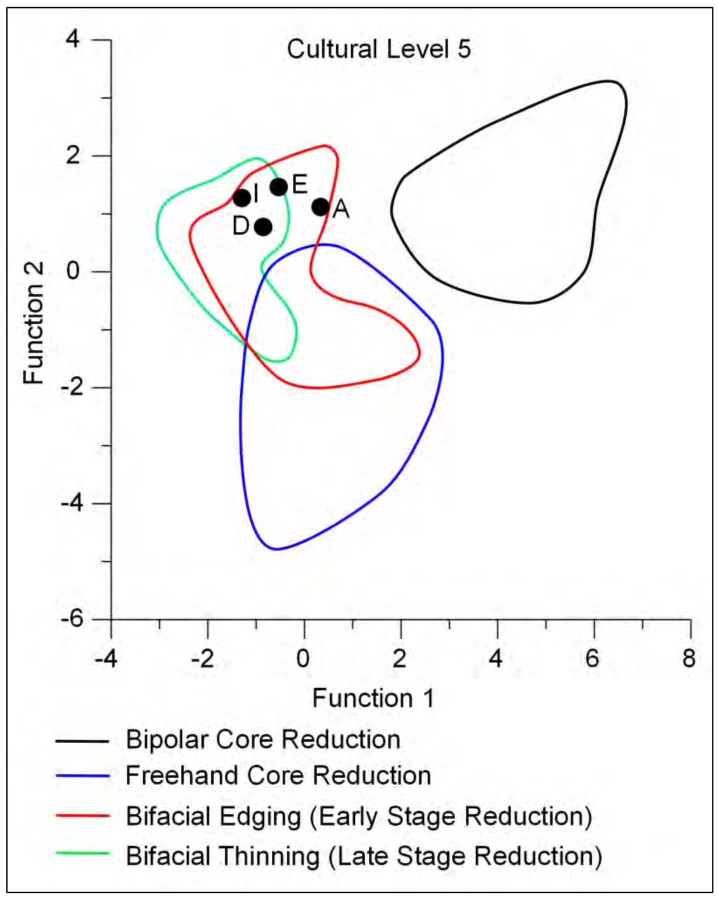


Figure 5-43 Results of the discriminant function analysis of debitage from Cultural Level 5.

Radiocarbon Dates

Four radiocarbon dates were obtained on material recovered from Cultural Level 5. Three of these dates came from Feature 7 charcoal. The fourth date is from a large artiodactyl long bone fragment found in Block E. All four dates are statistically the same with a pooled mean age of 5519±86 cal BP. Although standard processed bone collagen has been shown to produce systematically younger age estimates than wood charcoal from associated contexts, the error increases with the age of the dated specimen (Potter and Reuther 2012). There is no clear evidence for multiple occupations within Cultural Level 5, but if the bone date is younger than the dated event, then the deposits in and around Block E could have been from an earlier occupation.

Summary

Cultural Level 5 produced evidence of a single component. In Block A this component was represented by a large roasting pit feature surrounded by three dispersed scatters of fire-cracked rock likely deposited during reuse of the pit. Roasting pits were widely used throughout the Central Rockies and surrounding regions to process roots and tubers. There are several root crops that were of economic importance to the peoples of the High Country including blue camas, sego lily, biscuitroot, arrowleaf balsamroot, tobacco root and wild onion (Bender and Wright 1988; Reeve 1986; Wright 1984; Wright et al. 1980). Blue camas was the primary root resource in northern Jackson Hole, but it is not presently found in South Park. However, the wet meadows along the Snake River and Flat Creek floodplains provide ideal habitat for wild onion and sego lily, and the dry hillsides and open meadows are suited to balsamroot and biscuitroot (Reeve 1986). Francis (2000) reported a similar roasting pit excavated at 48SU1002 in the upper Green River basin. Using a range of ethnographic and ecological data Francis (2000) concluded that about 200 kg of blue camas or 266 kg of biscuitroot could have been cooked in the large roasting pit at 48SU1002 providing approximately 226,000 kcal, or enough to supply the daily caloric needs of a family of four for about a month. Feature 7 was approximately half the size of the 48SU1002 roasting pit and therefore could have cooked about 130 kg of biscuitroot. Since it appears that the feature was reused at least once, the total mass of roots that could have been processed is very near Francis' (2000) 266 kg estimate for the roasting pit at 48SU1002. It would have taken one person four to seven days to collect that weight of roots based on modern experiments (Francis 2000), but a small band with a residential camp on site could have collected that amount of roots in a day or two.

A small assemblage of stone tools including two projectile points was recovered from around the feature. The dearth of artifacts in and around Feature 7 indicates that it was special use activity area. In the western several meters of Block A we identified a concentration of chipped stone and butchered bone consistent with occupational debris associated with a campsite. Despite a large roasting pit that had apparently been used on several occasions, there was very little charcoal collected from the level. Depositional rates decreased dramatically at the end of Cultural Level 5 falling to around 5 mm a century. It is probable that the Cultural Level 5 component remained exposed or shallowly buried for a long period of time, which explains the poor preservation of the faunal assemblage. Fortunately, the area encompassed by Block A saw very little use following the Cultural Level 5 occupation so despite low depositional rates and persistent faunalturbation there were very few artifacts deposited above Cultural

Level 5 that could have been mixed.

Forty meters to the south, around Block E and units N436 E503 and N440 E504, we found concentrations of debitage, chipped stone tools and butchered bison bone. A scatter of fire-cracked rock was identified over several square meters in and around the block indicating the presence of another roasting pit in the vicinity. Two small debitage concentrations appear to reflect individual knapping episodes but there are otherwise no obvious activity areas.

Radiocarbon dates from both blocks produced ages that are statistically the same (Table 5-18). The radiocarbon age estimates place the occupation at the beginning of the Middle Archaic period. The McKean complex is the only named cultural taxon for the Middle Archaic in the Northwestern Plains and Central Rockies. There are some similarities between the Cultural Level 5 occupation and the McKean complex generally, such as the presence of roasting pits, an expedient flake tool industry and projectile points that resemble the Hanna type. Bender and Wright (1988) and Wright (1984) argue that the widespread and common distribution of fire-cracked rock and Hanna points in northern Jackson Hole evidences the intensive use of the area by McKean complex people during the Middle Archaic period. Yet, all of the characteristics of the Cultural Level 5 assemblage were also present in Cultural Level 4 and predated the appearance of the McKean complex by over two thousand years.

Cultural Level 6

The cultural levels at Game Creek are based on the stratigraphic interpretation of the T3 terrace. Cultural Level 6 has the longest duration, circa 5290 to 1000 cal BP, of the defined levels because the depositional rate on the T3 was only about 5 mm a century. Cultural Level 6 on the T3 terrace contained little more than a scatter of debitage, a few stone tools and two small features (Table 5-19). There was a small faunal assemblage with 11 large artiodactyl elements recovered from Block A, but they too were scattered. Both of the features were found on the southern half of the terrace along with a low density scatter of fire-cracked rock that was observed in several excavation units.

Feature 5

Feature 5 was a small concentration of fire-cracked rock found about 25 cm below the surface at 96.48 m in Block F at the southern end of the T3 terrace (Figures 5-44 and 5-45). Organic staining was found towards the center of the concentration with seven pieces of fire-cracked rock. It is believed that the stained area represents the approximate size of the depression into which the rock was placed to form a roasting pit. The fire-cracked rock surrounding the stained area appears to be clean-out. The organic stain was 64 cm in length, 45 cm in width and 5-10 cm thick. The total thickness of the feature from the top of the fire-cracked rock to the base of the stain was 14 cm. The rocks used in the pit were mostly metaquartzite cobbles, 38 of which weighing 14.6 kg were recorded in and around the feature. A total of 5.5 liters of feature fill was removed for flotation. Only 5 mg of unidentifiable charcoal was recovered

Table 5-18 Artifacts recovered from Cultural Level 6 on the T3 Terrace.

Artifact Description	Block				Total
	A	D	E	I	
Projectile Point	2				2
Biface	5	1			6
End Scraper	1				1
Spokeshave	1				1
Retouched Flake	4				4
Utilized Flake	15	1			16
Primary Flake	1				1
Secondary Flake	4		3		7
Tertiary Flake	68	5	20	4	97
Flake Fragment	648	69	147	54	918
Shatter	116	27	23	7	173
Bone	14	2	1	1	18
Tooth Enamel	8				8
Total	887	105	194	66	1,252

Figure 5-44 Photograph of Feature 5 in plan view at 96.4 m (30 cmbs) elevation (Page 8/11/2010).

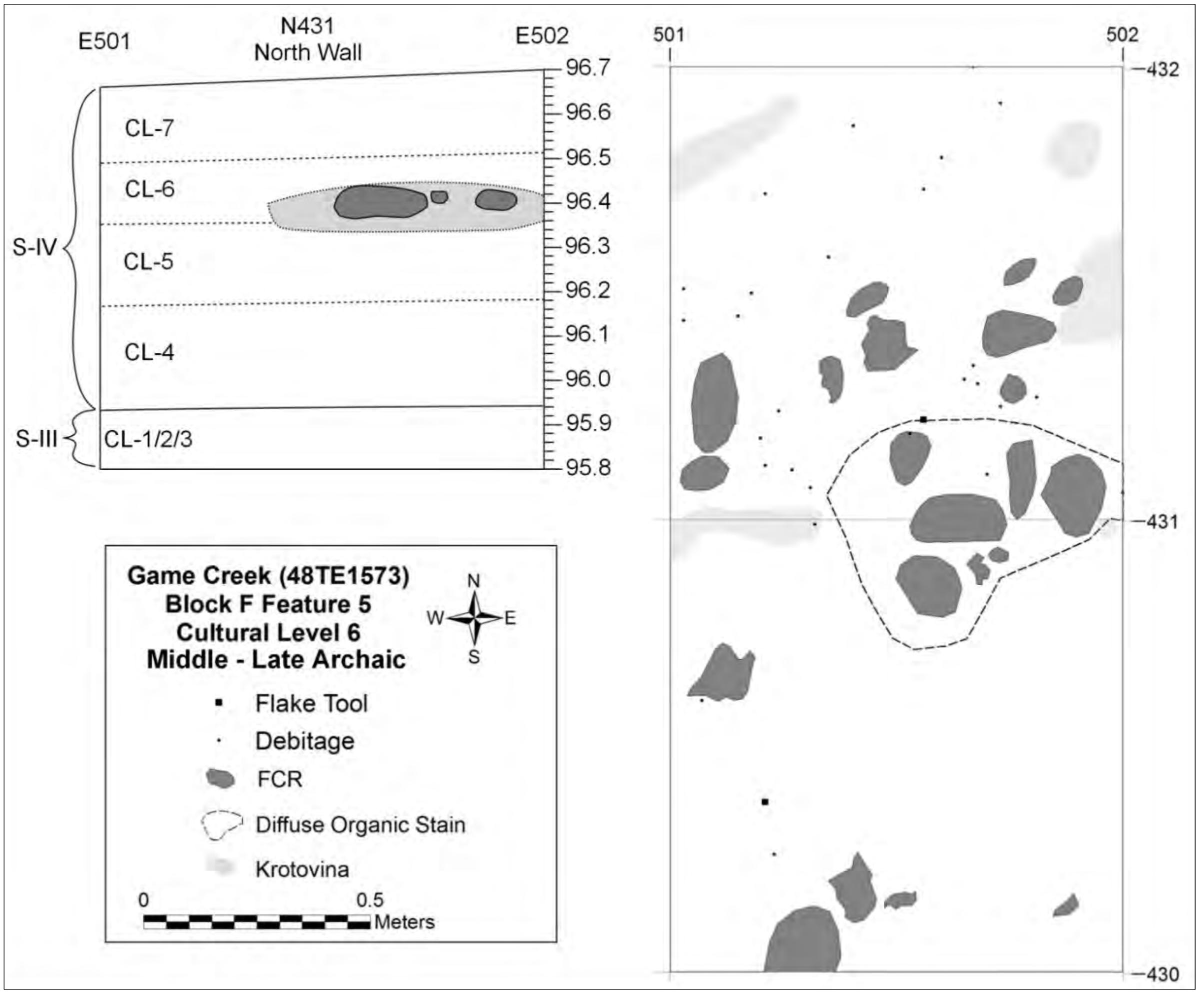


Figure 5-45 Plan view and profile drawings of Feature 5 in Block F.

from the light fraction, too little to provide an adequate sample for radiocarbon dating in this context. The heavy fraction produced 13 pieces of obsidian microdebitage and eight intrusive rodent bones. The feature was poorly preserved and several krotovina were recorded in and around it.

Feature 10

Another roasting pit, Feature 10, was found in unit N470 E493 at about 20 cm below the surface (Figures 5-46 through 5-48). Approximately 3/4 of the feature was exposed in the unit and excavated. All of the fire-cracked rock was found within a ~20 cm deep pit. No organic staining was evident during excavation. The pit was 64 cm in maximum length and 51 cm in width and contained 64 metaquartzite cobbles weighing 19.5 kg. One large piece of charcoal was collected *in situ*, but no other artifacts were recovered during excavation. Since there was no organic staining the 30 liters of feature fill was water screened through 1/16” mesh. The fill contained 29 obsidian and 10 chert flakes, 73 pieces of charcoal weighing .55 g, seven unidentifiable mammal bone fragments and 80 intrusive, mouse-sized, rodent

Figure 5-46 Photograph of Feature 10 in plan view at 96.7 m (20cmbs) elevation (Page 6/23/2011).

Figure 5-47 Photograph of Feature 10 in plan view at 96.615 m (29cmbs) elevation (Page 6/23/2011).

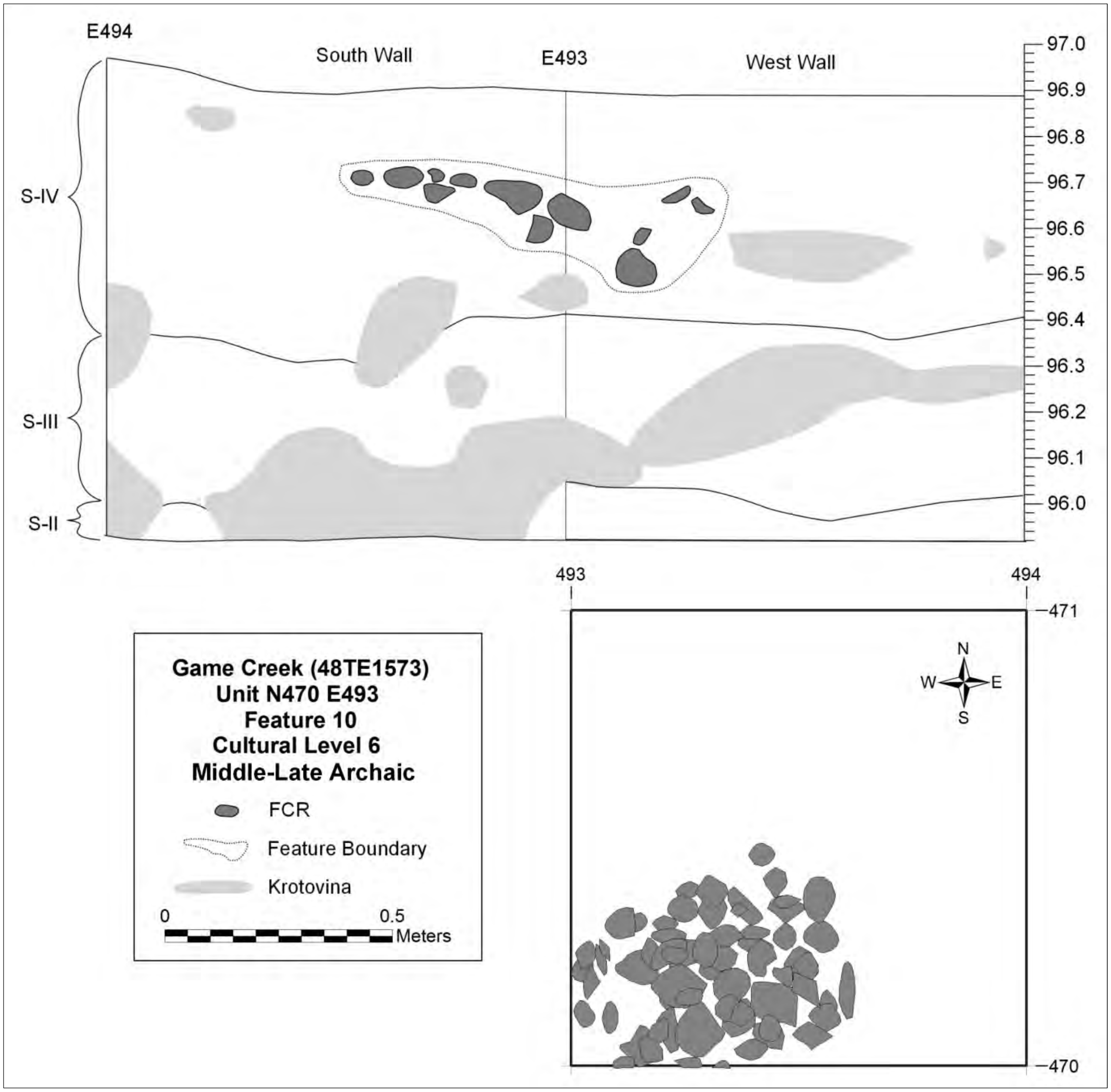


Figure 5-48 Plan view and profile drawings of Feature 10 Unit N470 E493.

bones. Birch charcoal was the only identifiable botanical remains in the feature. Only 13 pieces of obsidian debitage were found at the occupation surface adjacent to the feature.

Summary

The lithic assemblage from Cultural Level 6 on the T3 terrace differed significantly from Cultural Level 5 (Chi^2=7.993, *df*=3, *p*=.046). Much of the difference is due to an increase in chert and metaquartzite from the previous cultural level. Yet, the size of the assemblage from Cultural Level 6 was small and these slight differences may be due more to sampling than raw material use. Two obsidian flake tools and an obsidian projectile point were submitted for ed-xrf analysis. The projectile point and one of the flake tools were sourced to Crescent H Ranch and a retouched flake was sourced to Lava Creek, a welded tuff that is found near Grassy Lake in northern Jackson Hole. The source of the cherts in Cultural Level 6 on the T3 is difficult to assess because most of the flakes were too small for identification. Lacking, however, are Green River Formation-Laney Member cherts that were present in the previous two cultural levels. There was a much higher proportion of cortical chert debitage (9.1%) than in the Cultural Levels 4 or 5, but this may be due to the small sample. No multiple or single item analytical nodules were identified in the Cultural level 6 assemblage.

Samples of obsidian debitage from all excavation blocks were included in the mass analysis. Again, all of the block samples were classified as bifacial thinning. The small assemblage of bifaces recovered from the level bear this out. Two of the six bifaces were stage III, and three small lateral fragments also appear to have been produced during bifacial thinning. Only one small stage II biface fragment was found. Moreover, no cores were recovered which lends further support to the results of the mass analysis.

No radiocarbon dates were obtained from Cultural Level 6 on the T3. Feature 5 contained only a small amount of charcoal and was too eroded to confidently date. Feature 10 did contain more than enough charcoal for a date but the lack of significant associated cultural materials provided little context. During the 2002 testing a 4288±74 cal BP date was acquired from a piece of charcoal recovered from a fire-cracked rock concentration in the wall of Trench 1. The sample was collected from 50 cm below the surface, deeper than either Feature 5 or 10. However, the sample came from the eastern margin of the T3 terrace where depositional rates were greater than along the western edge where Features 5 and 10 were located. Unfortunately, the Trench 1 profile provided by Eakin and Eckerle (2004) lacks sufficient detail to ascertain the stratigraphic position of the sample.

Only one diagnostic projectile point was found in Cultural Level 6 on the T3 terrace. The specimen is a midsection of a corner-notched dart, virtually identical to numerous points recovered from the Game Creek alluvial fan. Since Cultural Level 6 accumulated over a 4,000 year period it is impossible to say whether the point was deposited during the Middle or Late Archaic periods.

The T3 terrace saw limited use during the period from 5290 to 1000 cal BP. No significant occupational debris consistent with anything beyond a short-term occupation was found. All the evidence points to the special use of the terrace for processing roots and tubers in roasting pits, and even this is limited. It is fortunate that the terrace was not reused as a residential camp because the low rate of deposition and the faunalturbation would likely have led to the creation of a palimpsest spanning several thousand years, similar to what was found on the S3 landform. There is evidence for extensive and/or repeated Middle and Late Archaic occupations at Game Creek, but they were found on the S3 in poor context and are discussed at length below.

Cultural Level 7 on the T2 and T3 Terraces

Cultural Level 7 encompasses most of the Late Prehistoric period at Game Creek (ca. 1000-550 cal BP). There was very little evidence for significant occupation on the T3 terrace during this time. The small assemblage that was recovered came mostly from Block A where a diffuse scatter of artifacts was found. On a small remnant of the T2 terrace, at the south end of the site east of the highway, the remains of a single butchered bison and a small associated assemblage of stone tools and debitage was uncovered and is believed to date to the Late Prehistoric period. Most of the Late Prehistoric-aged cultural material was recovered from the S3 alluvial fan.

T3 Terrace

The Cultural Level 7 assemblage from the T3 is small and largely confined to Block A (Table 5-20). No features or definite activity areas were identified. All of the artifacts were found within Stratum V, where present, or in the upper 10-15 cm of Stratum IV. Several historic period artifacts were found in Cultural Level 7. Two pieces of clear container glass, three 22 Long Rifle cartridge cases, a 22 and a 38 caliber bullet, a chain link and an unidentifiable piece of ferrous metal came from the sod layer. No diagnostic prehistoric artifacts were found. Bison was the only identifiable species present in the small faunal assemblage, and most of the remaining bones are large artiodactyl, probably bison. One piece of bone found directly on top of the Stratum V debris flow in Block A produced a radiocarbon date of 828±51 cal BP. This date is statistically the same as three dates from the S3 alluvial fan, two of which are also associated with a debris flow (S3 Stratum VI).

The lithic assemblage from Cultural Level 7on the T3, though predominantly obsidian (90.2%), has a higher percentage of chert (5.5%) and metaquartzite (1.6%) than Cultural Level 6. However, these differences are not statistically significant (Chi^2=6.43, df=3, p=.092). None of the obsidian from this level on the T3 was sourced. One piece of Bridger Formation chert and three pieces of Madison chert were found. Cortical chert debitage (7.5%) was again less frequent than obsidian cortical debitage (15.4%), but was more common than in earlier levels. The presence of upper Green River Basin chert and the comparatively low percentage of cortical debitage again suggest that much of the chert in the assemblage was acquired elsewhere. No multiple or single item analytical nodules were identified in the assemblage.

Overall, the lithic assemblage from Cultural Level 7 contained a higher proportion of cortical debitage and larger flakes than any other cultural level on the T3. The discriminant function tests used in the mass analysis of obsidian debitage classified the T3 Cultural Level 7 assemblage as being produced predominantly from early stage bifacial reduction. These results should be viewed with caution given the small sample size. Nevertheless, the Cultural Level 7 occupation of the T3 did differ from Cultural Levels1 through 5 in the absence of substantial occupational debris indicative of a residential camp. The level also lacked any substantial evidence for intensive root crop processing such as was found in both Cultural Levels 5 and 6.

Table 5-19 Artifacts recovered from Cultural Level 7 on the T3, T2 and S3 landforms.

Description	T3 Terrace				T2 Terrace	S3 Alluvial Fan		Total
	A	D	E	I		G	N696 E426	
Projectile Point					1	2	1	4
Biface	2					14	1	17
Drill						2		2
Graver	1					1		2
Spokeshave	1							1
End Scraper							1	1
Retouched Flake	3			1	2	7		13
Utilized Flake	15		1		1	27		44
Bone Tool						2		2
Primary Flake			1			11		12
Secondary Flake	7		3		1	36	4	51
Tertiary Flake	40	5	19	2	13	768	26	873
BF Thinning Flake	1					14		15
Flake Fragment	447	66	156	45	112	6,512	687	8,025
Shatter	108	9	27	5	27	1,459	112	1,747
Nail						1		1
Glass						1		1
Cartridge	2							2
Bison	1		1		114	8	2	126
Elk						1		1
Beaver						2	2	4
Porcupine						1		1
Fish						1		1
Bird							1	1
L. Artiodactyl	8		2		9	9	2	30
M. Artiodactyl					1			1
UID Artiodactyl	1				2	9		12
Unidentified	11	30		1	269	1,244	106	1,661
Total	648	110	210	54	552	10,132	945	12,651

T2 Terrace

The small cultural assemblage from the T3 may be associated with the butchered remains of a young bison identified in unit N410 E489 on the T2 terrace (Figure 5-49). The bone was encountered at about 20 cmbs, and 98% of it was found within a 35 cm thick layer. However, fragments of bison bone occurred throughout the unit to a depth of nearly 1 meter below the surface, indicating impacts from burrowing rodents. Very few artifacts were found in association with the bison remains, but included three flake tools and a midsection fragment of a projectile point that was probably an arrow point. The deposit did not appear to be heavily disturbed, but the vertical distribution of bison bone suggests otherwise.

Figure 5-49 Photograph of bison vertebrae at 93.15 m (20cmbs) in unit N410 E489 on the T2 terrace (Kelly Phillips 6/20/2012).

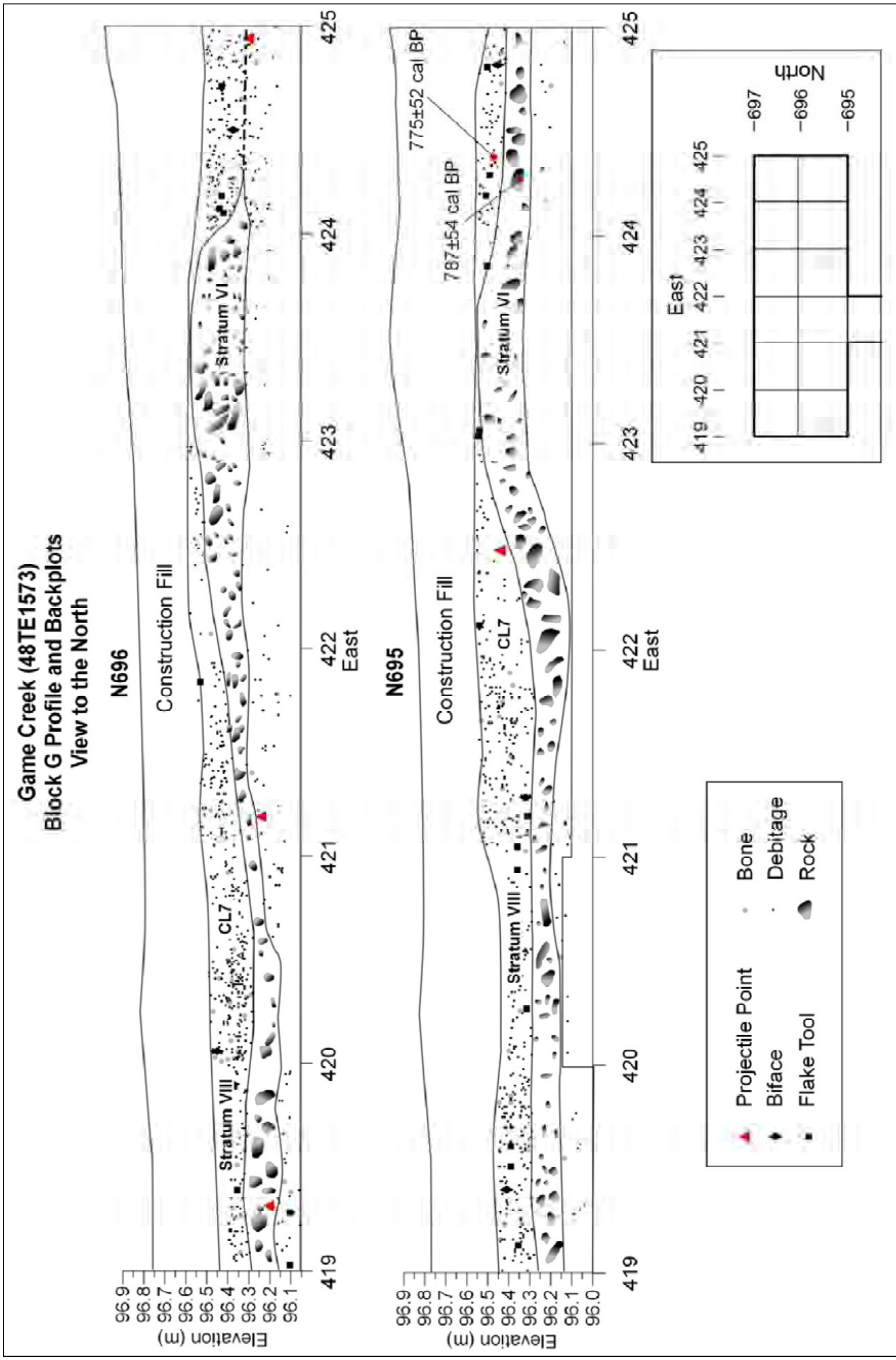
There were 118 identifiable bison elements recovered, most consisted of vertebral (n=79) and rib (n=30) fragments. The only other identifiable remains included two long bone fragments, five metatarsal fragments and two sesamoids. Five of the vertebrae were found in a partially articulated arrangement. Four of the vertebrae and one rib fragment showed cut marks and one vertebra had an impact or chop mark. The only identifiable rib portion is a proximal fragment. The sample is limited because only two units were excavated on the T2. Yet, it would appear that this assemblage reflects a single kill and butchering event. The limbs were removed largely intact and transported away from the kill for further processing, and meat was stripped from the vertebral column. The rib cage was probably removed by breaking the bones near the proximal end and cutting away the soft tissue (Plew et al. 1987). A likely location for the processing of this animal would be on the S3 250 meters to the north where a large faunal assemblage was uncovered, but the scatter of bison bone in Block A may also reflect some processing nearer the kill.

Cultural Level 7 on the S3 Alluvial Fan

Cultural Level 7 is within S3 Stratum VIII in the northern half of Block G and one adjacent unit (N696 E426). The cultural level is 10-25 cm thick and was found immediately above the S3 Stratum VI debris flow deposit that covered all of northern half the block (Figure 5-50). Two radiocarbon dates, one from within S3 Stratum VI and another collected immediately above the debris flow in S3 Stratum VIII indicate that the mass wasting even occurred around 780 cal BP (Figure 5-50). Artifacts were recovered from within S3 Stratum VI and appear to have been entrained in the flow as it removed cultural bearing deposits upstream. There does appear to have been some post-depositional mixing of artifacts between Cultural Level 7 and S3 Stratum VI because one Late Prehistoric-aged side-notched arrow point was found within Stratum VI. Side-notched arrow points have been dated in other contexts to circa 800 cal BP to the historic period (Holmer 2009; Justice 2002) and therefore likely post-date the deposition of S3 Stratum VI. However, chipped stone, bone and burned bone artifacts show different spatial distributions in Cultural Level 7 than in the underlying S3 Stratum VI (Figures 5-50 through 5-54). Thus, there is no evidence that the deposits have been reduced to a palimpsest through post-depositional mixing. Cultural Level 7 (S3 Stratum VIII) was overlain by 20-40cm of highway construction fill that contained a mixture of prehistoric artifacts. It was difficult in places to identify the boundary between the overlying construction fill and Cultural Level 7 and the recovery of two Late Archaic corner-notched darts near the contact of Cultural Level 7 and the construction fill indicates some mixing of the deposits. The presence of a nail and a piece of glass in Cultural Level 7 may suggest that Cultural Level 7 was at or near the surface prior to the highway construction. Cultural deposits in units N695 E423 and N696 E423 were either removed or seriously disturbed during highway construction.

Large lithic and faunal assemblages were found in Cultural Level 7 on the S3 (Table 5-20). The impacts from highway construction make it difficult to assess the number of occupations present in Cultural Level 7. There are no discernable stratified living surfaces apparent in the artifact backplots. However, radiocarbon dates and diagnostic artifacts provide evidence for at least two components. The earlier occupation occurred around 775±52 cal BP, based on the date from unit N696 E424. Several Rose Spring corner-notched arrow points found on the S3 were likely deposited during this occupation. Evidence of the later component comes from the Desert side-notched arrow point found in unit N696 E419. Although no later radiocarbon dates are available from northern half of Block G, there are several dates ranging from 676±22 cal BP to 546±38 cal BP, from other excavation blocks on the S3 that may date the later occupation(s).

The distribution of artifacts in Cultural Level 7 reveals two activity loci. In the western part of the block there are clusters of chipped stone, bone and burned bone (Figures 5-51 through 5-54). A large number of tools were also found in the western half of the block, including one Late Prehistoric Desert side-notched arrow point, six bifaces a drill, a graver, two bone scraping tools and 20 flake tools. One unusual artifact, a shell bead made from a marine gastropod, was found in unit N696 E421. The bead is barrel-shaped and has been carefully worked. Modifications of the shell have obliterated most of the diagnostic characteristics but it resembles *Olivella* or *Marginella* shells from the Pacific coast (Johnson


Game Creek (48TE1573)
Block G Profile and Backplots
View to the North
N696
Construction Fill
Stratum VI
CL7
Stratum VIII
N695
775±52 cal BP
787±54 cal BP
East
Elevation (m)
Projectile Point
Biface
Flake Tool
Bone
Debitage
Rock
North

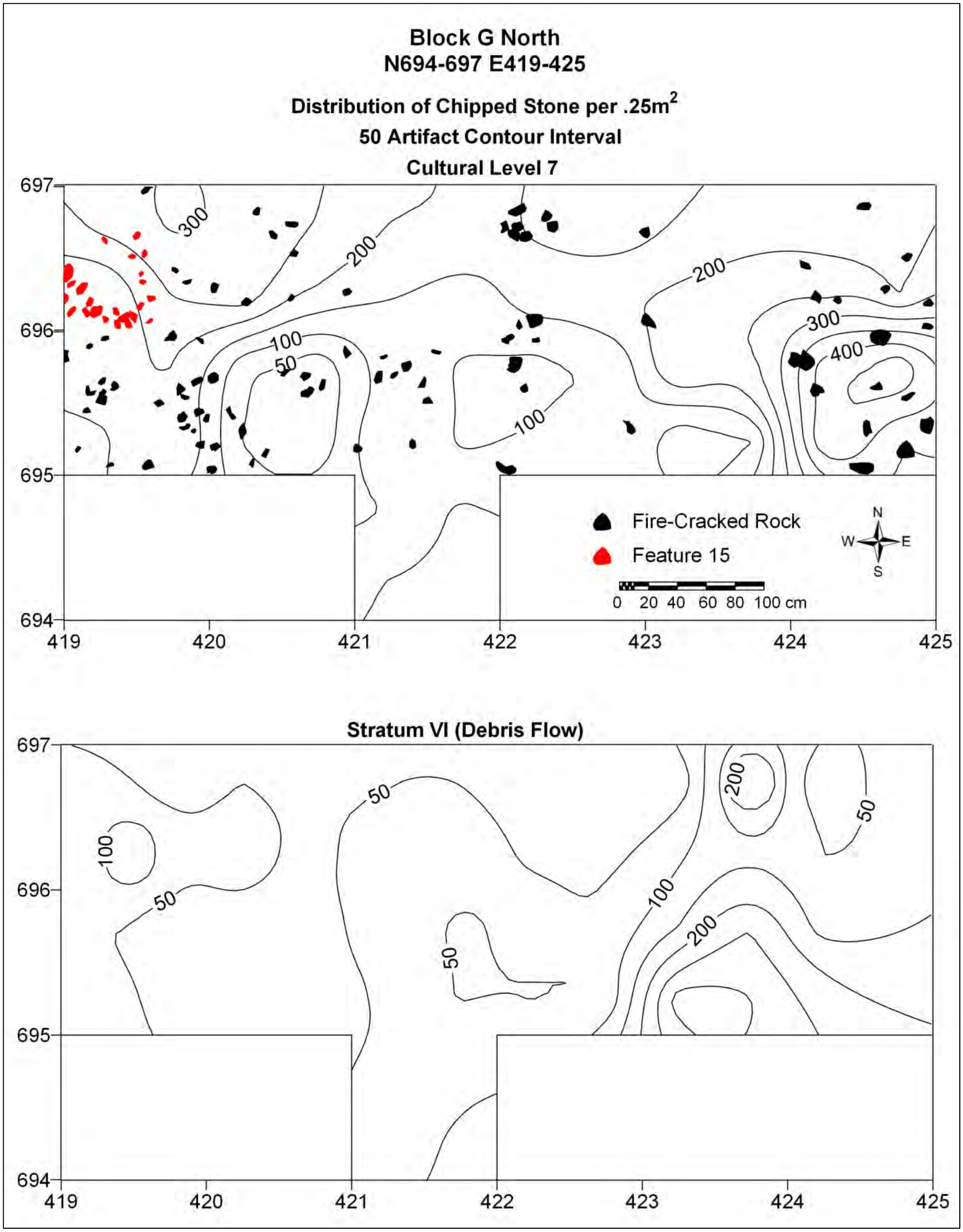


Figure 5-51 Distribution of chipped stone artifacts in Cultural Level 7 and underlying S3 Stratum VI in the northern half of Block G.

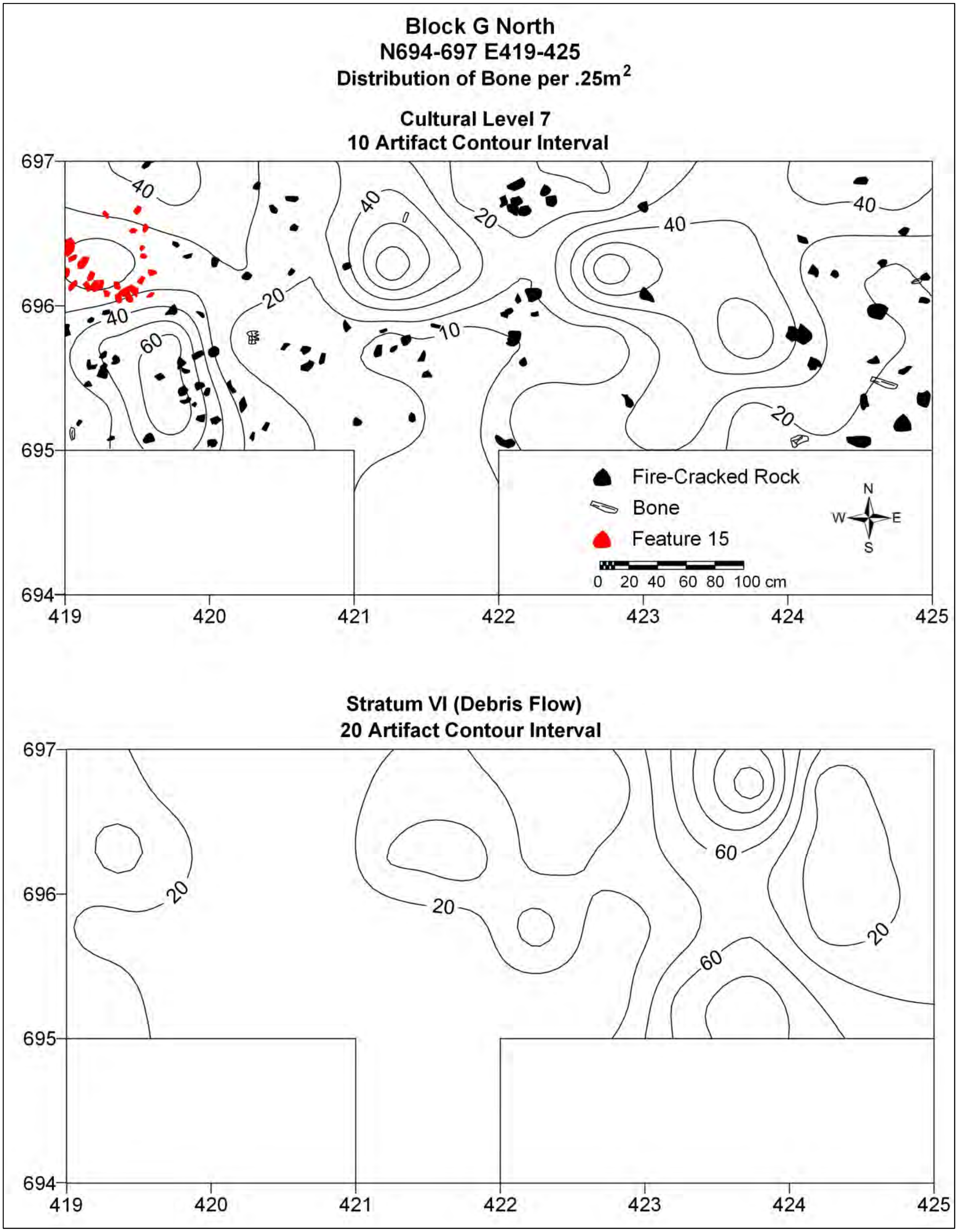


Figure 5-52 Distribution of faunal remains in Cultural Level 7 and underlying S3 Stratum VI in the northern half of Block G.

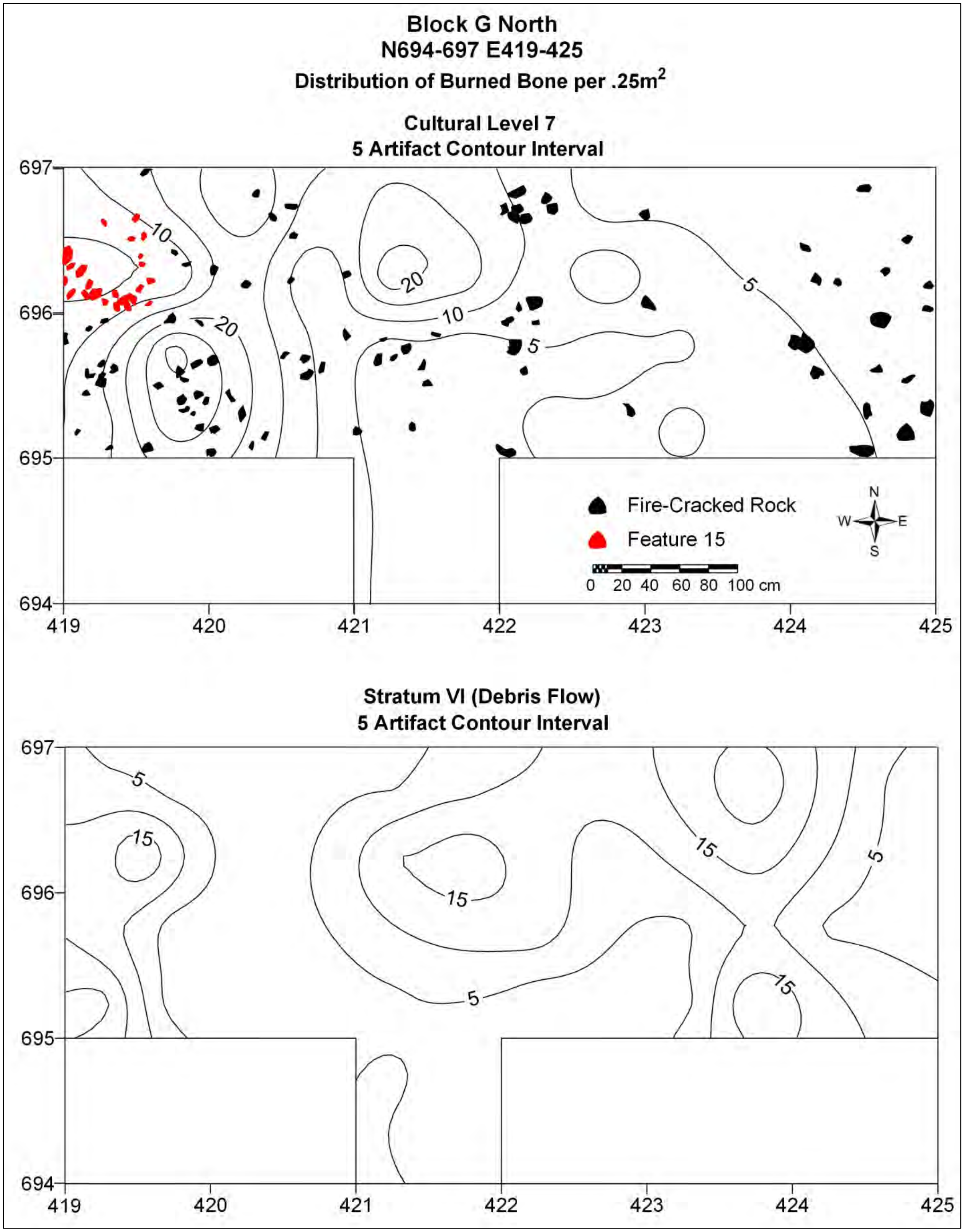
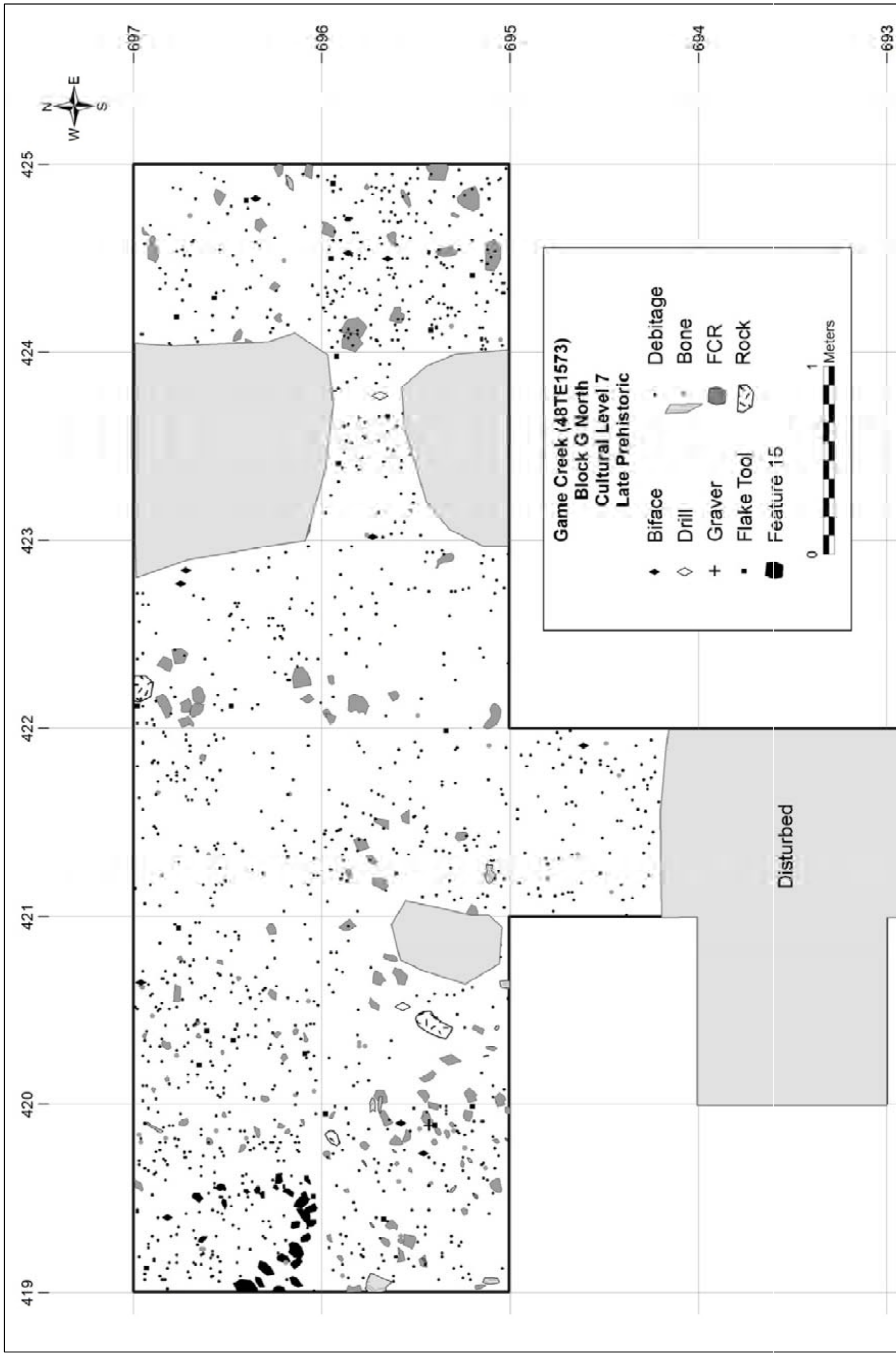


Figure 5-53 Distribution of burned faunal remains in Cultural Level 7 and underlying S3 Stratum VI in the northern half of Block G.


Game Creek (48TE1573)
Block G North
Cultural Level 7
Late Prehistoric
Biface
Drill
Graver
Flake Tool
Feature 15
Debitage
Bone
FCR
Rock
0
1
Meters
Disturbed
N
E
S
W
-697
-696
-695
-694
-693
425
424
423
422
421
420
419

and Snook 1967). A possible *Olivella* bead was found at the similarly aged Bugass-Holding site (Kornfeld et al. 2010). These concentrations of artifacts are adjacent to a semicircular arrangement of fire-cracked rock in unit N696 E419 that is designated Feature 15 (Figure 5-54). This feature was not identified during excavation and only became apparent during spatial analysis. Consequently, samples were not collected for flotation. There was no evidence that the feature was placed in an excavated basin. Some charcoal was present, but no definitive evidence of intensive fire, such as oxidation or dark carbon staining. Generally speaking there was far less rock in Feature 15 than was found in the roasting pits (Features 5, 7 and 10) on the T3 terrace. Another marked difference between Feature 15 and the T3 roasting pits is the large quantity of highly fragmented bone, much of which was burned. In particular, there was a dense cluster of bone immediately south of the feature (Figures 5-52 and 5-53). In all, there were 950 pieces of bone found in the western activity area. Of the 18 faunal specimens that could be identified to species or body class size, there were seven bison, one elk seven large artiodactyl, two beaver and one porcupine.

Similar fire-cracked rock rings associated with large quantities of bone were found at the Bugas-Holding (Kornfeld et al. 2010), Wardell (Frison 1988), Piney Creek (Frison 1967) and Goff Creek (Page 2016) sites. Frison (1967, 1988) interprets these as specialized meat roasting and bone grease processing features. Stones were first heated in a fire then placed in a water and bone filled skin container that was either placed in a pit or within an above ground stone ring. Given the large volume of bone and fire-cracked rock, Feature 15 may have been put to similar use.

The other activity area was in the eastern part of the block and extended into unit N696 E426 two meters east of Block G. Although there was a substantial amount of fire-cracked rock, none of it was arranged in any particular pattern that might suggest the location of a feature (Figures 5-51 through 5-54). There was a sizeable concentration of debitage especially in unit N695 E424 (Figure 5-51). Chipped stone tools found in the eastern activity area included two projectile points, six bifaces, one drill, one end scraper and 12 flake tools. There were fewer than half as many faunal specimens in the east (n=447), but again bison (n=3) and large artiodactyl remains (n=4) were the most frequent.

Lithic Assemblage

The raw material composition of Cultural Level 7 in the northern half of Block G on the S3 differed significantly (Chi^2=8.37, *df*=3, *p*=.039) from the T3 and T2 terraces. Overall there was more obsidian (93.3%), less chert (3.9%) and twice as much meta-quartzite (2.3%). None of the obsidian artifacts from this level were submitted for sourcing, but a Late Prehistoric side-notched point found beneath the debris flow was sourced to Bear Gulch, Montana. Green River basin cherts include five Bridger Formation and 16 Green River Formation specimens. Thus, there is again clear evidence that the people who occupied Game Creek during the Late Prehistoric period had either recently been to the Green River Basin or had been in contact with someone who had.

There was a much higher percentage of cortical chert debitage (11.1%) than in the previous levels, most of which came from the same material and maybe even the same nodule, suggesting the use of a prepared core or early stage biface. Six of the 15 bifaces are too fragmentary to identify the stage of production. Of the remaining nine, two are stage I, four are stage II and two are stage III. One exceptionally well-crafted bifacial knife (stage IV) was also recovered (Figure 5-55). The biface assemblage reflects all stages of reduction. Although no cores were found in Cultural Level 7, some of those from mixed deposits on the S3 probably came from the same occupation. Four single item analytical nodules all made from distinctive cherts were found. Three of these are flake tools and one is a large bifacial knife.

Diagnostic Artifacts

Late Prehistoric side and tri-notched points were relatively uncommon at Game Creek, but four of the five specimens recovered came from Block G. Only one of these, a tri-notched arrow point base (#28,838), was found in Cultural Level 7 (Figure 5-55). However, a side-notched point (#1,519) was surprisingly recovered from below the S3 Stratum VI debris flow in the western activity area. Another tri-notched point (#27,721) was found in the construction fill immediately above Feature 15. The fourth point came from S3 Stratum VIII deposits in the south half of Block G. The fifth Desert type point was found in Block L in apparently disturbed context.

One nearly complete corner-notched arrow point (#28,138) was found in the debris flow deposit and two more came from the southern half of Block G. These points may be from the same component dated to circa 760 cal BP identified in the eastern activity area of Cultural Level 7. The large bifacial knife may also be affiliated with that occupation.

Several Late Archaic Pelican Lake corner-notched darts were found in the northern half of Block G, one of which came from the top of Cultural Level 7 near the contact of the construction fill. It is likely that this specimen was incorporated into the deposit from the construction fill that overlaid Cultural Level 7. Two similar specimens were found in the sampled portion of the construction fill that capped Cultural Level 7 in Block G. One more corner-notched dart and a drill/awl crafted from a corner-notched dart were recovered from the debris flow deposits beneath Cultural Level 7.

Summary

If the dates from within and immediately above the debris flow are right, then Cultural Level 7 in the northern half of Block G dates after circa 760 cal BP. The date from the eastern activity area is consistent with other sites that produced corner-notched arrow points. At Mummy Cave a large assemblage of corner-notched arrow points was found in Cultural Layer 36 and dated to 1325-933 cal BP. At Baker Cave III in southern Idaho, interpreted as mid-winter camp, a large assemblage of corner-notched arrows, and several large bifacial knives similar to the specimen found in the eastern activity

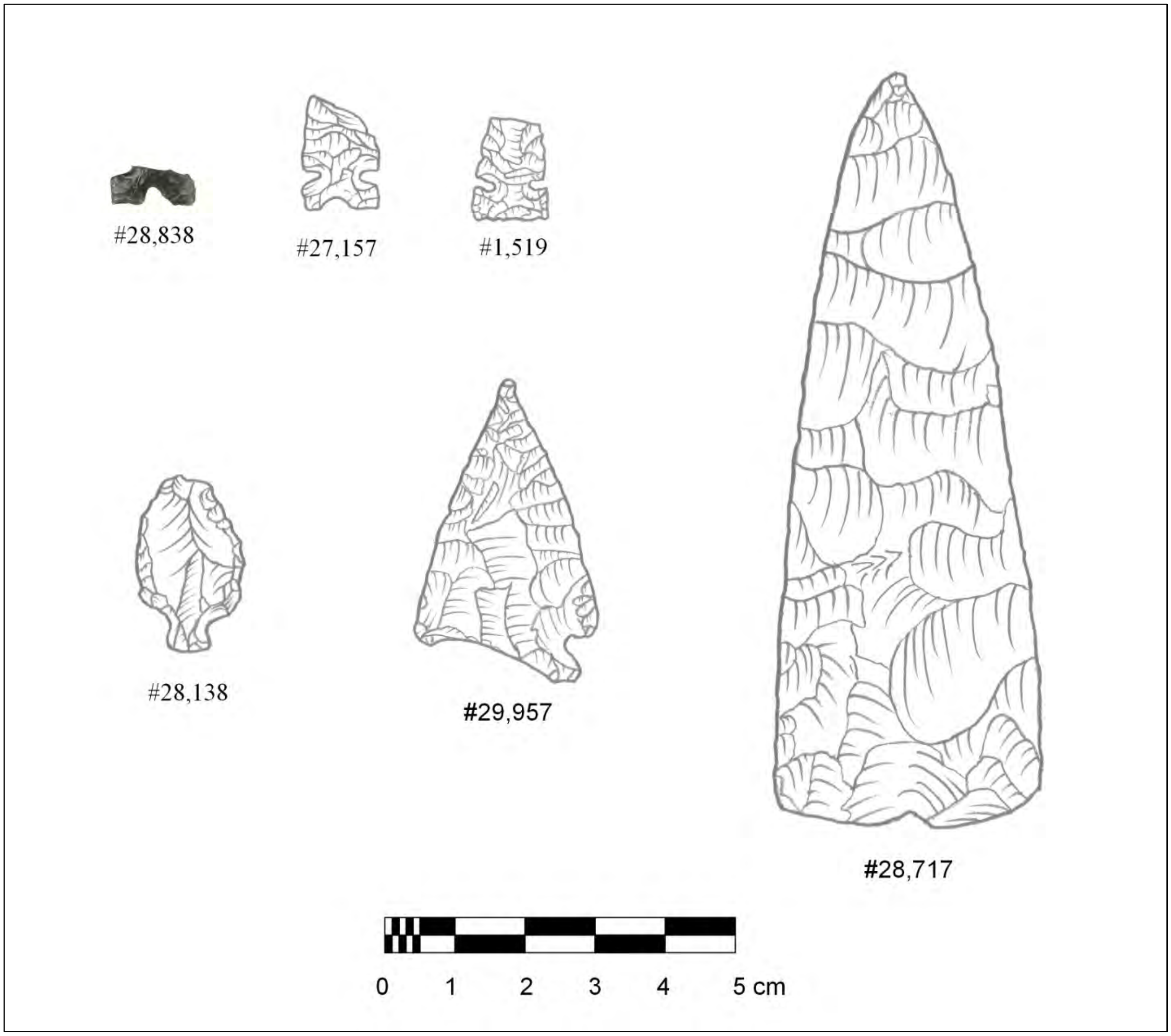


Figure 5-55 Diagnostic artifacts found in or associated with Block G north Cultural Level 7.

area, were dated to 770±47 cal BP (Plew et al. 1987). Unfortunately, only a small sample of this occupation in the eastern half of Block G can be identified with any confidence. Moreover, it would appear that this occupation is inextricably mixed with a later component, associated with the side and tri-notched arrow points.

There are two pooled mean dates, 692±15 cal BP and 554±36 cal BP, from other parts of the S3 that may be associated with the Cultural Level 7 occupation the produced the Desert type points. Many similar specimens were found at the Bugas-Holding site dated to circa 500 cal BP (Kornfeld et al. 2010). It is argued that ancestors of the Shoshone produced the small well-made side and tri-notched arrow points found throughout western Wyoming (Kornfeld et al. 2010). However, points of this style were manufactured by a wide array of people throughout western North America (Justice 2002), including the Crow who also are known to have inhabited the Central Rocky Mountains (Kornfeld et al. 2010). Other artifact types, such as intermountain ware pottery and Wahmuza lanceolate points, that have known affiliation with the Shoshone were not recovered from Game Creek. Nevertheless, the marine shell bead, Green River Basin cherts and Bear Gulch obsidian artifacts, as well as the ethnographic record (Wright 1984), tend to support the interpretation that at least some of the Cultural Level 7 artifacts were produced by the Shoshone.

The faunal assemblage is dominated by highly fragmented and frequently burned pieces of bone. Large artiodactyl remains, predominantly bison, are the most frequent identifiable specimens in the assemblage. Feature 15 and the several concentrations of fragmented bone suggest the inhabitants were intensively involved in bone marrow extraction and grease production. Similar features and associated bone concentrations were found at Bugas-Holding (Kornfeld et al. 2010) and many other sites in the region. There is no evidence as to the season(s) of occupation for Cultural Level 7, but fetal bison bone was recovered from S3 Stratum VIII 20 meters to the south of Block G and may be associated with the Late Prehistoric occupations(s). Comparison with fetal bison of known age indicates the animal died at approximately 8 months gestation, or between February and April. This is the first evidence of a late winter or early spring occupation in Jackson Hole. Bender and Wright (1988) explicitly assumed that Jackson Hole was abandoned in the winter due to deep snow and low or unreliable populations of big game. Yet, the evidence from Game Creek clearly shows that bison and/or elk were hunted during all of the occupations. It would appear that hunting, rather than intensive root and tuber harvesting was the focus of the subsistence strategy practiced by the inhabitants of Game Creek throughout much of the prehistory. The wide array of tools reflecting a variety of activities such as hunting, butchering, hide preparation, clothing manufacture and maintenance, the large volume of debitage and bone indicate that the S3 served as a primary base camp during the part of the Late Prehistoric period.

Archaeological Interpretation of the S3 Landform

As discussed at length in the previous chapter, the integrity of the cultural deposits on the S3 has been severely compromised by faunalturbation and periodic hydrologic events. The suite of available radiocarbon dates, as well as the diagnostic artifact assemblage, from the S3 indicates that the landform was occupied, at least intermittently, from 7900 cal BP till around 550 cal BP (Tables 5-21 and 5-22, Figures 5-56 and 5-57). Post-depositional mixing has impacted cultural deposits in a variety of ways and to varying degrees over all of the S3. As Figures 5-58 through 5-60 show there are nearly identical horizontal distributions of chipped stone and bone in each stratum of each excavation block, which indicates that sediments and artifacts have been homogenized (Boeka 2001). Moreover, it would appear that larger artifacts, such as fire-cracked rock and bone >6.3 cm in maximum length, have aggregated at the base of the soil column, particularly in and around Block L. Both the homogenization of artifacts and ecofacts, and stone or artifact lines are well documented at archaeological sites that have been severely impacted by fossorial rodent burrowing (Boeka 2001; Bocek 1986; Johnson 1989, 1990; 2002; Johnson et

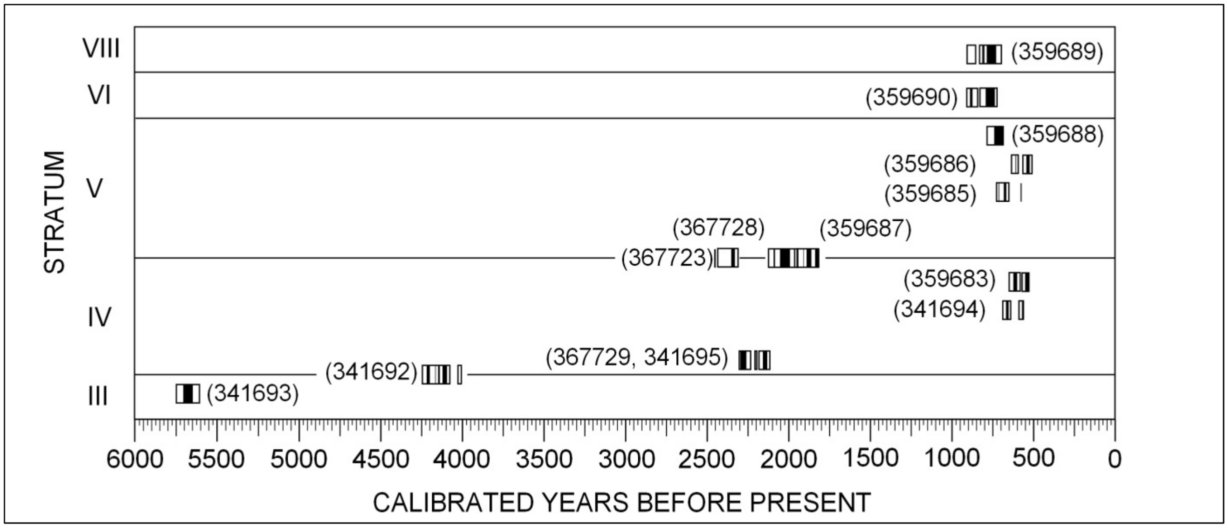


Figure 5-56 Calibrated ages of radiocarbon dates from the S3 arranged by relative stratigraphic position. Calibrated at 2σ using CALIB 7.0.4, Intcal13 calibration curve (Stuiver and Reimer 1993; Reimer et al. 2013).

Table 5-20 Radiocarbon dates from the S3 alluvial fan.

Beta#	Block/Provenience	Elevation	Strat (S3-)	Material	Conv. RCYBP	M cal BP ±1σ
359684	Blk L, N679.76 E423.74	96.22m	VIII	charcoal	30±30	58±73
359686	Blk L, N680.46 E423.1	96.14m	V	charcoal	540±30	546±38
359683	Blk L, N679.27 E422.88	96.02m	IV	charcoal	570±30	601±36
Pooled mean of Beta 359686 and 359683					555±21	554±36
182051	TR6 N54	30cmbs	?	sediment	650±100	619±71
341694	Blk JK, N664.53 E425.06	95.88m	IV	charcoal	690±30	658±40
359685	Blk L, N680.77 E422.68	96.075m	V	charcoal	730±30	676±22
Pooled mean of Beta 341694 and 359685					710±21	669±19
359688	Blk G, N691.54 E421.86	96.255m	V	charcoal	820±30	727±30
359689	Blk G, N695.76 E424.315	96.485m	VIII	charcoal	870±30	775±52
359690	Blk G, N695.67 E424.195	96.351m	VI	charcoal	880±30	787±54
Pooled mean of Beta 359688, 359689 and 359690					856±17	759±22
359687	Blk G, N690.69 E421.26	96.135m	IV/V	charcoal	1930±30	1878±36
367728	Blk JK, F. 12	95.945m	IV/V	bone	2070±30	2039±45
341695	Blk JK, N665.6 E425.06	95.86m	IV	charcoal	2150±30	2144±80
367729	Blk JK, N665.94 E425.36	95.846m	IV	bone	2190±30	2236±57
Pooled mean of Beta 341695 and 367729					2170±21	2249±66
367723	Blk L, N679.44 E424.55	96.04m	IV/V	bone	2340±30	2350±39
341692	Blk JK, N663.2 E425.185	95.9m	III/IV	charcoal	3780±30	4154±56
182052	TR6 N50.2	70cmbs	?	charcoal	4080±40	4583±102
341693	Blk JK, N664.89 E424.53	95.77m	III	charcoal	4960±30	5685±42
182053	TR6 N46.5m	80cmbs	III	charcoal	7070±40	7896±40
171708	TU101 F. 1	57cmbs	III	charcoal	8530±40	9517±20

Table 5-21 Diagnostic projectile points recovered from the S3.

Period	Type	Haft Style	Block					Type Total
			S3 Misc.	JK	L	G South	G North	
Late Prehistoric	Desert	TN/SN	2		1	1	3	7
	Rose Spring	CN			2	2	1	5
Late Archaic	Blue Dome	CN	1				1	2
	Pelican Lake/Elko	CN	7	1	4	4	1	17
Middle Archaic	Duncan/Gatecliff	ST	4	1	3	2		10
	McKean/Humboldt	LNC			1			1
Early Archaic	Bitterroot/Northern	SN		1	1			2
	Elko	CN	2					2
Block Total			16	3	12	9	6	46

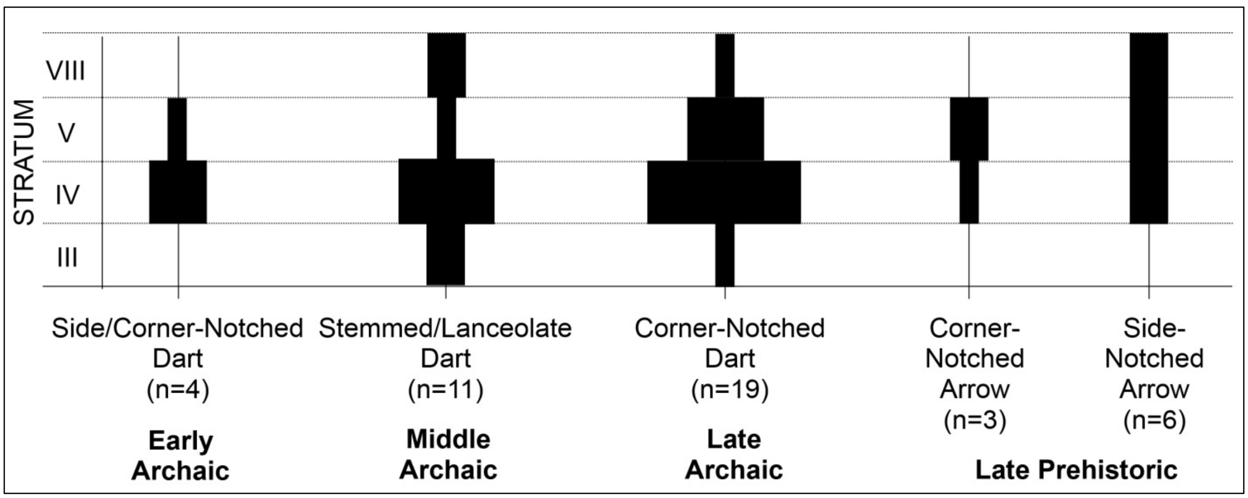


Figure 5-57 Vertical distribution of diagnostic projectile points found on the S3.

al. 1987, 1990; Michie 1990). Consequently, it is not possible to spatially isolate components or even broad cultural levels for all but the northern half of Block G. Based on the range of radiocarbon dates (Figure 5-56), evidence for post-depositional size-sorting of artifacts (Chapter 4), the homogenous nature of the faunal and lithic assemblages and wide array of projectile point styles (Figure 5-57) it would appear that most of the S3 has been reduced to a palimpsest.

The effects of bioturbation, though pervasive, have not rendered the information gathered on the S3 entirely useless. In addition to the north half of Block G just described, there was a feature with sizeable associated faunal and lithic assemblages in Block J/K at the south end of the landform. Furthermore, although there are diagnostics from multiple temporal periods in all areas of the S3 (Table 5-22 and Figure 5-57), a substantial percentage (41%) of the identifiable specimens are Late Archaic

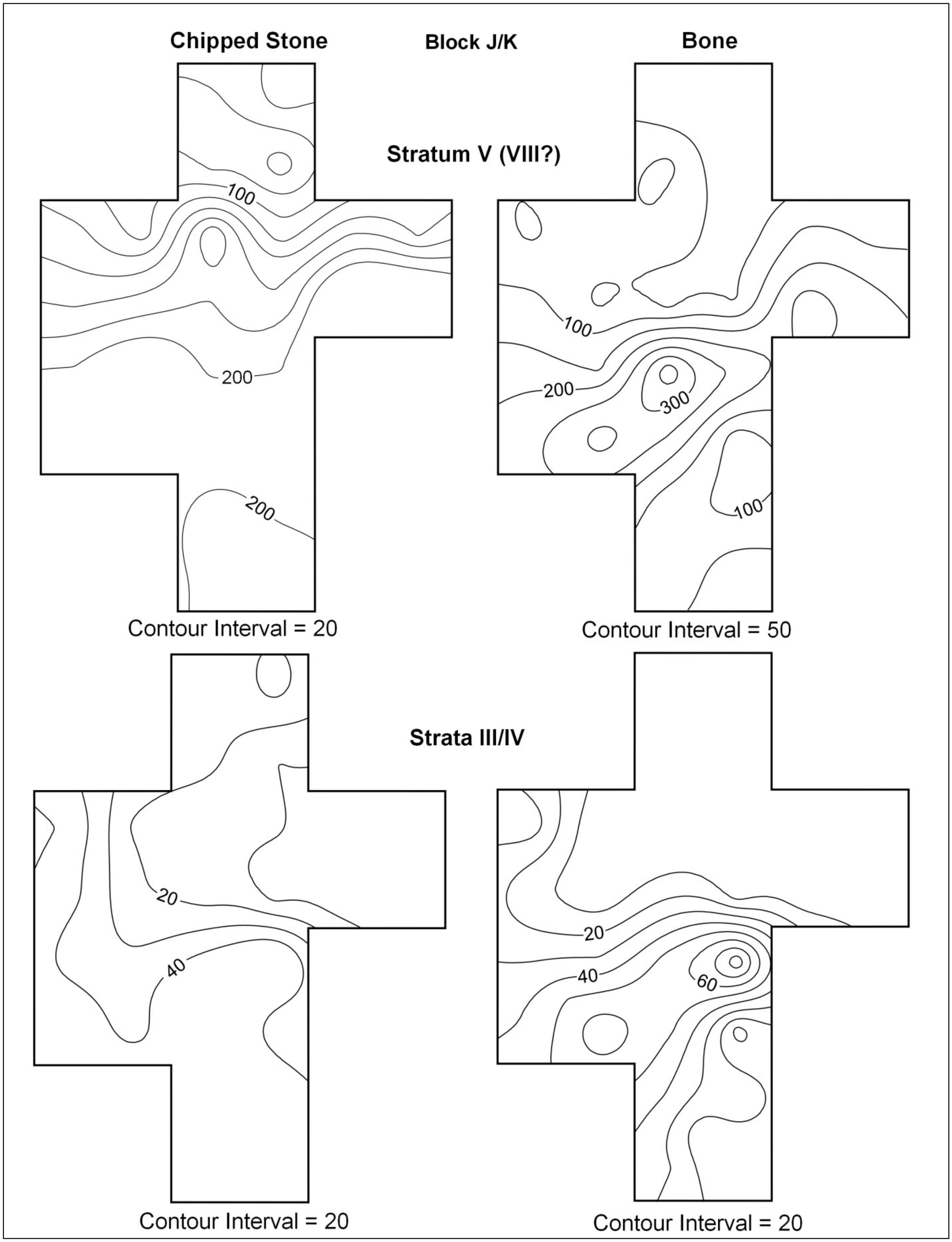


Figure 5-58 Distribution of chipped stone and bone by stratum in Block J/K.

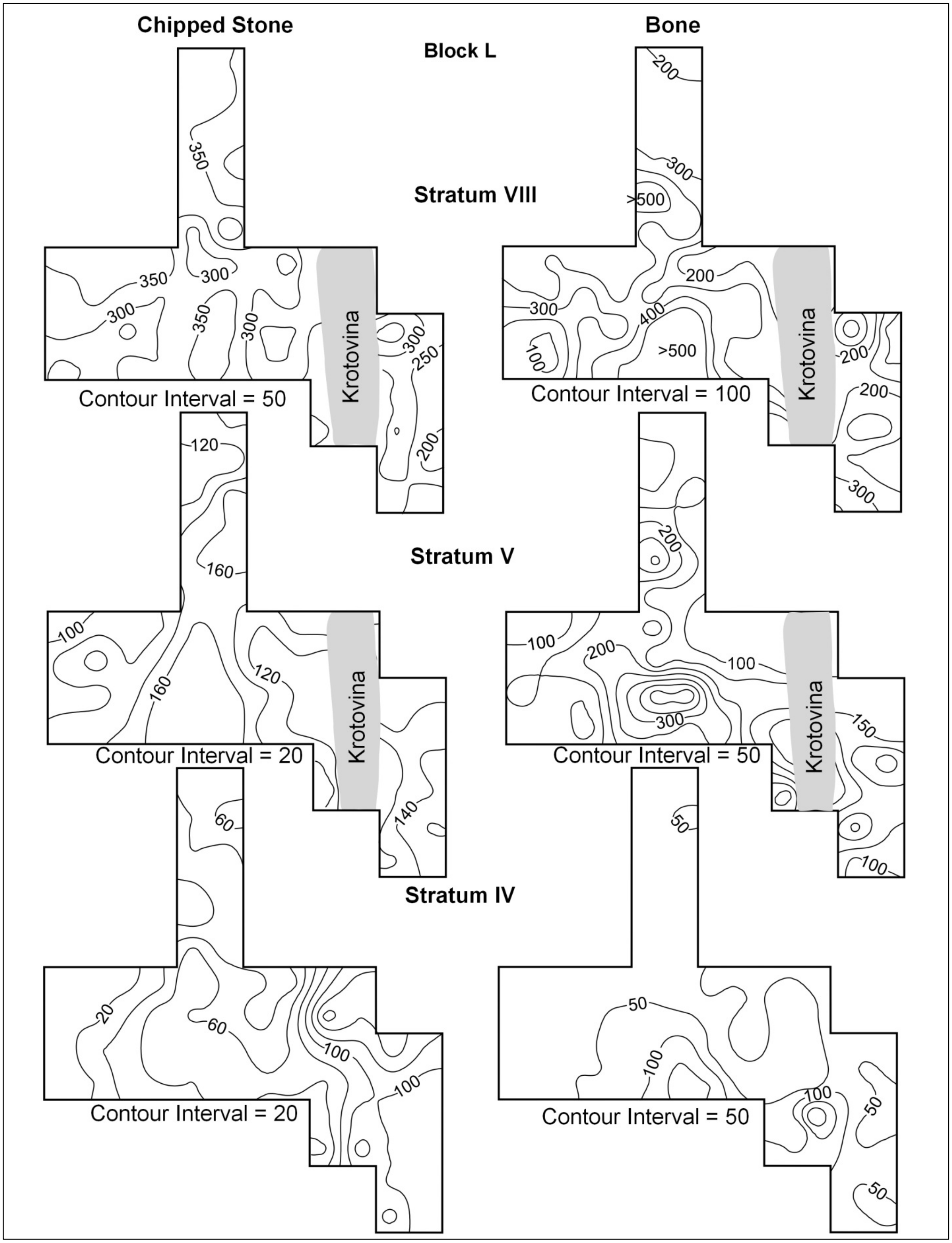


Figure 5-59 Distribution of chipped stone and bone by stratum in Block L.

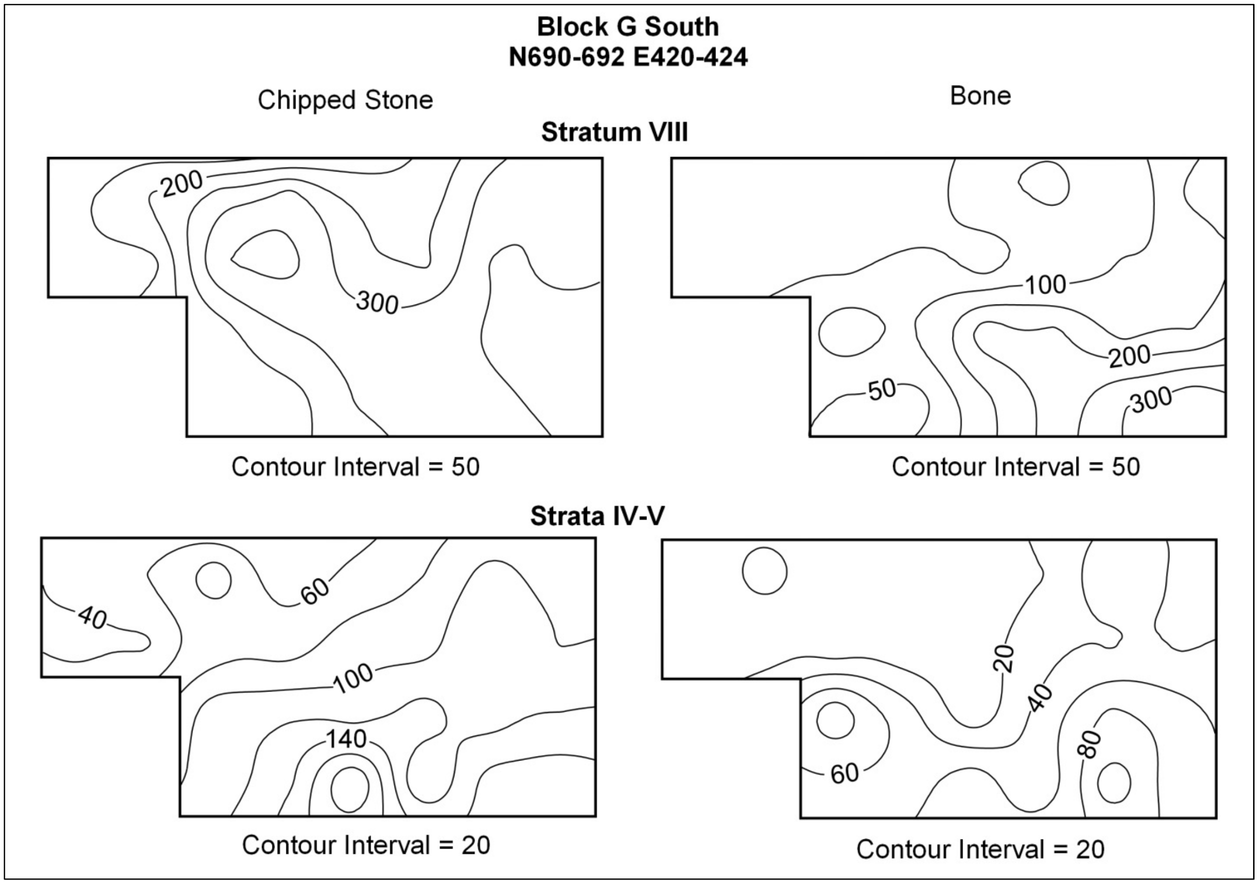


Figure 5-60 Distribution of chipped stone and bone by stratum in the south half of Block G.

Pelican Lake/Elko points, which may indicate that much of the cultural material also dates to this period. Excavations on the S3 produced the largest faunal assemblage thus far recovered from Jackson Hole and provide a wealth of information on subsistence practices.

Excavations on the S3 produced an enormous quantity of chipped stone, bone and fire-cracked rock (Tables 5-23 and 5-24). Three features, 12, 13 and 14 were also identified. A total of 65 m^2 of the S3 was excavated A layer of construction fill that varied in thickness from 23.5 cm to 100 cm covered all the S3. The construction fill from 14 units was screened through ¼" mesh in order to obtain a sample of cultural material. In places it was difficult to discern the contact between the construction fill and underlying deposits. Consequently, many levels or parts of levels within 10 units contained construction fill that was excavated using standard procedures. The fill was removed by shovel without screening for the remaining 41 units. Over 7,000 artifacts were recovered from the sampled construction fill, including seven diagnostic projectile points. In addition to the Archaic and Late Prehistoric-aged diagnostics, a Paleoindian point fragment was found within the fill during the 2002 testing (Eakin and Eckerle 2004). The fill likely originated from the borrow ditch and road bed on the S3 alluvial fan as well as the T2 and T3 terraces. Portions of the S3 also appear to have removed during highway construction, but it is unclear

Table 5-22 Artifacts, excluding faunal remains and Cultural Level 7, recovered from the S3.

Description	Block					Total
	Misc Units	JK	L	GS	GN	
Chipped Stone						
Projectile Point	27	7	24	13	11	82
Biface	22	14	50	10	25	121
End Scraper	2		5		2	9
Graver	2		1			3
Drill		1		1	2	4
Retouched Flake	15	6	19	13	4	57
Utilized Flake	59	19	149	41	33	301
Core	13	3	22	13	1	52
Primary Flake	8	5	8	11	9	41
Secondary Flake	145	66	243	111	78	643
Tertiary Flake	1,303	566	2,371	1,143	928	6,311
BF Thinning Flake	29	6	36	14	9	94
Flake Fragment	14,070	4,496	25,968	9,489	7,584	61,607
Shatter	3,034	947	4,907	1,861	1,828	12,577
Debitage <1/8"			1,971		488	2,459
Chipped Stone Subtotal	18,729	6,136	35,774	12,720	11,002	84,361
Groundstone						
Hammerstone	2		1	2	1	6
Mano			2		2	4
Net Sinker				1		1
Pestle					1	1
Groundstone Subtotal	2		3	3	4	12
Bone/Antler Tools						
Awl		1	2			3
Punch/Flaker			1			1
Digging Stick Tip					1	1
Unidentified			1		1	2
Antler Tool			1			1
Bone/Antler Tool Subtotal		1	5		2	8
Botanicals						
Charcoal	83	37	112	67	157	456
Cherry pit					1	1
Seed		1				1
Botanical Subtotal	83	38	112	67	158	458
Historic Artifacts						
Shotgun Shell			1			1
Lead Shot			9			9
Glass	2			1	1	4
Horseshoe			1			1
Nail			1		1	2
Historic Subtotal	2		12	1	2	17
Fire-Cracked Rock (ct.)	395	371	1,156	342		2,264
(weight kg)	67.8	56.04	266.61	38.71		429.16
Total	19,211	6,546	37,062	13,133	11,168	87,120

Figure 5-61 Photograph of the base of Feature 12 and the quartzite biface.

Figure 5-62 Feature 12 cleanout of fire-cracked rock and bison rib bones.

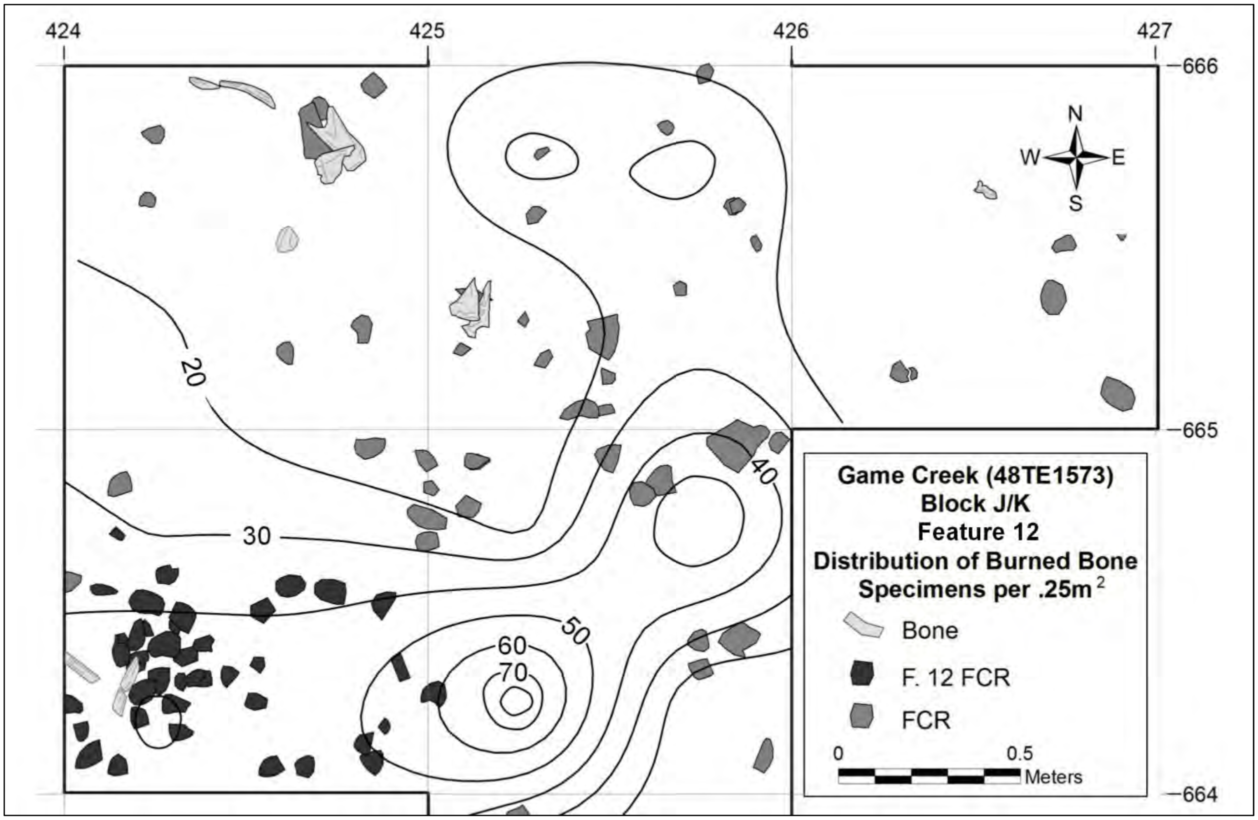


Figure 5-63 Plan view map of Feature 12 with burned bone distribution contour.

how much of the landform was stripped away prior to filling and leveling of the surface. Since the contextual integrity of the S3 has been severely compromised, the artifacts found in the construction fill are included in the Block and unit totals in Tables 5-23 and 5-24.

Block J/K, Feature 12

The upper portion of Block J/K was stripped during highway construction removing all or most of S3 Stratum VIII. A layer of artifact-bearing fill was then placed over the area. Block J/K contained a fairly dense concentration of chipped stone, bone, fire-cracked rock and one feature (Tables 5-23 and 5-24), most of which came from S3 Stratum V. Spatial analysis of chipped stone and bone in Block J/K reveals no stratigraphic separation of artifact clusters (Figure 5-59). Although there were Early, Middle and Late Archaic-aged diagnostics it would appear that most of the artifacts were likely deposited during use of Feature 12 dated to the Late Archaic period.

Feature 12 was not identified in the field in part because the deposit had been severely mixed. It was only during analysis that the outlines of a small pit and associated cleanout were identified (Figures 5-61 through 5-64). Consequently, the feature was not cross-sectioned and a profile drawing was not made. The feature consists of a small pit approximately 20 cm in depth that contained a ring of fire-

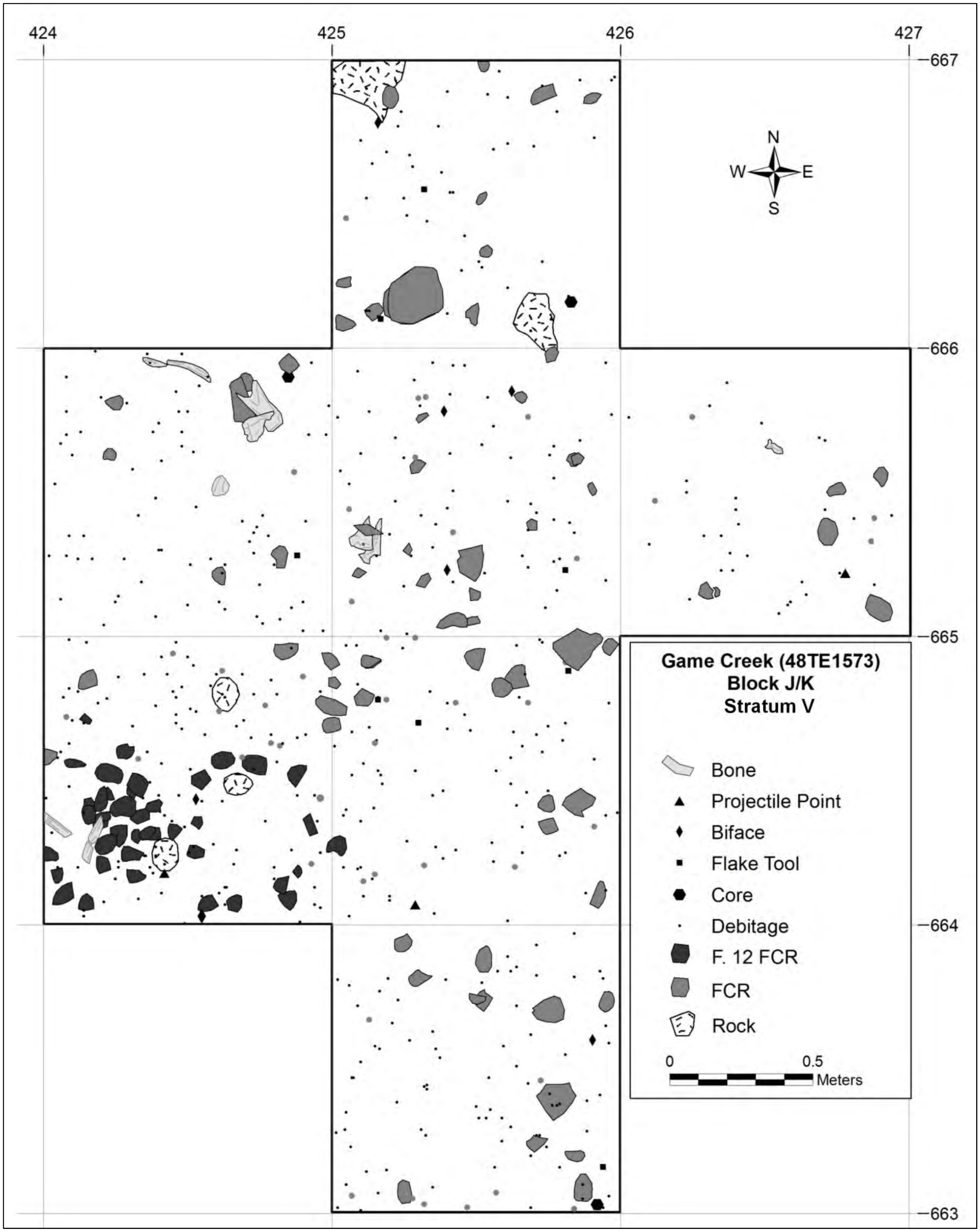


Figure 5-64 Plan view map showing Feature 12 and piece plotted artifacts from Block J/K.

cracked rock that was about 50 cm in diameter. Within the ring was a complete heavily utilized quartzite biface (Figure 5-61). Immediately west of the pit was a pile of fire-cracked rock and bison bone (Figures 5-62 through 5-64). No organic staining was observed and very little charcoal was collected. However, one bison rib bone from the feature was dated to 2039±45 cal BP. There were 66 pieces of fire-cracked rock >5 cm in diameter with a combined weight of 11 kg. A diffuse scatter of fire-cracked rock was found throughout the block at about the same elevation as the feature (Figure 5-64). These rocks may be from previous cleanouts or may be from one or more features in the areas that were not excavated. There were two clusters of burned bone adjacent to Feature 12 (Figure 5-63). Like Feature 15 from Cultural Level 7 in the north half of Block G, Feature 15 appears to have been used to process bone grease.

Block L, Features 13 and 14

Block L contained the densest artifact assemblage at Game Creek with 33,630 pieces of chipped stone, 17,149 faunal specimens, and 1,156 pieces of fire-cracked rock weighing 371 kg (Table 5-23, Figure 5-65). Yet, as discussed at length in Chapter 4 the integrity of the cultural deposits in Block L have been severely compromised. The vertical distribution of both radiocarbon dates and temporally diagnostic projectile points indicates that multiple occupations perhaps spanning thousands of years were superimposed and mixed through a variety of processes. Almost all of the artifacts larger than 5 cm have accumulated near the base of the soil column as an artifact and stone line (Figures 5-65 and 5-66). As discussed in Chapter 4, smaller artifacts are concentrated higher in the profile and show a near identical vertical distribution as the gravel. Consequently, there is little, if any, vertical separation of artifact concentrations.

Feature 13

Feature 13 was identified at the stratigraphic contact of Strata IV and III as a dark circular stain in unit N679 E423 (Figures 5-65 and 5-66). No oxidation of sediments was observed and no concentration of burned bone was found within or adjacent to the feature (Figure 5-67). Krotovina that were otherwise invisible in the black, compact soil were easily seen at the stratigraphic contact (Figure 5-67). Feature 13 could have been a large rodent burrow. Nevertheless, numerous small flecks of charcoal were observed during excavation. The Feature was about 50 cm in diameter and 4 cm thick. It had a diffuse boundary and was roughly lenticular in profile. The entire stained area was removed and floated. Only a few milligrams of unidentifiable charcoal were recovered from the light fraction. Ten pieces of debitage, 36 pieces of unidentifiable bone and 11 pieces of unidentifiable tooth enamel fragments were recovered from the 1 mm sieve. Given the small amount of charcoal and the extensive evidence for faunalturbation, the charcoal was not submitted for radiocarbon dating. Feature 13 may be the remnant of a simple unlined surface hearth, an ash and charcoal cleanout from the nearby Feature 14 or a rodent burrow. Yet, apart from the stain there is little additional evidence for burning.

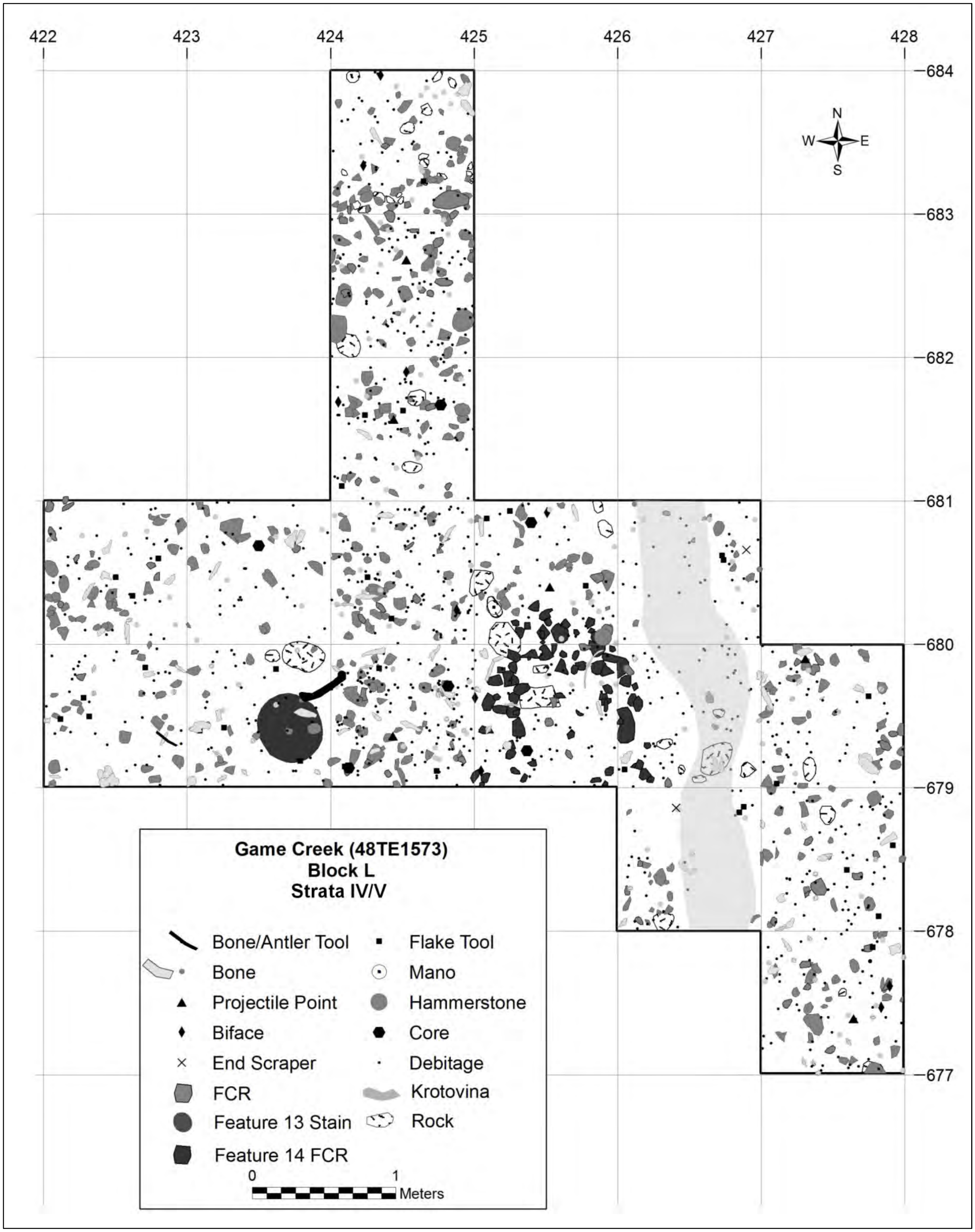


Figure 5-65 Plan view map of Block L showing Features 13 and 14 and piece plotted artifacts from S3 Strata IV and V.

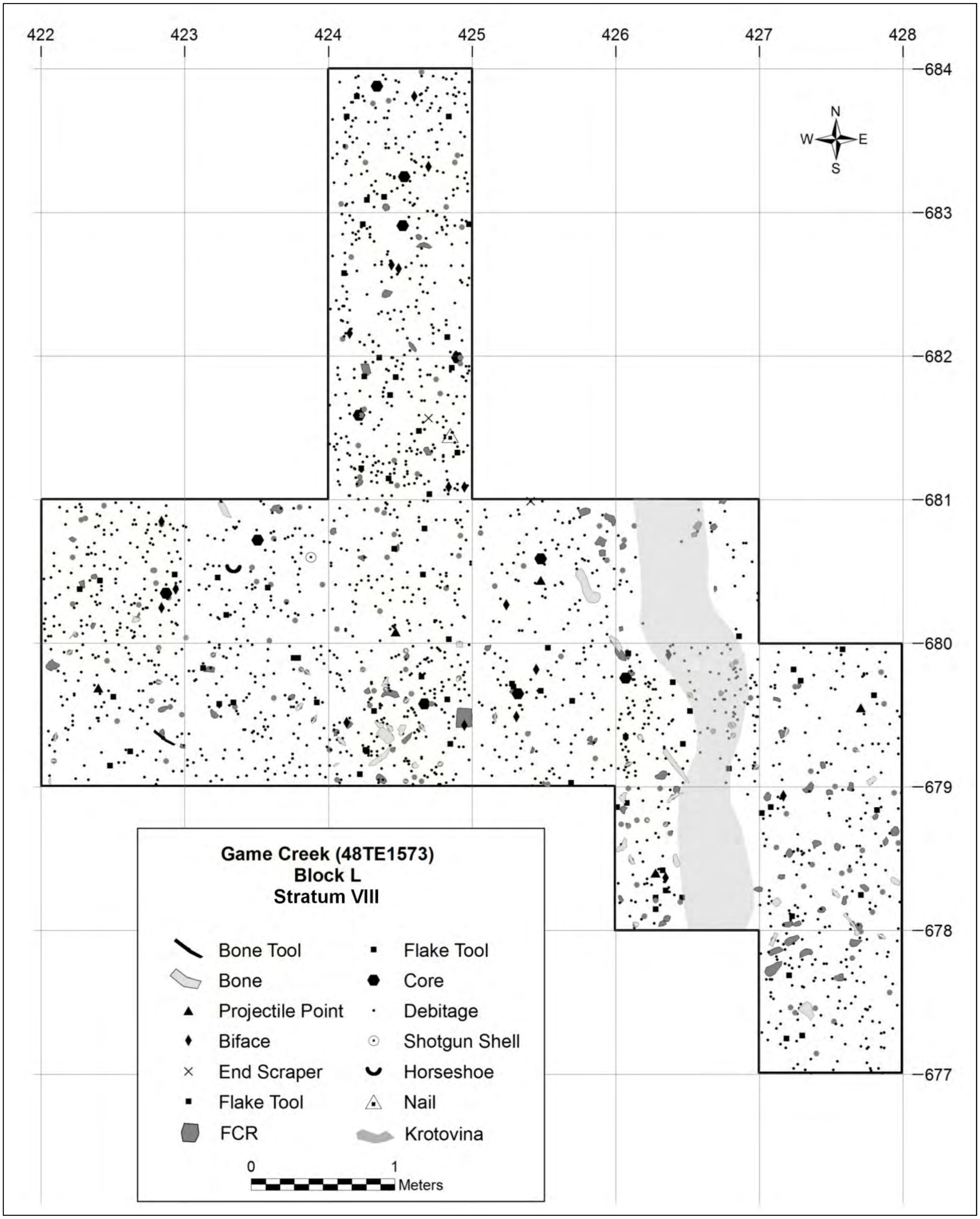


Figure 5-66 Plan view map of Block L showing piece plotted artifact found in S3 Stratum VIII.

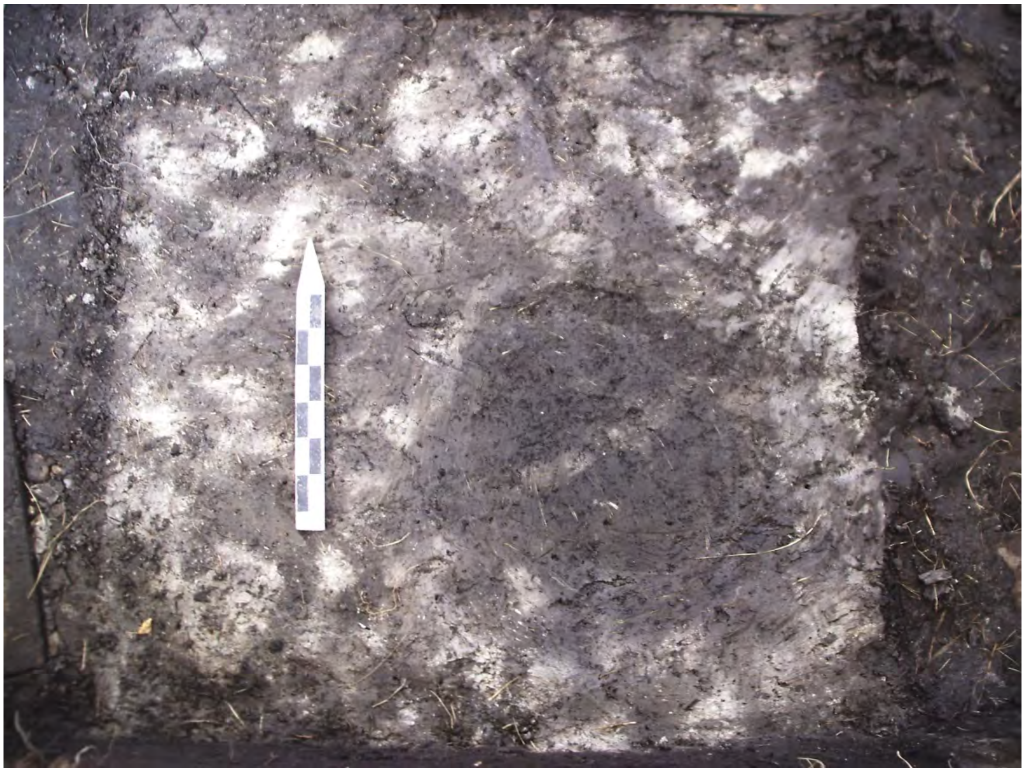


Figure 5-67 Photograph of Feature 13 in Block L. Note the numerous krotovina in and around the feature.

Feature 14

Feature 14 was a shallow, 5-10 cm deep, 1.0-1.2 m diameter, basin that had a ring of 41 pieces of fire-cracked rocks along the perimeter. Three pieces of unburned limestone were also found within the feature. This feature was not identified in the field and only became apparent during spatial analysis of the artifacts from Block L. One biface, one utilized flake, 56 pieces of debitage, one core, and 13 pieces of bone were collected *in situ* within the feature. The feature fill was screened through 1/8" mesh resulting in the recovery of an additional biface and utilized flake, 459 pieces of debitage and 791 pieces of bone. The fire-cracked rock provides the only evidence for intensive fire in Feature 14. No oxidation of sediment and no clustering of burned objects were observed within or near the feature (Figure 5-68). Feature 14 does not closely resemble a hearth or a roasting pit. The circular alignment of stones in the bottom of a shallow pit is similar to Feature 12 from Block J/K. Given the large volume of bone, most of which had been heavily processed for marrow extraction and much of which was burned, suggests that the features, and more generally the large quantity of fire-cracked rock, reflect intensive bone grease processing.

Block G

Block G can be separated into north and south portions that are demarcated by a two to three meter wide trench that was cut through the landform during construction of the highway. The northern portion also differs from the south by the presence of a debris flow, Stratum VI that was deposited during

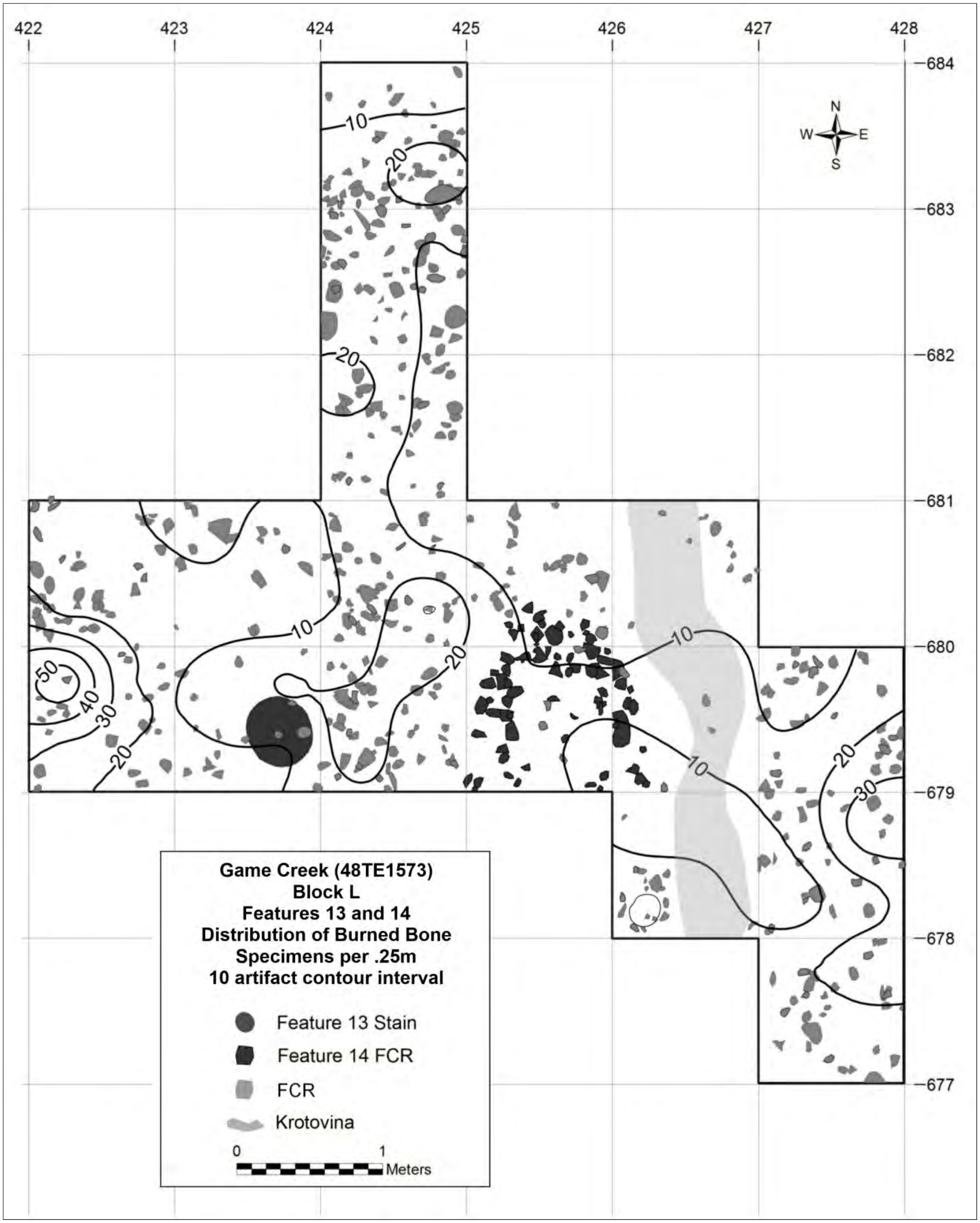


Figure 5-68 Distribution of burned bone in Block L S3 Strata IV/V.

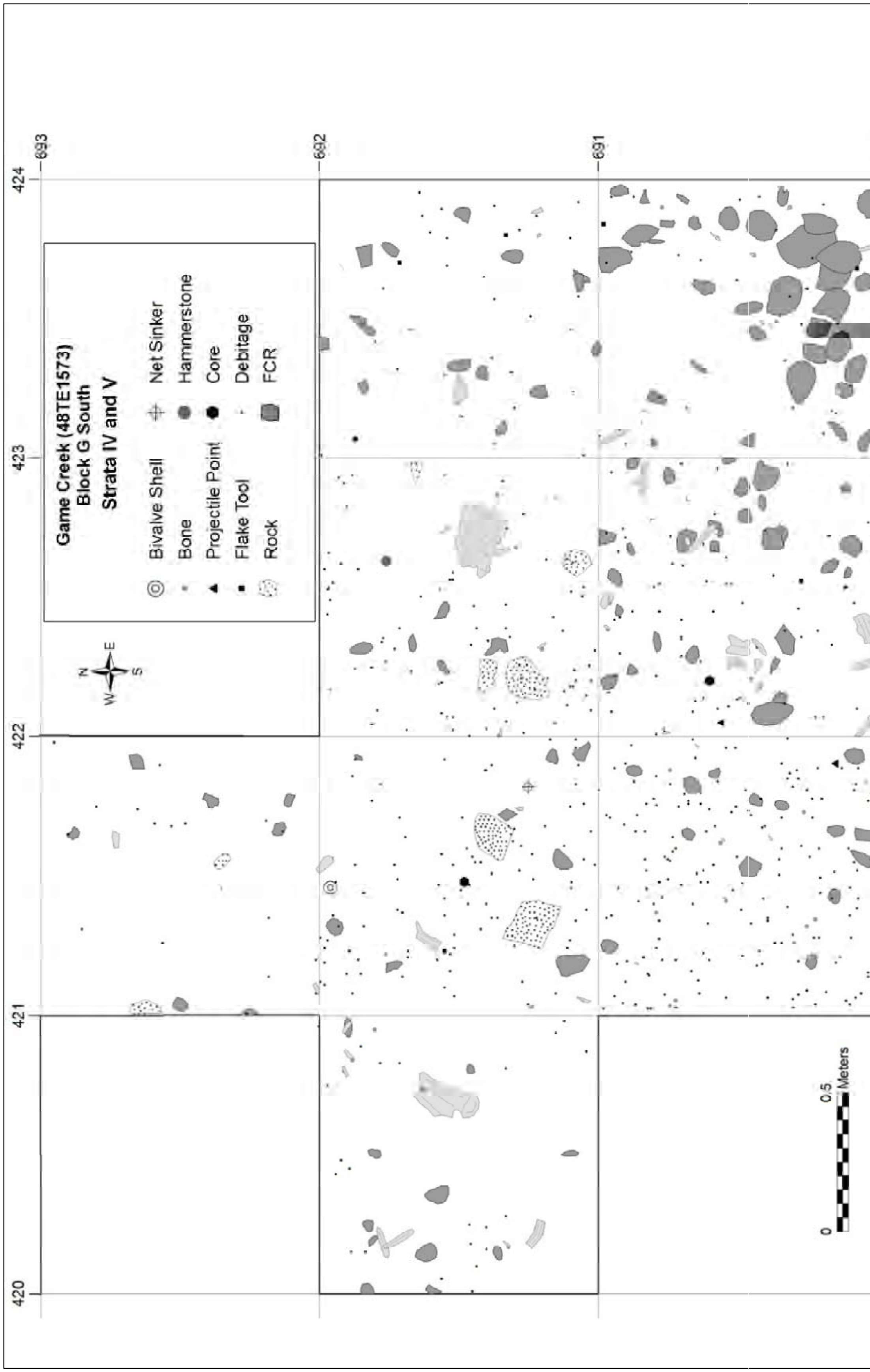
a catastrophic flood that removed severely mixed all of the Cultural Level 6 deposits. The Cultural Level 7 deposits present above the debris flow are discussed above. A relatively large number of artifacts were found within the debris flow sediments, including 5,040 pieces of debitage, five projectile points, 12 bifaces, a drill, an end scraper, 13 flake tools, a mano, a hammerstone and 1,060 faunal specimens. There were fewer artifacts found below the debris flow in S3 Strata III, IV and V because large segments of these deposits were washed away. There were two projectile points, two bifaces, eight flake tools, 2,135 pieces of debitage, a groundstone pestle and 455 faunal remains. Again, these deposits were in a poor state of preservation with abundant krotovina and fossorial rodent bones.

There was also much less fire-cracked rock in Block G than in Blocks J/K and L. Only 111 pieces of fire-cracked rock weighing about 12 kg was documented. Most of the fire-cracked rock was again found near the base of the soil column in S3 Strata IV and V, but there were more large artifacts found in S3 Stratum VIII in the south half of Block G than in Blocks L and J/K. These artifacts may be associated with the Cultural Level 7 occupation documented in the north half of Block G. Nevertheless, Block G lacks clearly definable cultural stratigraphy (Figure 5-58). No features could be identified in the level, but a cluster of fire-cracked rock in unit N690 E423 may represent the remnant of a feature similar to Features 12, 14 and 15 (Figures 5-70 and 5-71). However, the distribution of burned artifacts is in no way correlated with the fire-cracked rock cluster. There was much less burned bone than in Blocks J/K and L and most of it was concentrated in unit N690 E421, two meters west of the fire-cracked rock cluster. The faunal assemblage was large and diverse like the rest of the excavation blocks (Table 5-24) suggesting that the same focus on intensive bone grease processing occurred in Block G.

Faunal Assemblage

The faunal assemblage from the S3 is not only large, but markedly diverse (Table 5-24). Bison is the most common identifiable specimen in the assemblage followed by beaver and elk. Remains of both black and grizzly bear, deer, bighorn sheep, canid (dog or wolf), pronghorn, rabbit, grouse and an unidentified larger bird, possibly goose, unidentified fish, a possible turtle and freshwater bivalves were found. There were a minimum of six bison represented in the assemblage based on right humeri from five adults and one fetal bison (Chapter 7). The fetal bison bone is from an eight month old fetus, which would place the time of death between the end of February to the middle of April, or a late winter through spring occupation. There may be two fetal bison, but this could not be determined with any degree of confidence. Bison appear to have been the primary targeted species, but all bone appears to have been subjected to the same intensive processing for bone grease.

This is the first and only evidence of a cold season occupation in Jackson Hole. All of the previous formulated subsistence and settlement models make the explicit assumption that area was abandoned during the winter months (Bender and Wright 1988; Connor 1998; Love 1972; Wright 1984; Wright et al. 1980). Based on the radiocarbon dates there were at least nine components over the course


Game Creek (48TE1573)
Block G South
Strata IV and V
Bivalve Shell
Bone
Projectile Point
Flake Tool
Rock
Net Sinker
Hammerstone
Core
Debitage
FCR
N
E
S
W
424
423
422
421
420
693
692
691
0
0.5
Meters

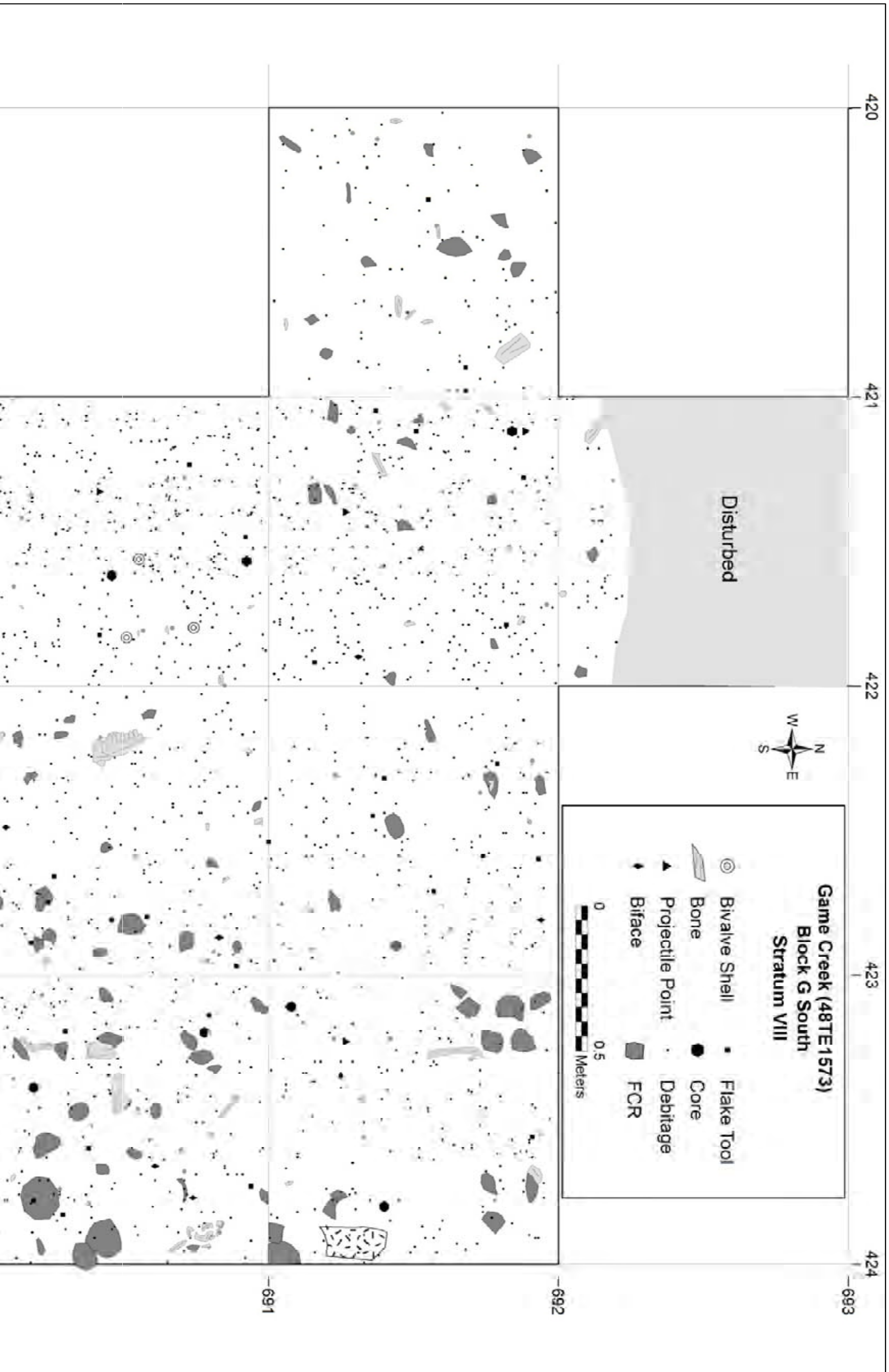

Game Creek (48TE1573)
Block G South
Stratum VIII
Bivalve Shell
Bone
Projectile Point
Biface
Flake Tool
Core
Debitage
FCR
0
0.5
Meters
N
E
S
W
Disturbed
420
421
422
423
424
691
692
693

Table 5-23 NISP and MNI in the Faunal Assemblage from the S3 excluding Cultural Level 7.

Species	Block				total	MNI
	Misc. Units	J/K	G	L		
Bison	51	12	37	82	136	5
Beaver	22	6	13	21	54	5
Elk	15	1	9	16	32	1
Bivalve Shell	5		8	1	12	na
Canid	2	1	4	3	7	1
Sheep	2		3	1	4	1
Bird	3			1	4	2
Bear	1		1	3	3	2
Fish			3	2	3	1
Pronghorn				2	2	1
Rabbit	1			1	2	1
Deer	1				1	1
Turtle			1		1	1
Lg. Artiodactyl	46	30	43	73	133	
Med. Artiodactyl	7	1	2	6	14	
Artiodactyl	22	11	5	13	44	
NISP Subtotal	178	62	129	225	452	
unidentified	4,768	1,327	2,604	16,728	43,430	
Intrusive Rodent	25	83	215	196	519	
Total	4,971	1,472	2,948	17,149	44,401	

of four thousand years on the S3. During this time there were periods of decreased or highly variable effective moisture and decreases in human population particularly in the Upper Green River basin (Chapter 3). A marked decrease in winter snowpack could account for either an earlier than assumed arrival of people into Jackson Hole on a seasonal round or a year-round occupation of the area.

In aggregate, there was much more bone in Stratum VIII than in Strata IV and V. However, there were slightly fewer identifiable remains in Stratum VIII (0.6%) than the lower deposits (1.6%) which in part reflect the overall size of the specimens recovered from the two levels, with most of the larger bone found in the artifact/stone line at the base of the soil column. It may be that much of the bone from Stratum VIII originated from the lower deposits and was dispersed upward through pedoturbation.

There were eight bone or antler tools recovered. Three of the tools are small bone awl fragments found in Blocks JK (n=1) and L (n=2). A digging stick tip, made from a large artiodactyl bone was found in the debris flow deposits in the north half of Block G in addition to a long bone fragment with wear and polish along one edge. A bone punch or flaker was recovered from Block L. A unique bone tool fragment was also found in Block L. The tools was made from a 17.6 cm long large mammal long bone fragment that was scoured and polished on the interior surface and four small holes were drilled around the perimeter on two sides. One straight long edge of the object has been smoothed and polished through some type of use. The purpose of this specimen is unknown. A large worked elk antler was also recovered adjacent to Feature 13 in Block L. The base and bez tine of the antler was scoured and snapped off and the second tine appears to have been modified and later broke. Some attempt was made to remove the section that retained the broken second tine but it was not snapped off. This artifact is very similar to end scraper hafts used by Plains tribes at the time of contact. The Lakota still use these scraper handles, which they call *wahnike,* to haft scrapers. A similar elk antler tool was found in association with a sheep trap in the Absaroka Mountains and is thought to have been used as a club to dispatch sheep (Kornfeld et al 2010).

Lithic Assemblage

Obsidian is the most abundant material type in the S3 assemblage (92.4%) followed by chert (4.1%) and metaquartzite (2.8%). The raw material composition of the lithic assemblages from Strata III/IV, V and VIII, as well as the construction fill are nearly identical with less than 1% difference in the percentage of each material type, which again underscores the impacts of post-depositional mixing on the landform. A sample of eight artifacts, including seven obsidian projectile points and one bifacial thinning flake were analyzed using ed-xrf all but one of which were found to be from either the Teton Pass or Crescent H Ranch sources. A Late Prehistoric Desert side-notched point, found just below Cultural Level 7 in the north half of Block G sourced to Bear Gulch Montana. Most of the chert debitage was too small to be confidently identified, but at least 21 flakes of Green River Formation-Laney Member chert and 30 pieces of Bridger formation chert were identified. Therefore, most of non-local stone appears to have originated in the Green River Basin.

Attempts to identify multiple item analytical nodules proved futile because most of the chert debitage was too small. Nine single item analytical nodules including four projectile points, one biface, one end scraper and three flake tools, all made of chert, were identified. These unique specimens all likely arrived at the site as finished tools or tool blanks. All of the projectile points and the biface were broken and probably discarded and replaced by locally derived obsidian tools.

Given the amount of mixing apparent on the S3, the obsidian debitage was not included in the mass analysis. The percentage of cortical chert debitage is very low (3.8%) compared with obsidian (10%). The wide variety of chert and the low proportion of cortical pieces suggest that much of the chert came to the site as prepared cores, tool blanks or finished tools at least some of these originated in the Upper Green River Basin. Judging from the biface and core assemblages there were a wide variety of tool production strategies employed. Approximately one-third of the bifaces are stage I, thirty-one percent are stage II, nine percent are stage III and about three percent are large hafted bifacial knives. The high proportion of stage I and II bifaces indicates that all stages of bifacial tool production were taking place on the site. The low number of stage III bifaces probably reflects the transport of useable tool blanks and finished items off the site. A large assemblage of cores were recovered (n=52), including 17 bifacial, nine bipolar, 21 multidirectional and five fragments too small to identify to type. The cores were made of obsidian (n=36), chert (n=6) and metaquartzite (n=10) and all appeared to be locally procured given their size and amount of cortex. The presence of such a wide variety of core types may suggest a lack of a specialized core reduction strategy.

The use of metaquartzite is not well-documented in the earlier cultural levels on the T3. The large flakes struck from these cobble cores are basically the same tool the Eastern Shoshone call Teshoas, or women's knives. There were 30 large metaquartzite flake tools and three metaquartzite cores that showed use wear. It is possible that these tools were specifically used for butchering, a task to which the hard, sharp and serrated edges of a metaquartzite flake would be ideally suited. The absence of such tools in earlier components therefore may be due to limited butchering on site. On the other hand the heavy reliance on metaquartzite flake tools may reflect a technological innovation, something entirely new to the tool kits of the people in the area.

Diagnostic Projectile Points

Of the 82 projectile points recovered from the S3, 61 are complete enough to identify haft type and probably type association. As shown in Table 5-22 the sample includes specimens diagnostic of all periods of the Archaic as well as the Late Prehistoric (Figure 5-71). The earliest occupation on the S3 for which there is definitive evidence occurred during the Early Archaic period. In addition to the several radiocarbon dates from this period, four side-notched darts were found. A nearly complete specimen (#960) was found in the fill from the fiber-optics trench excavated at the site in 2004 (Eakin and Eckerle 2004). Two small lateral base fragments of side-notched darts were found in Block J/K and one came from the debris flow in the north half of Block G. There are several named types of Early Archaic side-notched dart including Northern, Bitterroot, Pahaska and Black Water (Holmer 2009; Husted and Edgar2002; Justice 2002), but with the exception of the Black Water type, they are all very similar in form. The three specimens just mentioned conform most closely to the Northern/Bitterroot/Pahaska types that have been dated from circa 8300 cal BP to 5700 cal BP (Kornfeld et al. 2010). A complete point (#17,195) that most closely resembles the Mount Albion type (Benedict and Olson 1978) from the Southern Rockies was found in unit N659 E429. Francis and Widman (1999) report several similar points from the Trappers Point site in the Upper Green River Basin. This assemblage differs markedly from the Early Archaic assemblage recovered from the T3 terrace. The corner-notched-bifurcated base points found in Cultural Level 4 and 5 are entirely absent from the S3.

Stemmed dart points typical of the McKean complex Duncan type, known as Gatecliff Stemmed in the Great Basin and Snake River Plain (Holmer 2009; Justice 2002) are the second most frequent type (13.1%) in the S3 assemblage (Figure 5-72). Some of the points are small base fragment that may have

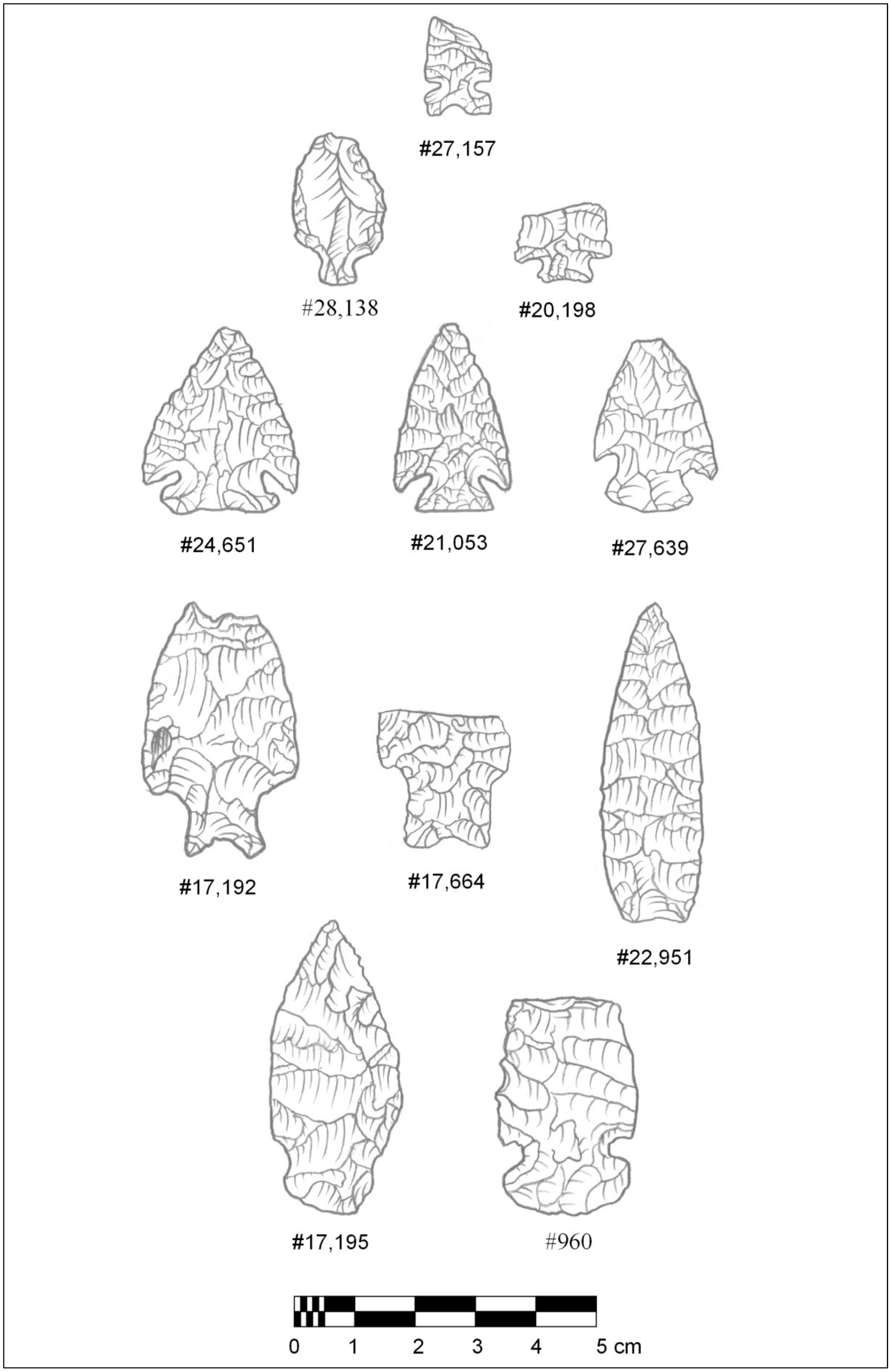


Figure 5-71 Select diagnostic artifacts recovered from the S3.

been lanceolates, like the complete specimen found in Block L. Combined these two types comprise nearly 15 percent of the assemblage. No stemmed or lanceolate points were found on the T3 terrace, but then again the Middle Archaic occupation (Cultural Level 5) produced mostly evidence of specialized use of the landform for root and tuber processing. The S3 could have been the location of the main camp associated with the special use activity areas on the T3 terrace.

Corner-notched dart points are the most frequent type (67.2%) and most fall within the range of variation of the Pelican Lake or Elko types (Chapter 6). However, since corner-notched darts were also made during the Early Archaic period the possibility remains that some of the specimens from the S3 are much earlier. Dyck and Morlan (2001) report that arrow-sized corner-notched points do occur, albeit infrequently, in Late Archaic Pelican Lake sites. Some have suggested that these small points mark the initial use and development of the bow in North America. One small point from Block L (#20,198) may be an example of early bow use, it may be out of context, or perhaps it is just a small dart. Given the preponderance of corner-notched darts it is tempting to ascribe a similar proportion of the cultural material on the S3 to the Late Archaic period, but there are other factors, not the least of which is the subsistence focus of the inhabitants, that could have influenced the number of projectile points per occupation. The sample of corner-notched darts provides valuable information on the range of variation found within the Late Archaic. These data, combined with other sites in the Central Rockies, may provide some meaningful and objective means of distinguishing Early and Late Archaic corner-notched darts (Chapter 6).

Late Prehistoric arrow points are relatively uncommon at Game Creek. The Desert side and tri-notched specimens have already been described in the Cultural Level 7 section above. Two corner-notched arrow points were also found in Block G. A base fragment of a corner-notched arrow was also recovered from the T1 terrace during the 2002 testing.

Summary

The S3 landform could have served as the location of a base camp during one or more periods of occupation from circa 6000 cal BP to 550 cal BP. On the other hand, it is equally plausible that the S3 witnessed repeated short-term occupations over several thousand years resulting in gradual accumulation of artifacts that, when inseparably mixed, mimic the signature of a base camp with dense and diverse tool and faunal assemblages. The large faunal assemblage found on the S3 points to hunting as the primary subsistence activity. Yet, the recovery of three manos and a pestle indicate that some degree of plant processing also occurred. Some or all of the roasting pits identified on the T3 terrace may have been associated with the occupations on the S3. Bison appears to have been the primary target species, but elk and beaver were also found in sizeable quantities in all tested portions of the landform. A small quantity of freshwater mussel shell, fish bone and one net sinker evidence the exploitation of aquatic resources. Although the fish bone could not be identified to species, Cutthroat trout and possibly Mountain

Whitefish are known to have been present and harvested in Jackson Hole by the Shoshone in Historic times (Baillie-Grohman 1882:217-218; Haines 1955:97; Raynolds 1868:95). Features 12, 14 and possibly 13, as well as the thousands of pieces of fire-cracked rock, and pulverized bone, indicate that marrow extraction and intensive bone grease production occurred during at least one of the occupations. Similar concentrations of features, fire-cracked rock and fragmented bone have been found at numerous sites in the Central Rockies and reflect the persistent and intensive exploitation of medium and large artiodactyls as well as a wide range of smaller fauna.

Summary of the Occupational History at Game Creek

The excavations at Game Creek produced evidence for nineteen components, 10 of which are supported by multiple radiocarbon dates, spanning much of the prehistoric period (Figure 5-72). Even with high precision AMS dates, the age estimates for these components, calculated at 2σ, span 100-400 calibrated years. Consequently, it is likely that multiple components are represented in some of the pooled mean dates. Moreover, it is probable that some of the components at Game Creek were not sampled or if they were produced few or inadequate datable remains. With these limiting factors taken into consideration, there is solid evidence for intermittent occupation of Game Creek during much of the last 10,350 years.

Cultural Levels 1 and 2 contained the bulk of the Late Paleoindian assemblages at Game Creek. The sample of radiocarbon dates from Cultural Level 1 indicates that the initial occupation of the site occurred no later than 10,391±61 cal BP. Most of the evidence for the Cultural Level 1 component was found in the eastern half of Block A and around Block I. There may have been earlier ephemeral occupations associated with a Haskett component west of Block D, but no conclusive data was collected to confirm this. This occupation coincided with an early Holocene peak in human populations in the Central Rockies. The circa 10,300 cal BP peak was immediately followed by a period of population decline. The 10,207±68 cal BP date from TU10 shows that there was another component during the period of decline, but little data was recovered from Block B to elaborate on the nature of that occupation. Populations in the region began to increase again after 9900 cal BP. The three dates from Cultural Level 2, the densest occupation on the T3 terrace, indicate that the site was again occupied around 9660±53 cal BP. The evidence seems to suggest that there were multiple short-term occupations probably occurring over a relatively brief period around Blocks A, D and I. Three features were identified in Cultural Level 1 (Features 4, 6 and 11). Features 4 and 11 appear to have been simple unlined surface hearths. Spatial analysis of analytical nodules and thermally altered artifacts confirm patterns consistent with hearth-centered use of space. There was some degree of post-depositional mixing that prevented the complete segregation of artifacts between Cultural Levels 1 and 2. Nevertheless, at least one projectile point similar to the unnamed fishtail variety recovered from Mummy Cave Cultural Layer 4 (Husted and Edgar 2002;

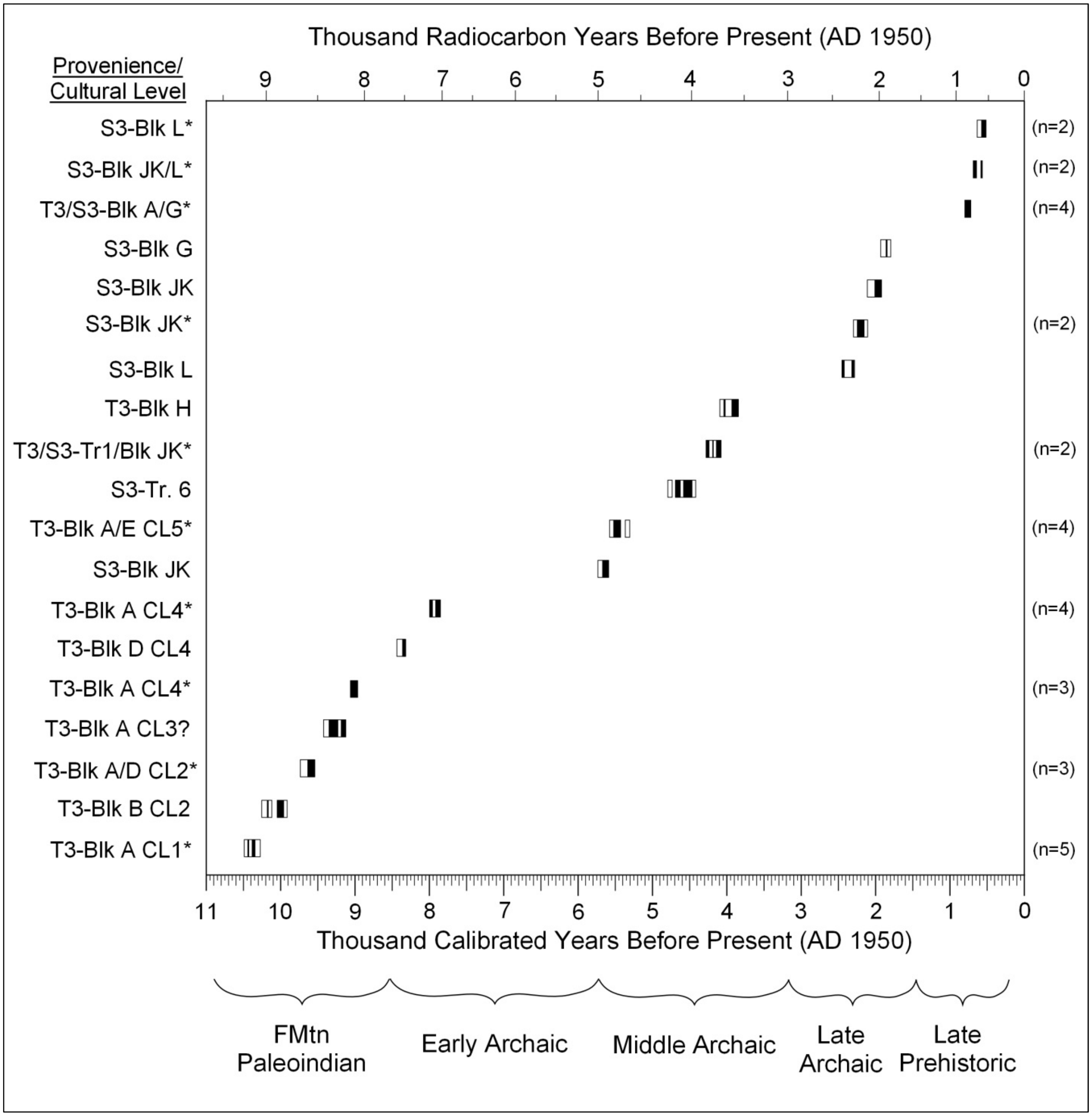


Figure 5-72 Probability block plots of calibrated radiocarbon dates at Game Creek. Plots denoted with an * are pooled mean dates. The number of dates included in the pool is listed at the right of the figure. The bone dates from Cultural Level 4 are excluded. Calibrated at 2σ using CALIB 7.0.4, Intcal13 calibration curve (Stuiver and Reimer 1993; Reimer et al. 2013).

Larson 2012). Three projectile point fragments were also recovered from Cultural Level 2, two of which conform closely to the Angostura type, and the remaining most closely resembles the Birch Creek type. Cultural Levels 1 and 2 produced a small but markedly diverse faunal assemblage containing bison, deer, pronghorn, beaver, porcupine and rabbit. The low diversity of tools and sparse faunal remains suggest that the site served as a temporary hunting camp. The multiple high precision AMS dates from relatively good context make Cultural Levels 1 and 2 some of best dated Late Paleoindian components in the Central Rocky Mountains.

The terminal Paleoindian occupation(s) of the site were confined to Cultural Level 3 and 4. The former level produced only a scatter of artifacts and an Allen projectile point. There may have been a small ephemeral hearth in Block A, which is a possible source for a 9305±81 cal BP date found about 30 cm below in Cultural Level 1. Bracketing radiocarbon dates place the occupation at sometime between 9650 and 9000 cal BP. There was a concentration of debitage and a few stone tools found within this level in Block I. One of the tools is a bifacial drill. Given the low frequency of artifacts, dearth of tools and apparent lack of features, it would appear that the T3 terrace at Game Creek served as a short-term hunting camp.

There is evidence for at least three occupations in Cultural Level 4. The earliest, dated to circa 9000 cal BP, produced a small assemblage of Lovell/Pryor stemmed points and a small faunal assemblage that included at least one bison. One small fragment of a metate was also found, but the scarcity of artifacts indicates that the occupation was either an ephemeral hunting camp or perhaps a secondary base camp centered in a part of the site not excavated.

There is a 500 calibrated radiocarbon year hiatus in the occupation of Game Creek following the Lovell/Pryor component in Cultural Level 4. This break in the sequence corresponds to the post-Paleoindian population crash reflected in the radiocarbon record (Kelly et al. 2013; Surovell et al. 2009). The decline of Foothills-Mountain Paleoindian populations appears to have occurred gradually with steadily decreasing growth rates that coincided with steadily decreasing rates of effective moisture. At around 8750 cal BP the population appears to have completely collapsed.

At around 8400 cal BP Game Creek was again inhabited, probably as a temporary hunting camp. Evidence of this occupation was recovered from Block D and consisted of a fire-cracked rock feature (Feature 8), a concentration of debitage, a few stone tools and a complete projectile point. Although only a small portion of this component was tested, it is the oldest well-dated Early Archaic components identified in all of western Wyoming. Slightly later occupations are documented elsewhere (Chapter 3), but Game Creek is the first to produce a diagnostic artifact in firmly dated context. As limited as these data may be, they do shed some light on the temporal parameters of projectile point styles during the initial stages of the Early Archaic.

After a 300-400 year gap in the occupational sequence the T3 terrace was again visited around 8000 cal BP. Most of the artifacts from Cultural Level 4 probably date to this last occupation in evidence. Projectile points associated with this Early Archaic component closely resemble the Hanna type of the McKean complex (Frison 1991; Kornfeld et al. 2010) and/or the Elko Eared type of the Great Basin (Justice 2002). Only one side-notched dart, the prototypical Early Archaic point type (Frison 1991; Kornfeld et al. 2010), was recovered from the T3, but it was out of context. The small number of Early

Archaic side-notched points from the S3 may be related to the T3 Cultural Level 4 occupations. A radiocarbon date on charcoal collected from 80 cmbs in Trench 6 on the S3 in 2004 is statistically the same as the dates from Block A Cultural Level 4, but none of the side-notched darts were associated with the date and it is unclear from which stratum the charcoal was collected. A sizeable faunal assemblage containing bison, elk and deer was also found in the latest occupation of Cultural Level 4. Although no features were identified there were several diffuse scatters of fire-cracked rock, which suggests that roasting pits or stone boiling features are present on the T3. A mano was also collected from Cultural Level 4 indicating some processing of seeds. The data indicate that the T3 terrace served as a base camp during the latest Cultural Level 4 occupation.

There is a 2100 calibrated year hiatus in occupation at the site following the circa 8000 cal BP occupation in Cultural Level 4. This gap corresponds with most of the Holocene Climatic Optimum. There was a decline in human populations in the Central Rockies between 7500 and 6900 cal BP, followed by an increase between 6900 and 6300 cal BP (Chapter 3). There was a corresponding increase in the gravel fraction of slopewash sediment on the T3 at Game Creek that likely reflects decreased vegetation and denudation of the adjacent hillside. It is possible that there were occupations dating to this period at Game Creek, but subsequent migration of the Snake River Channel, perhaps exacerbated by the Devil’s Elbow flood, may have removed these cultural deposits. It is also possible that the decrease in effective moisture between circa 9000 and 5600 cal BP reduced the carrying capacity of southern Jackson Hole making Game Creek a less desirable place to live.

The next occupation in evidence, Cultural Level 5, produced relatively few artifacts. A large roasting pit (Feature 7) discovered in Block A and a scatter of fire-cracked rock in and around Block E indicates that the landform served as a special use activity area for the processing of roots and tubers. The Cultural Level 5 occupation is dated to about 5520 cal BP. One of the radiocarbon dates from the S3 is just slightly older than the dates from the T3, which may indicate that both landforms were utilized during the Cultural Level 5 occupation. There was a small faunal assemblage that contained bison, elk and beaver bones. Three diagnostic artifacts were recovered and all again closely resemble the Hanna type.

There was another occupational hiatus of approximately 500 years following the Cultural Level 5 component. Again it is possible that this gap is the result of erosional processes because overall this period witnessed a steady increase in human populations in the Central Rockies and adjacent regions associated with the development and spread of the McKean Culture complex.

Cultural Level 6 was very similar to Cultural Level 5 in that it produced a small artifact assemblage and widespread evidence for root and tuber processing. Two roasting pit features (Features 5 and 10) were found in this level, but given their poor state of preservation and lack of associated artifact assemblages neither was dated. It is possible that Feature 1, found during the 2002 testing and dated to 4288±74 cal BP, dates the Cultural Level 6 occupation. One of the dates from the S3 is statistically the same as the date from Feature 1 and may indicate that the S3 served as the residential camp with which the roasting pits were associated. A slightly later date (3970±64 cal BP) was obtained from Block H on the T3. Thus, it is likely that there were multiple occupations at Game Creek during the Middle Archaic period. The small assemblage of stemmed Duncan/Gatecliff and/or McKean Lanceolate points found on the S3 may well have been deposited during these occupations.

The radiocarbon dates indicate that there was a circa 1400 calibrated year break in the occupational sequence between 3850 and 2450 cal BP. There were steady declines in human populations throughout most of western Wyoming during this time. However, the demographic reconstruction of the Central Rockies indicates that there was a dramatic increase in human populations during the first half of the period, circa 3800-3100 cal BP. At least two other sites in Jackson Hole, 48TE1079 and 48TE509 (Lawrence site) have components dated to this time, but most of the sites are in the Yellowstone Plateau (Chapter 3). This period of increased population growth coincided with climatic drying trend in the Central Rockies resulting in decreased winter snow accumulation that may have allowed greater hunting opportunities. The lack of an occupation at Game Creek dating to this period is therefore somewhat surprising.

Between 3100 cal BP and 2700 cal BP populations in the Central Rockies began to decline, which coincided with a return to near modern effective moisture in the region. Populations appear to have rebounded following yet another decline in effective moisture in the region. The inverse correlation between population growth and effective moisture from 3850 to 2000 cal BP in the Central Rockies may reflect emigration from surrounding regions that were adversely impacted by the drying trend. This is essentially the same hypothesis Husted (1969) and Benedict (1981) proffered regarding Early Archaic population shifts during the Holocene Climatic Optimum. Although recent data cast doubt on Husted (1969) and Benedict's (1981) "Mountain Refugium" hypothesis as it pertains to the Early Archaic (Bender 2016; Kelly et al. 2013; Surovell et al. 2009), the underlying argument may well explain population dynamics during the Middle and Late Archaic periods in western Wyoming.

There was little evidence for occupation of the T3 during the Late Archaic period. However, there are multiple Late Archaic-aged radiocarbon dates and diagnostic artifacts from the S3. The radiocarbon record from the S3 indicates that there were at least four components between 2350 and 1880 cal BP (Figure 5-72). Corner-notched Pelican Lake/Elko dart points are the most numerous diagnostic artifacts at Game Creek, which suggests that the Late Archaic occupations were intensive as well as redundant. Much of the faunal assemblage from the S3 probably dates to these occupations. The evidence shows a clear focus on the exploitation of high-value big game species, predominantly bison. The two features and numerous concentrations of pulverized faunal remains indicate that bone was intensively processed for marrow and grease, a pattern seen in many sites throughout the Central Rockies (Kornfeld et al. 2010). The remains of one eight month old fetal bison were found on the S3, which indicates a late winter through spring occupation. The poor integrity of the S3 cultural deposit precludes assignment of the fetal remains to a particular component, but three of the four Late Archaic-aged dates correspond with a period of decreased effective moisture that likely resulted in a decrease in snowpack and/or duration of snow cover. Thus, the climate of Jackson Hole during the Late Archaic occupations may have been more amenable to winter habitation than at present. There were also several pieces of groundstone found on the S3 as well as a bone digging stick tip that suggest some degree of plant resource exploitation. Moreover, some of the vast quantity of fire-cracked rock found on the S3 could have been associated with roasting pits and plant processing. If so, then there may have also been spring-summer occupations on the S3 landform as well. The wide range of functional tool types and enormous quantity of debitage and bone recovered from the S3 indicates that the landform likely served as a primary base camp during the Late Archaic. Then again, it is possible that these artifacts accumulated slowly over thousands of years of ephemeral site use and only mimic the signature of a base camp.

Despite evidence for a mild climate with effective moisture and temperatures near the historic mean, as well as evidence for dramatically increasing human populations throughout western Wyoming, there is no evidence for human occupation at Game Creek from 1800 cal BP to 800 cal BP. There is some indication of a population decline following a circa 1350 cal BP peak, but there has been a well-documented bias against dating Late Prehistoric sites in Archaeology that may very well have influenced the data. Nevertheless, the absence of occupations at Game Creek during this period is somewhat surprising and may well be the result of sampling at the site. There is evidence of a component that may date to this period on the T1 terrace (Eakin and Eckerle 2004), but this area was not included in the data recovery excavations.

The beginning of the Late Prehistoric period in the Wyoming is demarcated by the appearance of arrow-sized points and/or pottery, an event somewhat arbitrarily set at circa 1450 cal BP (Kornfeld et al. 2010). The earliest arrow points in the region are loosely affiliated with the Avonlea culture complex. The Wardell site in the upper Green River Basin contained a stratified bison bone bed with hundreds of Avonlea points and produced three standard radiocarbon dates with calibrated ages ranging from 1700 to 692 cal BP several. According to Connor (1998) there have been Avonlea points found in Jackson Hole, but no evidence was recovered from Game Creek. The other early style of arrow point more closely resembles a miniature Pelican Lake dart point and is commonly referred to as the Rose Spring corner-notched type. This style of point appears as early as 1700 cal BP in Idaho, and around 1300 to 900 cal BP at Mummy Cave and continued to be produced until historic contact in some places (Holmer 2009).

Four Rose Springs points were found on the S3 at Game Creek. Unfortunately, the integrity of the deposit precludes a thorough assessment of the component. Yet, the rarity of the point style suggests that the occupations dating to this period were few and or brief and may either be associated with the circa 800 cal BP radiocarbon dates from the T3 and S3 or from an undated component perhaps located on the

T1 terrace where another Rose Springs point was recovered in the 2002 testing.

The final prehistoric occupations at Game Creek were contained within Cultural Level 7. There was little evidence for occupation on the T3 terrace, but the remains of a bison kill was found on a small remnant of the T2 terrace at the south end of the site. The northern half of Block G on the S3 contained most of the artifacts associated with the Late Prehistoric occupation(s). Most of the Cultural Level 7 deposit on the S3 is likely associated the Desert side and tri-notched points found within or immediately above or below the level. There was evidence of a feature that was used in bone grease production. Although no radiocarbon dates are available from Block G Cultural Level 7, two sets of dates from other parts of the S3 provide evidence for occupations at 669±36 cal BP and 554±36 cal BP, either or both of which may date the latest Late Prehistoric occupations that produced the Desert side and tri-notched arrow points.

There was no evidence at Game Creek for human occupation after circa 550 cal BP. This may be explained in part by climate change. With the onset of the Little Ice Age (circa 525-150 cal BP) mean annual temperatures dropped by 1-3° C in the Central Rockies. There is also evidence of decreased spring and summer precipitation that may have been offset by increased winter precipitation. There were also severe droughts in AD 1580 and AD 1717-1718. In addition to the inhospitable climate it was during this period, perhaps as early as the 17th Century that epidemic diseases introduced by Europeans began to spread through Native American populations resulting in catastrophic loss of life (Trimble 1989). Thus, it is not shocking that there was no evidence of occupation at Game Creek after 550 cal BP.

Discussion and Conclusion

The data collected from the Game Creek data recovery excavations shed considerable light on a variety of research topics including, but not limited to, those outlined in the data recovery plan. Evidence for subsistence strategies, mobility patterns, chronological variation in projectile point styles and human adaptational response to climate change were all recovered to varying degrees in the investigations. All of these topics are addressed above and will be further elaborated on in the following chapters. There were other findings, however, that have some bearing on research designs and the evaluation of the integrity of archaeological sites.

The cultural deposits Eakin and Eckerle (2004) assessed as being severely disturbed on the T3 terrace, were found to be largely intact and cultural deposits on the S3 interpreted as intact were shown to be almost completely destroyed. Eakin and Eckerle’s (2004) assessment of the integrity of deposits at Game Creek was by no means inadequate. It was, however, based on a sample too limited to fully assess the integrity of cultural deposits scattered over 34,000 m^2. The results of the data recovery excavations show that interpretations based on limited testing of a fairly large site that has complex and varied depositional and post-depositional histories are susceptible to error. It is hoped that these finding provide a cautionary note to future archaeological investigations. All archaeological sites have been impacted to some degree by post-depositional processes. Assessing these impacts is one of the primary roles of archaeological research and is absolutely essential in determining a site's eligibility to the National Register of Historic Places. Therefore, it is incumbent on archaeologists to appropriately tailor their methods to collect data that is not only pertinent, but susceptible to addressing the contextual integrity of cultural deposits. Moreover, samples must be sufficiently large to adequately account for intrasite variation in preservation before potentially detrimental recommendations are made.

In conclusion, the Game Creek site is the largest stratified archaeological site in Jackson Hole to be thoroughly excavated. In all, 191 m^2 of the site was excavated producing over 170,000 artifacts, and 47 AMS radiocarbon dates. The radiocarbon dates and diagnostic artifacts provide evidence for at least 19 cultural components reaching back 10,400 years. These data show that Jackson Hole and adjacent regions share a culture history that is distinct from the Northwestern Plains and perhaps parts of the Central Rockies as well. Moreover, the data, though limited in some respects and instances, enable us to address the subsistence practices and mobility patterns of the people who chose to camp at Game Creek throughout prehistory.

CHAPTER 6 TOOLS AND ORNAMENTS

Michael K. Page

The data recovery excavations at Game Creek resulted in the recovery of 1,202 tools, one marine shell bead and one modified bone object of unknown use (Table 6-1). The context in which most of these artifacts were found is discussed in the Chapter 5. What follows is a more detailed description and discussion of the tools and ornaments found at Game Creek. Several of the projectile points, point preforms and a possible Cody knife recovered during the 2004 testing at Game Creek are also included in the discussions that follow.

Table 6-1 Tools and ornaments recovered from the data recovery excavations at Game Creek.

Description	Cultural Level							?	Total
	1	2	3	4	5	6	7		
Projectile Point	2	3	1	9	4	2	4	87	113
Knife				2			1	8	11
Biface	4	13	2	14	2	6	16	133	190
Drill/Awl		2	2	1	3		2	4	14
End Scraper			1	1		1	2	9	14
Side Scraper				1				2	3
Spokeshave						1	1		2
Graver	1	2		2			2	6	13
Retouched Flake	10	18	9	18	11	4	13	82	165
Utilized Flake	22	52	30	71	39	16	44	374	648
Chipped Stone Subtotal	39	90	45	119	59	30	85	705	1,173
Groundstone									
Hammerstone	1	2			1			8	12
Mano				1				5	6
metate				1					1
Net Sinker								1	1
pestle								1	1
Groundstone Subtotal	1	2		2	1			15	21
Bone/Antler Tools									
Bone Awl								2	2
Bone Punch/Flaker								2	2
Bone digging stick tip								1	1
Bone flesher									
Utilized Bone							2	1	3
Unidentified bone tool								1	1
Antler Tool								1	1
Bone/Antler Tools Subtotal							2	8	10
Shell Bead							1		1
Total	40	92	45	121	60	30	88	728	1,204

Projectile Points

The projectile point assemblage from Game Creek is large and diverse with specimens from most of the major cultural periods (Table 6-2). There are 14 projectile point fragments, representing 12 separate specimens that, because of stylistic traits and/or stratigraphic position, are believed to be related to several Paleoindian complexes. All of the Paleoindian points were found on the T3 terrace, and several were recovered in direct association with radiocarbon dates. As is typical, the Early Archaic assemblage, though containing only 16 specimens, displays a wide range of variation (Francis and Widman 1999; Kornfeld et al. 2010; Larson 2012) including stemmed, corner-notched, side-notched and corner-notched bifurcated base forms. Yet, the Game Creek assemblage is somewhat unique in having a relatively low proportion of the classic Early Archaic side-notched dart types. Moreover, corner-notched bifurcated-base points, or Elko Eared, were common and recovered from well dated contexts. The Game Creek Early Archaic point assemblage also contains a complete specimen of an uncommon and poorly-dated broad stemmed point type in direct association with one of the oldest Early Archaic radiocarbon dates from western Wyoming. The Middle Archaic assemblage contained 10 Duncan/Gatecliff stemmed points and one McKean/Humboldt lanceolate, but all were found in disturbed contexts on the S3 landform. The Late Archaic point assemblage was the largest at the site represented by 19 Pelican Lake/Elko corner-notched points and point fragments and two points identified as the Blue Dome type, but unfortunately all but one were recovered from disturbed, mixed contexts on the S3 landform. The Late Prehistoric point assemblage is small, but contains five corner-notched Rose Spring arrow points and seven side-notched arrow points of the Desert type. Despite the limitations and problems of context, the assemblage as a whole represents the best dated sequence of projectile point types thus far documented in Jackson Hole. These data show that the stylistic sequence of projectile points in Jackson Hole differs from that of the Northwestern Plains and perhaps even other parts of the Central Rockies.

Haskett

A small base fragment of a projectile point (#2) identified as Haskett was found during the evaluative testing at Game Creek (Eakin and Eckerle 2004:71). The specimen was found at the contact of strata III and IV in TU6, but patches of encrusted calcium carbonate indicate that it likely originated in stratum III and was displaced through faunalturbation. The area around TU6 proved to be one of the most heavily disturbed portions of the T3 terrace (Chapter 4). The base fragment is rather small, precluding identification of overall morphology and flaking pattern (Figure 6-1, Table 6-3). It appears to be the base of a tapered stemmed lanceolate point with a convex base and heavily ground lateral margins. The surfaces show randomly placed invasive pressure flaking and the remains of one possible percussion flake scar on the left side of one surface (Figure 6-1). Invasive pressure flaking is not typical of Haskett points, which usually display distinct collateral percussion flaking with only minor margin retouch (Holmer

Table 6-2 Projectile points recovered from Game Creek.

	Cultural Period						
Projectile Point Type	Late Paleoindian	FM Paleoindian	Early Archaic	Middle Archaic	Late Archaic	Late Prehistoric	Total
Desert Tri-Notched						4	4
Desert Side-Notched						3	3
Rose Spring Corner-Notched						5	5
Blue Dome “Side-Notched”					2		2
Elko/Pelican Lake Corner Notched					19		19
Gate Cliff/Duncan Stemmed				11			11
McKean/Humboldt Lanceolate				1			1
Bitterroot/Northern Side-Notched			4				4
Elko Corner-Notched			5				5
Elko Eared/Hanna Corner Notched			6				6
Broad Stem			1				1
Lovell/Pryor Stemmed		4					4
James Allen	1						1
Birch Creek		1					1
Angostura		4					4
Fishtail		1					1
Haskett	1						1
UID Corner Notched							10
UID Point Fragment							30
Total	2	10	16	12	21	12	113

2009). The point is made of obsidian that was sourced to the Packsaddle Creek geochemical source, which can be found in several locations of eastern Idaho, the closest of which is only about 50 km west of Game Creek.

The Haskett point type is one of several types associated with the Western Stemmed tradition (Chapter 3). Though relatively uncommon in western Wyoming, Haskett points have been recovered from the Lawrence (48TE509) site on Jackson Lake (Bartholomew 2001; Reeve 1986), the Osprey Beach (48YE409/410) site on Yellowstone Lake and from a component dated to 12,277±165 cal BP at the Helen Lookingbill (48FR308) site (Kornfeld et al. 2001). According to Holmer (2009), Haskett points continued to be produced until about 10,200 cal BP. A stage III biface (#12,139), or preform, of a Haskett point was recovered approximately 15 m east of TU6 at the contact of strata II and III in Cultural Level 1 (see below). Given the temporal duration of Haskett points, and the stratigraphic position of the preform, it is possible that the component at Game Creek is associated with Cultural Level 1, dated to 10,391±61 cal BP.

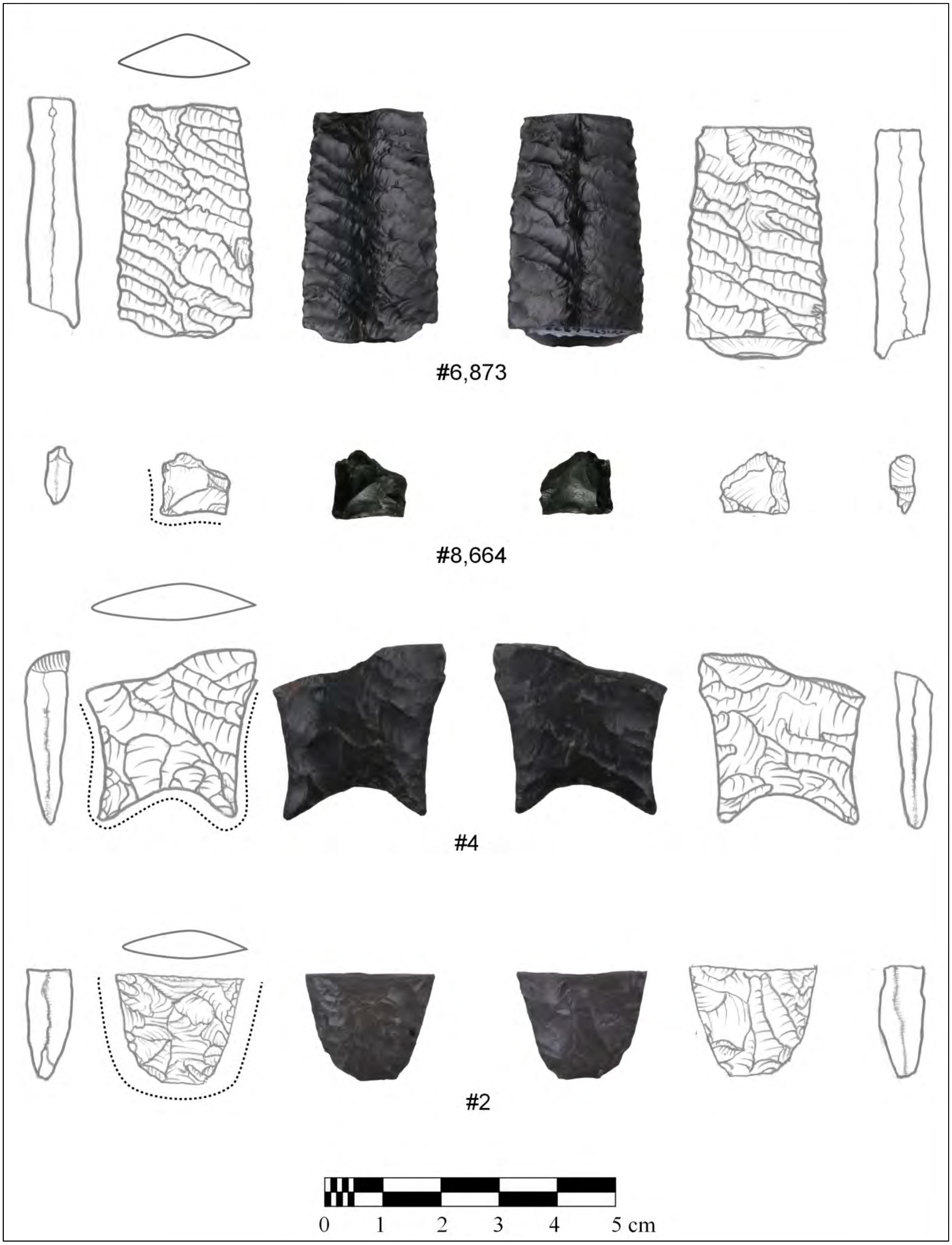


Figure 6-1 Haskett (#2) and Fishtail points (#4, 8,664, 6,873) recovered from the Game Creek site.

Table 6-3 Attributes of Paleoindian projectile points found at the Game Creek site. Measurements in mm.

Cat#	CL	Block	Unit	Type	Haft Style	Material Type	Portion	Max Length	Max Width	Max Thickness	Blade Width	Haft Width	Base Width	Base Length
9409	4	H	N445 E501	Pryor	ST	CH		32.2	16.4	5.8	15.7	13.5	13.8	13
6958	4	A	N502 E499	Pryor	ST	CH		49.5	17.4	5.2	17.4	13.5	14.2	19.5
6661	?		N495 E491	Pryor	ST	OB	BSM	42.4	22	6.1		12.1		12.2
5643	4	A	N499 E491	Pryor	IND	OB	MI	18.4	14.6	4.5				
8348	3	A	N501 E497	James Allen	ST	CH	MI	32.5	36.1	5.4				
4895	3	A	N499 E498	James Allen	ST	CH	BAS	32.5	36.1	5.4				
8499	2	A	N503 E497	Birch Creek	LNC	OB	BAS	17.9	22.7	6.4			18.3	13.4
12801	?		N559 E479	Angostura	LNC	OB	BAS	21.3	15.3	5.7				15.1
1	?		STP4	Angostura	ST	OB		32.1	17.5	5.2	16.6	15.8	12	16.4
5210	2	A	N498 E493	Angostura	IND	OB	TP	20	17.5	4				
4498	2	A	N498 E500	Angostura	LNC	OB	BSM	29	24.6	8.2	23.5	24.7	23.1	20.8
8664	1	A	N503 E497	Fishtail	IND	OB	BAS	11.8	12.9	5.8				
6873	1	A	N502 E497	Fishtail	IND	OB	MI	40.8	23.4	8.7				
4	?		Trench 2	Fishtail	ST	OB	BSM	25.5	27.1	6.3		22.1	22.4	22
2	?		TU6	Haskett	LNC	OB	BAS	16.6	20.4	6.4				

Abbreviations: Haft Style – ST=stemmed, LNC=lanceolate, IND=indeterminate; Material Type – CH=chert, OB=ob
BAS=base, MI=midsection, TP=tip; Base Shape-CC=concave, CV=convex, ST=straight; Flaking Pattern-PO=parall

Fishtail

A midsection (#6,873) and a base fragment (# 8,664) of a projectile point were found in Block A Cultural Level 1 (10,391±61 cal BP). As the two items were less than a meter apart in the same stratigraphic context and made of macroscopically identical obsidian it is likely they are fragments of the same broken projectile point. The small base fragment has heavily ground, concave, lateral margins and a slightly expanding base with small ears (Figure 6-1). The piece is too small to identify flaking pattern or type. The midsection has nearly parallel sides with very finely executed serial parallel-oblique pressure flaking with no indication of margin retouch. The midsection is relatively thick and plano-convex in cross-section suggesting that it was manufactured from a large flake blank (Table 6-3). The broken edges of the midsection show bending fractures that are indicative of an impact break (Bradley 2013).

A more complete specimen of what may be the same point type was found in the backfill of Trench 2 near what later became Block A (Eakin and Eckerle 2004). The point was encrusted with calcium carbonate, which suggests that it originated in stratum III (Eakin and Eckerle 2004:71). The specimen (#4) is a base-midsection fragment made of locally available Crescent H Ranch obsidian. The point base has heavily ground, concave, lateral margins resulting in well-defined ears and a “fishtail” appearance (Figure 6-1, Table 6-3). Like the point fragments recovered from Cultural Level 1, the specimen is relatively thick and plano-convex in cross-section and has a serial parallel-oblique flaking pattern on both faces. There is a percussion flake scar remaining on the flatter face of the specimen. Noninvasive pressure flaking was used to form the ears, and several small margin retouch flakes occur on both faces. The bend fracture indicates the point broke during impact or perhaps by prying (Bradley 2013). Unlike, the other possible “fishtail” point, specimen #4 appears to have had ovate blade margins.

Points of this style have not been assigned a type in the Central Rockies. Larson (2012:155-156) refers to these as “unnamed Foothills-Mountain Paleoindian.” Others (Johnson et al. 2004:288; Sanders 2000:79) have invariably described these points as “fishtail.” This unnamed “fishtail” type should not be confused with later Lovell Constricted type, which Kornfeld et al. (2001) and Larson (2012) have also referred to as “fishtail.” Lovell Constricted points have significantly narrower hafts and shorter bases than the “fishtail” points discussed here. Fishtail points are exceptionally rare in the Central Rockies (Chapter 3), but one was recovered from the lowest cultural layer at Mummy Cave (Husted and Edgar 2002), and several more from one of the earliest components at Medicine Lodge Creek (Frison 2007). Both components have been dated to circa 10,500 cal BP, or slightly earlier than Cultural Level 1 at Game Creek (10,391±61 cal BP). Specimens have been found in undated contexts at Osprey Beach (48YE409/410 [Johnson et al. 2004]), 48YE243 (Sanders 2000) and 48FR3942 (Chapter 3).

Although there is variation in the flaking pattern, shape of the basal ears and perhaps blade shape, all of the fishtail points are thick, have concave lateral base edges, pronounced ears, are plano-convex in cross-section and occasionally display parallel-oblique flaking patterns. Some of the points, especially those from Medicine Lodge Creek and 48YE243, bear a striking resemblance to the Beaver Lake and Quad point types that date to about the same period in the Eastern Woodlands (Justice 1987). The specimens with more pointed ears, like the points from Mummy Cave, 48FR3942 and Game Creek, could almost be mistaken for the James Allen type given the expanding base and parallel-oblique flaking, but the latter type is much thinner and lenticular in cross section (Bradley 2009; Wiesend and Frison 1998). Differences in blade shape may well be due to resharpening of points in the haft, which is evident on several specimens.

Angostura/Ruby Valley

A complete, though heavily resharpened, point (#1) was found in STP4 on the T3 terrace during the initial survey at Game Creek (Eckles and Rosenberg 2002). The point was mistakenly identified as a Middle Archaic McKean lanceolate (Eakin and Eckerle 2004). The specimen is made of Teton Pass obsidian (Eakin and Eckerle 2004). It is relatively thick with ground lateral and basal margins (Table 6-3). The lateral margins taper towards the concave base (Figure 6-2). The flaking pattern is difficult to discern given the amount of resharpening. Flake scars suggest invasive pressure flaking, with minimal retouch used to fashion the base. One edge of the blade shows beveled resharpening, which is a trait most common to the Pryor Stemmed type but also documented for other Paleoindian point types (Davis et al. 1988, 1989; Frison and Grey 1980) including Angostura (Bradley 2013; Davis et al. 1988, 1989; Frison 1983).

A large point fragment (#4,498), broken distally by an impact fracture, came from Cultural Level 2 (9660±53 cal BP) in the eastern end of Block A. This specimen is made of locally available Teton Pass obsidian. The point is thick and biconvex in cross-section with a concave, heavily ground, contracting base (Figure 6-2, Table 6-3). The flaking pattern is parallel-oblique on both faces with minor margin retouch along lateral margins. On one face, the base bears the remnant of a percussion flake scar with subsequent margin and invasive retouch. The other face of the base has three invasive pressure flake scars. The base of this point is wide (23.1 mm) and markedly concave, which is unusual for Angostura points (Bradley 2013; Kornfeld and Barrows 1995; Pitblado 2003). It is possible that this point had broken and the base of the midsection/tip portion was thinned and reworked for reuse.

A tip fragment of a gray obsidian projectile point (#5,210), identified to the locally available Crescent H Ranch source, was recovered from Cultural Level 2 in the west end of Block A. The point fragment is thin, biconvex in cross-section. Serial parallel-oblique pressure flaking, with little to no margin retouch, was used to craft the specimen (Table 6-3, Figure 6-2). The overall form of the point is unknown since it is lacking most of its midsection and base. Nonetheless the stratigraphic association with point #4,498 and parallel oblique flaking pattern indicate that it was probably from an Angostura point. Several small pressure flakes of the same gray obsidian with carefully prepared oblique platforms were found near the point and likely represent the parallel-oblique thinning flakes. The presence of these

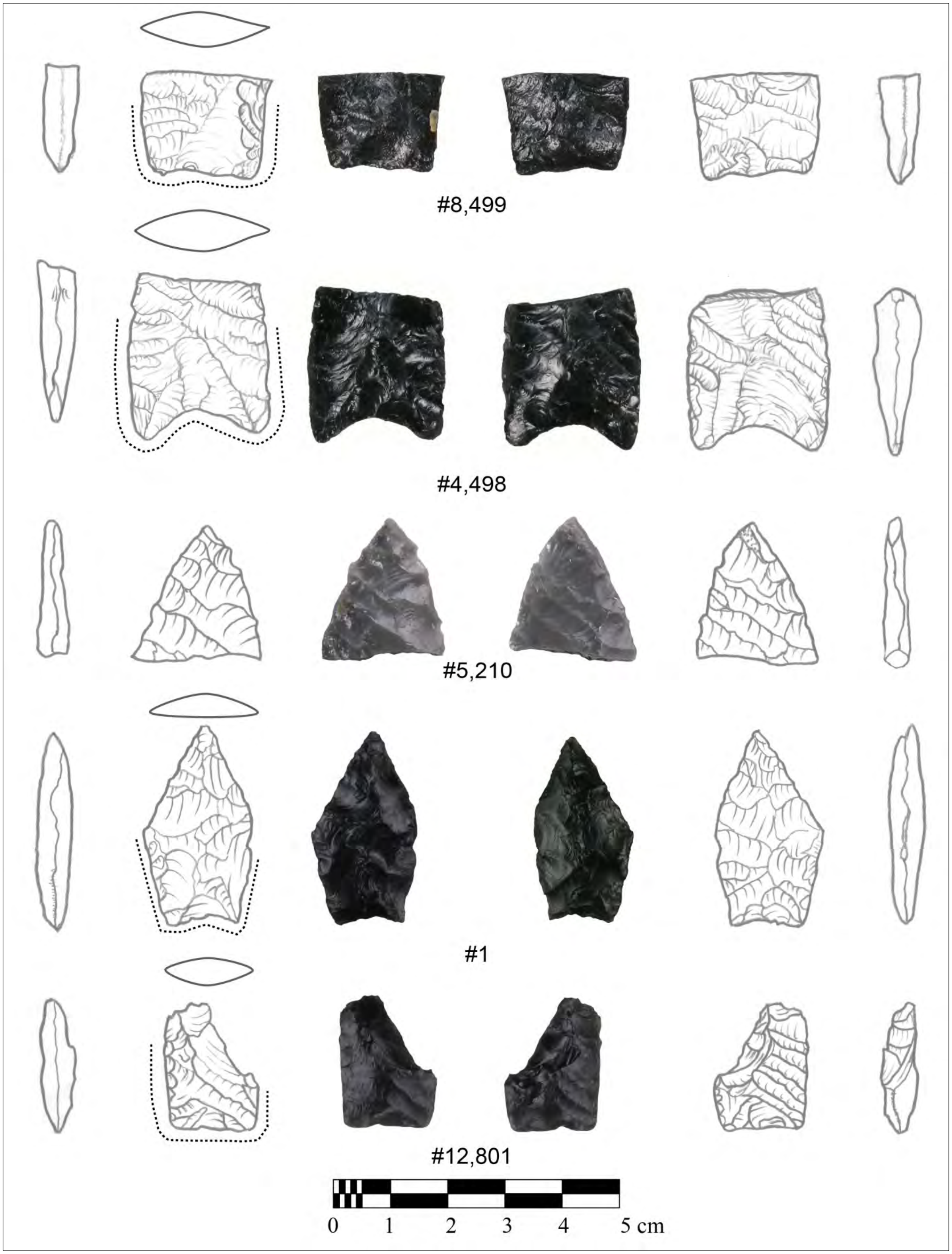


Figure 6-2 Angostura and Birch Creek (#8499) points found at Game Creek.

parallel-oblique flakes may indicate that the point broke during manufacture.

A small point base fragment (#12,801) was found in unit N559 E479 on the northeastern portion of the T3 terrace in an undated context. Subsequent excavation in the area revealed only a diffuse lithic scatter, most of which was found 20 cm above the level of the point fragment. Point #12,801 is made of Teton Pass obsidian and has ground lateral margins that taper towards a straight base (Table 6-3). Finely executed serial parallel-oblique flaking is present on both faces with some margin retouch (Figure 6-2). Unfortunately the point was damaged during excavation, which obscured the original fracture pattern. Point # 12,801 is likely an Angostura point given its form, size and flaking pattern.

The Angostura point type is the most widespread and frequently occurring Foothills-Mountain Paleoindian point type in the Central Rockies (Chapter 3). There is variation in base shape and flaking pattern within and between assemblages, but most Angostura points are relatively narrow and thick and exhibit constricting bases (Bradley 2013; Kornfeld and Barrows 1995; Pitblado 2003). Bradley (2013) argues that parallel-oblique flaking is a requisite characteristic of the Angostura type, but Pitblado (2003) expands the definition to include points with random flaking patterns. The earliest occurrence of the type is from the Barton Gulch site in Montana, dated to 10,674±227 cal BP (Davis 1989), but it continued to be produced throughout the Foothills-Mountain Paleoindian and remained a part of the toolkit even after the emergence of the Lovell Constricted and Pryor Stemmed types (Frison 1973; Frison and Grey 1980; Husted 1969; Kornfeld et al. 2002).

Birch Creek

Point fragment #8,499 is made of Teton Pass obsidian. The fragment is biconvex in cross section with an irregular shaped, heavily ground, slightly contracting base. Percussion flake scars are present on both faces, but have been obscured by subsequent, randomly placed, invasive and marginal pressure flaking (Table 6-3, Figure 6-2). This point most closely resembles the Birch Creek type, common to the Snake River Plain and surrounding mountains. The Birch Creek type is substantially similar to Angostura, except parallel-oblique flaking is absent and bases are almost invariably straight or irregular in outline (Holmer 2009; Swanson 1972). There are no well-dated and/or fully reported Birch Creek components (Chapter 3). Thus, the recovery of a Birch Creek point dating to 9660±53 cal BP in Cultural Level 2 at Game Creek provides invaluable chronometric data.

James Allen

A lateral base fragment of a projectile point made from lustrous, opaque white chert (#4,895) was recovered from a rodent burrow in Cultural Level 2 of Block A in 2010. In 2011 a conjoining midsection fragment of the same projectile point (#8,348) was recovered from intact deposits in Block A Cultural Level 3 (ca. 9660-9000 cal BP) a few centimeters below the contact of strata III and IV. The material type of this specimen was unique at the site. Not even a small flake of the same material was recovered, which

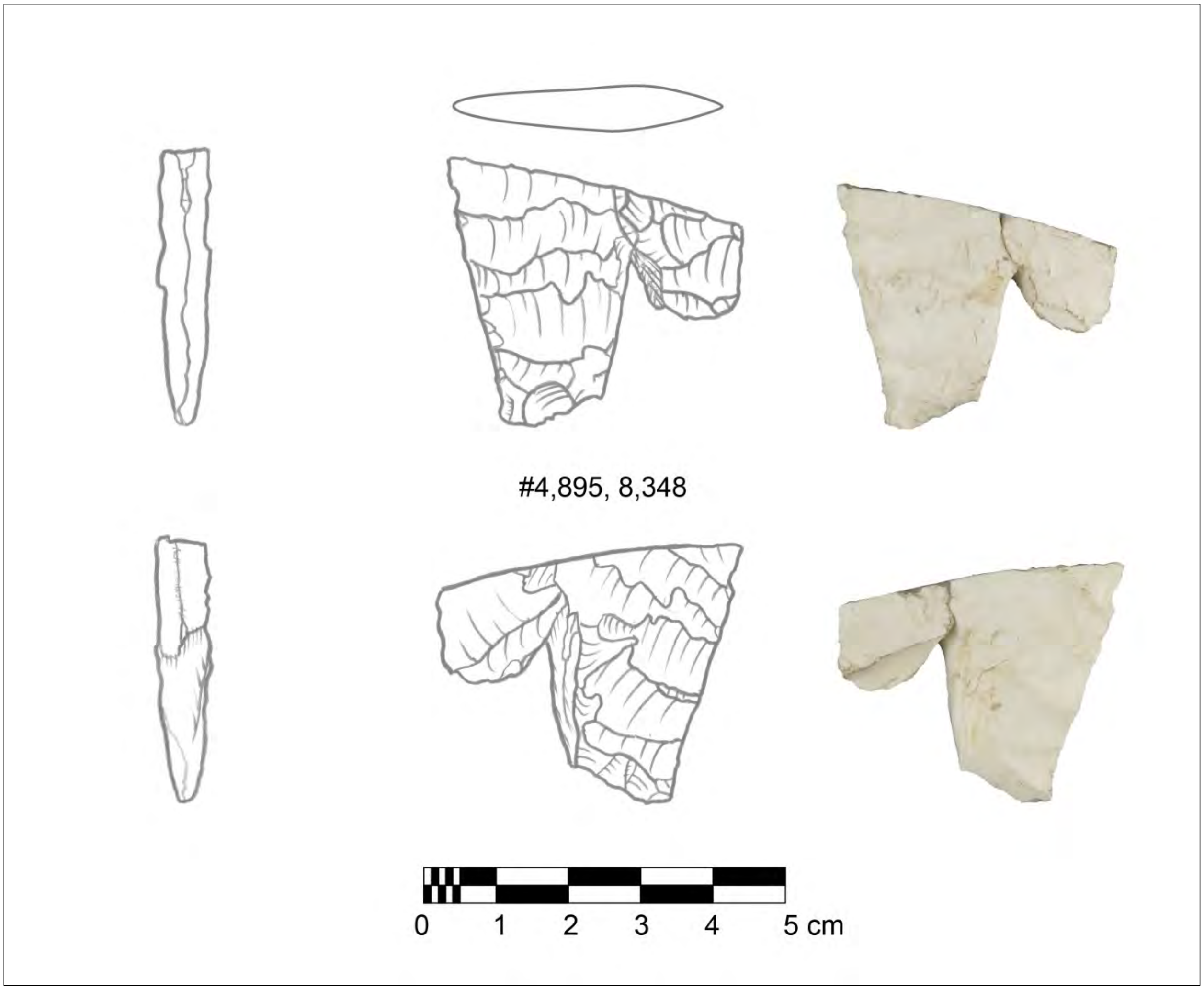


Figure 6-3 James Allen point fragment recovered from Cultural Level 3 at Game Creek.

suggests the point arrived on site in a broken condition, perhaps still partially secured in a haft. The point is thin, wide and lenticular in cross-section with what appears to be a concave, tapering base with small basal ears. (Table 6-3, Figure 6-3). The lateral margins of the base are not ground. The flaking was well-executed serial, parallel-horizontal on one face and serial parallel-oblique on the other with minimal margin retouch. Based on the bend fractures, it appears that the point broke as a result of impact (Bradley 2009).

The contracting base and parallel-oblique flaking pattern found on this specimen would, at first glance, suggest Angostura, but the specimen was more than 36 mm in width, which would make it by far the widest Angostura point documented in the region. Moreover, this point would be unusually thin (5.4 mm) for Angostura. Given the quality of workmanship and dimensions of the point, it is likely a James Allen type. James Allen points are typically, thin, biconvex or lenticular in cross-section, with serial parallel-oblique flaking. Specimens as wide as 43.6 mm have been reported. James Allen points are rare in the Central Rockies but have been reported from the Green River Basin (Wimer 2001). Cultural Level 3, from which the specimen in question originated, is bracketed by dates of 9660±63 cal BP and 9009±28 cal BP, which is within the range of dated James Allen components (10,200-8700 cal BP [Hill 2005; Hoffman et al. 1995; Katz 1973]). Evidence of bison, the target prey species of James Allen complex, was recovered from every cultural level at Game Creek. It is therefore not entirely surprising that James Allen hunters might have ventured into Jackson Hole, perhaps following migratory herds out of the Green River Basin.

Pryor Stemmed

A complete Pryor Stemmed point made of opaque brown chert, likely from the Tipton member of the Green River formation, was found in Block H Cultural Level 4 (ca. 9000-6900 cal BP). Point #9,409 has a nearly parallel- sided stem with a thinned, slightly concave and ground base (Table 6-3, Figure 6-4). Though most of the blade is missing, traces of a serial parallel-oblique flaking pattern remain. The specimen has been heavily resharpened on alternate sides creating a bi-beveled cross-section. There is a possibility that point #9,409 was out of context since the deposit in Block H from which it was recovered was approximately 50% disturbed by burrowing rodents.

A complete semi-translucent chert projectile point (#6,958) was found in Block A at the base of Cultural Level 4 in association with a date of 9009±28 cal BP. The point is biconvex in cross-section with a slightly expanding stem, deeply concave, and slightly ground base (Table 6-3, Figure 6-4). There is faint evidence of a parallel-oblique flaking pattern, though it appears that the point has been resharpened. The tip has been modified into a graver. Repurposing of points into drills or gravers is well-documented in the Pryor Stemmed complex (Davis 1991; Frison 1973; Frison and Gray 1980). This projectile point is atypical of Pryor Stemmed in that the stem is rather long and the base in markedly concave with pointed basal ears.

A Teton Pass obsidian mid-section fragment (#5,643) was found at the western end of Block A Cultural Level 4 (9009±28 cal BP) at the contact of stratum III and IV. Point fragment #5,643 is biconvex in cross-section with fine parallel-oblique flaking and slightly serrated blade edges (Table 6-3, Figure 6-4). Although this specimen is missing its base, the parallel-oblique flaking pattern and stratigraphic position would indicate Pryor Stemmed, especially given the serrated blade edge, which is a trait of Pryor Stemmed points, though more common to the south (Pitblado 2003).

A large obsidian projectile point fragment that includes most of the blade and half of the base (#6,661) was found on the surface about 5 m south of the western end of Block A. Point #6,661 has a slightly expanding stem with ground lateral margins (Table 6-3). The blade is ovate, relatively thick and plano-convex in cross-section. The specimen appears to have been crafted from a relatively small flake blank with little bifacial thinning resulting in parallel-oblique flaking on the dorsal flake surface and only a few randomly placed flakes removed from the ventral surface (Figure 6-4).

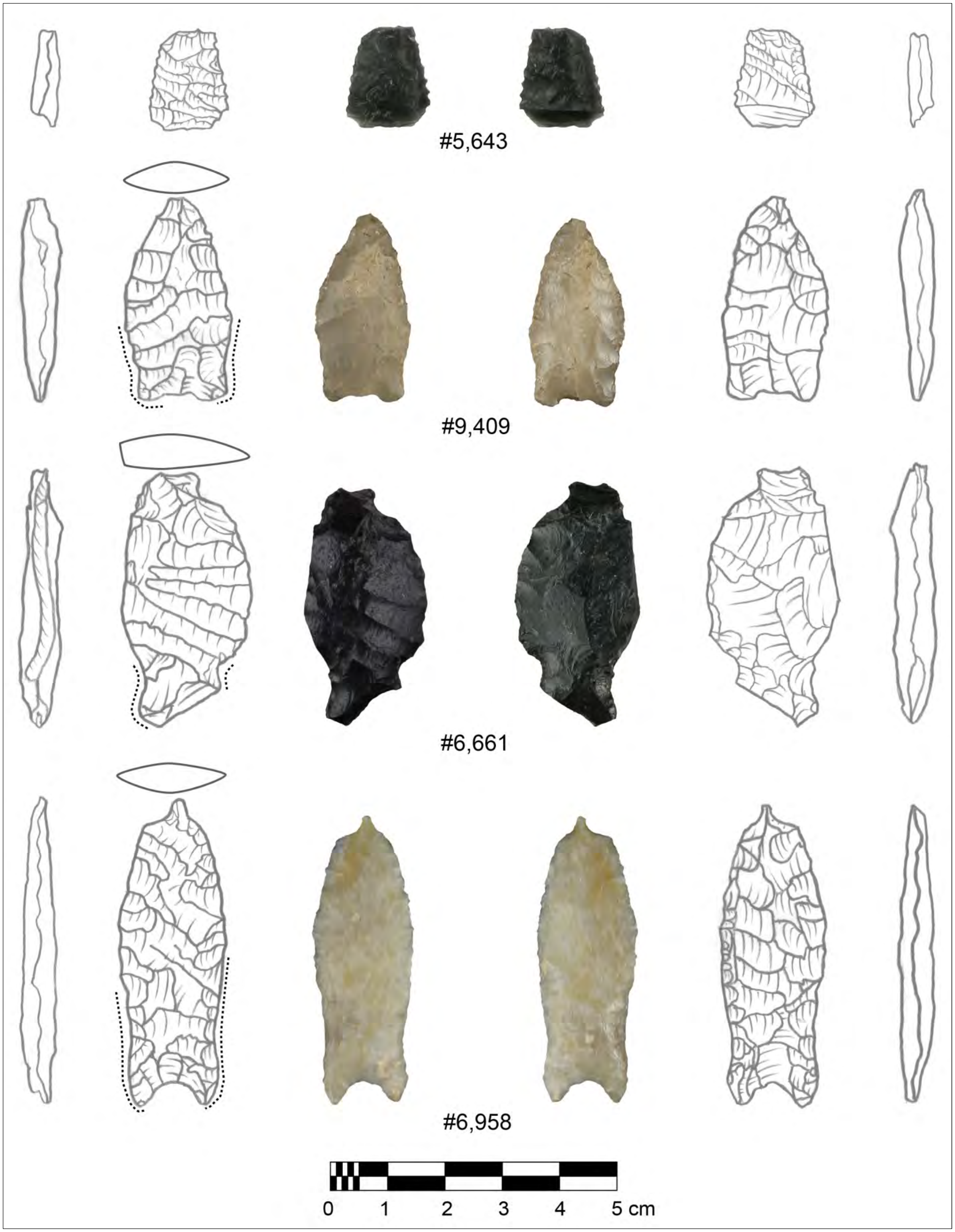


Figure 6-4 Pryor Stemmed projectile points recovered from the Game Creek site.

Figure 6-5 Photograph and illustration of Broad Stem point found at Game Creek.

Stemmed points with parallel-oblique flaking, ground basal edges and beveled resharpening characterize the Pryor Stemmed projectile point type that dates to 9500-8600 cal BP (Frison 1973; Frison and Grey 1980; Pitblado 2003:99-100). Pryor Stemmed points have been recovered from numerous sites in the Central and Southern Rockies including at least three other sites in Jackson Hole. The component at Game Creek is one of the youngest well-dated components in the region. Pryor Stemmed, along with the Angostura type, with which it frequently co-occurs, were the last Paleoindian point types produced in the Central Rockies.

Early Archaic – Broad Stem

A complete light grey meta-quartzite projectile point (#2,364) was found in Block D cultural level 4 (8390±28 cal BP). The point is biconvex cross-section, has a wide, slightly expanding, stem with a slightly convex base (Figure 6-5, Table 6-4). The blade appears to have been barbed, but the tips of the barbs have been broken. There is no discernable flaking pattern. There are percussion flake scars remaining on both faces that have been partially eradicated by invasive and marginal pressure flaking. The base was thinned by removal of a percussion flake from each face with minor margin retouch (Figure 6-5). With its barbed blade, wide and long stem, point #2,364 is dissimilar to most reported projectile points from Early Archaic contexts in the region. However, similar projectile points have been recovered from the Upper Green River basin and Bighorn Mountains (Chapter 3). These points closely conform to the Borax Lake Widestem type of northern California and surrounding regions where it has been found to be roughly contemporaneous with the Early Archaic period of the Central Rockies (Justice 2002).

Table 6-4 Attributes of Early Archaic projectile points found at the Game Creek site. Measurements in mm

Cat#	Cultural Level	Block	Provenience	Type	Haft Style	Material Type	Portion	Max Length	Max Width	Max Thickness	Blade Width	Haft Width	Base Width	Base Length
960	?		Trench 6	Northern	SN	CH	BSM	35.9	23.9	6	23.9	15	21.2	8.
1624	?		N440 E520	Northern	SN	CH	BAS	11.6	16.8	3.4		12.6		4.
18830	?	JK	N665 E426	Northern	SN	OB	BAS	12.7	14.3	5.4				3.
22439	?	L	N679 E424	Northern	SN	CH	BAS	8	16.1	3.6			16.1	6.
19302	?		N670 E428	Elko	CN	OB	CO	30	20	4.1	20	12	18.7	4.
25279	?		N685 E421	Elko	CN	OB	BAS	9	19.6	4.3		12.5	19.6	4.
11495	5	D	N464 E508	Elko	?	OB	BRB	8.8	8.2	2.5				
11041	4	E	N450 E502	Elko	?	OB	BRB	5.7	5.7	2.2				
3313	4	A	N497 E500	Elko	CN	OB	BSM	17.6	21.6	4.2	21.7	16.8	18.6	3.
10	5		TU6	Elko Eared	CNBB	OB	BAS	9.2	13.5	3.7		11	12.2	7.
1236	5		N440 E504	Elko Eared	CNBB	OB	CO	20.4	13.9	3.5	14	10.5	12.4	7.
7596	5	A	N503 E498	Elko Eared	CNBB	OB	BSM	18.7	24.8	5.8		16		8.
3056	5	A	N497 E499	Elko Eared	CNBB	OB	CO	38.6	28.9	5.6	28.9	13.8	18.1	8
2905	4	A	N496 E502	Elko Eared	CNBB	OB	BSM	16.4	17.9	6.5		13.8	17.9	8.
4609	4	A	N498 E501	Elko Eared	CNBB	OB	BAS	10	18.2	5.8		15.6	18.2	
2364	4	D	N464 E509	Broad Stem	CN	MQTZ	CO	41.7	28.6	6.1	28.6	16.3	19	11.

Abbreviations: Haft Style – SN=side-notched, CN=corner-notched; CNBB=corner-notched bifurcated base; IND=in
OB=obsidian; MQTZ=metaquartzite; Portion- BSM=base/midsection, BAS=base, MI=midsection, TP=tip, BRB=ba
ST=straight;

Early Archaic – Elko Eared

Of the 16 Early Archaic points found at Game Creek, six were identified as Elko Eared. These points were recovered from Cultural Levels 4 and 5 on the T3 terrace (Figure 6-5). All are made of obsidian, four of which were sourced to locally available Teton Pass and Crescent H Ranch varieties and one was sourced to the Malad variety found in southeastern Idaho. One point (#3,056) is nearly complete, with only minor damage to one blade edge near the tip. Another specimen (#1,236), though complete, appears to have broken and been reworked producing an asymmetrical blade edge. Two fragments (#10 and #7,596) retain the entire base and a portion of the midsection. The two remaining specimens (#4,609 and #2905) are only base fragments. All of the points have wide corner notches and concave, notched bases and distinct rounded basal corners (ears). Those with blades remaining are slightly plano-convex or irregular in cross-section (Figure 6-5, Table 6-4). The specimens appear to have been formed though percussion flaking with limited marginal pressure flake retouch. The concave bases were formed by the removal of deep percussion flakes on both faces followed by minimal retouch around haft margins, similar to the Broad Stem point discussed above.

Points of this style have been variously defined as Pinto, Elko Eared and Hanna. The Pinto type, common to the western Great Basin, where they have been dated from about 8000-5000 cal BP, though highly variable, often display barbed blades, corner notching and concave bases with pronounced, rounded basal ears (Harrington 1957; Aikens 1970; Holmer 1980; Justice 2002). Pinto points were produced through percussion flaking followed by limited margin retouch (Justice 2002), much like the Game Creek sample. Extensive reuse and resharpening of points is another characteristic of Pinto (Harrington 1957; Justice 2002), which is also a trait shared with the Game Creek assemblage. However, Pinto points are typically thicker and have wider hafts and longer bases (Justice 2002; Vaughn and Warren 1987) than the sample from Cultural Levels 4 and 5 at Game Creek.

According to Green (1975), Pinto points frequently display parallel-oblique flaking patterns that were produced using similar techniques as Foothills-Mountain Paleoindian points. A component containing stemmed points with deeply concave or notched bases and parallel-oblique flaking was found at Weston Canyon Rockshelter in southeastern Idaho dated to 7921±83 cal BP (Green 1975; Plew 2008), or about the same age as the Cultural Level 4 component in Block A from which points #4609 and #2,905 originated. However, according to Vaughn and Warren (1987), the “Pinto” points described by Green (1975) from southern Idaho do not resemble, in form or technology, the points from the Stahl site (Harrington 1957), which is the type site for the Pinto series (Justice 2002).

Elko Eared points have been found in Early and Middle Archaic contexts in the eastern Great Basin and Snake River Plain (Aiken 1970; Swanson 1972), but date to the Late Archaic in the western Great Basin (Holmer 1986; Justice 2002; Thomas 1981). Elko Eared were manufactured through randomly oriented invasive pressure flaking with subsequent margin retouch used mostly to shape the haft

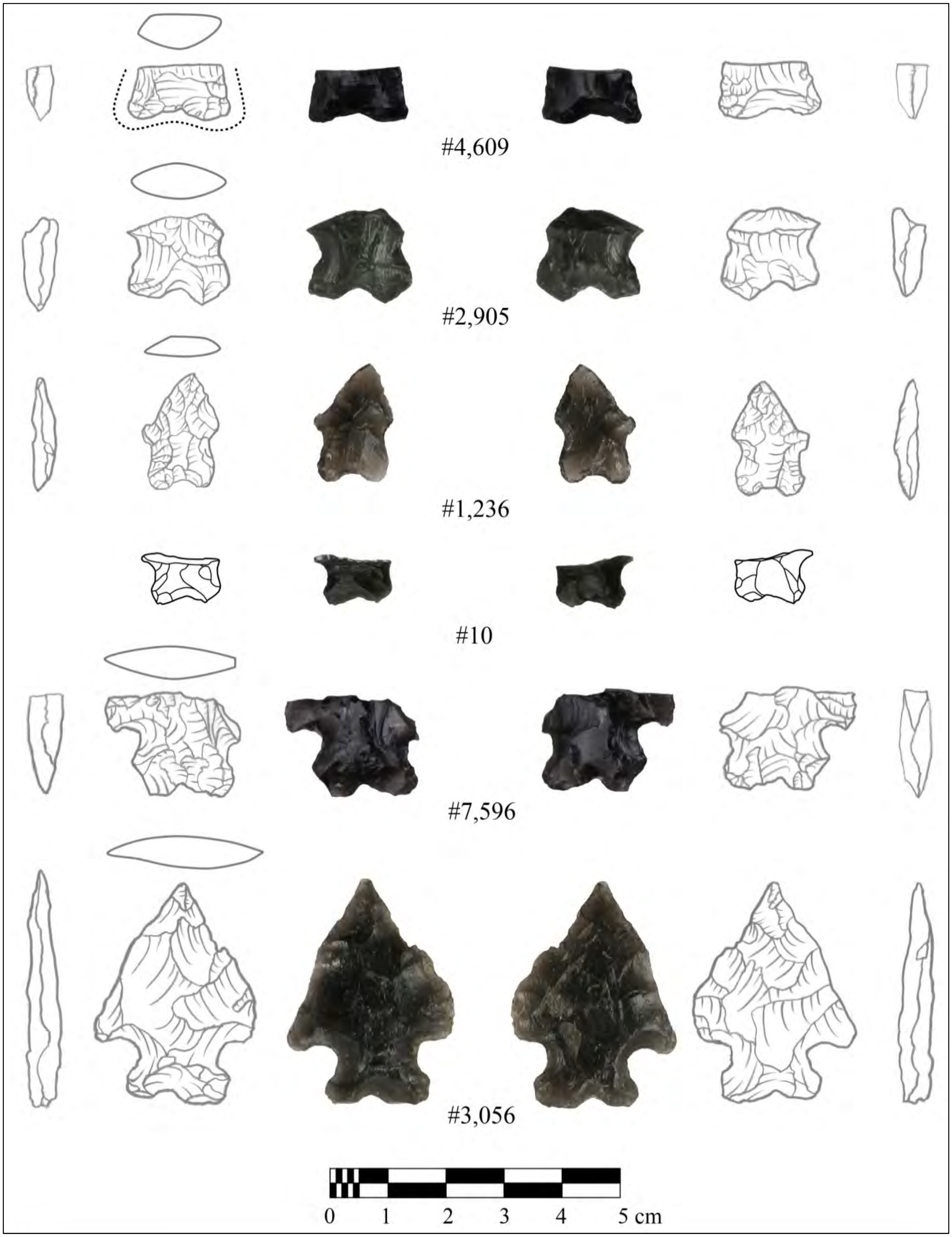


Figure 6-6 Elko Eared points recovered from Game Creek.

Justice 2002). Relatively small flake blanks were used resulting in points that are often plano-convex in cross-section, occasionally curved, with remnants of the original ventral flake surface showing on the plane face (Justice 2002). Thus, the reduction strategy and flaking pattern used for Elko Eared points does not closely resemble the sample from Game Creek. However, Elko Eared points do share many metric variables, such as haft width, thickness, base width and length.

The Hanna type is one of four projectile point styles diagnostic of the Middle Archaic McKean complex (Kornfeld et al. 2010; Wheeler 1954). Hanna points, like the other McKean complex point types- Duncan, McKean Lanceolate and Mallory - were manufactured using collateral to randomly oriented pressure flaking of either small flake blanks or from bifaces reduced first through percussion flaking (Davis and Keyser 1999; Keyser and Fagan 1993). Percussion flake scars from earlier stages of bifacial reduction rarely remain on the faces of finished specimens. The basal ears of Hanna points are not as pronounced as Elko Eared, Pinto or the sample from Game Creek. Metric attributes of Hanna points have not been reported in sufficient detail to allow for a statistical summary or comparison (Davis and Keyser 1999; Frison and Walker 1984; Green 1975; Husted and Edgar 2002; Keyser and Fagan 1993; Kornfeld et al. 1995; Webster 2004), but Hanna points are, on average, roughly the same thickness and width as the Game Creek sample (Husted and Edgar 2002). The most striking difference between Hanna points and the sample from Game Creek is age. All of the eared points from Game Creek were found in stratigraphic contexts predating 5519±86 cal BP, and two specimens were found in direct association with a mean date of 7951±23 cal BP. A recent review of radiocarbon dates from McKean sites shows that of 120 dated components from 47 sites, there are only four dates from three sites that are older than circa 5400 cal BP. All of these were standard radiocarbon dates with large standard deviations (Webster 2004). Thus, the eared points from Cultural Levels 4 and 5 at Game Creek are significantly older than Hanna points of the McKean complex.

The similarities between McKean complex Hanna and Elko Eared points warrant further investigation. It is entirely possible that they are but one “type” known by two different names. If so, then the Elko Eared/Hanna type emerged during the Early Archaic period in the eastern Great Basin and Snake River Plain (Holmer 2009). It was in use in Jackson Hole by circa 7900 cal BP and at Mummy Cave in cultural layer 16 perhaps as early as 8450 cal BP (Husted and Edgar 2002). Examples of the Elko Eared/Hanna type occur sporadically and in low frequency throughout the Early Archaic, not only at Game Creek, but in cultural layer 24 at Mummy Cave (Husted and Edgar 2002), stratum V at Trappers Point (Francis and Widman 1999), Medicine Lodge Creek (Frison 2007) and Laddie Creek (Kornfeld et al. 2010). Later, with the genesis of the McKean complex, the Elko Eared/Hanna type experienced a resurgence in use. There may be spatially and temporally significant variation in the type, but presently the data are not available to make this determination.

Although the flaking technique of the Cultural Level 4 and 5 eared point assemblages most closely conforms to the Pinto type, the size and general morphology of the specimens more closely correspond with the Elko Eared type. Moreover, the closer proximity of stratified and dated components containing Elko Eared points, such as Bison and Veratic Rockshelters (Swanson 1972), Weston Canyon Rockshelter (Holmer 2009; Plew 2008) and Wilson Butte Cave (Gruhn 1961), argue in favor of some level of cultural continuity during the Early Archaic between Jackson Hole and the Snake River Plain. Though speculative, the presence of Malad obsidian in the Game Creek assemblage lends some support to this supposition. It is possible that point #4,609, merely a small base fragment, could be affiliated with Green's (1975) "Pinto" points, given that specimens lack of distinct ears and presence of basal grinding.

Early Archaic – Corner-Notched

Two typologically similar corner-notched dart points were recovered from the S3 landform. One is complete (#19,302), and the other is a base fragment (#25,279). Both specimens have wide concave bases with pointed ears (Figure 6-7). The complete point has ovate blade edges and a horizontal lower blade edge. Pressure flake scars, both invasive and margin retouch, cover the surfaces of both points. These points closely resemble specimens found in Cultural Levels 1 and 2 (ca. 7500-6500 cal BP) at Goff Creek (Page 2016) and cultural layers 16 (ca. 8400 cal BP) and 24 (ca. 6100 cal BP) at Mummy Cave (Husted and Edgar 2002). Although there is overlap in the ranges of variation of Early Archaic and Late Archaic corner-notched dart assemblages, Early Archaic specimens have bases that are nearly as wide, or wider than the blade, shallower and wider notches, higher proximal shoulder angles (ca 133°), and more frequently exhibit concave bases (Page 2016). Points such as these have not been named, but some are similar to the Blackwater "Side-Notched" type found in cultural layer 16 at Mummy Cave. Yet, these points would also fall into the Elko Corner-Notched type as defined by Holmer (2009) and Justice (2002).

A corner-notched projectile point, broken distally and reworked into a scraper (#3,313), was collected from Block A cultural level 4. Point #3,313 is rather crudely made, plano-convex in cross-section, with much of the ventral side of the flake from which it was struck still present on one face (Figure 6-7). It may not have been intended for or used as a projectile point. The corner notching is shallow and not particularly representative of Early Archaic corner-notched darts (Page 2016). Lastly, two small barb fragments of corner-notched points were also found in Cultural Levels 4 and 5 and are therefore likely date to the Early Archaic (Figure 6-7, Table 6-4), but it is unclear whether they came from Elko Eared or corner-notched points.

Early Archaic – Bitterroot/Northern Side-Notched

Four points or point fragments with side-notching were recovered from Game Creek (Table 6-4, Figure 6-8). All but one of the points was found on the S3 landform in disturbed contexts. Point #1,624 was found in a rodent burrow in unit N440 E520 near the spring at the south end of the T3 terrace. Three

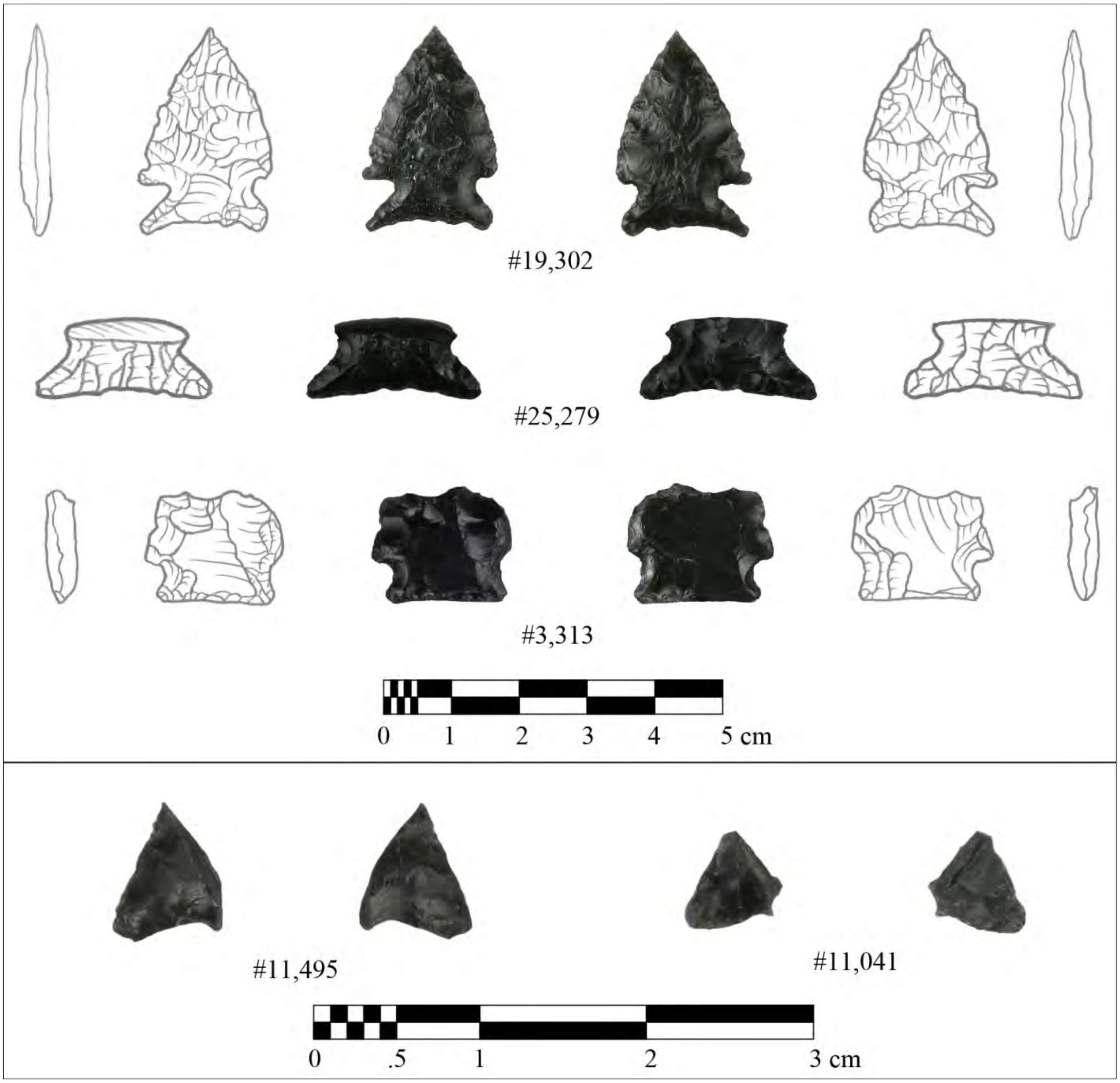


Figure 6-7 Corner-notched darts recovered from Game Creek that are believed to date to the Early Archaic.

of the four specimens are made of chert - unusual for the Game Creek chipped stone assemblage which is over 90% obsidian. The points have straight to slightly convex basal edges. The basal margins of one specimen (#18,830) are ground.

Despite the common occurrence of side-notched dart points in Early Archaic contexts throughout the region, this type was underrepresented in the Game Creek assemblage. Several types have been coined for Early Archaic period side-notched darts, such as Northern, Bitterroot, Elko, Pahaska, Blackwater, Lookingbill and Hawken. As with other Early Archaic types, there is a clear need for further research into variation within and between types. Side-notched dart points have been recovered from

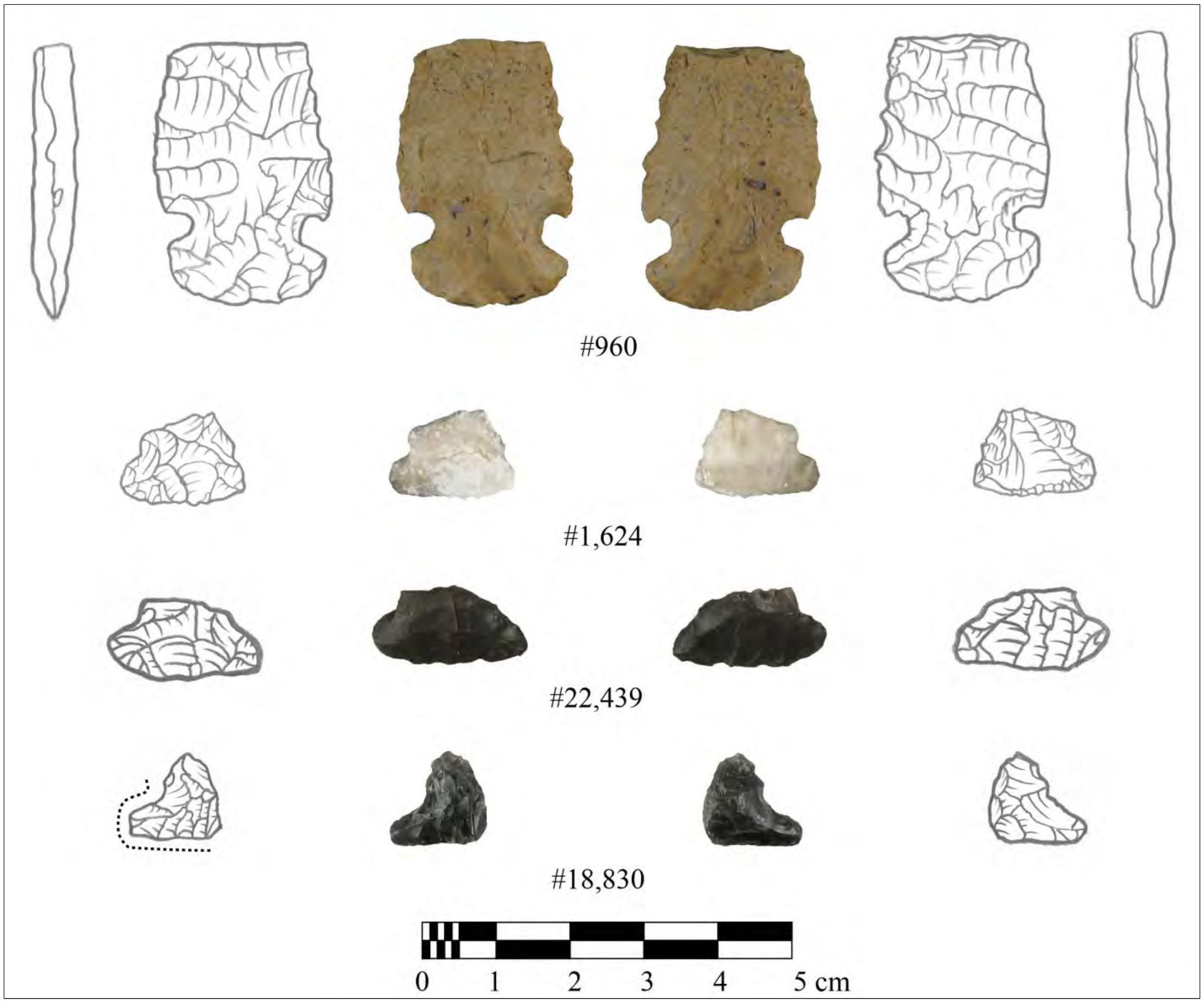


Figure 6-8 Early Archaic side-notched darts recovered from Game Creek.

numerous components throughout the Central Rockies and surrounding region in contexts dated from roughly 8400 cal BP to 5700 cal BP (Francis and Widman 1999; Holmer 1986, 2009; Husted and Edgar 2002; Kornfeld et al 2010; Page 2016).

Middle Archaic – Duncan/Gatecliff Stemmed and McKean/Humboldt

Stemmed dart points comprise the second most numerous point type in the Game Creek assemblage. In all, 10 fragmentary points were found in disturbed contexts on the S3 landform. Seven of the 10 points are made of obsidian, two of which were sourced to Teton Pass. The remaining three points are made of chert, silicified wood and Tensleep quartzite. One specimen is nearly complete, missing only the tip; three are base and midsections, and the remaining six are base fragments. Blades on the more complete specimens are plano-convex in cross-section with slightly ovate blade edges and barbs (Figure

Table 6-5 Attributes of Middle Archaic stemmed and lanceolate points recovered from G

Cat#	Block	Unit	Type	Haft Style	Material Type	Portion	Max Length	Max Width
22951	L	N679 E426	McKean/Humboldt	LNC	OB	CO	53.1	17.6
30061		N696 E426	Duncan/Gatecliff	ST	SWD	BAS	12.3	12.7
26519	G	N690 E422	Duncan/Gatecliff	ST	OB	BAS	10.7	17.2
23135	L	N679 E427	Duncan/Gatecliff	ST	OB	BAS	17	15.5
21865	L	N679 E422	Duncan/Gatecliff	ST	OB	BAS	13.7	15.3
20588		N677 E421	Duncan/Gatecliff	ST	OB	BAS	13.1	13.8
1565	G	N691 E421	Duncan/Gatecliff	ST	OB	BAS	15.3	16.4
23011	L	N679 E427	Duncan/Gatecliff	ST	CH	BASM	33.9	27.4
17664	JK	N663 E425	Duncan/Gatecliff	ST	OB	BASM	22.3	22.3
17192		N659 E429	Duncan/Gatecliff	ST	MQTZ	BASM	42.8	26.2
19694		N673 E427	Duncan/Gatecliff	ST	OB	CO	30.6	17

Abbreviations: Haft Style – LNC=lanceolate, ST=stemmed; Material Type – CH=chert, OB=obsi
BSM=base/midsection, BAS=base; Base Shape-CC=concave, NCH=notched.

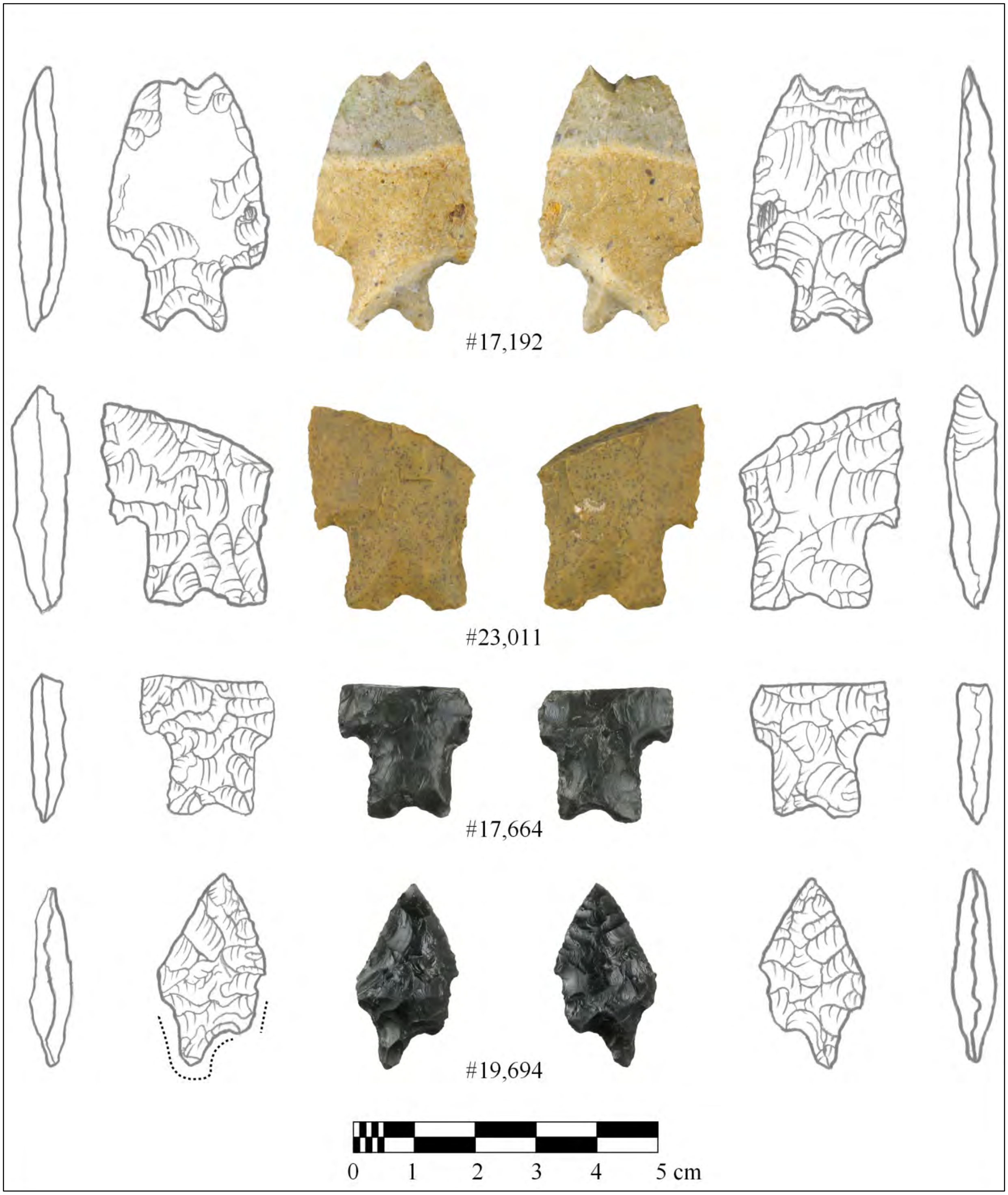


Figure 6-9 Middle Archaic Duncan/Gatecliff stemmed projectile points recovered from Game Creek.

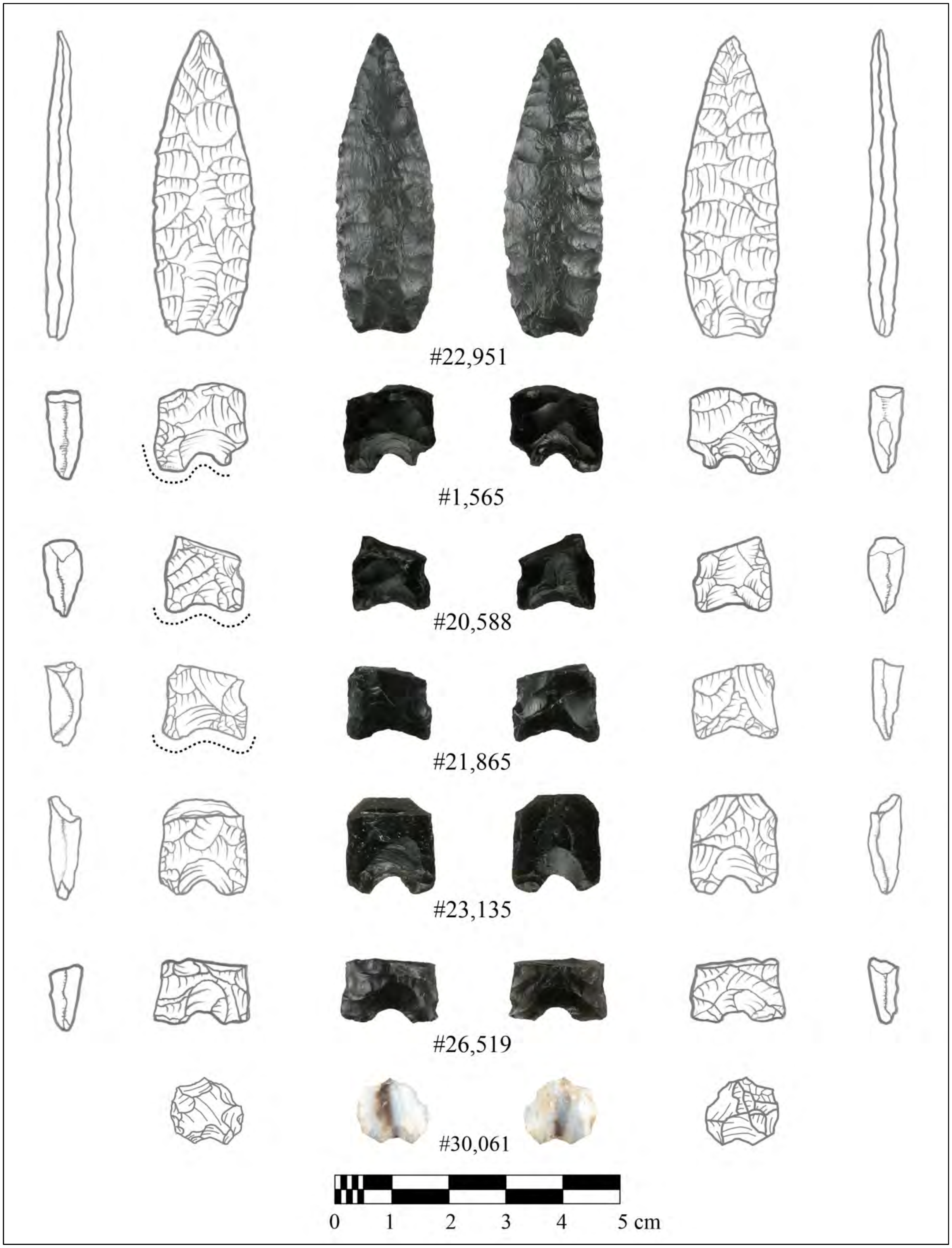


Figure 6-10 Middle Archaic Duncan/Gatecliff stemmed and McKean/Humboldt lanceolate points recovered from Game Creek.

6-8). One of the base/midsection fragments appears to have been broken and resharpened creating an asymmetrical blade edge. Stems are on average slightly expanding with proximal shoulder angles of between 80° and 103°, and all have pronounced concave or notched bases (Figures 6-9 and 6-10, Table 6-5). A slight amount of grinding was found on four of the point bases. No discernible flaking pattern is evident. The points appear to have been produced using bifacial percussion flaking followed by invasive pressure thinning and marginal retouch to shape the haft.

One complete lanceolate point, made of Crescent H Ranch obsidian, was found on the S3 landform in disturbed context. The specimen is well made, biconvex in cross-section with ovate blade edges and a contracting concave base (Figure 6-9, Table 6-5). Well-executed invasive pressure flake scars cover both faces with some marginal retouch noted near the tip and base. The tip may have been resharpened resulting in a slightly asymmetrical outline.

Stemmed points such as these date to the Middle Archaic period and are known as Duncan on the Northwestern Plains and Central Rockies where they comprise one of the four types of projectile points diagnostic of the McKean complex (Wheeler 1954). In the Great Basin and Snake River Plain this type is called Gatecliff Split-stem (Holmer 2009; Justice 2002; Thomas 1981). Lanceolate points are called McKean lanceolates on the Northwestern Plains and Central Rockies (Keyser and Fagan 1993; Kornfeld et al. 2010; Wheeler 1954) but are known as Humboldt in the Great Basin (Aikens 1970; Holmer 1980; Justice 2002; Thomas 1981). Humboldt points from the Great Basin often, though not invariably, display parallel-oblique flaking (Green 1975; Justice 2002). Both the stemmed and lanceolate types have been recovered from numerous stratified sites dated from roughly 5700 cal BP to about 3200 cal BP. Although the contextual integrity of S3 landform has been severely compromised by bioturbation and hydrologic events, three Middle Archaic-aged radiocarbon dates (4154±56 cal BP, 4583±102 cal BP and 5685±42 cal BP) were obtained that may date one or more of the components that produced the Duncan/Gatecliff and McKean/Humboldt point assemblage.

Late Archaic – Pelican Lake/Elko Corner-Notched

Corner-notched dart points are the most numerous projectile point type recovered from Game Creek. Unfortunately, all but one of the 19 identifiable specimens was found in disturbed contexts. An obsidian mid-section fragment (#3,906) from a corner-notched projectile point was recovered from Cultural Level 6 in Block A on the T3, but few other artifacts were found in association with it. The cultural level as a whole spans all of the Middle and Late Archaic periods (ca. 5290-1000 cal BP). Obsidian was the most frequently used raw material, comprising 68.4 percent of the assemblage (Table 6-6). Three obsidian points were submitted for ed-xrf analysis. Two were found to be from the Teton Pass source and one from the Crescent H Ranch source. Four specimens were made of chert, one of which appears to be from the Laney member of the Green River formation. One specimen was made of silicified wood, probably of local acquisition, and one was made of meta-quartzite (Table 6-6). The points tend to

Table 6-6 Attributes of Late Archaic corner-notched darts recovered from Game Creek. Measurements in r

Cat#	Type	Block	Unit	Material Type	Portion	Max Length	Max Width	Max Thickness	Blade Width	Haft Width	
29529	Blue Dome	G	N696 E424	CH	NCO	31.7	21.1	3.9	21.1	13.9	1
19090	Blue Dome		N670 E428	CH	NCO	30.6	20.1	4.3	20.1	14.9	1
4165	Elko/Pelican Lake	A	N498 E499	OB	CO	31	23.6	4.2	23.6	13.5	1
21053	Elko/Pelican Lake		N677 E424	CH	CO	31	19.8	4.5	19.8	7.9	1
24651	Elko/Pelican Lake	L	N681 E424	OB	CO	31	26	5	26	14.3	2
27639	Elko/Pelican Lake	G	N692 E421	CH	CO	29.5	20.6	5.3	20.6	11	1
29934	Elko/Pelican Lake		N696 E426	OB	NCO	41.7	24.1	4.9		13	1
29957	Elko/Pelican Lake		N696 E426	OB	NCO	44.8	26.8	4.6	26.8		
13631	Elko/Pelican Lake	G	N694 E421	OB	BASM	21	22.3	4.6		11.8	
20198	Elko/Pelican Lake		N675 E425	OB	BASM	12.8	16.4	3.2	16.4	7.7	8
20611	Elko/Pelican Lake		N677 E421	CH	BASM	11.8	19	4.9		8.7	1
23985	Elko/Pelican Lake	L	N680 E425	CH	BASM	31.5	20.6	4.2		16.9	
26284	Elko/Pelican Lake	G	N690 E421	OB	BASM	40.7	23.1	4.5	23.1	9.5	
20363	Elko/Pelican Lake		N675 E429	SWD	BAS	7.9	13.8	3.2			1
25768	Elko/Pelican Lake	G	N690 E421	OB	BAS	9.6	13.6	3.2		10.2	1
27654	Elko/Pelican Lake	G	N693 E421	MQTZ	BAS	8.4	15.1	4.4		12	1
21262	Elko/Pelican Lake	L	N677 E427	OB	BAS	8	17	3.1			
24901	Elko/Pelican Lake	L	N682 E424	OB	LBAS	6.7	9	3.2			
3906	Elko/Pelican Lake	A	N498 E497	OB	MI	19.7	21.3	4.5	21.3		
20153	Elko/Pelican Lake		N675 E425	OB	MI	24	14.5	4			
18175	Elko/Pelican Lake	JK	N664 E425	OB	MITP	38.5	21.5	5.2		10.3	

Abbreviations: Material Type – CH=chert, OB=obsidian; MQTZ=metaquartzite, SWD=silicified wood; Portion- CO=
BSM=base/midsection, LBSM=lateral base/midsection, BAS=base, LBAS=lateral base, MI=midsection, MITP=mids
CC=concave, CV=convex, ST=straight.

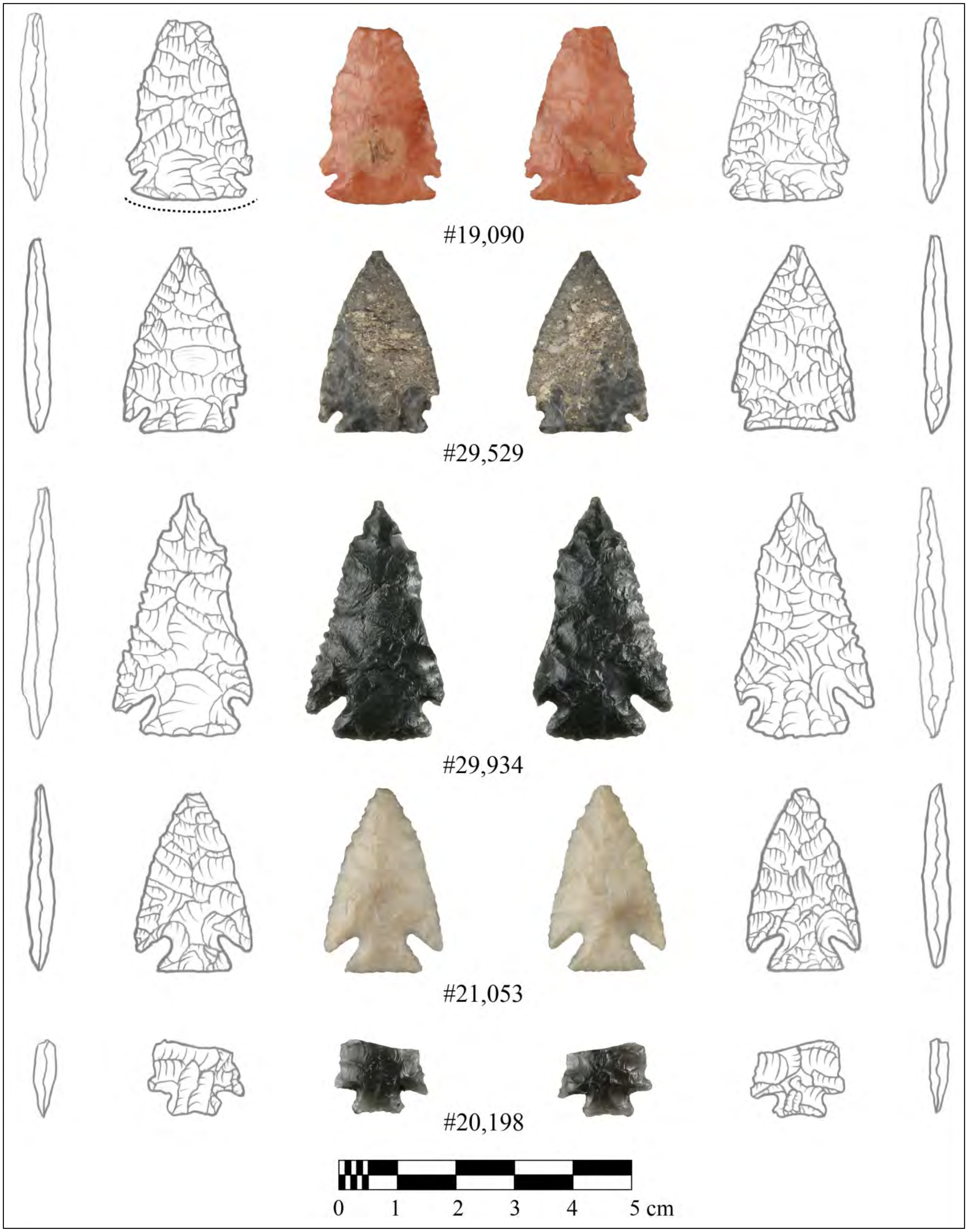


Figure 6-11 Complete and nearly complete corner-notched dart points recovered from Game Creek.

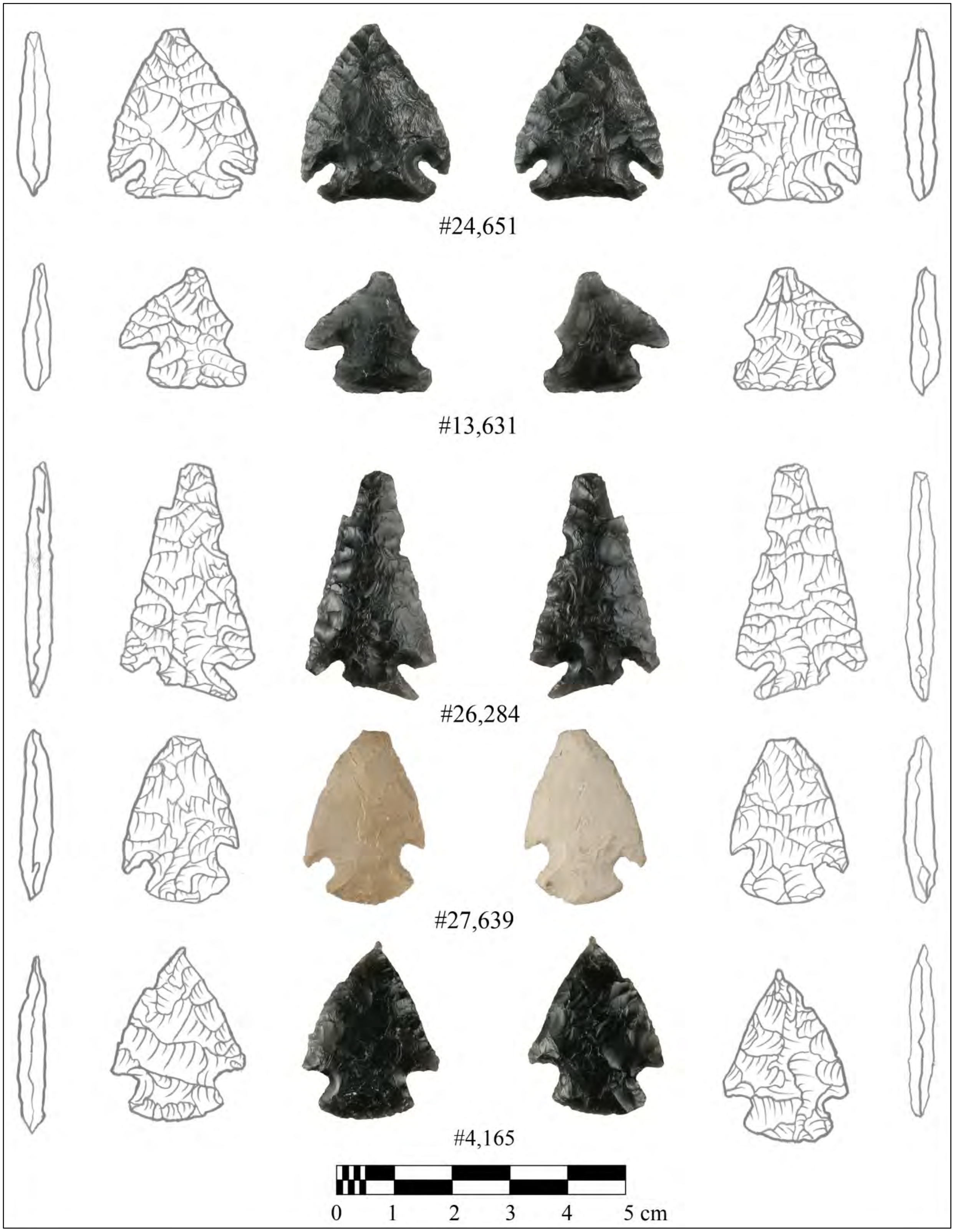


Figure 6-12 Complete and nearly complete corner-notched dart points recovered from Game Creek.

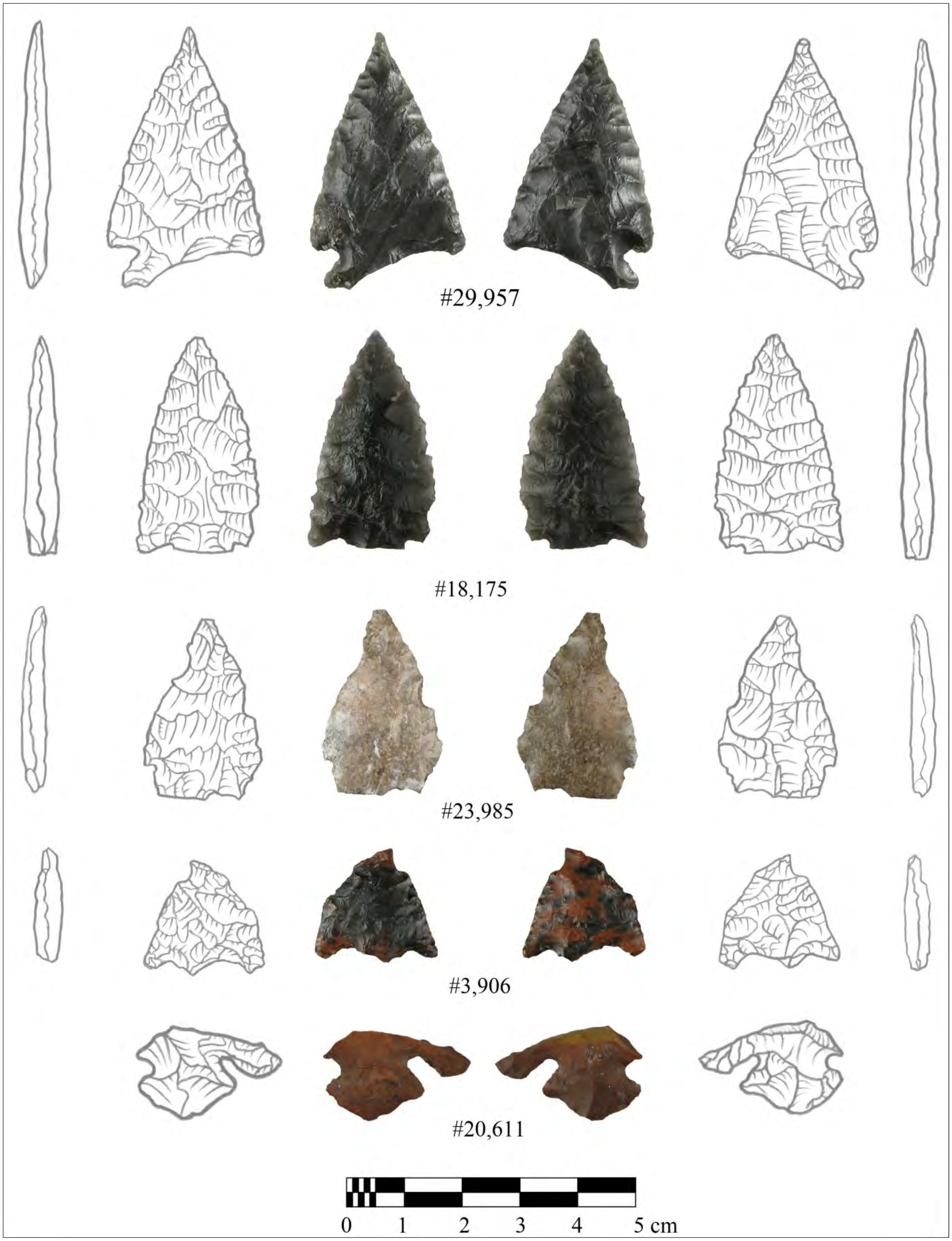


Figure 6-13 Corner-notched dart point fragments recovered from Game Creek.

Figure 6-14 Corner-notched dart point fragments recovered from Game Creek.

be plano-convex in longitudinal cross-section and are often curved in latitudinal cross-section with straight to slightly ovate blade edges (Figures 6-11 through 6-17). All but two of the specimens with intact or partially intact blades are barbed. Two complete points, however, have horizontal lower blade edges. The corner-notches are narrow and relatively deep on average with a mean proximal shoulder angle of 125° (Table 6-6). Of the 26 specimens with complete or nearly complete bases, nine are straight, nine convex and eight concave (Table 6-6). Points appear to have been produced from flake blanks using bifacial pressure flaking that often failed to completely eradicate the original ventral surface of the blank.

Corner-notched dart points were produced throughout the Archaic but were most common during the Early (ca. 8300-5700 cal BP) and Late Archaic periods (ca. 3400-1400 cal BP [Holmer 1986; Page 2016]). Although there is overlap in the ranges of variability, Early and Late Archaic corner-notched darts differ is several ways. Late Archaic corner-notched dart points on average have wider blades and narrower bases than Early Archaic specimens (Table 6-7, Figure 6-14). Notching on Late Archaic corner-notched darts also tends to be deeper and narrower than on points made during the Early Archaic (Table 6-7, Figure 6-14). Lastly the shape of bases differs between the two periods, with convex (67%) and

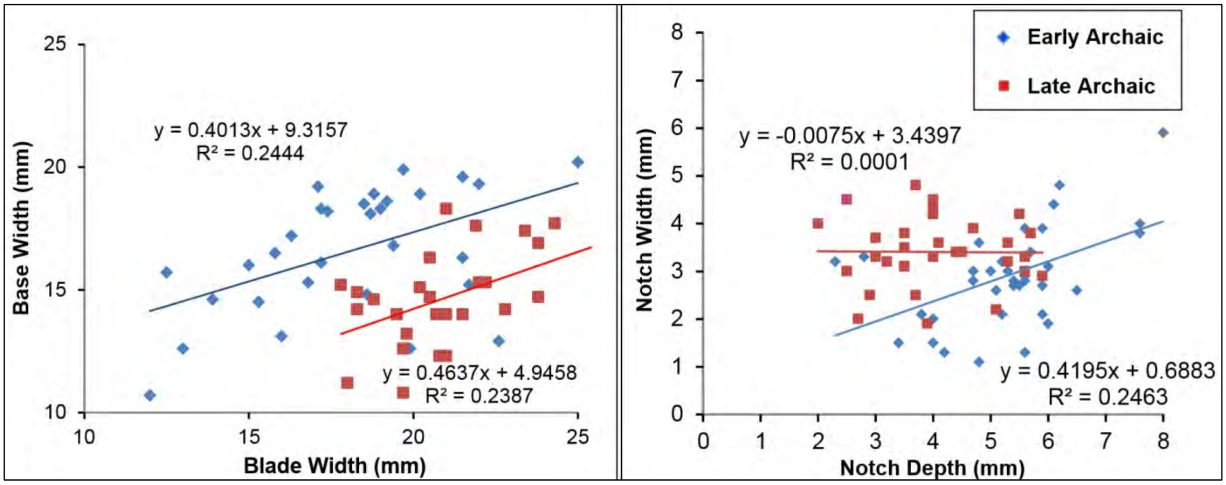


Figure 6-15 Graphs showing base width:blade width and notch depth:notch width for samples of Early and Late Archaic corner-notched darts.

straight (25%) far more common than concave bases (8%) in the Late Archaic sample. Conversely, the bases of Early Archaic corner-notched points are typically concave (39%) or straight (40%) and only occasionally convex (21%). Although these tendencies are far from a bright line test, they do provide useful information for cross-dating of sites using corner-notched darts.

Late Archaic corner-notched darts, known on the Northwestern Plains and Central Rockies as the Pelican Lake type, have been recovered from numerous components ranging in age from 3400 cal BP till about 1400 cal BP (Kornfeld et al. 2010). In the Great Basin, corner-notched darts are part of the Elko series and are most common during the Early and Late Archaic periods (Holmer 1986, 2009; Justice 2002). Yet, the Elko type is so loosely defined that it can include almost any corner-notched and some side-notched forms. Consequently, it has become a wastebasket type with little value as cultural or temporal diagnostic. There are five radiocarbon dates, ranging from 1878±36 cal BP to 2350±39 cal BP, from the S3 landform that are likely associated with the corner-notched darts found there.

Late Archaic – Blue Dome "Side"-Notched

Two nearly complete corner-notched darts (#19,090 and #29,529) that differ from the remainder of the Game Creek assemblage were recovered from disturbed contexts on the S3 landform. The points are made of unidentified cherts. Point #19,090 has been burned. Both points are well made with slightly ovate blade edges and small barbs. The corner notches are shallow, narrow and placed very near the base of the point (Figure 6-11, Table 6-6). Bases are straight and concave, and one has a slightly ground basal edge. A sample of similar points was recovered from Bison and Veratic Rockshelters in Eastern Idaho with an associated date of 1474±85 cal BP (Swanson 1972). Despite the fact that these points have corner notches and slightly barbed blades, Swanson (1972:112) chose to name the type "Blue Dome Side-

Table 6-7 Summary statistics for Early and Late Archaic corner-notched darts.

	Max. Length	Max. Thick.	Blade Width	Haft Width	Base Width	Base Height	Notch Depth	Notch Width	PSA
Late Archaic CN Darts[1]									
Sample	n=16	n=28	n=33	n=41	n=36	n=39	n=33	n=31	n=52
Range	23.3-35.4	2.8-5.9	17.8-28.4	9.2-15.6	10.8-18.4	3.8-12.3	1.9-4.8	2.0-5.9	101-139
Mean	28.6	4.4	21.0	12.0	14.9	6.9	3.4	4.0	121
Median	27.4	4.4	20.7	12.3	14.8	6.7	3.4	4.0	121
Std. Dev. Dev	3.5	0.8	2.4	1.8	1.9	1.7	0.7	1.1	11
Early Archaic CN Darts[2]									
Sample	n=20	n=50	n=35	n=56	n=50	n=45	n=39	n=36	n=72
Range	18.2-48.0	2.7-7.2	12.0-27.0	7.7-16.3	10.7-20.2	5.7-11.2	1.1-5.9	2.3-8	102-141
Mean	30.6	4.6	18.4	12.4	17.0	8.3	2.9	5.3	128
Median	29.3	4.4	18.6	12.2	17.2	8.1	2.9	5.4	131
Std. Dev. Dev	9.8	0.9	3.4	1.7	2.1	1.4	1.0	1.2	10
Game Creek CN Darts									
Sample	n=6	n=19	n=8	n=13	n=12	n=14	n=9	n=10	n=13
Range	29.5-44.8	3.1-5.3	16.4-26.8	7.7-16.9	8.8-20.5	3.5-8.0	2.7-6.2	2.0 -6.2	114-137
Mean	34.8	4.2	22.2	11.3	15.0	6.4	4.4	3.3	126
Median	31.0	4.5	22.2	11.0	15.0	6.5	4.6	3.3	127
Std. Dev. Dev	6.6	0.7	3.4	2.7	3.0	1.3	1.1	1.2	7

[1] Data from Goff Creek (Page 2016), Mummy Cave (Husted and Edgar 2002), Pagoda Creek (Eakin 1986), 48PA852 (Eakin 1993; Eakin and Sutter 1991), Moss Creek (Eakin 2011), 48PA1245 (Eakin 1993).
[2] Data from Goff Creek (Page 2016), Mummy Cave (Husted and Edgar 2002), Trappers Point (Francis and Widman 1999), Little Canyon Creek Cave (Shaw 1980).

Notched." Swanson (1972:112) argues that the type is technologically and temporally related to the Avonlea point type, but noted that they are thicker, more crudely made, and more variable than Avonlea. Furthermore, the size of these specimens is closer to the range of Late Archaic dart points than Avonlea arrow points. Nevertheless, this type may represent a terminal Late Archaic point form of limited geographic and temporal range. Accordingly, this type may prove to be a useful temporal diagnostic.

Late Prehistoric – Rose Spring Corner-Notched

Five small corner-notched arrow points, or fragments thereof, were recovered from Game Creek. One base fragment (#803) was found in a shovel test on the T1 terrace during testing (Eakin and Eckerle 2004). The remaining specimens were found on the S3 landform in disturbed contexts. One point is nearly complete; two are base fragments and two are lateral base/midsection fragments (Figure 6-16, Table 6-8). All are made from obsidian. These points appear to have been created by pressure flaking of surfaces of the flake blank. Given the size, shoulder angle and convex bases of these points they most closely resemble the Rose Spring type of the Great Basin and Snake River Plain that date to circa 1600 - 700 cal BP and perhaps as late as Euro-American contact (Holmer 1986, 2009; Justice 2002; Thomas

Figure 6-16 Photographs and illustrations of Rose Spring points recovered from Game Creek.

1981). There are three radiocarbon dates from Game Creek, the pooled mean of which calibrates to 759±22 cal BP, which may be associated with the Rose Spring corner-notched arrow points.

Late Prehistoric – Desert Side & Tri-Notch

Seven fragments of Late Prehistoric side and tri-notched arrow points were recovered from the S3 landform at Game Creek. The base of a Desert Tri-notch (#28,838) point was found in Cultural Level 7 in Block G, but the remainder was found in disturbed contexts. All of the points were made of obsidian, with one (#1,519) identified as the Bear Gulch source from southwestern Montana and adjacent parts of Idaho. The specimens (Figure 6-17) are well-made, thin, but slightly plano-convex in cross- section. Points appear to have been manufactured by pressure flaking a small flake blank. Desert Side-Notched points are common throughout the Central Rockies and surrounding regions. They appeared in the Great Basin by circa 700 cal BP and continued to be produced into the 19th century (Justice 2002). The Desert Tri-Notched type may have appeared slightly later (Holmer 2009), but both types are frequently found

Table 6-8 Attributes of Late Prehistoric projectile points recovered from Game Creek. Measurements in mı

Cat#	Block	Unit	Type	Haft Style	Material Type	Portion	Max Length	Max Width	Max Thickness	Blade Width	Haft Width
27157	G	N691 E421	Desert	TN	OB	BSM	17.4	11.5	2.8	11.3	5.9
27721	G	N695 E420	Desert	TN	OB	LBAS	6.1	7.1	2.3		
28838	G	N696 E419	Desert	TN	OB	BAS	5.7	12.2	2.5		6.3
24660	L	N681 E424	Desert	SN	OB	LBAS	5.7	7.2	1.7		
1519	G	N696 E422	Desert	SN	OB	BSM	14.8	12.3	2.8	10.4	5.8
20211		N675 E425	Desert	SN	OB	LBAS	7	6.8	3		
20916		N677 E424	Desert	SN	OB	LBAS	5.5	8.7	3		
28138	G	N695 E421	Rose Spring	CN	OB	NC	24.4	14.8	2.9	14.8	4.8
803		STP-B4	Rose Spring	CN	OB	BAS	7.6	9.1	2.6		6.7
1518	G	N690 E423	Rose Spring	CN	OB	LBAS	13.6	8.8	4.4		
13147	G	N691 E420	Rose Spring	CN	OB	BAS	8.2	9.6	2.8		6.3
22073	L	N679 E423	Rose Spring	CN	OB	LBAS	11.9	11.4	3.4		

Abbreviations: Material Type –OB=obsidian; Portion- CO=complete, NC=nearly complete, BSM=base/midsection, I
BAS=base, LBAS=lateral base; Base Shape-CC=concave, CV=convex, ST=straight, NCH=notched.

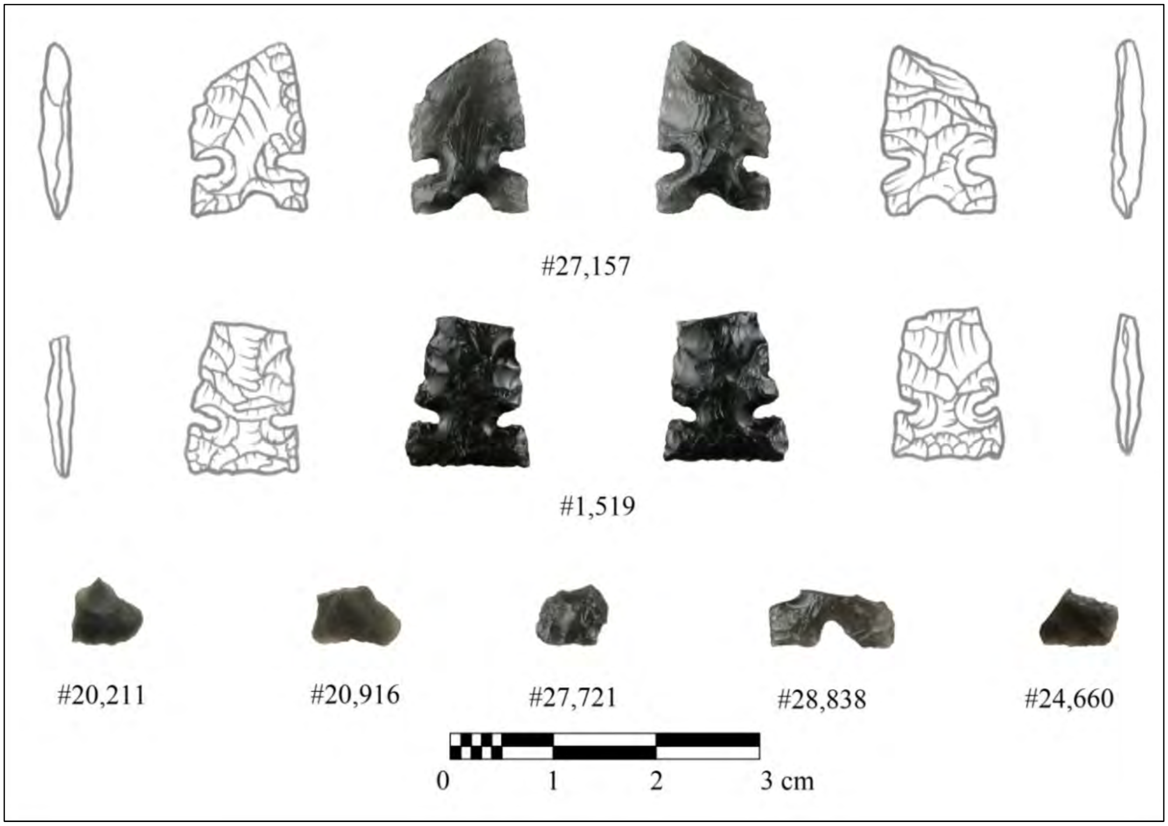


Figure 6-17 Photographs and illustrations of Late Prehistoric Desert Side and Tri-Notch points recovered from Game Creek.

together (Frison 1971; Kornfeld et al. 2010). Side and tri-notched arrow points were made and used by a wide variety of Native American groups during the Late Prehistoric and Protohistoric periods, including the Shoshone and Crow (Justice 2002; Kornfeld et al. 2010). There are several radiocarbon dates from Game Creek, ranging from 546±38 cal BP to 676±22 cal BP, that are likely associated with the side and tri-notched arrow points.

Miscellaneous Projectile Points

One complete obsidian projectile point (#17,195) recovered from the S3 does not closely resemble any named type in the region. The point has slightly ovate and asymmetrical blade margins and a weak shoulder (Figure 6-18). The base is narrower than the blade and has wide, shallow side notches and a convex, irregular basal margin (Table 6-9). Randomly placed percussion flaking was used to shape the specimen followed by limited and sporadic margin retouch. This point may be a crudely-made side-notched dart or stemmed dart point,

Numerous small, unidentifiable projectile point fragments were found at Game Creek (Table 6-9, Figure 6-18). Most of the specimens were found on the S3 landform, which precluded identification based on stratigraphic position or association.

ıtes of unidentifiable projectile point fragments recovered from Game Creek.

Unit	Haft Style	Material Type	Portion	Max Length	Max Width	Max Thickness	Blade Width	Haft Width	Base Width	Prox. Shldr Ang.	Base Length	Notch length
N691 E422	CN	OB	LBAS	11.7	10.7	3.3				129	10.4	
N695 E421	CN	OB	LBAS	7.5	12.2	2.9					5.4	
N675 E429	CN	OB	BSM	24.2	20.7	4.5	20.7	14.4		128	5.9	3.5
N677 E421	CN	OB	LBAS	5.1	5.9	2.3						
N677 E424	CN	OB	LBAS	7.6	12	3.1						
N679 E422	CN	CH	BAS	8.3	13.1	2.5			13.1	122		
N680 E423	CN	OB	LBAS	4.2	10.9	3				132		
N680 E424	CN	OB	LBAS	6.4	15	3				125		
N680 E426	CN	OB	LBAS	6.9	13.7	2.8				118		
N680 E430	CN	OB	LBAS	8.5	14.8	4				120		
N695 E419	IND	OB	MITP	37.1	19.6	4.9						
N696 E420	IND	OB	LBAS	7.3	11.8	3.4						
N500 E489	IND	OB	BRB	6	5.1	2.1						
N416 E486	IND	OB	LMI	16.1	12.7	2.6						
N490 E493	IND	OB	MI	6.9	9.1	2.6						
N660 E423	IND	OB	LMI	4.2	7.1	2.6						
N663 E425	IND	OB	LBAS	4.1	6.9	1.5						
N664 E424	IND	OB	LBAS	5.8	8	3						
N664 E424	IND	OB	BSM	27	22.8	6	22.8	14.4				
N665 E425	IND	OB	TP	15.8	16.8	2.5						
N670 E427	IND	OB	TP	12.3	8.8	2.1						
N675 E425	IND	OB	BRB	5.5	5.2	2.1						
N675 E429	IND	OB	BRB	7.3	5.9	1.6						
N678 E426	IND	OB	LBSM	20.1	17.7	5						

ıt fragments recovered from (

Max Length	Max Width	Max Thickness	Blade Width
49.7	22	6.9	22
7.5	12.7	3	
14.2	12.8	1.6	
11.9	19.4	3	19.4
5.7	4.6	2.5	
13.7	14.8	3.1	
34.3	18.3	4.2	
7.9	9.6	2.2	
27.6	15.1	3.6	
18.4	17.2	4.9	
141.8	15.6	4.7	
3.5	7.5	2.3	
12.3	19.6	4.6	
16.8	19.3	4.6	
6.4	5	2.5	
34.2	15	3.4	
6.6	8.1	1.8	

ıinate; Material Type – CH=cher
dsection/tip, MI=midsection, LM
t;

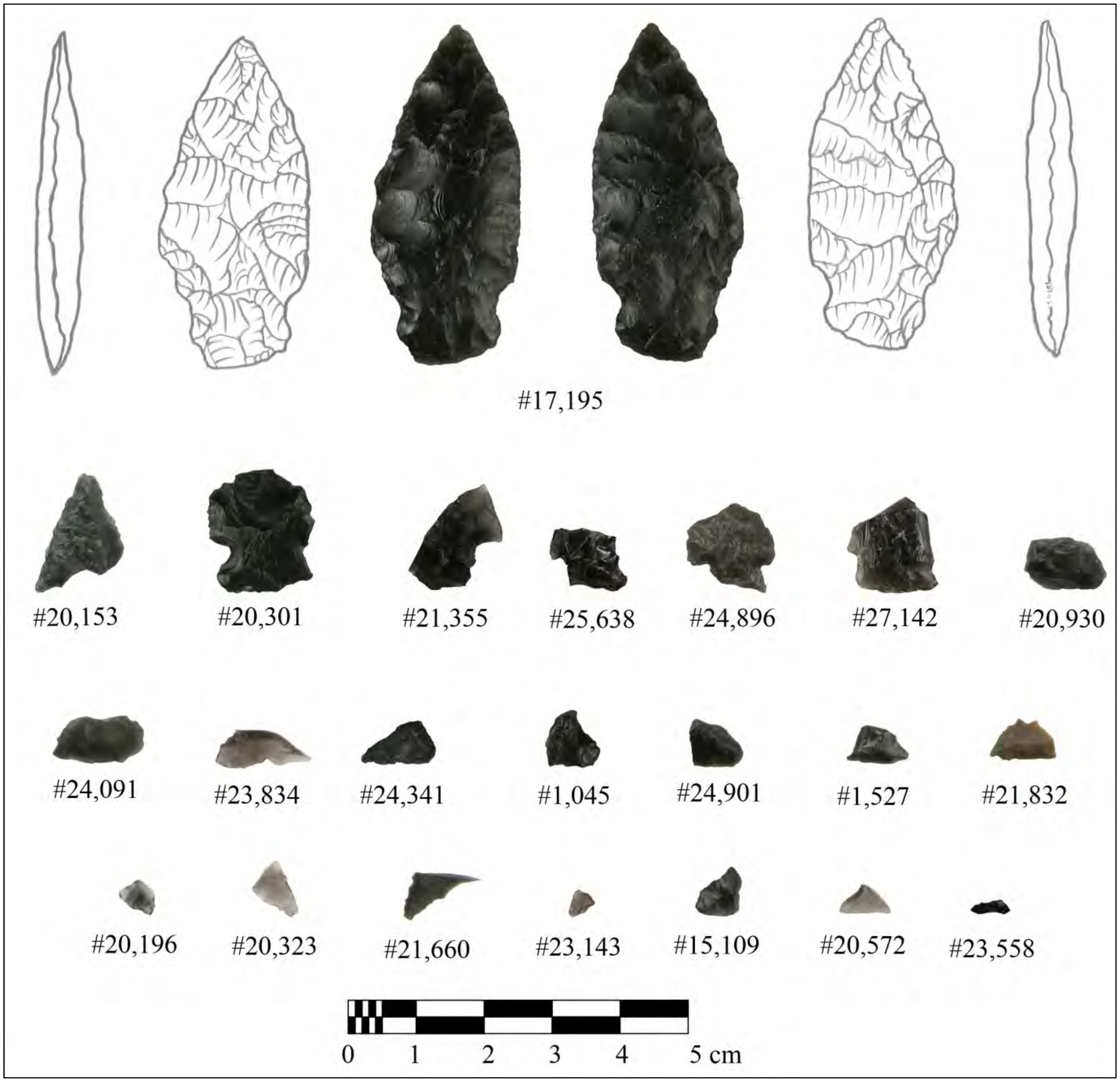


Figure 6-18 Projectile point and fragments that could not be assigned to a type.

Knives

Fourteen bifaces that showed heavy use-wear indicative of repeated use as a knife were found. As a group these items are highly variable in morphology. Some have flake patterns and/or morphology that allow for identification to a cultural period or complex. The first of these is a large obsidian midsection/tip fragment (#5) that was recovered from the backdirt pile of Trench 2 during testing at Game Creek (Eakin and Eckerle 2004). The artifact was encrusted with calcium carbonate, which indicates that it likely originated in stratum III and therefore was associated with cultural levels 1, 2 or 3 (ca. 10,400-9000 cal BP). The specimen is made of Teton Pass obsidian (Eakin and Eckerle 2004). The specimen is plano-convex in cross-section with one slanted blade edge (Figure 6-19, Table 6-10). The flaking is very

Table 6-10 Attributes of bifacial knives recovered from Game Creek.

Catalog #	CL	Block	Unit	Material Type	Portion	Length	Width	Thickness
5	1or2?		Trench 2	OB	MITP	45	28	7
1954	4	E	N450 E504	CH	CO	58	25	7
11795	4	I	N517 E486	OB	CO	64	25	6
14267	?	G	N695 E419	CH	BAS			
28717	7	G	N695 E424	CH	CO	108	38	7
21291	?	L	N677 E427	MQ	NCO	93	36	7
19092	?		N670 E428	BT	BAS		31	8
6662	?		T3 surface	OB	BAS		36	8
23302	?	L	N680 E422	MQ	TP		26	6
21345	?	L	N678 E426	CH	TP			5
14059	?	G	N695 E419	CH	CO	58	33	7
14262	?	G	N695 E419	OB	CO	49	30	11
17968	?	JK	N664 E424	QTZ	CO	79	42	8
24997	?	L	N682 E424	OB	CO	47	27	7

Abbreviations: Material Type – CH=chert, OB=obsidian, MQ=metaquartzite, BT=basalt, QTZ=orthoquartzite; Portion- CO=complete, NCO=nearly complete, BAS=base, MITP= midsection/tip, TP=tip.

well-executed, serial parallel-oblique on one face and parallel horizontal on the other. Flake scars tend to terminate near the midline (comedial), but transmedial flaking is present near the tip. The blade edges are sharp, and there is no evidence of edge retouch. The flaking pattern and technique is suggestive of the Foothills-Mountain Paleoindian and nearly duplicates Bradley's (2013) description of Angostura point production. The slanted blade edge, however, is a characteristic of Cody complex knives that also typically show serial horizontal and comedial pressure flake removal (Bradley 2009, 2010). Given the recovery of several Angostura points from Cultural Level 2 it is likely that this specimen is associated with the Foothills-Mountain Paleoindian occupation of the site.

Two remarkably similar knives (#1,954 and #11,795) were found in Cultural Level 4 of Blocks E and I (Table 6-10). They are both made from a large blade and are plano-convex in cross-section. One is obsidian and the other an unidentified brown chert. The dorsal surfaces have both invasive pressure flaking and margin retouch, but the ventral surfaces have only margin retouch (Figure 6-19). Edges of both specimens showed heavy use-wear on edges, and the dorsal and ventral surfaces of the obsidian specimen (#11,795) had numerous scratches and striations indicative of bag-wear (Figure 6-20). Similar knives were recovered from Early Archaic components at the Goff Creek site (Page 2016).

A large, black chert base fragment of a hafted knife (#14,267) was found in debris flow deposits in Block G on the S3. The specimen appears to have been side-notched with a concave base and slightly rounded corners (Figure 6-19, Table 6-10). This specimen was badly burned and is nearly covered in pot-lid fractures. Similar specimens have been recovered from Early Archaic contexts at Goff Creek (Page

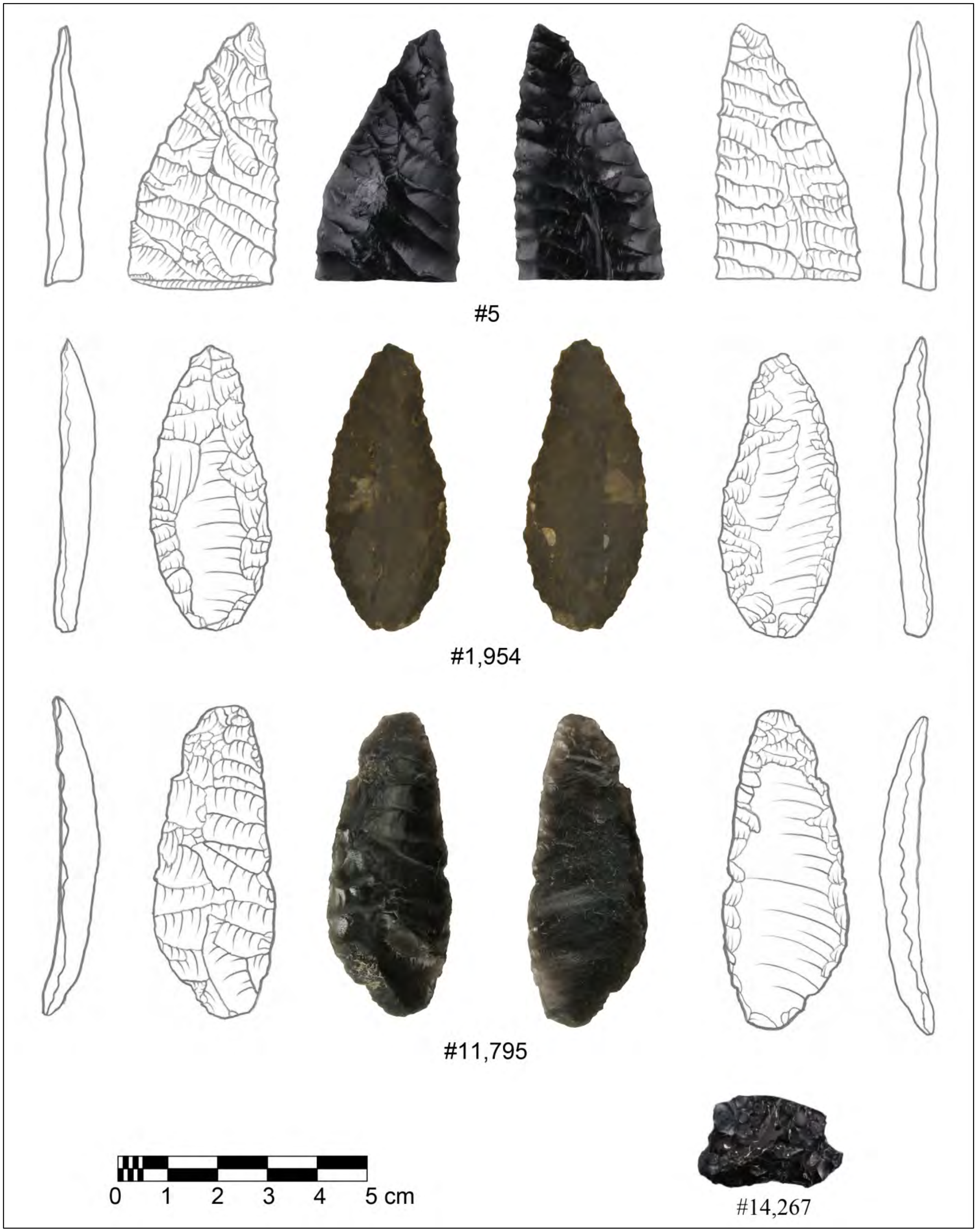


Figure 6-19 Photographs and illustrations of Paleoindian and Early Archaic knives recovered from Game Creek.

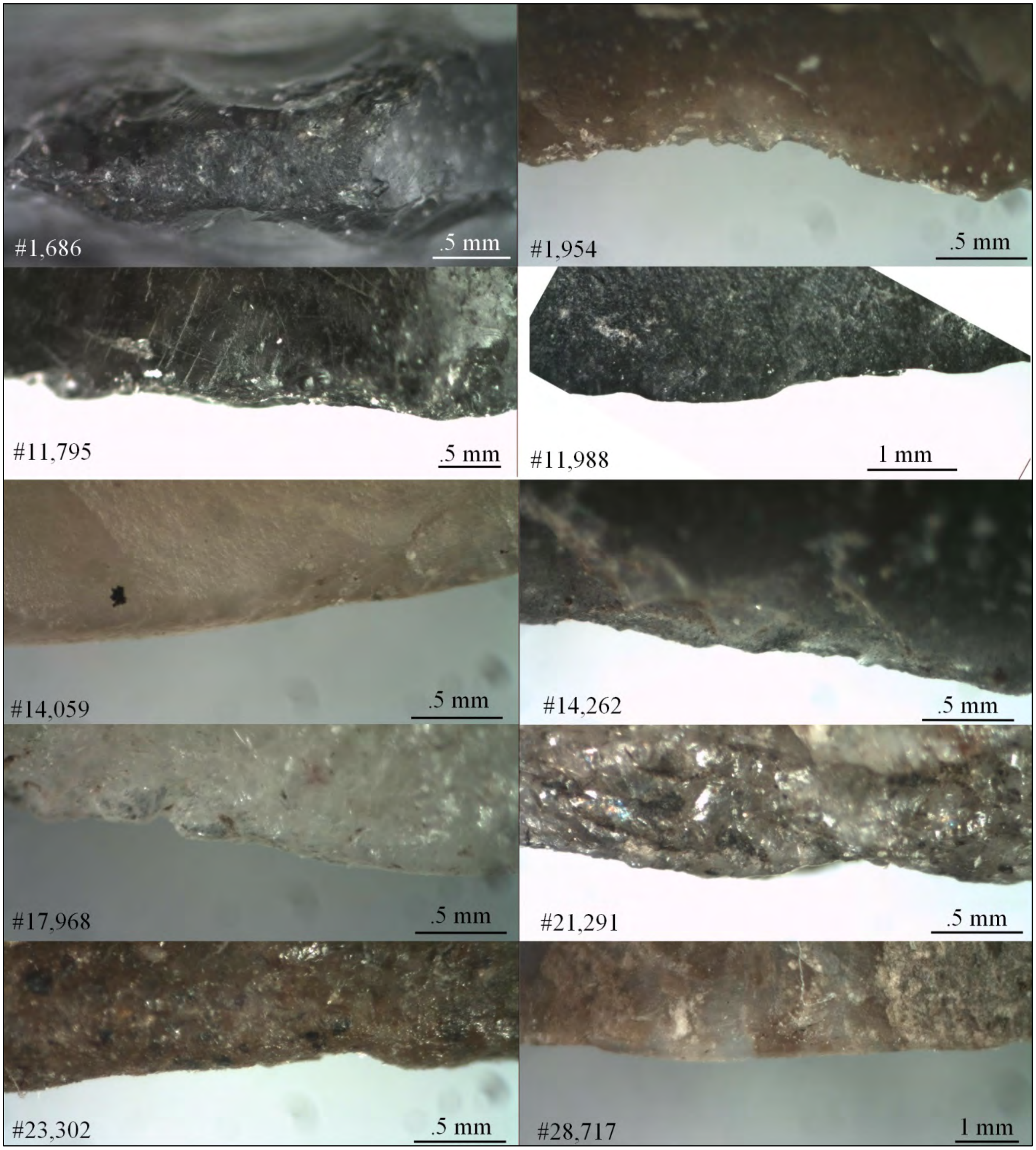


Figure 6-20 Photomicrographs of knife edges showing use-wear.

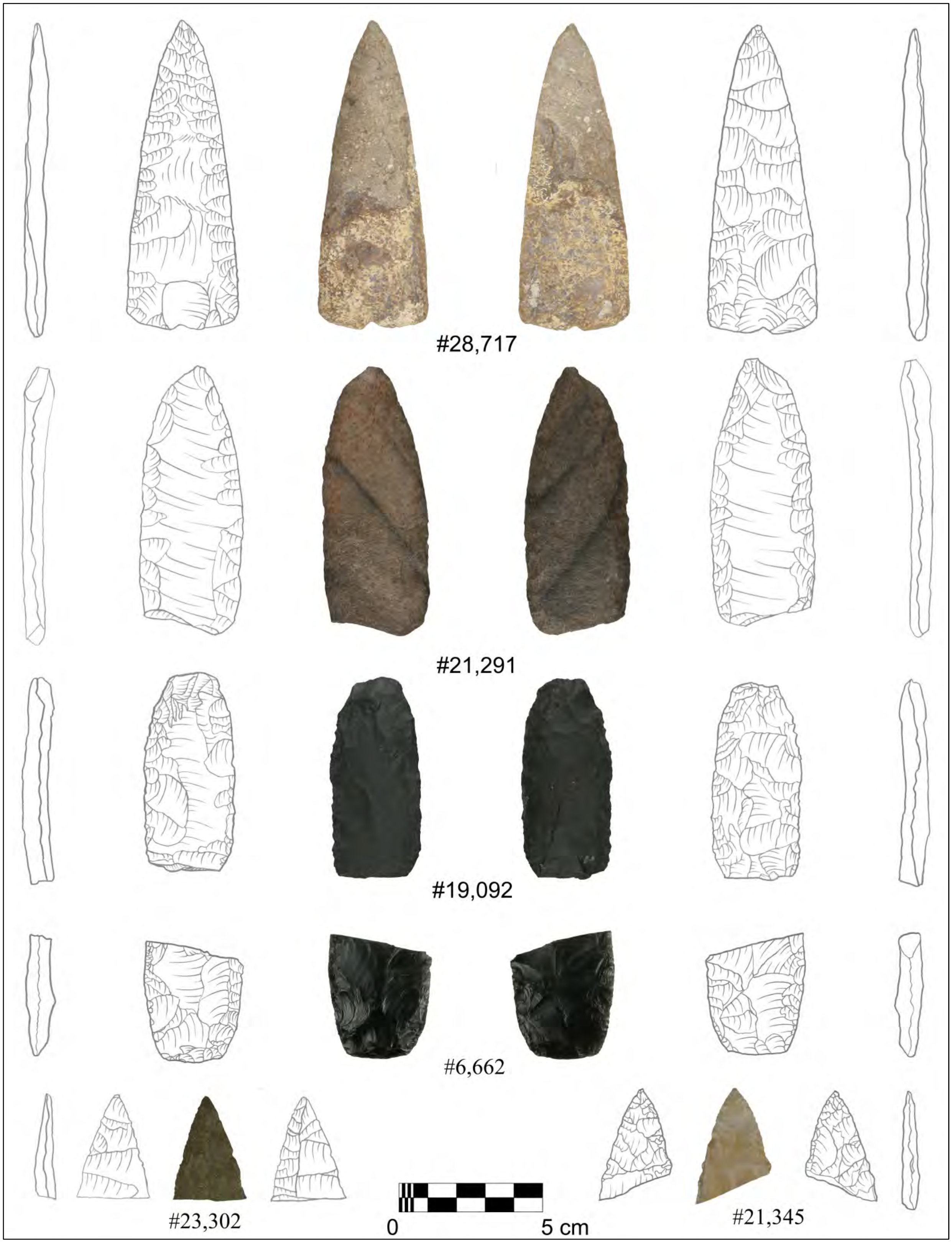


Figure 6-21 Photographs and illustrations of bifacial lanceolate knives recovered from Game Creek.

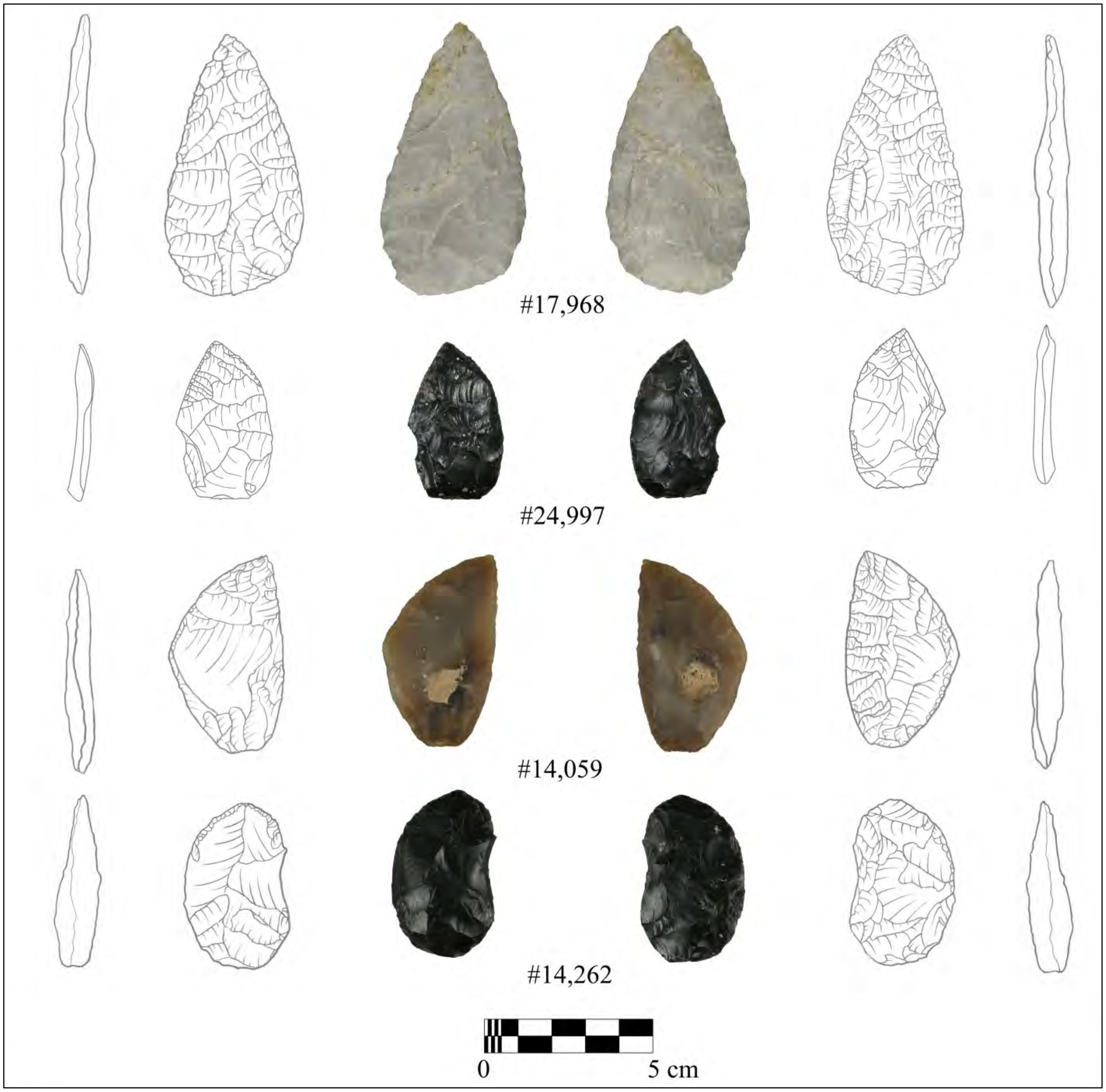


Figure 6-22 Bifacial knives recovered from the S3 landform at Game Creek.

2016), Little Canyon Creek (Shaw 1980) and Trappers Point (Francis and Widman 1999).

Three complete (#28,717, #21,291 and #19,092), one base (#6,662) and two tip fragments (#23,302 and #21,345) of large lanceolate knives were found (Table 6-10). One knife was recovered from Cultural Level 7 in Block G, but given the amount of disturbance, it may have been out of context. These knives were made from large flake blanks, are plano-convex in cross-section and still retain the curvature of the original flake (Figure 6-21). Blade edges are straight to slightly ovate. Percussion flaking was used to shape and thin the dorsal surface of two specimens (#28,717 and #19,092), followed by margin retouch along edges. Bases are straight to slightly convex, and one knife (#28,717) had percussion flakes removed from both faces near the center of the base. All specimens showed some evidence of use-wear (Figure 6-20). Notably, none of these knives was made of obsidian. Knife #28,717 was made of chert from the Laney member of the Green River formation; two are made of metaquartzite, one of basalt and one of chert that may be from the Tipton member of the Green River formation. Somewhat similar knives were recovered from Baker Cave in eastern Idaho in contexts dated to circa 780 cal BP and in direct association with Rose Springs corner-notched arrow points (Plew et al. 1987).

Four bifacial knives, also recovered from the S3, are smaller than the lanceolate knives just discussed (Table 6-10, Figure 6-22). Two are made of obsidian, one of white orthoquartzite and one of Madison chert. The orthoquartzite knife (#17,968) has a rounded base, one ovate and one straight edge. Both faces have random invasive pressure flaking accompanied by margin retouch. Similar knives were also found at Baker Cave (Plew et al. 1987). Two knives (#24,997 and #14,059) have straight bases and a slanted blade edges that appear to have been repeatedly resharpened. The last specimen (#14,262) has convex ends, one concave blade edge and one convex blade edge, the latter of which appears to have been resharpened.

Bifaces

A total of 191 bifaces and biface fragments have been from Game Creek. By and large, these bifaces represent items that either broke during manufacturing or were otherwise unsuitable for further reduction into finished tools. Analysis of biface reduction follows the procedures and criteria outlined by Whittaker (1994). Stage 1, or "edged blank" is a fairly thick biface with width to thickness ratio of about 2:1 with steep edges of 50 to 80 degrees all around the edge. A stage 2 biface, or preform, is smoothly biconvex or lenticular in cross-section with evidence of the removal of bifacial thinning flakes, fairly straight and centered edges of 40 to 60 degrees and a width to thickness ratio of 3-4:1. A stage 3 biface, or refined biface, has large, flat flake removals past the midline, is flattened in cross-section, has thin edges of 25 to 45 degrees and a width to thickness ratio ≥4:1. A stage 4, or finished biface, is identified by the presence of carefully executed percussion or pressure flaking around the edges and haft element. A stage 4 biface is synonymous with a projectile point or hafted biface.

The stage 1 biface assemblage contains 58 specimens, of which 17 are complete or nearly complete (Table 6-11). All but 16 of the specimens were found in on the S3 landform in disturbed contexts, which precludes statistical comparison of the cultural level assemblages. Obsidian was the most commonly used material type, followed by chert, metaquartzite and basalt, which were likely acquired locally (Table 6-11). Percussion flaking using both hard and soft hammers was used to form the bifaces. Many bifaces retain cortex. Edge grinding or possible use-wear was observed on seven specimens. As a group they tend to be oval, thick and asymmetrical (Figure 6-23). Many of the complete or nearly complete items were likely discarded due to imperfections or overly thick cross-sections.

Table 6-11 Summary of Stage 1 biface assemblage.

	Cultural Level							Sample Total
	1	2	4	5	7	7b	S3/Other	
n=	3	5	3	2	1	2	42	58
Material Type								
OB	100.0%	60.0%	100.0%	100.0%	100.0%	50.0%	88.1%	86.2%
CH		40.0%					4.8%	6.9%
MQ						50.0%	2.4%	3.4%
BT							4.8%	3.4%
Portion								
CO		20.0%	66.7%	50.0%			28.6%	27.6%
NCO							2.4%	1.7%
BSM							7.1%	5.2%
BAS							9.5%	6.9%
MITP	33.3%						4.8%	5.2%
MI							4.8%	3.4%
TP	33.3%						4.8%	5.2%
LT	33.3%	60.0%	33.3%	50.0%	100.0%	100.0%	31.0%	37.9%
IND		20.0%					7.1%	6.9%

Summary Metrics for Complete Specimens

	Length	Width	Thickness	W:T
Range	35-99	24-58	7-19	1.9-3.4
Mean	51.5	34.1	13.8	2.5
Median	48.0	33.0	13.5	2.5
St Dev.	15.4	7.8	3.5	0.5

Abbreviations: Material Type – CH=chert, OB=obsidian, MQ=metaquartzite, BT=basalt; Portion-CO=complete, NCO=nearly complete, BASM=base/midsection, BAS=base, MITP= midsection/tip, MI=midsection, TP=tip, LT=lateral, IND=indeterminate.

The stage 2 biface assemblage contains 60 specimens (Figure 6-24), all but six of which are fragmentary. Obsidian is the most common material type but overall contributed a smaller percentage (81.7%) than the stage 1 assemblage (Table 6-12). A considerable number of the stage 2 bifaces from the S3 were made of unidentified chert, silicified wood and orthoquartzite. The stage 2 bifaces are highly variable in form and size, but are thinner and usually have percussion flake scars covering most of both faces. Most are plano-convex in cross-section and roughly symmetrical. Cortex is rare. Use-wear and/or platform preparation grinding was noted on 11 specimens. Two large complete silicified wood bifaces (#13,875 and #13,877) were found with 10 cm of each other near the edge of the debris flow in Block G. These may have been in a cache that was disturbed by the flood that caused the debris flow.

Figure 6-23 Photographs of complete and nearly complete stage 1 bifaces recovered from Game Creek.

Table 6-12 Summary of stage 2 biface assemblage from Game Creek.

	Cultural Level						S3/Other	Sample Total
	1	2	4	6	7	7b		
n=	2	2	5	1	1	4	45	60
Material Type								
OB	50.0%	100.0%	100.0%	100.0%	100.0%	75.0%	80.0%	81.7%
SWD							4.4%	3.3%
CH	50.0%						11.1%	10.0%
QTZ						25.0%	4.4%	5.0%
Portion								
CO			20.0%				11.1%	10.0%
BAS		50.0%	20.0%				20.0%	18.3%
BSM							13.3%	10.0%
IND							6.7%	5.0%
LBAS							2.2%	1.7%
LBSM							2.2%	1.7%
LT			40.0%		100.0%		33.3%	30.0%
TP	100.0%	50.0%	20.0%	100.0%	0.0%	100.0%	11.1%	23.3%

Summary Metrics	Length (n=5)	Width (n=16)	Thickness (n=19)	W:T (n=16)
Range	19-87	11-73	3-19	1.6-5.3
Mean	50.8	30.2	8.4	3.6
Median	44.0	27.4	7.8	3.5
St Dev.	27.5	25.2	7.2	3.6

Abbreviations: Material Type – CH=chert, OB=obsidian, SWD=silicified wood, QTZ=orthoquartzite; Portion- CO=complete, BASM=base/midsection, BAS=base, LBSM=lateral base/midsection, LBAS=lateral base/midsection, TP=tip, LT=lateral, IND=indeterminate.

Twenty-one stage 3 bifaces were found (Figures 6-25 and 6-26). Of these, nine were recovered from identifiable cultural levels and 13 from the disturbed contexts. Most of the bifaces are made of obsidian with equal percentages of metaquartzite basalt and chert (Table 6-13). All were likely made from locally obtained raw material. Stage 3 bifaces, by definition, are relatively thin, symmetrical, and display evidence of bifacial-thinning pressure flake removal. Although only two of the stage 3 bifaces are complete, four of the fragments are complete enough to identify them as projectile point preforms. Some of these have distinctive characteristics and/or were found in stratigraphic contexts that allow further identification to cultural period. The remaining 15 stage 3 bifaces consist of small fragments, of which little can be said (Table 6-13).

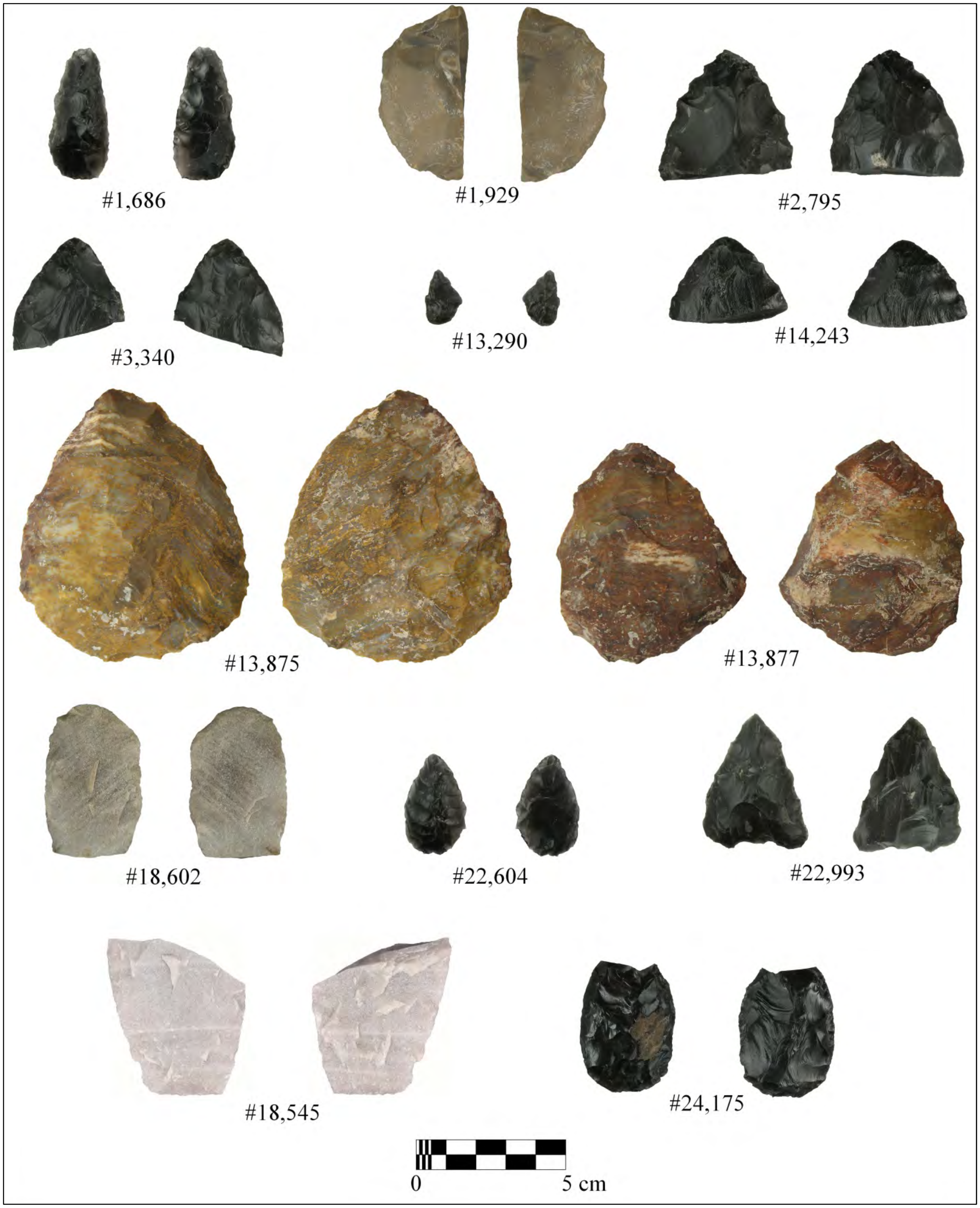


Figure 6-24 Photographs of stage 2 bifaces recovered from Game Creek.

Table 6-13 Summary of stage 3 biface assemblage from Game Creek.

Catalog #	Cultural Lvl	Block	Unit	Material Type	Portion	Length	Width	Thickness	W:T	Use Index	Comments
12139	1		N464 E504	Q	BSM	63	35	11	3.18		Haskett preform
5389	2	A	N498 E495	OB	TP	20	12	5	2.4	0.06	
9939	2	A	N497 E492	OB	TP	44	36	7	5.14		Angostura preform
15444	2	A	N501 E490	OB	BAS		11	2.4	4.6		
3310	4	A	N497 E500	OB	CO	46	25	5	6.25		Elko preform
7944	6	A	N501 E499	OB	TP	11	10	4	2.5		
9018	6	A	N495 E501	OB	LT	14	14	5	2.8		
13714	7b	G	N694 E421	OB	BAS	28	25	5	5	0.38	
29376	7b	G	N696 E422	OB	CO	34	21	4	5.25	0.5	
18545		JK	N665 E425	MQ	BAS		46	12	3.8		
13289		G	N691 E422	OB	TP	23	18	3	6	0.63	
20929			N677 E424	OB	TP		16	3	5.3		
22186		L	N679 E424	OB	MITP		28	9	3.1		
22531		L	N679 E425	OB	MI			5	0		
26458		G	N690 E422	OB	LMI	21	14	6	2.3		
2687		C	N479 E498	B	LBAS	78	31	11	2.82		
23185		L	N679 E427	C22	MITP		25	4	6.25		
12477			N490 E489	OB	TP	46	44	8	5.5		
24180			N680 E430	OB	BAS		17	5	3.4		Duncan preform
25740			N689 E429	OB	TP	31	31	5	6.2		
27722		G	N695 E420	OB	MI	18	16	4	4		

Abbreviations: Material Type – CH=chert, OB=obsidian, MQ=metaquartzite, BT=basalt; Portion-CO=complete, BAS=base, LBAS=lateral base/midsection, MI=midsection, LMI=lateral midsection, TP=tip, MITP=midsection/tip, LT=lateral.

One large base/midsection metaquartzite fragment of a stage 3 biface (#12,139) was recovered from near the contact of strata 2 and 3, below the buried A horizon in unit N464 E504 on the T3 surface. The specimen is lanceolate in form and plano-convex in cross-section. The sides are slightly irregular and contract slightly towards the convex base. Reduction appears to have been accomplished through serial comedial percussion flaking. The point appears to have broken on an imperfection and was discarded. The shape and flaking type and pattern on this specimen indicate that it is likely a preform of a Haskett point that broke during production. The stratigraphic position, in or near Cultural level 1, indicates that it likely dates to circa 10,400 cal BP, which is within the known temporal range of Haskett points (Holmer 2009).

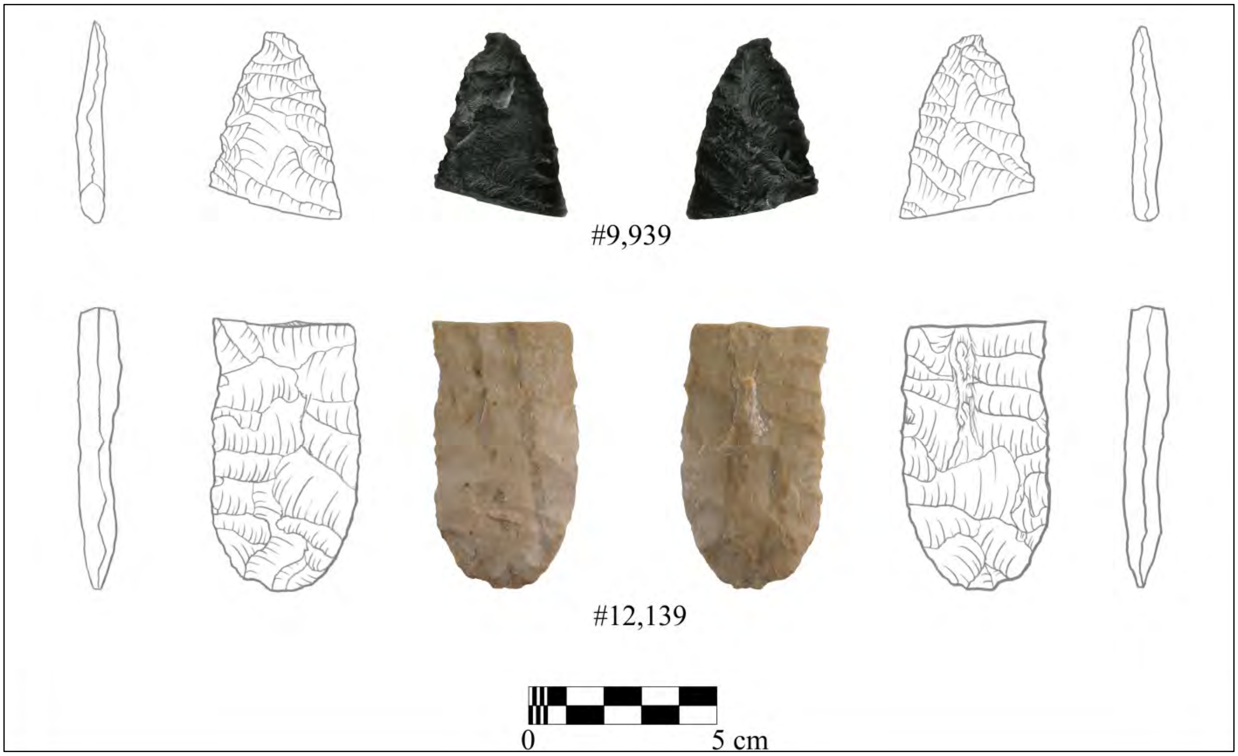


Figure 6-25 Photographs and illustrations of Paleoindian-aged stage 3 bifaces recovered from Game Creek.

One obsidian tip fragment (#9,939) found in Cultural Level 2 in Block A is likely the preform of an Angostura point. The specimen is plano-convex in cross-section with slightly irregular straight blade margins. A portion of the original ventral surface of the flake blank is present on the plane surface (Table 6-13, Figure 6-25). Both faces retain scars of serial parallel-oblique pressure flaking. Although Bradley (2013) has outlined the inferred production sequence of Angostura points, no preforms or early stage bifaces were present in the Ray Long site assemblage, which precluded a detailed description of the reduction sequence. Specimen #9,939 appears to represent an early reduction stage of an Angostura point. Unlike most reconstructed Paleoindian point production sequences, Angostura points may not have been created through repeated reduction of a biface through percussion flaking followed by refined pressure flaking. Angostura points may have been created solely through repeated episodes of parallel-oblique flake removal from a large flake blank.

Specimen #3,310 is a complete obsidian point preform recovered from Cultural Level 4 in Block A in direct association with two Elko Eared points (#4609 and #2905). The biface has slightly asymmetrical edges, with one roughly straight blade margin and one ovate edge (Figure 6-26, Table 6-13). The convex base is nearly as wide as the maximum width of the blade. Percussion flake scars are present on both faces as is limited margin retouch. It is highly probable that this is a preform for an Elko Eared point.

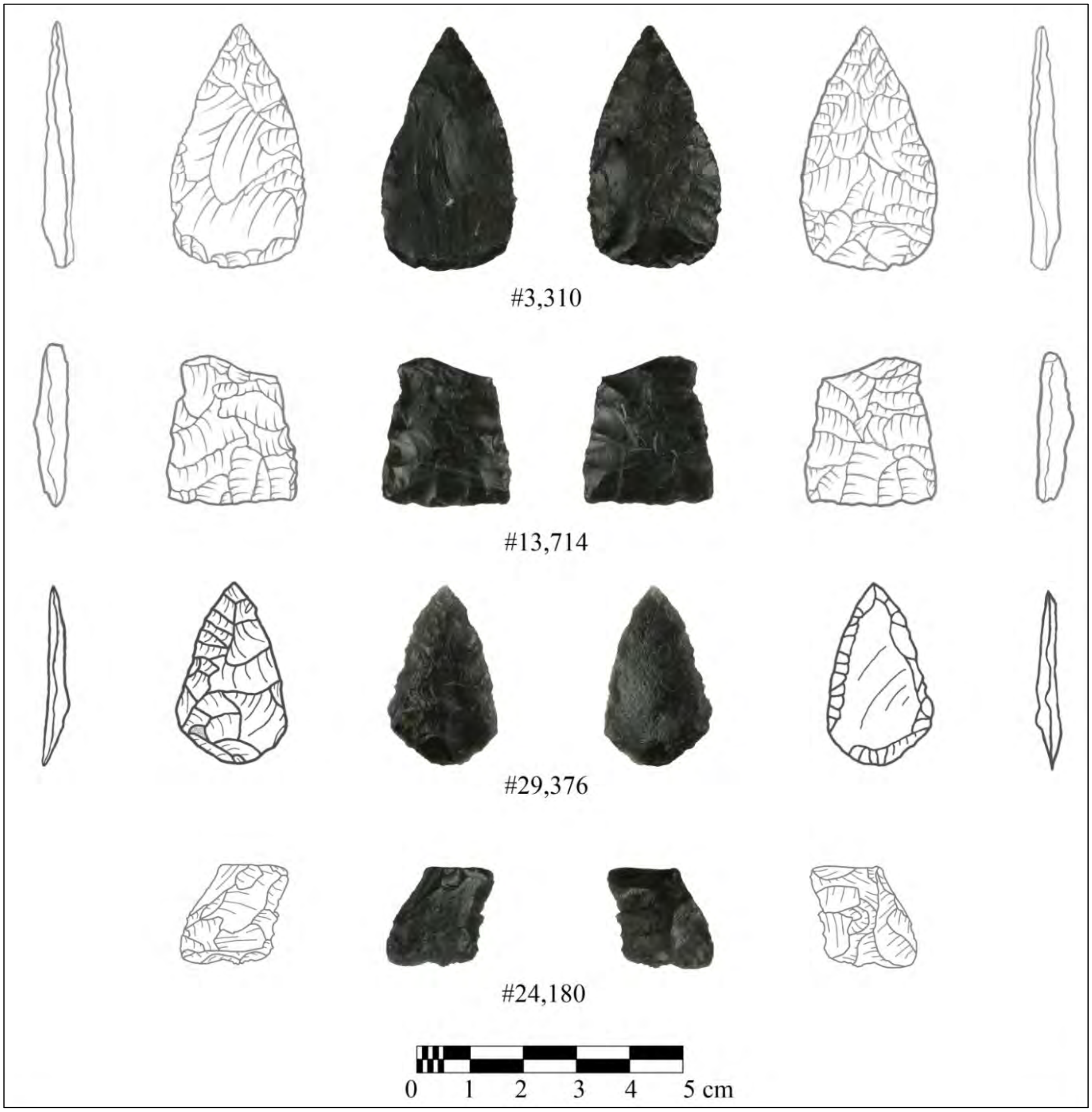


Figure 6-26 Photographs and illustrations of stage 3 bifaces recovered from Game Creek.

One complete (#29,376) and one nearly complete specimen (#13,714) were recovered from Block G Cultural Level 7 on the S3 landform (Table 6-13, Figure 6-26). Both are plano-convex in cross-section and retain slight curvature of the flake blank. Invasive pressure flaking covers both surfaces of specimen #13,714, but only the dorsal flake blank surface of #29,376. Cultural Level 7 in Block G is believed to be associated with one or more Late Prehistoric components that produced side and tri-notched arrow points. Both of these stage 3 bifaces appear too large to have been intended for arrow points. However, it is possible that they are earlier stage bifaces for small arrow points. The basic biface reduction stages (Whittaker 1994) presume that the earlier stages (1 and 2) of reduction are performed using percussion

Table 6-14 Attributes of drills/awls recovered from Game Creek.

Cat #	Cultural Lvl	Block	Unit	Material	Portion	Length	Width	Thickness	Bit Width	Bit Length	Functional Interpretation
4831*	2	A	N499 E497	CH	BAS	20	15	5	11.1	-	drill/reamer (hafted)
5359*	5	A	N498 E495	CH	TP	15	7	4	7.1	-	drill/reamer (hafted)
15744	3	I	N517 E484	CH	CO	41	13	5	7.5	21.8	drill/reamer (hafted)
10979	5	E	N450 E502	OB	TP	9	7	3	-	-	drill/reamer
27859	7	G	N695 E420	OB	TP	30	12	3	9.1	24.5	drill/reamer
14324		G	N695 E419	OB	TP	7	4	3	-	-	drill/reamer
27648		G	N693 E420	CH	CO	52	32	10	9.3	14.8	drill/reamer
3447	2	A	N497 E500	OB	CO	28	22	5	5.3	7.9	Awl
10724	3	A	N499 E494	OB	MI	25	7	3	4.2	-	awl (burin spall)
4347	4	A	N498 E500	SWD	CO	20	15	3	3.3	4.0	Awl
2323	5	D	N464 E509	OB	CO	14	13	3	4.8	-	Awl
28249	7	G	N695 E423	OB	CO	30	19	5	5.6	14.0	awl-hafted?
14369		G	N696 E420	OB	MI	18	13	4	4.2	-	Awl
18974		JK	N666 E425	OB	TP	20	6	4	5.4	-	Awl

* fragments of one specimen
Abbreviations: Material Type – CH=chert, OB=obsidian, SWD=silicified wood; Portion- CO=complete, BAS=base, MI=midsection, TP=tip, MITP=midsection/tip.

flaking. Yet, this may not have been the case with small arrow points. It is also possible that these items were out of context given the amount of post-depositional disturbance on the S3.

One obsidian base fragment of a stage 3 biface (#24,180) found on the S3 in disturbed context appears to be a preform of a Duncan/Gatecliff stemmed point (Figure 6-26). The specimen is plano-convex in cross-section and retains a portion of the ventral surface of flake blank on the plane surface. Invasive pressure flake scars cover the convex face, and margin retouch is present on both faces. The basal notch, ubiquitous in Duncan/Gatecliff assemblages, had not been formed when the specimen apparently broke.

Drills/Awls

There are 14 artifacts recovered from Game Creek identified as drills/reamers or awls. Of these, 10 were found in stratigraphic context and can be assigned to a cultural Level (Table 6-14). The drills/reamers have long tapering bits and are interpreted as woodworking tools used to form socketing of fore shafts. Chert appears to be the preferred raw material for drills/reamers and was used to make 50 percent of the specimens (Table 6-14). Obsidian, though sharp, is brittle and not well suited to mechanical strain of reaming, but nevertheless was used to make half of the specimens in the assemblage. Awls are believed to have been used to perforate leather for clothing and shelter production. Consequently awls have shorter and narrower bits than drills and were more frequently made of obsidian (83.3%). These awls may have had other uses, such as woodworking, but the amount and nature of use-wear would be

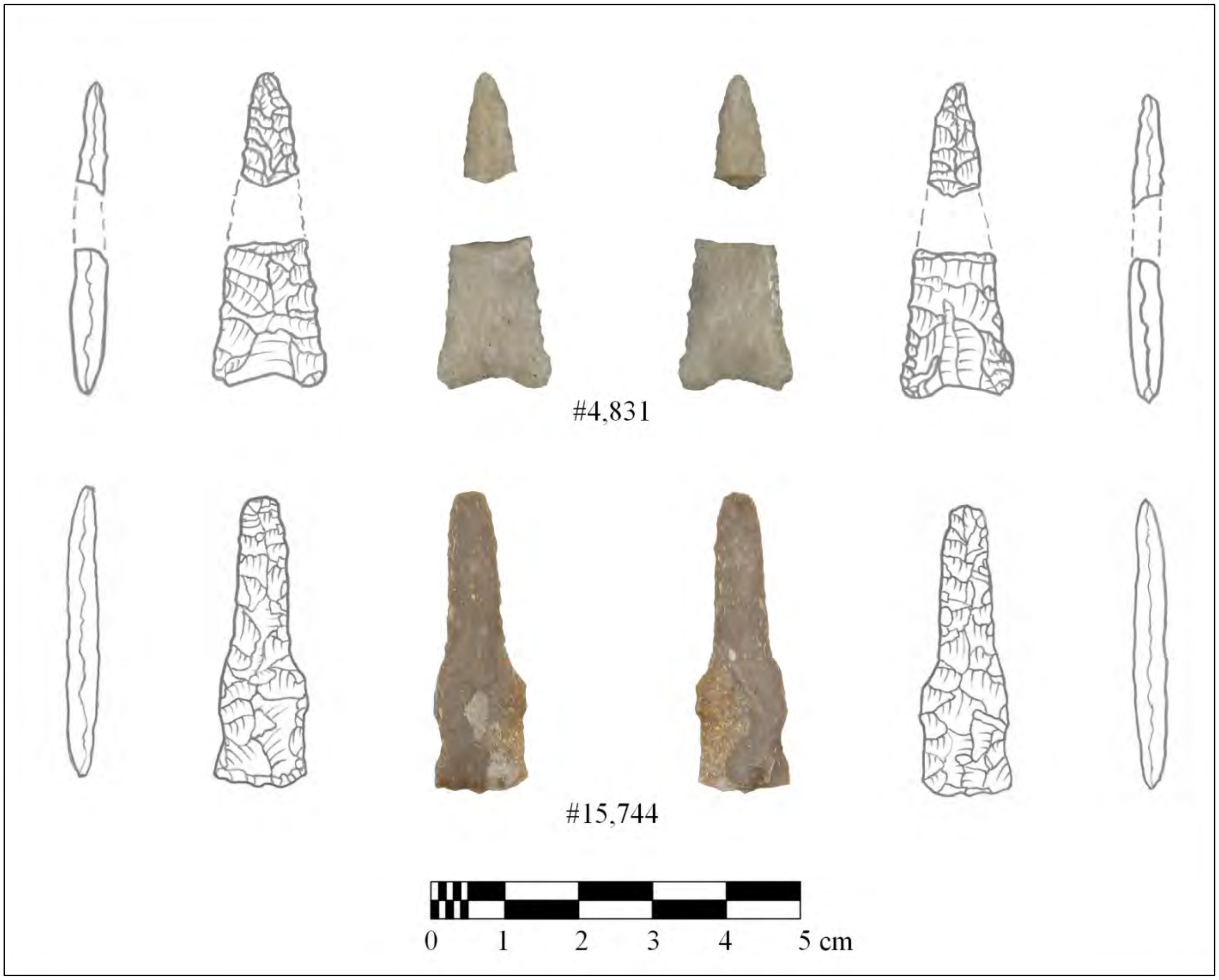


Figure 6-27 Hafted drills recovered from Cultural Levels 2 (above) and 3 (below) at Game Creek.

discernably different. However, the awls recovered from Game Creek did not display pronounced edge rounding and polish indicative of woodworking.

A base of chert drill (#4,831) was found in Cultural Level 2 of Block A. A tip (#5,359) of what is almost certainly the same specimen was recovered from Cultural Level 5, about two meters southeast of the base fragment, and had apparently been transported from its original context. The drill is well-made, biconvex in cross-section with an expanding concave base (Figure 6-27). The bit has been heavily utilized and shows distinctive polish. This specimen was likely hafted given the well-formed base. Virtually identical specimens have been found in undated surface contexts in southwest Wyoming at sites that also produced a variety of Paleoindian point types including Angostura (Frison et al. 2015). In the Midwest very similar specimens have been found in association with Late Paleoindian Dalton points and are often called “Dalton drills” (Justice 1987).

A complete drill (#15,744), similar to the specimen just described was recovered from Cultural Level 3 in Block I (Table 6-14). The material from which it is made closely resembles chert from the

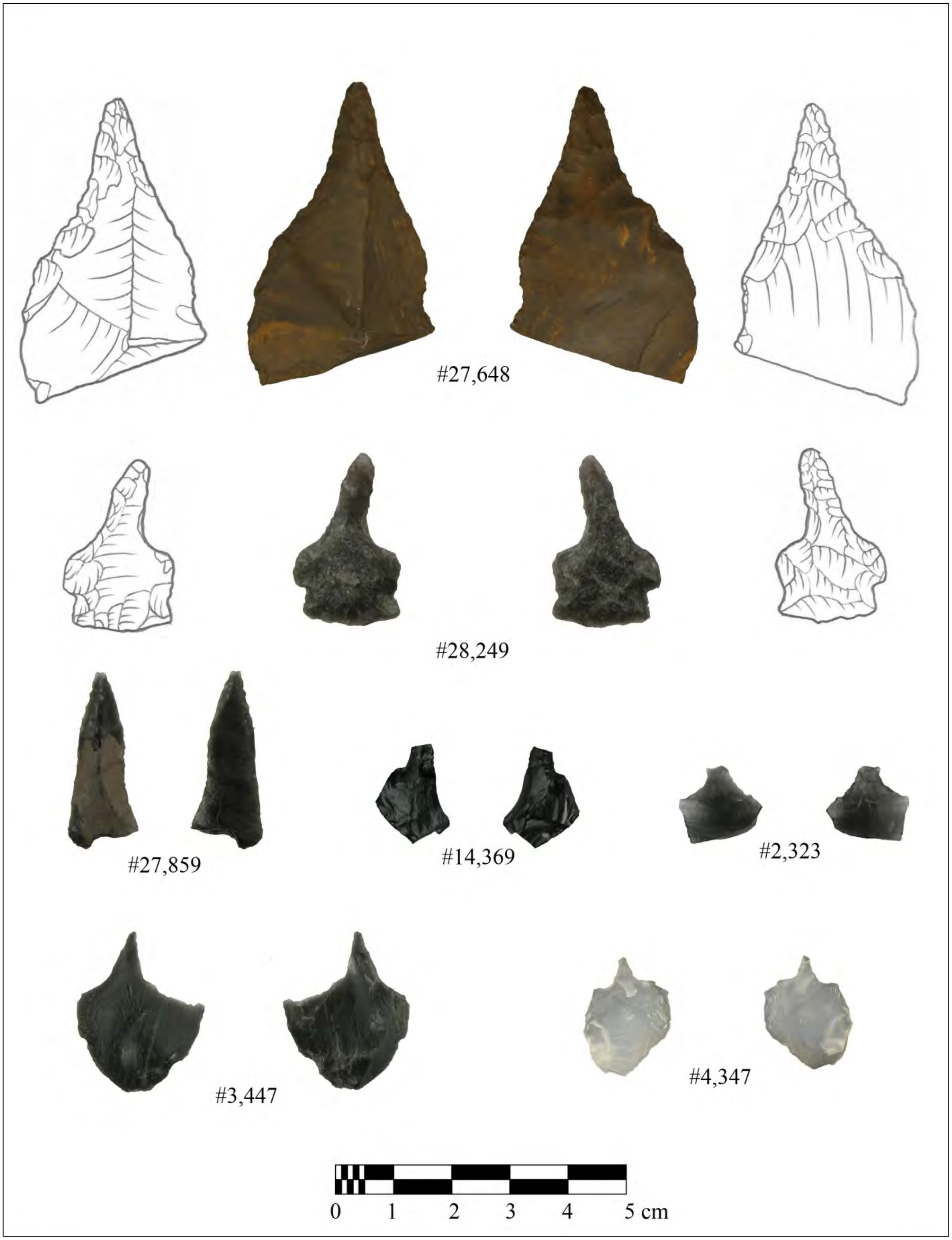


Figure 6-28 Drills and awls recovered from Game Creek.

Green River formation. The bit is 22.3 mm in length with nearly parallel straight sides and a rounded tip (Figure 6-27). Use-wear on the tip shows that it has been heavily utilized. A small flake appears to have been detached from one face of the distal end of the bit. The base is asymmetrical with one concave lateral margin and one straight margin. The proximal end of the base is concave. Both faces are covered with comedial pressure flake scars that meet near the midline of the bit, but they do not form a distinctive midline ridge. This drill was also likely hafted. Its presence in Cultural Level 3 indicates a Paleoindian age, and it may have been associated with the James Allen point recovered from Cultural Level 3 in Block A. Drills such as these have not been reported in association with Pryor or Lovell projectile points(Frison 1972; Frison and Grey 1980; Husted 1969; Husted and Edgar 2002; Kornfeld et al. 2001).

One complete (#27,648) and three bit fragments (#27,859, #10,979 and #14,324) of drills were also found (Figures 6-28 and 6-29). Bit fragments #10,979 and #27859 were recovered from Cultural Levels 5 and 7, respectively. The remaining drills came from disturbed contexts on the S3 (Table 6-14) The complete specimen is made on a large chert flake and has a tapering bit with a rounded end that shows rounding, abrasion and heavy polish. It was apparently handheld. The bit fragment from Cultural Level 7 appears to have been from a fortuitously shaped cortical flake with minimal margin retouch. The remaining tip fragments, though small, displayed pronounced rounding and abrasion indicative of use as a drill.

Two complete awls, (#3,447 and #4,347) very similar in form and dimensions, were recovered from Cultural Levels 2 and 4, respectively (Figure 6-28). Both specimens are made from small flakes, one of which is obsidian and the other silicified wood. The bits are between 4mm and 6 mm in length and have sharp, pointed ends that show some rounding and abrasion.

A bit fragment of an awl (#10,724) found in Block A Cultural Level 3 appears to have been made from a burin spall that was removed from blade edge of a projectile point (Figure 6-29). One surface retains the bifacial edge, and several small pressure flakes were detached from the broken edge of the spall. The working tip of the specimen has been broken off, but there is some abrasion and edge scarring present near the distal end. It is unclear how this specimen was used since it is too small to have been effectively held in the hand and no evidence of hafting was noted. The repurposing of broken projectile points into burins is a distinctive characteristic of Paleoindian assemblages, particularly Pryor assemblages (Frison and Grey 1980; Kornfeld et al. 2010).

A complete obsidian specimen (#28,249), found in Cultural Level 7 of Block G appears to have been made from a corner-notched dart point, or perhaps was intentionally notched for hafting. The bit is 14 mm in length, curved with a rounded end. The bit end shows abrasion, edge scarring and some polish. Given the curvature it is unlikely that it was used as a drill or reamer. Yet, the rounded bit end would not have been well-suited to perforating leather. Thus, the precise function(s) of the specimen are not known.

Figure 6-29 Drill and awl tip fragments recovered from Game Creek. Specimen #10,724 is made from a burin spall.

The remaining awls consist of two base fragments (#14,369 and #2,323) and one tip fragment (#18,974 [Table 6-14, Figures 6-28 and 6-29]). The base fragments retain the lower portion of the bit, which in both instances is about 4 mm in width and bi-convex in cross-section. The bit fragment is roughly flaked and slightly asymmetrical, but is only 5.4 mm in maximum width.

Scrapers

Surprisingly, only 14 end scrapers and three side scrapers were found during excavations at Game Creek (Figure 6-30). All but four of the scrapers are complete (Table 6-15). Half of the end scrapers, including all of the specimens from identifiable cultural levels, were expediently manufactured from flakes and show little evidence of haft preparation or polish on the proximal ends. This suggests that they saw relatively little use (Table 6-15, Figure 6-30). The distal ends consist of an edge of varying width with a series of flakes removed at a steep angle from the dorsal side of the flake. A majority of the expedient end scrapers were made of obsidian (71.4%). The two remaining expedient end scrapers were made on large primary flakes struck from metaquartzite and chert cobbles that were likely acquired locally. Both of these large scrapers were found on the S3 landform, one in Cultural Level 7 and the other in mixed context. These specimens stand in sharp contrast to the more carefully crafted, formal end scrapers that have unifacially-flaked proximal and distal margins and polish on both proximal and distal ends. Furthermore, six of the seven specimens are made of high-quality chert that does not appear to have obtained in Jackson Hole. Two of these were made of what is likely chert from the Madison formation. These formal items arrived as curated tools in a kit. Five have been almost completely expended or

Table 6-15 Attributes of scrapers recovered from Game Creek.

Catalog #	Description	CL	Block		Material Type	Completeness	Length	Width	Thickness
15919	EES	3	I	N518 E484	OB	CO	31	17	5
9466	EES	4	A	N499 E499	OB	CO	42	29	9
5412	EES	6	A	N498 E496	OB	CO	32	24	9
30038	EES	7		N696 E426	CH	CO	60	49	25
14254	EES		G	N695 E419	MQ	CO	82	75	30
16562	EES			N410 E489	OB	DS	13	16	5
21471	EES		L	N678 E426	OB	CO	34	30	5
28405	EES		G	N695 E422	OB	PR	38	20	9
21419	FES		L	N678 E426	OB	CO	29	28	6
23891	FES		L	N680 E425	CH	CO	34	21	9
24109	FES		L	N680 E426	CH	CO	23	20	4
24362	FES			N680 E430	CH	PR		28	10
24546	FES		L	N681 E424	CH	CO	31	25	5
25738	FES			N689 E429	CH	CO	75	48	13
8746	FSS	4	A	N495 E500	CH	CO	45	30	4
6455	FSS		B	N525 E496	OB	CO	45	40	20
6537	ESS		B	N526 E497	OB	LT	27	18	9

Abbreviations: Description – EES=expedient end scraper, FES=formal end scraper, ESS=expedient side scraper, FSS=formal side scraper; Material – OB=obsidian, CH=chert, MQ=metaquartzite; Portion – CO=complete, DS=distal (bit end), PR=proximal (haft end), LT=lateral.

suffered damage to distal ends. One however is a large "spurred scraper" (#25,738) made of banded chert that is still serviceable.

The side scrapers consist of two well-made specimens, one of obsidian and one of chert from the Tipton member of the Green River Formation (Table 6-15, Figure 6-31). The obsidian specimen was recovered from stratum III in Block B. Although there were few artifacts found in association with the scraper, its stratigraphic position indicates it is Paleoindian in age. The chert specimen was found in Cultural Level 4 of Block A in association with Elko Eared points. The remaining side scraper is a small lateral fragment of a blade edge.

Spokeshaves

Two spokeshaves, identified by unifacial retouch creating a deeply concave cutting edge, are present in the assemblage (Figure 6-31). Specimen #4,148 is complete, but #5,407 is missing one edge. Both are obsidian and were recovered from Block A, one in Cultural Level 6 and one in Cultural Level 7. They are remarkably similar in size and shape, each is 24 mm in length and about 20 mm in width and 6 mm in thickness. The working edge of the complete specimen is 13 mm in width. There is no evidence of

Figure 6-30 Photograph of end scrapers recovered from Game Creek.

Figure 6-31 Photograph of side scrapers and spokeshaves recovered from Game Creek.

tool curation in the form of polish or marked resharpening, which suggests these were expediently produced and discarded after limited use.

Gravers

Only 13 gravers are present in the assemblage (Table 6-16). The majority of the gravers are little more than fortuitously shaped flakes that have had a few pressure flakes removed to accentuate a small bit (Figure 6-32). One specimen is made of Madison chert and the others are obsidian. None of the gravers show any evidence of prolonged use such as extensive resharpening or polish on the proximal end or sides. However, all showed some edge rounding, scarring, abrasion and/or polish on or near the bit ends (Figure 6-33).

Gravers are presumed to have been used to engrave bone and/or wood, and they have been associated with the production of eyed bone needles in Paleoindian assemblages (Osborn 2014). There are disproportionate numbers of gravers in the Paleoindian-aged cultural levels at Game Creek. Cultural Levels 1 and 2 comprise only 8.5% of the total Game Creek assemblage, but 23.1% of the gravers were

Figure 6-32 Photographs of gravers recovered from Game Creek.

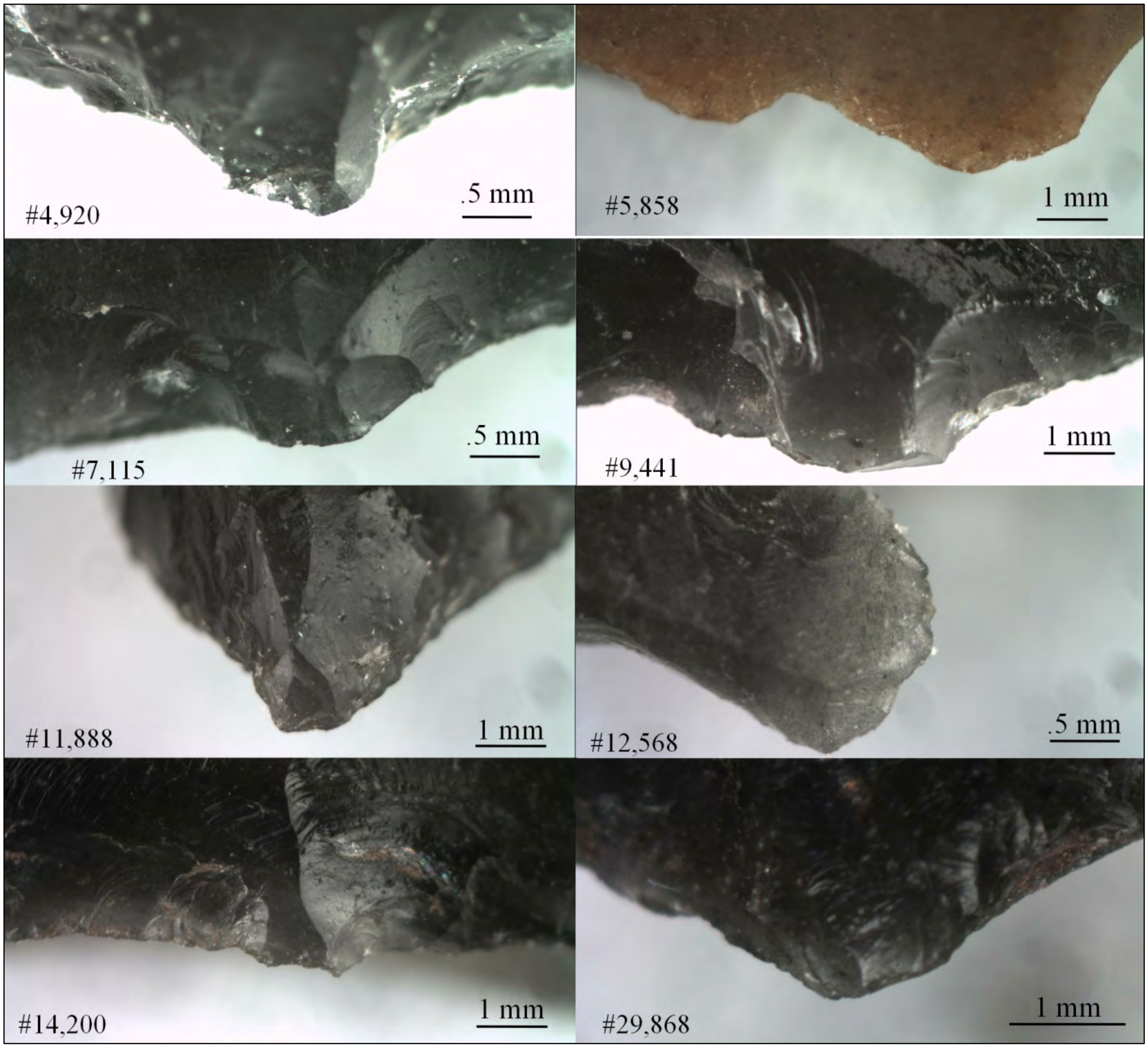


Figure 6-33 Photomicrographs showing use-wear on graver bits.

found in these two cultural levels. Similarly Cultural Level 4, which contained a mix of Foothills-Mountain (Pryor) and Early Archaic materials, accounts for only 4.6% of the total Game Creek assemblage, but 15.4% of the graver assemblage. These data, though limited do suggest a more frequent or intensive use of gravers during the Paleoindian period. Although there is little evidence for the production of the eyed bone needles following the Paleoindian period of the Northwestern Plains and Central Rockies (Osborn 2014), gravers continued to be made and used during the Archaic and Late Prehistoric periods at Game Creek as well as other sites (Page 2016).

Table 6-16 Attributes of gravers recovered from Game Creek.

Catalog #	CL	Block	Unit	Material Type	Portion	Length	Width	Thickness	Bit width	Bit Length
4920	1	A	N499 E498	OB	CO	36	25	7	1.8	0.9
3875	2	A	N498 E492	OB	CO	38	25	11	3.3	1.7
5858	2	A	N500 E497	CH	CO	55	34	13	1.4	1.3
4353	4	A	N498 E500	OB	CO	45	15	14	3.1	4
7115	4	A	N502 E498	OB	CO	22	18	4	1.6	0.5
9441	7	A	N499 E499	OB	CO	31	23	6	3.2	1.4
14200	7	G	N695 E419	OB	CO	23	15	5	0.7	0.6
20289			N675 E429	OB	CO	40	20	11	1	0.6
22088		L	N679 E423	OB	BAS	41	26	9	1.9	0.6
11888			N436 E503	OB	CO	34	20	6	2.7	1.6
12568			N529 E480	OB	CO	19	17	4	2.1	2
16711			N485 E493	OB	CO	47	20	10	1.8	0.7
29868			N696 E426	OB	CO	37	20	10	2.8	0.7

Abbreviations: Material – OB=obsidian, CH=chert; Portion – CO=complete, BAS=base.

Flake Tools

The majority of the tools recovered from Game Creek are expedient utilized and retouched flakes The utilized flake assemblage contains 648 specimens, examples of which were found in all cultural levels, but the majority of the site sample was recovered in disturbed contexts on the S3 (Table 6-17). Raw material use in the utilized flake assemblage roughly mirrors that of the debitage assemblages from most cultural levels. However, Cultural Level 1 and Cultural Level 7 on the S3 did contain higher percentages of chert and/or metaquartzite than their corresponding debitage assemblages. Similarly, the mixed deposits from the S3 produced a utilized flake assemblage that contained higher percentages of chert, metaquartzite and silicified wood than the debitage assemblage. Moreover, many of the chert specimens were made of materials that were not acquired locally. At least two of the non-local chert utilized flakes were made from material originating in the Tipton member of the Green River Formation, two from Bridger formation material, and one from the Laney member of the Green River Formation. These materials were likely acquired in the Green River basin to the south-southeast of Game Creek. The data suggest that people arrived at Game Creek with tool kits containing unused, or lightly used, flakes from the Green River Basin, a pattern that is also reflected in the debitage assemblage. This may indicate that there was regular, perhaps scheduled, use of Jackson Hole by people who were also residing in the Green River Basin.

Most (90.1%) of the utilized flakes were made from non-cortical flake fragments and tertiary flakes that averaged 33.5 mm in length and 22.9 mm in width. There are no statistically significant

Table 6-17 Summary of utilized flake assemblage recovered from Game Creek.

	Cultural Level								?	Sample Total
	1	2	3	4	5	6	7	S3-7		
n=	23	52	30	70	36	16	16	28	377	648
Material Type										
OB	78.3%	90.4%	100.0%	95.7%	94.4%	93.8%	93.8%	82.1%	86.7%	88.9%
CH	17.4%	3.8%		4.3%	2.8%	6.3%	6.3%	7.1%	5.6%	5.4%
MQ								10.7%	5.8%	3.9%
BT									1.6%	0.9%
OQ		1.9%			2.8%				0.3%	0.5%
SWD		3.8%								0.3%
OT	4.3%									0.2%
Debitage Type										
FF	65.2%	71.2%	73.3%	70.0%	75.0%	68.8%	87.5%	67.9%	70.8%	71.1%
TF	21.7%	25.0%	20.0%	22.9%	25.0%	18.8%	6.3%	10.7%	17.8%	19.0%
SF	4.3%	1.9%	3.3%	4.3%		12.5%		7.1%	8.0%	6.2%
SH	8.7%		3.3%	2.9%			6.3%	3.6%	1.6%	2.0%
CO									1.6%	0.9%
PF								3.6%	0.8%	0.6%
BFTF								3.6%		0.2%
Summary Metrics										
Range Length	18-88	14-96	11-61	11-78	14-67	14-43	18-43	15-127	11-143	11-143
Mean Length	37.7	36.0	32.0	35.4	29.6	25.8	28.0	41.0	35.9	33.5
Range Width	12-52	9-55	7-43	6-57	10-45	8-30	8-37	12-81	7-118	6-118
Mean Width	26.3	23.4	22.0	22.2	21.4	18.2	21.1	27.4	24.3	22.9
Mean Thick.	8.1	6.0	5.8	6.1	5.6	5.3	6.8	9.2	7.1	6.6
Mean Use Ind.	0.25	0.30	0.27	0.33	0.25	0.31	0.27	0.41	0.44	0.31

Abbreviations: Material – OB=obsidian, CH=chert; MQ=metaquartzite, BT=basalt, OQ=orthoquartzite, SWD=silicified wood, OT=other; Debitage Type – FF=flake fragment, TF=tertiary flake, SF=secondary flake, SH=shatter, CO=core, PF=primary flake, BFTF=bifacial thinning flake.

differences in size between cultural level assemblages. Tools of this size can be used without hafting to a handle, but specimens smaller than about 30 mm, of which there are 280 items, were likely hafted to some sort of implement (Lee et al. 2016). “Microliths” such as these have been recovered in Paleoindian as well as Late Archaic and Late Prehistoric contexts throughout the Northwestern Plains (Lee et al. 2016). “Microtools” have also been reported from numerous Early Archaic components in the Southern Rockies (Black 1991). Although no patterned micro-cores were recovered from Game Creek, the use of “microliths” that were presumably hafted to an implement of wood, bone or antler, are fairly common at Game Creek and were recovered from all cultural levels.

Figure 6-34 Photographs of *teshoa* and utilized cores recovered from the S3 landform at Game Creek.

There is a small sample of utilized flakes, six in all, that were made from large cortical flakes struck from metaquartzite river cobbles (Figure 6-34). All six were recovered from the S3 landform, one was found in Block G Cultural Level 7. These specimens are on average 112 mm in length and 82 mm in width. Each has a broad convex blade edge that shows rounding, abrasion and polish indicative of repeated use. Tools such as these, known as *teshoa*, were documented ethnographically among the Eastern Shoshone, who used them for dressing hides (Leidy 1872; Shimkin 1986). Yet, there is no reason to assume that *teshoa* are a culturally diagnostic artifact, since similar implements, often described as "choppers", are common and widespread (Eyman 1968). They are not, however, routinely recognized in the archaeological literature of the Rocky Mountain West (Butler 1978). Eakin (2006) recovered several *teshoa* from four sites on Boulder Ridge, which given the associated artifact assemblages and early historical accounts, were almost certainly made and used by Eastern Shoshone.

Included in the utilized flake category are six cores, all found on the S3 (Figure 6-34). Three of the specimens are made of metaquartzite, two of obsidian and one of basalt. They average 83 mm in length and 68 mm in width. Core types include two unifacial, one bipolar, one bifacial, one multi-directional and one of indeterminate type. These tools may have served a similar function as the *teshoa* in dressing hides, or may have been heavy-duty choppers used for butchering.

A use index was created to quantify the amount use for flake tools. Each segment of the tool showing use was counted and divided by eight to give a use index of between .125 (only 1/8 of the tool cutting edge was used) and 1 (the entire cutting edge was utilized). Results of the analysis show that utilized flakes in the Game Creek assemblage have an average use index of .31 (Table 6-17). There are no statistically significant differences in the use index of individual cultural levels from the T3. However, the data indicate that utilized flakes from the S3, including Cultural Level 7, were more intensively used (mean .42) than in any of the cultural levels on the T3 terrace. Results of a Kruskal-Wallis test show that the difference in use indexes is statistically significant (Table 6-18). This pattern may reflect the different activities to which the tools were put. Although the S3 landform contained multiple mixed components spanning much of the Archaic and Late Prehistoric periods, the evidence suggests that it was more intensively occupied than the T3 terrace. Furthermore, the faunal assemblage from the S3 reflects more intensive processing of fauna than the cultural levels on the T3. It is possible that higher use index of utilized flakes on the S3 reflects the greater occurrence of butchering and/or longer durations of occupation.

The retouched flake assemblage contained 165 specimens, examples of which were recovered from all cultural levels. The majority, however, was recovered from mixed contexts on the S3 (Table 6-19). Raw material use for retouched flakes was similar to that observed in the utilized flake assemblage. Most of the specimens are made of obsidian, in roughly the same percentages as the debitage assemblage.

Table 6-18 Results of Kruskal-Wallis test comparing central tendencies of use indexes.

	CL1	CL2	CL3	CL5	CL4	CL7B	S3
CL1		0.434	0.836	0.877	0.719	***0.009***	***2.053E-04***
CL2	1.000		0.527	0.293	0.686	***0.016***	***2.364E-05***
CL3	1.000	1.000		0.686	0.852	***0.006***	***2.954E-05***
CL5	1.000	1.000	1.000		0.549	***0.003***	***4.142E-06***
CL4	1.000	1.000	1.000	1.000		***0.011***	***1.771E-06***
CL7B	0.185	0.342	0.124	0.054	0.236		9.355E-01
S3	***0.004***	***4.964E-04***	***0.001***	***8.697E-05***	***3.718E-05***	1.000	

Mann-Whitney pairwise test *p* values in upper right, Bonferroni corrected *p* values in lower left.
H_0 = the samples are taken from populations with equal medians
Italicized-bold results are significant , i.e. reject the null hypothesis.

Table 6-19 Summary of the retouched flake assemblage recovered from Game Creek.

	Cultural Level									Sample Total
	1	2	3	4	5	6	7	S3-7	?	
n=	10	18	9	14	9	4	4	7	90	165
Material										
OB	60.0%	94.4%	88.9%	92.9%	100%	100%	100%	85.7%	74.4%	81.2%
CH	40.0%	5.6%	11.1%	7.1%	0.0%	0.0%	0.0%	14.3%	11.1%	10.9%
MQ									11.1%	6.1%
BT									1.1%	0.6%
OQ									2.2%	1.2%
Debitage Type										
FF	70.0%	44.4%	77.8%	50.0%	55.6%	100%	100%	71.4%	72.2%	67.9%
TF	30.0%	50.0%	22.2%	42.9%	33.3%			14.3%	17.8%	24.2%
SF		5.6%		7.1%				14.3%	3.3%	3.6%
SH					11.1%				3.3%	2.4%
?									1.1%	0.6%
FCR									1.1%	0.6%
TC									1.1%	0.6%
Summary Metrics										
Range L	17-60	16-77	16-86	21-65	14-61	22-39	18-38	20-65	16-113	14-113
Mean L	33.6	37.1	35.0	43.0	30.6	33.0	27.8	37.9	39.7	35.3
Range W	12-44	8-77	10-45	18-56	6-39	19-23	11-25	20-43	10-73	6-77
Mean W	22.1	25.9	24.0	29.5	23.0	20.7	19.3	30.1	27.3	24.6
Mean T	5.2	5.9	6.7	7.8	5.3	7.0	5.8	7.1	8.4	6.6
Mean UI	0.36	0.45	0.39	0.45	0.50	0.47	0.41	0.65	0.72	.49

Abbreviations: Material – OB=obsidian, CH=chert; MQ=metaquartzite, BT=basalt, OQ=orthoquartzite; Debitage Type – FF=flake fragment, TF=tertiary flake, SF=secondary flake, SH=shatter, FCR=fire-cracked rock, TC=tested cobble.

The exceptions again came from Cultural Level 1 and Cultural Level 7 on the S3, where there was a greater reliance on chert and metaquartzite than reflected in the debitage assemblage. None of the chert items could be identified to source.

Retouched flakes, on average, were slightly longer and wider than utilized flakes (Tables 6-17 and 6-19). The small sample sizes in the cultural level assemblages preclude statistical comparisons of artifact size. Most of the retouched flakes (92.1%) were made from non-cortical flake fragments and tertiary flakes. One specimen was made from a piece of a fire-cracked metaquartzite cobble, and one was crafted from a tested cobble.

Retouched flakes were, overall, more intensively used than utilized flakes. The mean use index for the entire sample is .49, or roughly half of the useable flake edge showed some evidence of use wear and/or retouch. Although the sample sizes from the cultural levels on the T3 are too small for statistical comparison they, like the utilized flake assemblage, have lower use indexes than the assemblages from the S3. Again, this may reflect a longer duration of occupation and/or a greater intensity of butchering for the occupations on the S3 than on the T3.

Groundstone

The excavations at Game Creek produced a small groundstone tool assemblage. By convention, the hammerstones are included in this category, but none were actually ground. The assemblage includes 12 hammerstones, six manos, one metate fragment, one pestle and one notched cobble similar to items categorized as net sinkers. Several of the hammerstones were found in Cultural Levels 1, 2 and 5 on the T3, and the metate fragment was recovered from Cultural Level 4 in Block A. The remaining items were either found on the S3 landform or came from other disturbed contexts.

All but one of the 12 hammerstones consists of small unmodified metaquartzite stream cobbles. They range in length from 60 mm to106 mm and in width from 36 mm to 87 mm (Table 6-20). One hammerstone is made of a sandstone cobble. All of the specimens show some battering on at least one end. They are otherwise unremarkable.

The six manos are similar in size and shape, with a mean length of 113 mm, a mean width of 81 mm and a mean thickness of 58 mm (Table 6-20). Four of the six specimens are made of sandstone and two of metaquartzite. The latter metaquartzite specimens (#2,619 and #13,885) are expedient tools that show relatively little use, but the sandstone items are well-crafted and symmetrical (Figure 6-35).

One well-made sandstone specimen (#1,617) was found in a krotovina in unit N440 E520 at the south end of the T3 terrace. The mano is too large to have been moved by a pocket gopher, and it appears that it either fell into an open burrow that was below it, or a burrow was dug around it. However, both the burrow and the mano were found at the base of Cultural Level 4 near the contact of strata III and IV. It is therefore likely that it was part of the Early Archaic component in Cultural Level 4. Both faces of the mano show extensive use and are slightly convex is latitudinal and longitudinal cross-section. The edges

Table 6-20 Attributes of groundstone artifacts recovered from Game Creek.

Cat#	Cultural Lvl	Block	Unit	Description	Material	Length	Width	Thickness	Weight (g)
10055	1	A	N497 E492	Hammerstone	MQ				
3870	2	A	N498 E492	Hammerstone	MQ	98	52	39	230.6
4702	2	A	N498 E501	Hammerstone	MQ	97	87	46	563.63
3917	5	A	N498 E497	Hammerstone	MQ	90	62	37	297.5
1430			N440 E504	Hammerstone	MQ				
3560		A	N497 E501	Hammerstone	MQ	60	36	24	
13495		G	N691 E422	Hammerstone	MQ	106	79	28	
13531		G	N691 E422	Hammerstone	MQ	72	68	38	
21067			N677 E424	Hammerstone	SS				953.2
24032		L	N680 E425	Hammerstone	MQ				1611
24409			N680 E430	Hammerstone	MQ				579.6
29473		G	N696 E422	Hammerstone	MQ				564.6
1617			N440 E520	Mano	SS	128	77	52	675.5
2619		G	surface	Mano	MQ	93	81	63	644.8
13885		G	N694 E421	Mano	MQ	96	69	49	383.8
24022		L	N680 E425	Mano	SS	117	85	49	676.4
24172		L	N680 E426	Mano	SS	122	98	46	753.4
27658		G	N695 E420	Mano	SS	123	78	90	1262.6
15144	4	A	N500 E489	Metate	SS	68	42	22	98.6
27516		G	N691 E421	Net Sinker	MQ	72	60	15	87.85
28769		G	N695 E424	Pestle	LS	283	57	63	1522.1

Abbreviations: Material – MQ=metaquartzite, SS=sandstone, LS=limestone

have been trimmed through pecking and grinding but display no grinding use-wear. A pollen wash was taken from the object, but was not submitted for analysis.

Two manos, #24,172 and #27,658, found in disturbed contexts in blocks L and G, respectively, are made from sandstone cobbles that were minimally modified. Both items have a single-facet working edge that is nearly flat with rounding edges. The sides of the specimens have not been trimmed. These specimens appear to have been fortuitously-shaped cobbles that saw limited use as grinding tools.

Mano #2,619 was recovered from the surface of the S3 landform near Block L. The artifact consists of an unmodified metaquartzite cobble with one nearly flat surface. Unlike the previously described manos, this specimen does not appear to have been used for grinding, since there is no sign of abrasion on the working surface. The working face is, however, highly polished. This item may have been used as a hide smoother, or perhaps it was first used as a mano for grinding then later used as a hide smoother that polished the surface and removed evidence of abrasion.

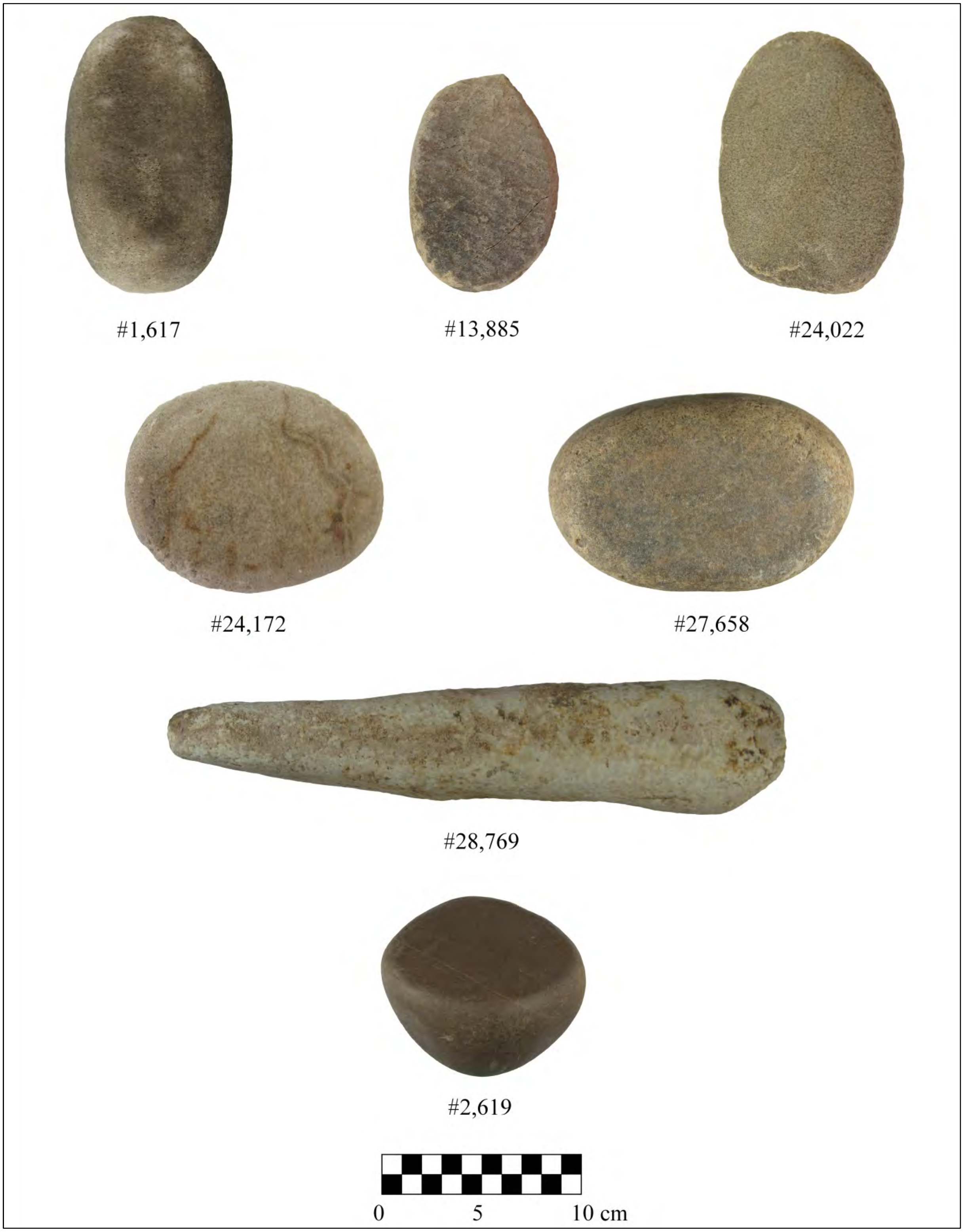


Figure 6-35 Photograph of manos and pestle found at Game Creek.

Another well-made and heavily used sandstone mano (#24,022) was found in Block L on the S3. One face of the mano has a single working facet that is convex in both latitudinal and longitudinal cross-section. The other face has two working facets with a slight rounded midline ridge running along the center of the long axis (Figure 6-35). The edges of the specimen have been shaped through pecking and grinding, but again no use-wear was observed on these surfaces.

The final mano (#1,617) is made from a fire-cracked metaquartzite cobble recovered from Block L on the S3. The broken face of the cobble, which is almost perfectly flat, is highly abraded and slightly polished. The edges and reverse face of the specimen have been unaltered.

A large piece of limestone was found in the debris flow deposits in Block G. The specimen (#28,769) is roughly conical in shape with one end that tapers to a blunt point and the other which expands to a flat surface that is roughly rectangular (Figure 6-35). The flat, wide rectangular end has nicks and abrasions indicative of use. The sides and narrow end do not appear to have been modified in any way. This may have been a fortuitously shaped limestone cobble that saw limited use as a pestle or hammerstone. However, it is equally possible that the evidence for battering was created when the artifact was entrained in the debris flow.

A small metate fragment was recovered from the west end of Block A in Cultural Level 4. Relatively few artifacts were found in this portion of Cultural Level 4, but a dated bison mandible found only two meters away suggests that the metate fragment is from the Foothills-Mountain Pryor stemmed component. The specimen is fairly thin and made of greenish sandstone that is local to the area, since similar material was found in the gravels on the T3 terrace (Table 6-20, Figure 6-36). One surface of the specimen is rough and uneven, but the other side is slightly concave and smooth. Microscopic examination of the smooth surface revealed small parallel striations on the surface of exposed quartz grains. Grinding tools have been recovered from similarly aged Pryor stemmed components in the Central Rockies (Husted 1969; Frison and Grey 1980).

A notched metaquartzite cobble fragment (#27,516), likely a spall from a fire-cracked rock, was found in Block G (Figure 6-36). The specimen has had flakes removed from both faces and both ends. Objects such as this have been found along Jackson Lake and identified as net sinkers (Connor 1998). Several fish bones were recovered from the S3. An ethnographic account from Reverend Parker in 1835 indicates that the Shoshone made fish nets out of wild flax (Wright 1984). The optimal time for netting fish would have been during the spring spawning runs of cutthroat trout. The close proximity of Flat Creek and the Snake River, both of which support healthy populations of cutthroat trout, would have made the area an ideal place to procure fish during spawning. Furthermore, the recovery of several fetal bison and perhaps elk indicate that the S3 landform was occupied during the spring.

Figure 6-36 Photographs of net sinker and metate fragment recovered from game creek.

Bone and Antler Tools

A small bone or antler tool assemblage was recovered from Game Creek (Table 6-21). All of the specimens were recovered from the S3 landform, but two were found in Cultural Level 7. The assemblage includes two awl fragments, two punches or flakers, a flesher, a digging stick tip, two pieces of utilized bone, a finely-crafted bone object of unknown use and a modified elk antler.

Bone awls

Two near-tip distal fragments of bone awls were found in Block L (Table 6-21, Figure 6-37). The fragments are too small to allow identification of the species or element from which they were made. Specimen #31,113 has been charred, but not calcined. Both fragments show longitudinally-oriented striations and polish. Bone awls have been recovered from numerous prehistoric sites in the Central Rockies, where conditions are favorable for preservation, and were produced during all cultural periods.

Bone Punches/Flakers

Two artifacts, one from Block L and another from Block JK are believed to be punches or flakers used for pressure flaking (Table 6-21, Figure 6-38). The more complete of the two (#30,796), missing only its tip and part of a lateral margin near the tip, was made from a tibia or metapodial of a large mammal. The sides and base have been shaped through grinding and are slightly asymmetrical. The base tapers to a blunt point. Cancellous bone tissue remains on the inner surface. The second punch/flaker (#18,447) consists of a distal fragment. It was made from a large mammal rib fragment. One lateral margin has been ground smooth, but the other is rough and uneven. The tip was formed by grinding, and it tapers to a blunt rounded point. Longitudinal striations are present near the tip, but there is no polish.

Table 6-21 Attributes of bone and antler tools recovered from Game Creek.

Cat#	Block	Unit	Description	Portion	Length	Width	Comments
31113	L	N679 E426	awl	DS	8.5	2.8	awl tip
31119	L	N679 E426	awl	DS	14.2	4.8	awl tip
18447	JK	N665 E425	punch/flaker	DS	51	10	Lg. mammal rib fragment
30796	L	N679 E422	punch/flaker	NC	125	11	Lg. mammal tibia or metapodial
13846	G	N694 E421	flesher	CO	19	32	elk tibia
14234	G	N696 E419	digging stick tip	DS	101.8	44.8	bison tibia
32526	G	N696 E419	util. bone	CO	55	20	Lg. mammal longbone
32533	G	N696 E419	util. bone	CO	102	20	elk radius
30509	L	N677 E427	unknown	FR	177	32.8	Lg. mammal longbone
30878	L	N679 E423	modified antler	FR	364	70.5	elk antler tool

Abbreviations: Portion – DS=distal, NC=nearly complete, CO=complete, FR=unidentified fragment

Figure 6-37 Photograph of the bone awl tips recovered from Game Creek.

Bone punches or flakers are a fairly common type of bone tool that have been recovered from numerous sites in Central Rockies and surrounding the regions (Aikens 1970; Gruhn 1961; Frison 2007a, 2007b; Husted and Edgar 2002; Lucius 1980; Plimpton 1980).

Flesher

A lightly modified elk tibia fragment (#13,846) appears to have been used as a flesher (Table 6-21, Figure 6-38). The bone has been split longitudinally, and the curved proximal end of the fragment has been slightly modified by the removal of several flakes. The working surface is rounded with signs of abrasion and polish. The remaining edges of the bone do not appear to have been modified.

Digging Stick Tip

The distal fragment (#14,234) of what is believed to have been a digging stick tip was found in the debris flow deposits in Block G (Table 6-21, Figure 6-39). The specimen consists of a distal fragment of what appears to be a bison tibia. The working end is battered with numerous longitudinal striations and some polish. The proximal end of the specimen is broken away. Bison tibia digging stick tips have not been reported from the Central Rockies but are a common bone tool form in Late Prehistoric assemblages in the Central Plains (Blakeslee 1999).

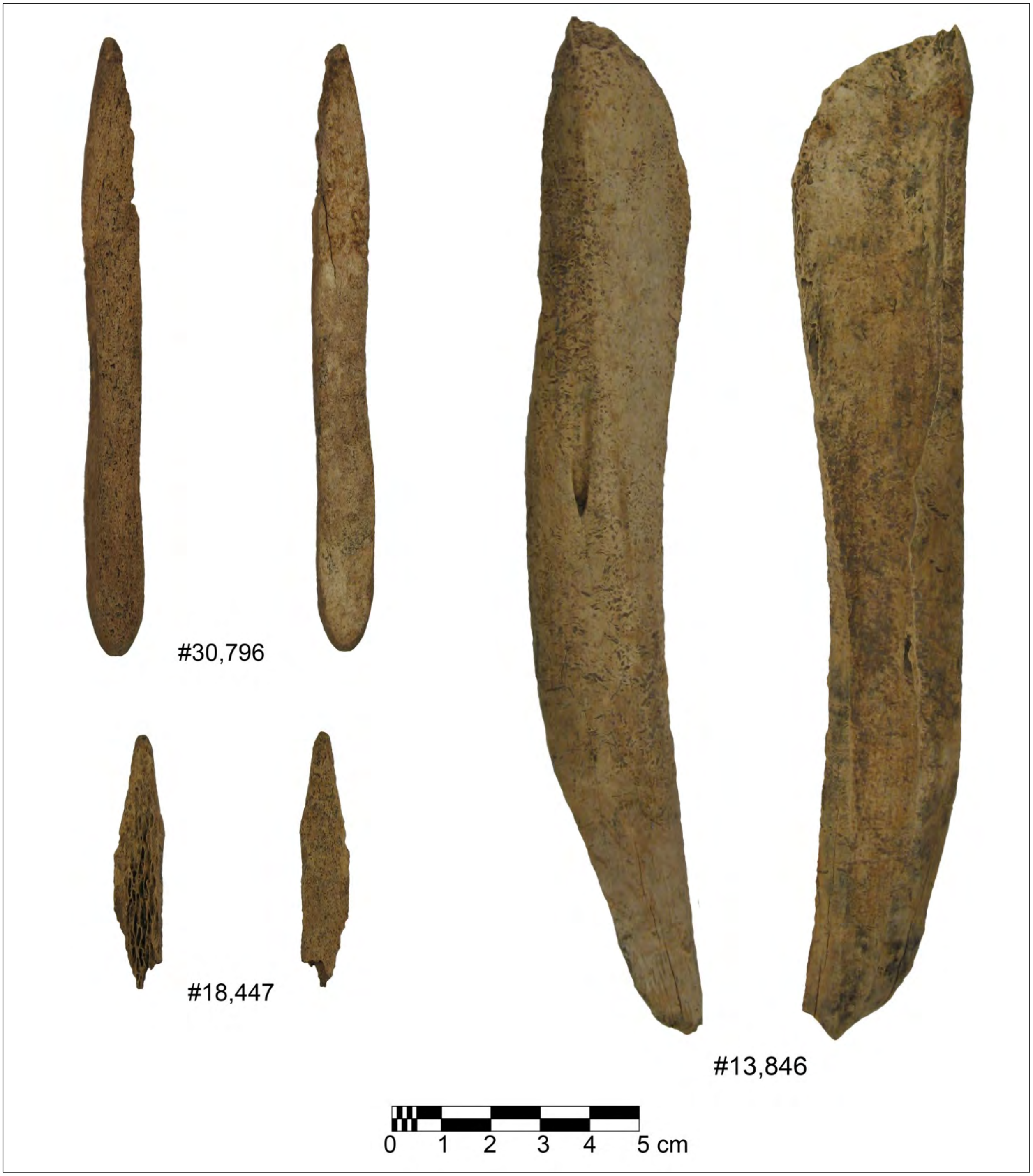


Figure 6-38 Photographs of bone punches/flakers and utilized bone fragment recovered from Game Creek.

Figure 6-39 Bone digging stick tip and utilized bone fragments recovered from Game Creek.

Utilized Bone Fragments

Two large bone fragments recovered from Cultural Level 7 in Block G showed some edge rounding and polish indicative of use (Table 6-21, Figure 6-39). Specimen #32,526 is a fragment of an unidentified large mammal longbone. One lateral edge is straight with rounding and polish, but the remaining edges are unmodified, irregular and rough. This specimen may have been used as a scraper or flesher. The other bone tool (#32,533) is made from an elk radius, split longitudinally with a pointed distal end and a rough unfinished proximal end. The edge of the distal end is rounded and polished, but otherwise unmodified. This tool may have been used as an expedient digging tool.

Unidentified Modified Bone

One peculiar bone artifact (#30,509), the purpose of which is unknown, was recovered from Block L (Table 6-21, Figure 6-40). The specimen is made from a fragment of a large mammal longbone split longitudinally. Given its size it is likely a femur of a bison. The interior of the bone has been scoured with an abrasive object leaving parallel-longitudinal striations (Figure 6-41h). The broken lateral edges have been ground smooth and are polished from some sort of use (Figure 6-41g). Four small holes, approximately 2 mm in maximum diameter and 1.7 mm in minimum diameter, were drilled through the exterior of the bone very near the margins. Two holes are present near the side end of the object and two, adjacent to each other near the center of one lateral margin (Figure 6-41a-f). The holes taper suggesting they were created using a tapering drill. One of the holes appears to have caused a break near the edge of the specimen, and a second hole was drilled adjacent to it. The lateral edge lacking holes is nearly straight and highly polished. The other edge is broken below the drilled holes and is jagged and unmodified along the break. The narrower end also appears to be broken and is unmodified. The wider end has been slightly ground but has only limited polish. No objects, even remotely similar to this item have been reported from sites in the Central Rockies or surrounding regions.

Antler Artifacts

A large segment of modified elk antler was recovered from Block L (Table 6-21, Figure 6-42). The specimen consists of a fairly well-preserved beam fragment of a left elk antler. The base and brow tine have been removed by chopping, scouring and snapping immediately below the bez tine. The bez tine was also removed by scouring and snapping. The upper portion of the antler was removed at the tres tine probably by chopping with a large chipped stone tool, such as *teshoa*, leaving a jagged edge with several clear chop marks. There was an attempt to remove the remaining juncture of the beam and bez tine by chopping a grove into and around the beam, but the end was never snapped off.

Figure 6-40 Photographs of an unidentified bone tool or object (#30,509) recovered from Game Creek.

The Lakota use the same segment of elk antler, known as a *wahnike*, as a flesher/scraper handle with the scraper lashed in slot cut in the bez tine. An elk antler club with a sharpened bez tine was found near several sheep traps in the Absarokas and is believed to have been used to dispatch sheep (Kornfeld et al. 2010). The specimen recovered from Game Creek may have served either of above purposes. Or it simply may have been a dropped antler from which the tines were removed for flakers and other tools.

Shell Bead

A shell bead was found in Cultural Level 7 in Block G. The bead is barrel-shaped and has been carefully worked. It is 5.5 mm in maximum length and 5.4 mm in width. Modifications of the shell have obliterated most of the diagnostic characteristics but it resembles *Olivella* or *Marginella* shells from the Pacific coast (Johnson and Snook 1967). A possible *Olivella* bead was found at the similarly aged Bugas-Holding site (Kornfeld et al. 2010).

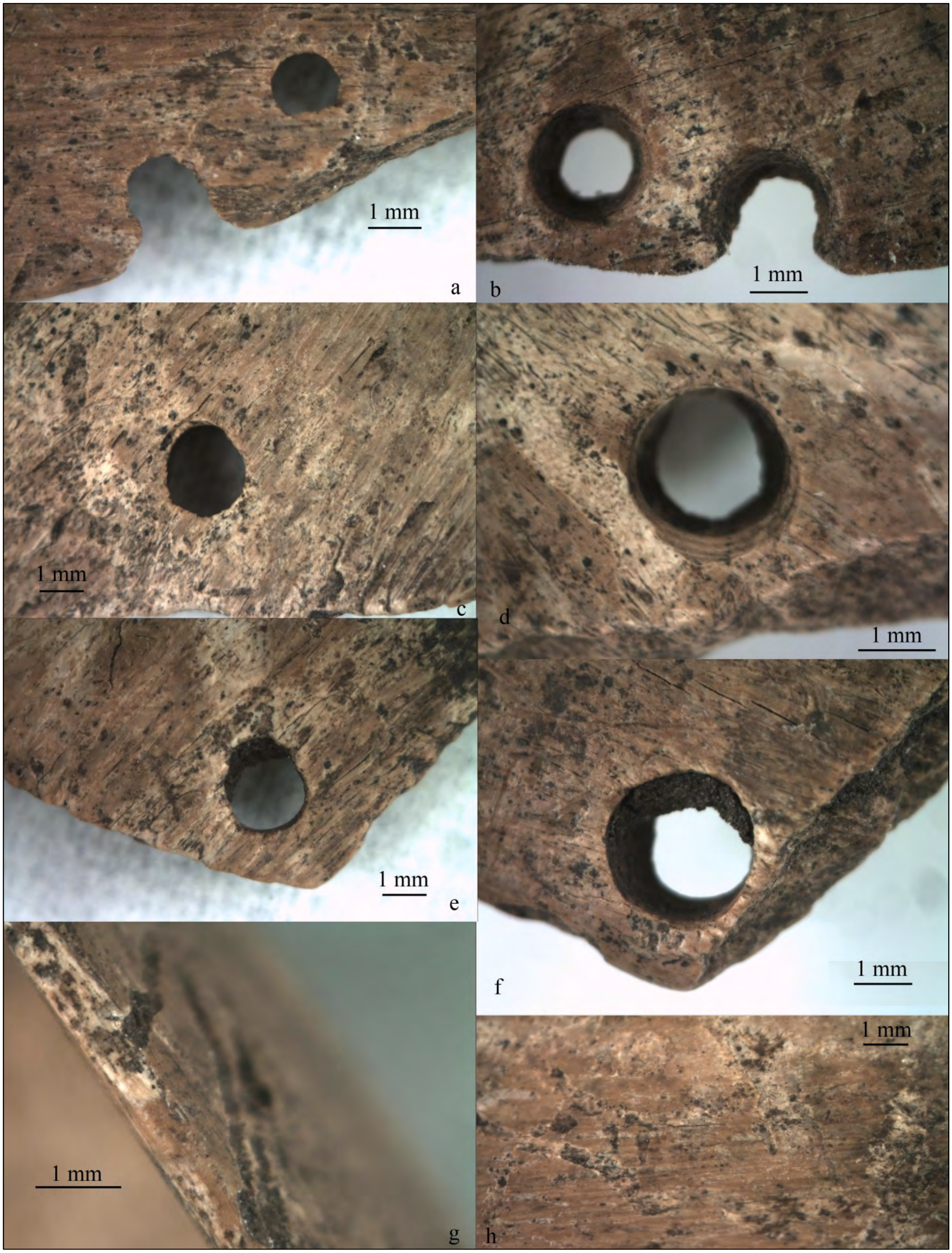


Figure 6-41 Photomicrographs showing drill holes, edge polish and scouring on unidentified bone object.

Figure 6-42 Photograph of modified elk antler recovered from Game Creek.

Figure 6-43 Photographs of multiple sides of the *Olivella* shell bead found in Cultural Level 7 at Game Creek..

CHAPTER 7 FAUNAL ASSEMBLAGE

Michael Page

The excavations at Game Creek produced a large and varied faunal assemblage. In all, 29,687 pieces of bone, teeth and tooth enamel fragments were recovered during the data recovery excavations (Table 9-1). However, most of the faunal remains were found on the S3 landform in poor context, which precludes detailed analyses of butchering practices and component- specific details of animal use. Nevertheless, the cultural levels on the T3 and T2 terraces, as well as the Cultural Level 7 deposit found above the debris flow in Block G on the S3 alluvial fan, contained 2,127 culturally modified faunal specimens. The vast majority (99.9%) of the faunal assemblage consists of mammalian fauna. The remaining specimens are from several species of birds, fish, freshwater bivalve and one possible reptile bone. Although most (98.1%) of the faunal remains are too fragmentary to allow identification to species, many specimens could be identified as large artiodactyl (bison or elk), medium artiodactyl (deer, pronghorn or bighorn sheep) or more generally as artiodactyl of unspecified size. Intrusive burrowing rodent bone was fairly abundant at the site, as discussed at length in Chapter 4. The data show that the prehistoric inhabitants of Game Creek were focused on the procurement of high value large game species such as bison and elk. These findings contradict the assertions of Wright et al. (1980), Wright (1984) and Bender and Wright (1988), who argue that bison and elk were either absent from Jackson Hole during much of prehistory or were too rare and unpredictable to allow a consistent and reliable harvest by prehistoric hunter gatherers.

Mammalian Fauna

Bison

Bison remains are the most frequent identifiable species in the Game Creek assemblage (Tables 8-1 and 8-2). The data show that bison were harvested and utilized at Game Creek during all cultural periods. Most (56%) of the 326 identifiable specimens were found on the S3 alluvial fan in poor context. However, a small number of bison remains were recovered from Cultural Levels 1 (10,391±61 cal BP), 4 (9000-6900 cal BP), 5 (6900-5290 cal BP) and 7 (1000-550 cal BP) on the T3 terrace in relatively good context. The remains of a single young bison were found on the T2 terrace in what is believed to be a Late Prehistoric (Cultural Level 7) context. The small assemblage of bison bone recovered from above the debris flow in the north half of Block G on the S3 alluvial fan also likely dates to the Late Prehistoric period (Cultural Level S3-7). In addition, two bison bones from Cultural Level 4 on the T3 and one from Feature 12 in Block J/K on the S3 landform were submitted for radiocarbon dating and produced age estimates of 8645±77 cal BP, 7629±25 cal BP and 2039±45 cal BP, respectively. The two early dates from Cultural Level 4 may not accurately date the age of the component (see discussion in

Table 7-1 Summary of faunal material recovered from Game Creek.

Taxon	NISP	MNI	ENI
Bison bison	326	5	10-14
Cervus canadensis (elk)	59	3	3
Large Artiodactyl (bison/elk)	294		
Odocoileus sp. (deer)	4	1	2
Ovis canadensis (bighorn sheep)	6	1	1
Antilocapra americana (pronghorn)	4	1	2
Medium Artiodactyl (deer/sheep/pronghorn)	29		
Unidentified Artiodactyl	80		
Ursus arctos horribillis (grizzly bear)	3	2	2
Ursus americanus (black bear)	4	2	2
Canis sp. (wolf/dog/coyote)	7	1	1
Vulpes sp. (fox)	3	1	1
Carnivora or. (unspecified carnivore)	1	1	1
Neovision vision (mink)	1	1	1
Castor canadensis (beaver)	70	5	7
Erethizontidae (porcupine)	6	1	2
Leporidae (rabbit or hare)	3	2	2
Anseriformes (goose or swan)	1	1	1
Branta candensis (Canada goose)	1	1	1
Galliformes (ruffed or dusky [aka blue] grouse)	3	1	1
Meleagris sp. (wild turkey)	1	1	1
Salmonid (cutthroat trout/mountain whitefish)	6	1	1
Margaritifera falcata (western pearlshell freshwater bivalve)	2	2	2
Total NISP	914		
Unidentified Mammal Bone/Teeth	27,387		
Freshwater Bivalve	13		
Reptile (Turtle?) Bone	1		
Intrusive Rodent Bone	1,372		
Total Number of Specimens	29,687		

Chapter 5), but nevertheless demonstrate a minimum of two individuals present in the level. Bison bone was also the most frequent identifiable species recovered during the 2002 testing on the T3 terrace and S3 alluvial fan (Eakin and Eckerle 2004).

There are a minimum of six individual bison in the assemblage based on five right distal humeri and one fetal specimen, all found in the mixed deposits on the S3 alluvial fan. However, if stratigraphic data and radiocarbon dated bone are taken into consideration, there are at least ten individual bison in the assemblage. One bison is represented in the Late Paleoindian Cultural Level 1 assemblage on the T3

Table 7-2 Identifiable bison elements recovered from Game Creek.

Cultural Level	Element	Portion	Side	NISP
S3-7	Astragalus	Complete	L	1
	Astragalus	Complete	L	1
	Astragalus	Complete	R	2
	Astragalus	proximal frag	L	1
	Atlas Vertebra	caudal frag		2
	Atlas Vertebra	Frag		4
T2-7	Axis Vertebra	Complete		1
T2-7	Axis Vertebra	transverse spinous process frag		2
	Calcaneus	articular frag	L	1
	Calcaneus	Complete	L	2
	Calcaneus	Complete	R	1
T2-7	Caudal Vertebra	#1 complete		1
	Cervical Vertebra	#3 complete		1
	Cervical Vertebra	#5 lateral frag		1
	Cervical Vertebra	#6 dorsal spinous process frag		1
	Cervical Vertebra	#6 frag		2
4	Cervical Vertebra	articular process frag	R	1
	Cervical Vertebra	caudal articular process frag	R	1
	Cervical Vertebra	Frag	L	1
	Cranium	Frag		1
	Cranium	frontal frag	L	1
	Cranium	nasal half frag		1
	Cranium	premaxillary frag		1
	Cranium	premaxillary frag	R	1
	Femur	distal <1/2 shaft	L	1
4	Femur	distal frag	R	4
	Femur	Frag	R	1
	Femur	proximal (head) frag		1
5	Femur	proximal (head) frag	R	1
	Femur	proximal <1/2 shaft frag	L	1
	Femur	proximal frag	L	1
	Femur	shaft frag	R	1
	First Phalanx	Complete		2
	First Phalanx	Frag		1
	First Phalanx	proximal <1/2 shaft frag		1
	Fused 2nd & 3rd Carpal	Complete	R	1
	Fused Central & 4th Tarsal	Complete	L	1
	Fused Second & Third Tarsal	Complete	R	1
	Fused Central & 4th Tarsal	Frag	R	1
	Horn Core	cranial frag		1
	Horn Core	Frag		1
1	Horn Core	Frag	N	1
	Humerus	deltoid tuberosity frag	L	1
	Humerus	deltoid tuberosity frag	R	1
	Humerus	distal <1/2 shaft	L	2
	Humerus	distal <1/2 shaft	R	2
	Humerus	distal >1/2 shaft	R	1
	Humerus	distal caudal frag	L	1
S3-7	Humerus	distal diaphysis frag	L	1
	Humerus	distal shaft frag	R	1
	Humerus	mid-shaft frag	R	1
	Humerus	shaft frag	L	1
	Humerus	shaft frag	R	4

Table 7-2 Identifiable bison elements recovered from Game Creek.

Cultural Level	Element	Portion	Side	NISP
	Humerus	shaft, w/ p/l nutrient foramen	L	1
	Innominate	acetabulum frag		1
	Innominate	acetabulum frag	R	3
	Innominate	ilium frag	R	1
7	Lateral Malleolus	Complete	L	1
T2-7	Lumbar Vertebra	#1-2 complete	A	1
	Lumbar Vertebra	articular process frag	R	1
T2-7	Lumbar Vertebra	centrum frag	A	1
4	Mandible	ascending ramus frag	L	1
	Mandible	ascending ramus frag	L	1
	Mandible	coronoid process frag		1
	Mandible	Frag	R	2
	Mandible	lateral frag	L	1
	Mandible	tooth row frag	R	2
	Mandible	tooth row, diastema frag	R	1
4	Mandible	tooth row, horizontal ramus frag	L	1
	Maxilla	Frag	L	1
4	Maxilla	tooth row frag	R	2
	Metacarpal	distal <1/2 shaft frag	L	2
	Metacarpal	distal diaphysis frag		1
	Metacarpal	prox diaphysis frag		1
	Metacarpal	proximal <1/2 shaft frag	R	2
	Metacarpal	proximal frag	L	1
	Metacarpal	proximal frag	R	1
	Metacarpal	proximal, articular surface frag	R	1
	Metacarpal	shaft frag	R	1
	Metapodial	diaphysis frag		1
	Metapodial	distal epiphysis frag		1
	Metapodial	epiphysis frag		2
	Metatarsal	diaphysis frag		1
	Metatarsal	distal epiphysis frag		1
T2-7	Metatarsal	distal mid-shaft frag	R	1
S3-7	Metatarsal	proximal <1/2 shaft frag	L	1
	Metatarsal	proximal <1/2 shaft frag	L	2
	Metatarsal	proximal >1/2 shaft frag	R	1
	Metatarsal	proximal frag	R	1
T2-7	Metatarsal	proximal mid-shaft frag	R	4
	Patella	Complete		1
T2-7	Proximal Sesamoid	Complete	N	1
	Radius	distal >1/2 shaft frag	R	1
	Radius	distal frag	R	1
	Radius	proximal <1/2 shaft frag	R	3
	Radius	proximal, articular surface frag	R	1
	Radius	shaft frag	R	1
	Radius Ulna	shaft frag	L	1
	Radius Ulna	shaft frag	R	1
T2-7	Rib	blade frag	L	4
	Rib	blade frag	L	1
T2-7	Rib	blade frag		25
	Rib	blade frag	R	1
	Rib	proximal >1/2 shaft frag		1
	Rib	shaft frag		1
	Scapula	blade frag	L	1

Table 7-2 Identifiable bison elements recovered from Game Creek.

Cultural Level	Element	Portion	Side	NISP
	Scapula	caudal blade frag	L	2
	Scapula	caudal frag	R	1
	Scapula	Complete	L	1
	Scapula	distal blade frag	R	1
	Scapula	distal glenoid/blade frag	L	1
	Scapula	distal glenoid/blade frag	R	2
	Scapula	Frag	R	1
	Scapula	glenoid frag	L	2
	Scapula	lateral glenoid frag	R	1
5	Scapula	medial frag	R	1
	Scapula	proximal >1/2 shaft frag	R	1
	Scapula	spine frag		1
	Scapula	spine frag	R	1
	Scapula	spine/blade frag	L	4
	Scapula	spine/blade frag	R	1
	Second Phalanx	Complete		1
	Second Phalanx	distal <1/2 shaft frag		1
	Sesamoid	Complete		1
	Third Phalanx	Complete		1
	Third Phalanx	Complete	L	1
T2-7	Thoracic Vertebra	centrum frag		3
	Thoracic Vertebra	dorsal spinous process frag		6
	Thoracic Vertebra	Frag		1
S3-7	Thoracic Vertebra	Frag		1
T2-7	Thoracic Vertebra	Frag		1
	Tibia	distal <1/2 shaft frag	L	1
	Tibia	distal <1/2 shaft frag	R	1
	Tibia	distal articular surface frag	R	1
	Tibia	lateral condyle frag	R	1
4	Tibia	mid-shaft frag	R	1
	Tibia	proximal shaft frag	L	1
	Tibia	shaft, w/ p/l nutrient foramen	L	1
	Tibia	shaft, w/ p/l nutrient foramen	R	1
S3-7	Tooth	1st premolar frag		1
	Tooth	complete, 1st premolar		1
	Tooth	complete, 2nd molar		2
S3-7	Tooth	complete, 2nd premolar		1
	Tooth	complete, 3rd molar	L	1
S3-7	Tooth	complete, 3rd premolar/1st molar		1
S3-7	Tooth	complete, incisor	L	1
4	Tooth	complete, mandibular premolar	L	1
	Tooth	complete, maxillary molar		3
4	Tooth	complete, maxillary molar	R	1
	Tooth	complete, maxillary premolar		1
	Tooth	complete, unidentified molar		2
	Tooth	mandibular molar frag		1
	Tooth	premolar/molar frag		6
S3-7	Tooth	premolar/molar frag		2
	Tooth	unidentified molar frag		4
1	Tooth	unidentified molar tooth root		1
	Tooth	unidentified premolar frag		1
	Ulna	distal <1/2 shaft frag		1
	Ulna	mid-shaft frag		1

Table 7-2 Identifiable bison elements recovered from Game Creek.

Cultural Level	Element	Portion	Side	NISP
	Ulna	olecranon frag	L	2
	Ulna	proximal <1/2 shaft frag		1
	Ulna	proximal frag		1
	Ulna	proximal frag	R	1
	Ulna	proximal, articular surface frag	L	2
	Ulna	shaft frag	L	1
	Ulna	shaft frag	R	1
	Ulna	shaft, diaphasis frag	R	1
	Ulna Carpal	Complete	R	1
7	Ulna Carpal	Frag	L	1
T2-7	Vertebra	anterior epiphysis frag		1
	Vertebra	caudal frag		1
T2-7	Vertebra	dorsal spinous process frag		4
T2-7	Vertebra	Frag		54
T2-7	Vertebra	posterior epiphysis frag		4
T2-7	Vertebra	spinous process frag		7

Table 7-3 Bison NISP with cultural and taphonomic modifications.

Cultural Level	Green Fracture	Cut/Impact marks	Burned	Gnawed	Lightly Weathered	Heavily Weathered	NISP
1							2
4	9				8	1	12
5	3	3			3		2
7				1	1	1	2
T2-7	58	21		18	56	57	115
S3-7	2			2	7	1	10
Other	89	43	4	98	90	66	183
Total	161	67	4	119	165	126	326

terrace. At least two bison are present in the Cultural Level 4 assemblage, with one dated to the Late Paleoindian component and the other dated and associated with the Early Archaic component. At least one bison is likely represented in the Early Archaic component of Cultural Level 5 where a large artiodactyl bone, probably from a bison, produced a radiocarbon age estimate that is statistically the same as the radiocarbon dates (5519±86 cal BP) from the large roasting pit (Feature 7) found in Block A. The four bison represented in Cultural Levels 1, 4 and 5 likely predate the earliest occupation on the S3. The remaining five bison are identified based on four distal right humeri and one fetal bison. The bison bone from the Cultural Level 7 components on the T3, T2 and S3 landforms may be included in the MNI of right humeri. This is a conservative estimate. There may be another bison, represented by a poorly preserved tooth found in stratum III of Block B. A radiocarbon date from Test Unit 10 indicates an occupation at 10,207±68 cal BP, two centuries following the Cultural Level 1 occupation and two centuries before the Cultural Level 2 occupation. Yet, the lack of associated artifacts and extensive bioturbation in Block B precludes a definitive assessment. Large artiodactyl bone, that is probably bison, was also recovered from Cultural Levels 2, 3 and 6, which may indicate three additional bison. In short, there could be as many as 14 bison represented in the Game Creek assemblage.

Both axial and appendicular bison elements are present, the vast majority of which appear to have been intensively processed for bone marrow and grease extraction (Table 9-2). Less than 3 percent of the assemblage consists of complete specimens, most (85%) of which are small dense bones, such as phalanges, carpals, tarsals, calcanei, astragali or teeth, that are difficult to break and/or contain little marrow or grease. Nutrient dense elements such as longbones, ribs, pelves, crania and vertebrae, though present in sizeable numbers, were almost invariably crushed. Specific evidence of cultural modification, such as spiral fracture patterns, indicative of green bone fracture, cut/impact marks or burning were observed on numerous specimens recovered from the T3 and S3 landforms (Table 9-3). The occupations on the S3, though badly mixed, contained extensive evidence of bone processing and stone boiling for grease production. Features 12, 13, 14 and 15 are interpreted as stone boiling features or hearths similar to features found at the Bugas-Holding (Kornfeld et al. 2010), Wardell (Frison 1988), Piney Creek (Frison 1967) and Goff Creek (Page 2016) sites, and each contained bison bone in close association.

The bison remains recovered from Cultural level 7 on the T2 terrace differed somewhat from the rest of the assemblage due largely to the nature of the occupation. It appears that a juvenile bison of undetermined sex was killed at that location. There was little evidence of occupational debris in the area. Excavations uncovered 115 identifiable, but poorly preserved remains consisting of a partially articulated vertebral column and a scatter of fragmented vertebrae, ribs, a metatarsal and a sesamoid. The evidence suggests that the cranium, limbs, pelvis, and rib cage were removed from the carcass and transported to a more suitable camp nearby, perhaps on the S3 alluvial fan 250 m to the north, for further processing. Cut and impact marks on vertebrae indicate that meat was stripped from the vertebrae.

The assemblage is too fragmentary to allow determination of sex and age structure. The recovery of several unfused epiphyses on the S3 and T3 landforms indicates that at least one juvenile is present. A complete scapula found within construction fill in Block G appears to be from a large mature adult, probably a bull. Fetal bison remains are represented by five specimens, likely from the same individual. Comparison with fetal bison of known age indicates the animal died at approximately 8 months gestation, or roughly 1 ½ months preterm. Most bison calve in April and May, which may indicate a time of death around mid-February to early April. However, bison have been documented to calve as late as October (Lott 2002), so it is possible that the animal and the cow that was carrying it died as late as August.

Carnivore gnawing was documented on 119 bison elements from Cultural Level 7 and the S3 landform, which indicates some degree of post-depositional modification to the assemblage through carnivore scavenging. However, the assemblage has not been severely impacted because only 14 specimens were characterized as heavily gnawed. Weathering of bison bone was highly variable, but a slight majority (56.7%) of the bison bone was characterized as lightly to moderately weathered. It is unlikely that taphonomic processes such as weathering and carnivore scavenging have significantly altered the composition of the bison assemblage.

Wright (1984) and Wright et al. (1980) argue that bison were rare or absent in Jackson Hole during prehistory and played little role in the subsistence strategies of prehistoric peoples in the area. This argument is largely based on the lack of historic accounts of bison and the dearth of bison bone recovered from investigated sites in northern Jackson Hole (Wright 1984; Wright et al. 1980). Contrary to the assertions of Wright (1984) and Wright et al. (1980), bison are documented in Jackson Hole in the early Historic era (Cannon et al. 2015). In 1833, Ferris (1940:163), a trapper, hunting in Jackson Hole, “found a large herd of buffalo in the valley, and killed several.” Ferris (1940) also noted the discovery of a possible bison jump near the Gros Ventre River. Although bison were not specifically mentioned, Russell after describing the abundance of bison, elk, deer and sheep in Teton Valley, noted that Jackson Hole “like all other parts of the country abounds with game.” Moreover, bison remains have been recovered from at least 14 sites in Jackson Hole, as well as most (if not all) of the cultural levels at Game Creek. Overall, bison are the most numerous and identifiable species in archaeological assemblages from Jackson Hole. Furthermore, modeling of forage production (Chapter 2) in South Park of Jackson Hole shows that the area is capable of producing an enormous quantity of forage that could sustain a herd numbering in the thousands. These data case serious doubt on the arguments of Wright (1984) and Wright et al. (1980). Bison appear to have played an integral role in the subsistence practices of the people who lived in Jackson Hole throughout prehistory.

Elk

Elk is the third most frequent identifiable species in the Game Creek assemblage, containing 59 identifiable specimens recovered from Cultural Level 4 (7531±28 cal BP) and 5 (6900-5290 cal BP) in Block E on the T3 terrace and Cultural Level 7 (1000-550 cal BP) on the S3 landform. Two phalanges and a distal tibia fragment were recovered from the northern half of the T3 terrace in the upper 30 cm of deposit, but few additional artifacts were found in association with them. Given the stratigraphic position they likely date to the Late Prehistoric period. The bulk of the elk assemblage (n=47) was found in disturbed contexts on the S3 (Table 9-4). The single elk tibia fragment found in Cultural Level 5 in Block E may have been out of context since several additional tibia fragments were found 10-20 cm below it in Cultural Level 4. There are minimum of three individuals based on the presence of three complete left astragali, one found in Cultural Level 4 and the other two in mixed deposits on the S3 (Table 9-4).

Apart from a fragment of a lumbar vertebra, the assemblage consists of appendicular elements, most of which appear to have been crushed. The low frequency of axial elements may be due to butchering practices, i.e. meat was stripped from the vertebral column and vertebrae left at the kill, or perhaps these fat-rich elements were pulverized beyond recognition for bone grease extraction (Page

Table 7-4 Elk bone and teeth recovered from Game Creek.

Cultural Level	Element	Portion	Side	NISP
	Antler	medial frag	L	1
4	Astragalus	complete	L	1
	Astragalus	complete	L	2
	Calcaneus	complete	R	1
	Cervical Vertebra	centrum/transverse spinous process frag		1
	Femur	shaft diaphysis frag		1
	Femur	shaft diaphysis frag	R	1
	Femur	shaft frag	R	2
	First Phalanx	complete	L	1
	Fourth Carpal	frag	R	1
	Fused 2nd & 3rd Carpal	frag	L	1
	Fused Central & 4th Tarsal	complete	R	1
	Humerus	distal articular surface frag	R	3
	Humerus	shaft frag	L	1
	Humerus	shaft frag, p/l nutrient foramen	L	1
7b	Lumbar Vertebra	centrum frag		1
4	Mandible	dentary ramus frag	L	1
	Mandible	diastema frag	R	1
	Mandible	Frag	R	2
	Maxilla	tooth row frag	R	1
4	Metacarpal	distal <1/2 shaft frag	R	1
4	Metacarpal	distal shaft frag	R	1
4	Metacarpal	mid-shaft fragment	R	3
4	Metacarpal	mid-shaft fragment		1
	Metatarsal	distal >1/2 shaft frag	L	1
4	Metatarsal	mid-shaft fragment	L	1
	Metatarsal	proximal <1/2 shaft frag	R	1
	Radius	caudal frag	R	1
	Radius	proximal frag	R	2
	Radius	proximal, medial glenoid cavity	R	1
	Scapula	glenoid frag	R	1
	Scapula	spine/blade frag	R	1
	Second Phalanx	complete	L	1
	Sesamoid	complete		1
	Tibia	diaphysis frag		3
	Tibia	distal <1/2 shaft frag	L	1
	Tibia	distal <1/2 shaft frag	R	3
	Tibia	distal frag	R	1
5	Tibia	lateral frag	R	1
4	Tibia	proximal frag	L	1
	Tibia	shaft frag, p/l nutrient foramen	R	1
	Tooth	complete, 3rd molar		1
	Tooth	incisor frag		2
	Tooth	mandibular premolar frag		1
	Tooth	premolar/molar frag		1
	Ulna	trochlear notch frag	R	1

Table 7-5 Elk NISP with cultural and taphonomic modifications.

Cultural Level	Green Fracture	Cut/Impact marks	Burned	Gnawed	Lightly Weathered	Heavily Weathered	NISP
4	9	1		3	7	1	10
5	1				1		1
7b					1		1
Other	25	8	1	26	34	8	47
Total	35	9	1	29	43	9	59

2016). Green bone, spiral, fracture patterns were noted on 35 of the specimens, and an additional nine specimens showed cut or impact marks (Table 9-5). As with the bison assemblage, it appears that nutrient rich elk bones were cracked for marrow extraction, further pulverized and then rendered for bone grease extraction. One distal humerus fragment, classified as large artiodactyl, may be a fetal elk bone.

Weathering was characterized as light to moderate for most (82.6%) of the small assemblage, which indicates slightly better preservation, overall, than displayed in the bison assemblage (Table 9-5). Gnawing was also noted on 29 elements, but only two were heavily gnawed (Table 9-5). These data indicate that post-depositional taphonomic processes are unlikely to have significantly modified the elk assemblage.

Elk remains are reported sporadically and in low numbers at in the Central Rockies (Frison 2004;Kornfeld et al. 2010). A small number of specimens were found at two sites (48TE1114 and 48TE1099) on the Snake River delta at Jackson Lake and also at the Henn Site (48TE1291) north of Jackson (Rapson 1995:135). Other sites in the Central Rockies, such as Bugas-Holding (Rapson 1990), Dead Indian Creek (Frison and Walker 1984), Pagoda Creek (Eakin 1989), Mummy Cave (Hughes 2003) and Goff Creek (Page 2016) produced small numbers of elk bone. Wright (1984) argues that elk were driven into Jackson Hole during the historic period from surrounding regions and were otherwise absent or rare in Jackson Hole during prehistory. Suffice it to say that elk were certainly present in Jackson Hole as early as 7951±23 cal BP and continued to be hunted until at least circa 1000-550 cal BP in Jackson Hole and the Central Rockies. The low frequency with which bones are recovered is a question worthy of further investigation. Based on evidence from Game Creek elk appear to have been one of the two, the other being bison, primary prey species of the prehistoric hunters of Jackson Hole.

Large Artiodactyl

Bone categorized as large artiodactyl could be from bison, elk or even moose. Given the proportion of bison to elk in the identifiable faunal assemblage, roughly 5.5 to 1, it is reasonable to assume that a similar proportion of bison and elk are represented in the large artiodactyl assemblage. Large artiodactyl bone was recovered from every cultural level as well as the mixed deposits on the S3 alluvial fan (Table 9-6). Four large artiodactyl bones, including one mandible fragment, a metacarpal

Table 7-6 Large artiodactyl bone recovered from Game Creek.

Cultural Level	Element	Portion	Side	NISP
	Axis Vertebra	spinous process frag		2
	Carpal	frag		1
	Cervical Vertebra	frag		1
	Cervical Vertebra	transverse spinous process frag		1
	Cervical Vertebra	transverse spinous process frag	R	1
	Cranium	auditory bulla frag		1
	Femur	diaphysis frag		2
	Femur	frag		1
	Femur	shaft frag	L	1
	Femur	shaft frag		1
	First Phalanx	frag		1
	First Phalanx	proximal articular surface frag		1
	Fused 2nd And 3rd Carpal	complete		1
	Fused 2nd And 3rd Carpal	frag	L	1
	Humerus	diaphysis frag	L	1
	Humerus	diaphysis frag	R	1
	Humerus	distal <1/2 shaft frag		1
	Humerus	mid-shaft frag		1
	Humerus	proximal shaft frag	L	1
	Humerus	shaft frag	R	2
	Humerus	shaft frag		1
	Innominate	acetabulum frag	R	1
	Innominate	ischium frag		1
	Long Bone	diaphysis frag		2
3	Long Bone	frag		1
7	Long Bone	frag		2
T2-7	Long Bone	frag		1
	Long Bone	frag		6
	Long Bone	mid-shaft frag		3
T2-7	Long Bone	mid-shaft frag		1
T2-7	Long Bone	shaft frag		4
2	Long Bone	shaft frag		1
4	Long Bone	shaft frag		4
5	Long Bone	shaft frag		5
6	Long Bone	shaft frag		1
7	Long Bone	shaft frag		1
7b	Long Bone	shaft frag		1
	Long Bone	shaft frag		22
	Mandible	coronoid process frag		1
4	Mandible	coronoid process frag	L	1
	Mandible	diastema frag	L	1
	Mandible	frag		4
	Mandible	tooth row frag		3
	Maxilla	frag		1
	Metacarpal	frag	L	1
5	Metacarpal	mid-shaft frag		1
	Metapodial	distal articular surface frag		1
	Metapodial	distal condyle frag		1
	Metapodial	mid-shaft frag		1
	Metapodial	proximal <1/2 shaft frag		1
	Metapodial	proximal >1/2 shaft frag		3
	Metatarsal	shaft frag		1
	Patella	frag		1

Table 7-6 Large artiodactyl bone recovered from Game Creek.

Cultural Level	Element	Portion	Side	NISP
7b	Radius	diaphysis frag		1
	Radius	diaphysis frag	R	1
	Radius	mid-shaft frag	R	1
	Radius	mid-shaft frag		1
	Radius	proximal <1/2 shaft frag	L	1
	Radius	proximal shaft frag	L	1
	Radius	shaft frag		3
	Radius	shaft frag	R	1
	Radius	shaft frag	R	2
	Rib	blade frag	L	1
	Rib	blade frag		2
4	Rib	blade frag		2
	Rib	frag		3
	Rib	proximal <1/2 shaft frag		1
	Rib	proximal epiphysis frag	L	1
	Rib	proximal frag (head)		1
	Rib	shaft frag	R	1
	Rib	shaft frag		16
	Scapula	blade frag		4
	Scapula	blade frag	R	1
	Scapula	frag		3
	Scapula	frag	R	2
7	Scapula	spine frag		1
	Scapula	spine/blade frag		2
	Second Phalanx	distal articular surface frag		3
	Second Phalanx	distal frag		3
	Sesamoid	frag		1
	Sesamoid	proximal frag		1
	Third Phalanx	frag		1
1	Thoracic Vertebra	posterior epiphysis frag		1
	Thoracic Vertebra	spinous process frag		1
T2-7	Thoracic Vertebra	spinous process frag		1
5	Thoracic Vertebra	spinous process frag		1
6	Thoracic Vertebra	spinous process frag		2
	Tibia	diaphysis frag		1
7b	Tibia	diaphysis frag	R	1
2	Tibia	proximal frag		2
	Tibia	shaft frag		2
	Tibia	shaft frag	L	2
	Tibia	shaft frag	R	1
7b	Tibia	shaft w/ p/l nutrient foramen	R	1
	Tooth	complete, incisor		1
	Tooth	complete, macillary premolar		1
	Tooth	enamel frag		32
7b	Tooth	enamel frag		2
6	Tooth	enamel frag		1
	Tooth	incisor frag		2
7b	Tooth	incisor frag		1
	Tooth	incisor frag		1
4	Tooth	molar frag		4
5	Tooth	molar frag		5
	Tooth	premolar/molar frag		20
7b	Tooth	premolar/molar frag		3

Table 7-6 Large artiodactyl bone recovered from Game Creek.

Cultural Level	Element	Portion	Side	NISP
T2-7	Tooth	premolar/molar frag		2
4	Tooth	premolar/molar frag		2
5	Tooth	premolar/molar frag		3
6	Tooth	premolar/molar frag		6
7	Tooth	premolar/molar frag		3
	Ulna	shaft frag		3
	Unknown	blade frag		5
4	Unknown	blade frag		1
5	Unknown	blade frag		1
	Unknown	flat bone frag		2
3	Unknown	flat bone frag		2
	Unknown	frag		1
7	Vertebra	anterior epiphysis frag		1
	Vertebra	articular process frag		1
	Vertebra	epiphysis frag		2
	Vertebra	frag		1
	Vertebra	posterior epiphysis frag		1
3	Vertebra	posterior epiphysis frag		1
4	Vertebra	posterior epiphysis frag		1
7	Vertebra	spinous process frag		1

Table 7-7 Large Artiodactyl NISP with cultural and taphonomic modifications.

Cultural Level	Green Fracture	Cut/Impact marks	Burned	Gnawed	Lightly Weathered	Heavily Weathered	NISP
1					1		1
2	3				3		3
3	3				4		4
4	5	1		3	5	1	15
5	7	2			8		16
6	4		1		2		10
T3-7	3		2	1	4		9
T2-7	5				4	1	9
S3-7	5			3	2	4	10
Other	100	52	187	71	102	50	217
Total	135	55	190	78	135	56	294

fragment, a long bone shaft fragment and a proximal scapula fragment, were submitted for radiocarbon dating, returning age estimates of 7531±28 cal BP, 5519±86 cal BP, 2350±39 cal BP and 767±26 cal BP, respectively.

Most (89.3%) of the 294 bones in the assemblage are from appendicular elements, all of which are fragmentary. The under representation of axial elements may be due either to butchering practices or destruction of the elements during bone grease processing. Green bone fracture patterns, cut/impact marks and burning was noted on numerous specimens, which is furthermore consistent with intensive marrow extraction and bone grease processing (Table 9-7). Carnivore scavenging and weathering do not appear to have significantly altered the assemblage since only seven of the 78 gnawed specimens were severely damaged and only 56 specimens were heavily weathered (Table 9-7).

Deer, Pronghorn and Bighorn Sheep

Remains of medium artiodactyls, including deer, pronghorn and bighorn sheep, were relatively scarce at Game Creek (Table 9-8). Most of the 43 specimens could not be identified to species. Deer elements were recovered from Cultural Level 4 on the T3 and from disturbed contexts on the S3 alluvial fan. A fragment of a pronghorn innominate was found in Cultural Level 2 of Block D, and three additional elements came from the S3. All six bighorn sheep bone were recovered from the S3. Undifferentiated medium artiodactyl bones were found in Cultural Levels 1, 2, 4 and 5, but 20 of the 29 specimens originated from the S3. The assemblage is too small to provide a reliable estimate of individuals based on elements. It would appear that at least two deer and two pronghorn are present given stratigraphic context and probably only a single bighorn sheep.

All but three of the medium artiodactyl specimens are from appendicular elements (Table 9-9). As is the case with the entire faunal assemblage from Game Creek, most of the bone appears to have been pulverized to extract marrow and likely boiled to render bone grease. The only complete elements are small dense lower limb bones that are difficult to crack and/or contain little marrow or bone fat such as sesamoids and carpals (Table 9-9). Slightly more than half of the specimens exhibit green bone spiral fracture patterns, several have cut/impact marks and a few have been burned (Table 9-10). Preservation appears to be fairly good with only nine specimens showing evidence of carnivore gnawing and six with heavy weathering (Table 9-10).

Although Bender and Wright (1988), Wright et al. (1980) and Wright (1984) argue that bighorn sheep and deer were the target prey species in their "High Country Adaptation Model," archaeological remains of these species are rare in Jackson Hole. The remains found at Game Creek are the first reported deer or bighorn sheep bones found in prehistoric contexts in Jackson Hole. Both species are present in sizeable numbers in the area today, making their paucity at Game Creek, and outright absence elsewhere in Jackson Hole, somewhat of a mystery. The area today supports large populations of both deer and bighorn sheep. Perhaps populations of bison and elk in the area were large enough and reliable enough to afford consistent targeted procurement to the exclusion of lower rank medium artiodactyls.

Pronghorn are usually seasonal residents of Jackson Hole, migrating from their winter range in the Green River Basin every spring. Evidence of pronghorn procurement along the migration route at the Trappers Point site in the upper Green River Basin suggests that the migratory herd has been in existence since Early Archaic times (Sanders and Wedel 1999). The relatively low number of pronghorn remains may be due to the location of Game Creek in relation to the primary migration corridor, which is along the Gros Ventre River, 20 miles north of the site.

Table 7-8 Medium artiodactyl remains recovered from Game Creek.

Cultural Level	Deer	Pronghorn	Bighorn Sheep	Medium Artiodactyl	NISP
1				2	2
2		1		2	3
4	1			2	3
5				3	3
Other	3	3	6	20	32
Total	4	4	6	29	43

Table 7-9 Medium artiodactyl remains recovered from Game Creek.

Cultural Level	Taxon	Element	Portion	Side	NISP
4	Deer	Accessory Phalanx	complete		1
	Deer	Calcaneus	proximal epiphysis frag	R	1
	Deer	Scapula	glenoid frag		1
	Deer	Tibia	proximal epiphysis frag	L	1
	Pronghorn	Humerus	distal <1/2 shaft frag	R	1
2	Pronghorn	Innominate	caudal ilium frag	R	1
	Pronghorn	Proximal Sesamoid	complete		1
	Pronghorn	Ulna Carpal	complete	L	1
	Sheep	Cervical Vertebra	centrum/trans. spinous process frag		1
	Sheep	Fused Second & Third Tarsal	frag	R	1
	Sheep	Humerus	distal <1/2 shaft frag	L	1
	Sheep	Radius	distal <1/2 shaft frag	L	1
	Sheep	Thoracic Vertebra	centrum/trans. spinous process frag		1
	Sheep	Tibia	distal articular surface frag	L	1
	Med. Art.	Cervical Vertebra	frag		1
	Med. Art.	Costal Cartilage	distal frag		1
	Med. Art.	Innominate	acetabulum frag		1
	Med. Art.	Innominate	caudal ilium frag	R	1
4	Med. Art.	Innominate	ilium frag	R	1
2	Med. Art.	Innominate	ischium frag		2
5	Med. Art.	Long Bone	mid-shaft frag		1
	Med. Art.	Long Bone	shaft frag		1
1	Med. Art.	Long Bone	shaft frag		2
	Med. Art.	Metacarpal	proximal frag	L	1
	Med. Art.	Metapodial	shaft frag		1
	Med. Art.	Metatarsal	diaphysis frag		1
	Med. Art.	Phalanx	distal articular surface frag		2
	Med. Art.	Phalanx	proximal articular surface frag		1

Table 7-9 Medium artiodactyl remains recovered from Game Creek.

Cultural Level	Taxon	Element	Portion	Side	NISP
	Med. Art.	Proximal Sesamoid	complete		1
	Med. Art.	Rib	mid-shaft frag		1
	Med. Art.	Scapula	frag	R	1
	Med. Art.	Second Phalanx	distal <1/2 shaft frag		1
	Med. Art.	Second Phalanx	distal >1/2 shaft frag		1
	Med. Art.	Sesamoid	complete		2
	Med. Art.	Tibia	distal frag		1
4	Med. Art.	Tooth	premolar/molar frag		1
5	Med. Art.	Tooth	premolar/molar frag		1
5	Med. Art.	Unknown	frag		1
	Med. Art.	Vertebra	articular process frag		1

Table 7-10 Medium artiodactyl NISP with cultural and taphonomic modifications.

Cultural Level	Green Bone	Cut/Impact	Burned	Gnawed	Lightly Weathered	Heavily Weathered
1					4	
2	3	1			3	
4	1			1	2	
5	2	1			2	
Other	17	5	3	8	18	6
Total	23	7	3	9	29	6

Undifferentiated Artiodactyl

Bone believed to be from bison, elk, deer, pronghorn or bighorn sheep, but that is too fragmentary to allow identification to species, was recovered from Cultural Levels 1, 2, 5, 6 and 7. Most of the undifferentiated artiodactyl bone came from disturbed contexts on the S3. Over half (62.5%) of the specimens consist of tooth fragments, one is a cranial fragment, and remaining specimens identifiable to element are from various appendicular bones. The element or class of elements for nine specimens could not be determined (Table 9-11). Most of the specimens are highly fragmentary reflecting intensive bone marrow and grease processing. Green bone fracture patterns, cut/impact marks and burning were noted on numerous specimens (Table 9-12). Post-depositional modification by carnivore scavenging and weathering appears to be light with only eight gnawed and six heavily weathered specimens (Table 9-12).

Table 7-11 Undifferentiated artiodactyl bone recovered from Game Creek.

Cultural Level	Element	Portion	Side	NISP
	Cranium	frag		1
	Innominate	ischium frag		2
2	Long Bone	frag		3
	Long Bone	frag		2
2	Long Bone	frag		1
	Long Bone	mid-shaft frag		1
	Long Bone	shaft frag		1
5	Long Bone	shaft frag		1
	Metapodial	proximal <1/2 shaft frag		1
	Phalanx	distal articular surface frag		1
	Rib	blade frag	R	1
	Rib	frag		1
	Rib	mid-shaft frag		1
	Rib	mid-shaft frag		1
	Rib	shaft frag		1
	Scapula	blade frag		2
	Tooth	frag		4
	Tooth	frag		32
7b	Tooth	frag		5
	Tooth	frag		2
2	Tooth	incisor		1
7b	Tooth	premolar/molar frag		2
	Tooth	premolar/molar frag		2
5	Tooth	premolar/molar frag		1
6	Tooth	premolar/molar frag		1
	Unknown	frag		1
1	Unknown	frag		2
2	Unknown	frag		4
5	Unknown	frag		1
7	Unknown	frag		1

Table 7-12 Undifferentiated artiodactyl NISP with cultural and taphonomic modifications.

Cultural Level	Green Bone	Cut/Impact	Burned	Gnawed	Lightly Weathered	Heavily Weathered	NISP
1	2					2	2
2	2	1	1		1		9
5	1	1			1		3
6							1
7	1			1	1		1
S3-7					1		7
Other	16	9	4	7	16	4	57
Total	22	11	5	8	20	6	80

Bear

Seven specimens, representing at least two black bears and two grizzly bears were recovered from Game Creek (Table 9-13). Two black bear bones, likely from the same individual, were found in Cultural Level 4 on the T3 terrace and are probably associated with the Early Archaic component dated to 7951±23 cal BP. Both specimens exhibit green bone spiral fracture pattern, one has multiple cut marks, an impact fracture and is charred. The remains of a second black bear are represented by humerus and ulna fragments found in disturbed contexts on the S3. Three grizzly bear elements from at least two individuals were also recovered from the S3. Two of the elements, consisting of humerus and maxilla fragments are from a large adult. An unfused radius diaphysis fragment indicates the presence of a juvenile. Cut/impact marks are present on the juvenile grizzly radius fragment, the adult grizzly humerus as well as one of the black bear elements recovered from the S3. Slight gnawing was observed on one black bear specimen from Cultural Level 4, and on two of the three grizzly bear specimens. Slight weathering was observed on four of the specimens.

Love (1972) reports the recovery of a bear mandible from the Goetz site north of Jackson, and a stone tool from a site on Jackson Lake tested positive to bear antiserum in a protein residue analysis (Connor 1998). Bear remains have also been reported in small numbers from other sites in the Central Rockies including Mummy Cave (Hughes 2003) and Bison and Veratic shelters in eastern Idaho (Swanson 1972). The economic importance of bear meat in the prehistoric diet was likely minimal given the low population density of bears. But nevertheless, there are nearly as many bears present in the Game Creek assemblage as there are medium artiodactyls.

Table 7-13 Bear remains recovered from Game Creek.

Cultural Level	Species	Element	Portion	Side	NISP
	Black Bear	Humerus	diaphysis frag	L	1
4	Black Bear	Humerus	mid-shaft frag	R	1
4	Black Bear	Metacarpal	proximal frag	R	1
	Black Bear	Ulna	proximal >1/2 shaft frag	L	1
	Grizzly Bear	Humerus	diaphysis frag	L	1
	Grizzly Bear	Radius	diaphysis frag	R	1
	Grizzly Bear	Maxilla	tooth row	L	1

Beaver

Beaver remains were the second most frequent identifiable specimens in the Game Creek assemblage. Beaver elements were recovered from Cultural Levels 1, 2, 5 and 7. The single beaver bone from Cultural Level 1 may have been displaced from Cultural Level 2. The remaining beaver specimens were found in disturbed contexts on the S3 (Table 9-14). A minimum of five beaver are represented in the

Table 7-14 Beaver remains recovered from Game Creek.

Cultural Level	Element	Portion	Side	NISP
	Calcaneus	proximal frag	L	1
	Carpal	complete		2
	Caudal Vertebra	frag		1
	Cranium	frag		3
	Cranium	frag	L	2
	Cranium	frag	R	2
	Cranium	frontal frag	R	1
	Femur	medial condyle frag	L	1
	Femur	proximal >1/2 shaft frag	R	2
	Fibula	shaft frag		1
	First Phalanx	complete		2
	Humerus	distal <1/2 shaft frag	L	1
	Humerus	distal >1/2 shaft frag	R	1
2	Humerus	distal frag	L	1
	Humerus	mid-shaft frag	L	1
	Innominate	frag		1
	Innominate	frag	L	3
	Innominate	frag	R	3
	Innominate	ilium frag	R	2
7b	Innominate	ilium frag	R	1
	Innominate	ischium frag	L	1
	Mandible	condyle frag	R	1
	Mandible	diastema frag	L	1
7b	Mandible	diastema frag	L	1
	Mandible	frag	L	1
	Mandible	frag	R	1
	Mandible	tooth row	R	1
	Metacarpal	proximal >1/2 shaft frag		1
	Metapodial	distal <1/2 shaft frag		1
1	Metapodial	distal articular surface frag		1
	Metapodial	proximal frag		1
	Phalange	complete		2
	Radius	diaphysis frag		1
	Radius	proximal <1/2 shaft frag	L	2
2	Rib	complete #1	R	1
	Rib	proximal head frag		1
7b	Sacrum	transverse spinous process frag		1
	Scapula	distal frag	L	1
	Second Phalanx	complete		1
	Third Phalanx	frag		1
	Tibia	complete	L	1
	Tooth	complete molar		2
	Tooth	first premolar frag	L	1
	Tooth	frag		2
5	Tooth	incisor frag		1
	Tooth	premolar/molar frag		3
7b	Tooth	premolar/molar frag		1
	Ulna	complete	R	2
	Ulna	distal diaphysis frag	R	1
	Ulna	proximal <1/2 shaft frag	R	1
	Ulna	proximal >1/2 shaft frag	L	1

Table 7-15 Beaver NISP with cultural and taphonomic modifications.

Cultural Level	Green Bone	Cut/Impact	Burned	Gnawed	Lightly Weathered	Heavily Weathered	NISP
1					1		1
2					3		2
5							1
S3-7	2	1	1	1	2	2	4
Other	28	6	9	17	35	11	62
Total	30	7	10	18	41	13	70

assemblage based on right innominate bones. There are at least two other individuals from Cultural Levels 2 and 5, resulting in a conservative estimate of seven beaver in the assemblage.

Most of the 70 beaver remains consist of appendicular elements. Eight of the 10 axial elements are fragments of beaver skull recovered from a single excavation level in the southern half of Block G. The dearth of axial elements is likely due to intensive processing of the fatty cancellous bones of the vertebral column. Many of the beaver bones showed evidence of green bone fracture, seven have cut/impact marks, and 10 are burned, leaving no question of cultural modification to the assemblage (Table 9-15). Taphonomic processes such as carnivore scavenging and weathering do not appear to have significantly altered the characteristics of the assemblage. Although roughly ¼ of the assemblage displayed some degree of gnawing, on only three specimens was it characterized severe (Table 9-15). Overall the beaver assemblage was well preserved with all but nine elements showing little to no weathering (Table 9-15)

According to Wright (1984:31) "Native Americans of the Rockies seldom ate beaver, the taste being somewhat disagreeable." Yet, Wright not only fails to provide a source for this information but clearly overlooked early historic accounts. Osborne Russel, a trapper who hunted throughout the Central Rockies provides an account of an encounter with a band of Shoshone in the Lamar River Valley. The Shoshone told him that there "had been a great many beaver on the branches of this stream but they had killed nearly all of them and being ignorant of the value of fur had singed it off with fire in order to drip the meat more conveniently" (Russell 1921:61). Moreover, beaver bone has been recovered from several archaeological sites in the Central Rockies including Mummy Cave (Hughes 2003), Goff Creek (Page 2016), the Hunt site at the base of Teton Pass (Wright 1984), and Medicine Lodge Creek (Miller 2007). Dated components with beaver bone range in age from Late Paleoindian to Late Prehistoric. Beaver are relatively easy to harvest if their habits are known and can provide up to 50 pounds of meat and fat. Beaver, unlike most other prey species in the Game Creek assemblage, retain thick layers of fat throughout the year which would provide valuable added nutrients to an otherwise lean diet. The data from Game Creek indicate that beaver were a regular, and likely targeted, prey species in subsistence practices of the prehistoric people of Jackson Hole.

Miscellaneous Small and Medium-Size Mammals

There are a small number of specimens, recovered mostly from the S3 landform, that are identified to one of several taxa (Table 9-16). Of these, porcupine is the most numerous represented by six identifiable elements recovered from Cultural Levels 1 and 7, as well as mixed deposits on the S3 (Table 9-17). It is estimated that a minimum of two individuals are present, one in Cultural Level 1 and one from the S3, which may be from the same individual as the specimen from Cultural Level 7 in Block G. Only two specimens, a vertebra with green bone fracture pattern and a charred tooth fragment, display evidence of cultural modification.

Table 7-16 Miscellaneous small to medium-sized mammals in the Game Creek Assemblage

Cultural Level	Porcupine	Canid	Fox	Carnivore	Rabbit/Hare
1	1				1
S3-7	1	1			
Other	4	6	3	2	2
Total NISP	6	7	3	2	3

Table 7-17 Miscellaneous medium to small mammals recovered from Game Creek.

Taxon	Cultural Level	Element	Portion	Side	NISP
Porcupine		Lumbar Vertebra	complete		1
Porcupine	1	Mandible	dentary ramus frag	R	1
Porcupine	7b	Phalanx	complete		1
Porcupine		Tooth	incisor frag		1
Porcupine		Tooth	mandibular molar frag		1
Porcupine		Vertebra	complete		1
Canid	7b	Tooth	frag	R	1
Canid		Tooth	premolar frag		1
Canid		Maxilla	tooth row	L	1
Canid		Metapodial	proximal frag		1
Canid		Phalanx	distal >1/2 shaft frag		1
Canid		Rib	proximal head frag	R	1
Canid		Tooth	complete canine	L	1
Fox		Cranium	frag		1
Fox		Tooth	complete mandibular molar	L	1
Fox		Metapodial	complete #2	L	1
Mink		Calcaneus	complete		1
Carnivore		Tooth	incisor frag		1
Rabbit/Hare	1	Femur	proximal frag	R	1
Rabbit/Hare		Metapodial	distal <1/2 shaft frag		1
Hare		Metapodial	distal <1/2 shaft frag		1

All seven of the canid bones were found on the S3, one in Cultural Level 7 (1000-550 cal BP) in the northern half of Block G (Table 9-16). The remains could be from the same individual. All were too fragmentary to allow identification to species, but the rib fragment is likely from a dog or coyote. Two of the specimens have green bone fractures, one has an impact mark, and two are burned indicating that they were likely butchered and processed in the same manner as the rest of the mammalian fauna. Light gnawing was noted on two specimens, and five showed light weathering, suggesting that the assemblage has not been significantly modified by taphonomic processes.

Three fox specimens, probably from a single red fox, were found within road construction fill on the S3 alluvial fan (Table 9-16). The sample consists of a cranium fragment, a tooth and a metapodial fragment (Table 9-17). The metapodial has green bone spiral fractures and has been burned, indicating it too was likely butchered and consumed on sight.

One mink calcaneus was recovered from the S3 (Tables 8-16 and 8-17). The specimen has several cut marks indicating that the animal had been dismembered. A tooth fragment, possibly from a dog, was also found (Tables 8-16 and 8-17). Lastly, two rabbit or hare bones, one from Cultural Level 1 and the other from the S3, as well as a metapodial identified as jackrabbit were recovered. All three specimens exhibit green bone fractures, and one is burned. Additional evidence for the procurement of rabbits or hares comes from two utilized flakes found in Cultural Level 4 that tested positive for rabbit/hare blood anti-serum.

Small mammals are frequently recovered from archaeological sites in the Central Rockies, usually in small numbers (Eakin 1989, 2011, Hughes 2003; Page 2016, Swanson 1972). The small number of specimens and individuals represented in the assemblage suggests that small to medium-sized mammals, excluding beaver, contributed little to the diet of the people who lived at Game Creek.

Avian Fauna

A small number of bird bones were found at Game Creek in Cultural Levels 5 and 7 as well as in mixed deposits on the S3 alluvial fan (Table 9-18). A second phalanx identified as turkey was recovered from Cultural Level 5 on the T3 terrace. Turkeys are not native to Jackson Hole and are not reported from any archaeological assemblage in the area. Brian Kemp from the Department of Anthropology, Washington State University requested the specimen to be included in a genetic study investigating the origins of domesticated turkeys in the New World (Brian Kemp personal communication 2014). The results of the analysis were inconclusive. Either there is no useable DNA remaining in the bone or it is not a turkey (Brian Kemp, personal communication 2014). It is possible that the specimen was misidentified. Other potential species include Sandhill and whooping cranes, both of which have similar foot morphology. A humerus fragment from a goose or swan was found in Cultural Level 7 on the S3 (Table 9-18). This specimen may be from the same Canada goose represented by a complete humerus nearby. Both of these specimens had numerous (20-24) fine cut marks and were lightly weathered. One specimen was lightly gnawed. The three remaining bones are from a single ruffed or blue grouse recovered from the S3 landform. Two of the specimens have green bone fractures, and they are lightly weathered.

Table 7-18 Avian fauna recovered from Game Creek.

Cultural Level	Taxon	Element	Portion	Side	NISP
7b	Goose or Swan	Humerus	distal frag		1
	Canada Goose	Humerus	complete	L	1
	Grouse	Humerus	distal >1/2 shaft frag	R	1
	Grouse	Humerus	distal <1/2 shaft frag	L	1
	Grouse	Sternal Element	frag		1
5	Turkey ?	Second Phalanx	complete	R	1

Avian fauna are rare in archaeological assemblages in the region (Eakin 1989, 2011; Hughes 2003; Page 2016; Swanson 1972). Grouse are available year round and are easy to harvest. Goose and swan are migratory species, available only from spring to fall. The presence of these bones would provide some indication of seasonality, but it is unclear to which of the many components in evidence on the S3 they belong.

Fish, Reptilian and Mollusk Fauna

Three fish bones likely from cutthroat trout and/or mountain whitefish were recovered from the S3 (Table 9-19). All three specimens are fragmentary and lack any evidence of human modification. A net sinker weight, also recovered from the S3, provides additional evidence of fish procurement. One small unidentifiable bone fragment appears to be reptilian, perhaps from a turtle. Turtle are not native to the upper Snake River drainage and have not been recently introduced (Wyoming State Wildlife Action Plan 2010). Two freshwater bivalves are western pearlshell, a species common to the region. The 13 additional freshwater bivalve shell fragments are also probably western pearlshell (Table 9-19). The assemblage indicates that fish and freshwater shell were utilized resources during prehistory. There are several early historical accounts of cutthroat trout fishing in Jackson Hole, and the local Shoshone were said to make fish nets out of “wild flax” (Wright 1984:32).

Table 7-19 Fish, reptile and mollusk remains recovered from Game Creek.

Cultural Level	Taxon	Element	Portion	NISP
	Fish	Mandible	frag	1
	Fish	Vertebra	frag	4
7b	Fish	Vertebra	frag	1
	Turtle?	Unknown	frag	1
	Western Pearlshell	Complete Valve		1
	Western Pearlshell	Valve Frag		1
	Bivalve Shell	Frag		12
1	Bivalve Shell	Frag		1

Unidentifiable Remains

The vast majority (92.3%) of the faunal assemblage recovered from Game Creek could not be identified to taxa. Specimens were recovered from every cultural level, and most is presumed to be mammal bone. Of the 27,387 specimens, 98.2 percent consist of nondescript small bone (n=25,965) and tooth (n=918) fragments (Table 9-20). There are 504 specimens that could be identified either to a specific element or a class of elements, such long bones. Most of the identifiable bone consists of appendicular elements (90.1%), of which long bone fragments (n=376) and ribs (n=39) were the most numerous (Table 9-20). The large number of highly fragmented bones reflects the prevalence of intensive bone marrow extraction and bone grease processing. Evidence of green bone fracture was observed on 1,468 specimens, 44 bore cut or impact marks, and 5,038 specimens were burned. Post depositional taphonomic processes do not appear to have impacted bone preservation (Table-21). Only 210 instances of carnivore gnawing were observed in the analysis, and of the 1,785 specimens for which weathering was assessed, only 34.2 percent were characterized as heavily weathered (Table 9-21).

Summary and Discussion

The excavations at Game Creek produced the largest archaeological faunal assemblage thus far recovered from Jackson Hole. Large artiodactyls, but particularly bison, were clearly the primary targeted prey of the people who lived at Game Creek in all documented time periods spanning nearly 10,000 years (Table 9-22). One means of assessing the importance of high-value artiodactyl prey is through the artiodactyl index (Grayson 1991; Hughes 2003; Janetski 1997). The index is simply the ratio of artiodactyl bone, which in this instance includes bison, elk, deer, pronghorn, bighorn sheep, large and medium artiodactyls and undifferentiated artiodactyls, to non-artiodactyl bone in the identifiable faunal assemblage. At Game Creek the artiodactyl index ranges from 0.70 in Cultural Level 1 to 1.0 in Cultural Levels 3 and 6 with a site average of 0.87 (Table 9-22). The sample sizes for most of the cultural levels are prohibitively small for statistical comparisons and should be viewed with caution. Nevertheless, the Game Creek faunal assemblage is dominated by artiodactyls.

Other sites in the region have also produced assemblages with high artiodactyl indexes. The 24 sampled cultural layers at Mummy Cave, ranging from Late Paleoindian to Late Prehistoric in age, produced artiodactyl indexes ranging from 0.33 to 1.0, with a site average of .85 (Hughes 2003). Only six of the 24 levels had artiodactyl indexes below 0.83 (Hughes 2003). The Early Middle and Late Archaic levels at Goff Creek also produced high artiodactyl indexes, ranging from 0.86 to 0.97 (Page 2016). The primary difference between Game Creek and these other sites is that bison and elk were the dominant prey rather than bighorn sheep or deer. The data, though limited, suggest that large artiodactyls, particularly bison, were persistently targeted and utilized throughout prehistory in Jackson Hole. Medium artiodactyl remains were relatively scarce at Game Creek, but this pattern may not hold for

Table 7-20 Unidentifiable faunal assemblage from Game Creek.

Cultural Level	Element	Portion	NISP
1	Cancellous Bone	frag	2
2	Cancellous Bone	frag	1
4	Cancellous Bone	frag	1
5	Cancellous Bone	frag	2
6	Cancellous Bone	frag	1
7	Cancellous Bone	frag	11
T2-7	Cancellous Bone	frag	1
	Cancellous Bone	frag	14
	Caudal Vertebra	centrum frag	1
	Caudal Vertebra	complete	1
	Cervical Vertebra	frag	2
S3-7	Cranium	fr	1
	Cranium	frag	28
	Cranium	maxilla frag	2
S3-7	Femur	proximal head frag	1
	Femur	distal condyle frag	1
	Femur	proximal head frag	1
	Femur	proximal shaft frag	1
	Femur	shaft frag	1
	Humerus	shaft frag	1
2	Innominate	frag	2
	Innominate	acetabulum/ilium frag	1
	Innominate	frag	2
1	Long Bone	frag	1
1	Long Bone	mid-shaft frag	1
2	Long Bone	frag	4
2	Long Bone	mid-shaft frag	1
3	Long Bone	mid-shaft frag	1
4	Long Bone	frag	1
5	Long Bone	shaft frag	2
7	Long Bone	frag	1
S3-7	Long Bone	diaphysis frag	5
S3-7	Long Bone	frag	1
S3-7	Long Bone	mid-shaft frag	1
S3-7	Long Bone	shaft frag	5
	Long Bone	articular surface frag	4
	Long Bone	diaphysis frag	22
	Long Bone	epiphysis frag	1
	Long Bone	frag	19
	Long Bone	mid-shaft frag	7
	Long Bone	shaft frag	298
4	Long Bone	shaft frag	1
4	Mandible	tooth row frag	1
	Mandible	frag	2
	Mandible	tooth row frag	1
	Maxilla	frag	3
	Metapodial	proximal >1/2 shaft frag	1
	Patella	frag	1
	Petrous	auditory bulla frag	1
	Petrous	frag	3
5	Phalanx	distal >1/2 shaft frag	1
	Phalanx	frag	1
	Phalanx	proximal frag	1
	Radius	shaft frag	1

Table 7-20 Unidentifiable faunal assemblage from Game Creek.

Cultural Level	Element	Portion	NISP
S3-7	Radius Ulna	diaphysis frag	1
S3-7	Rib	proximal <1/2 shaft frag	1
T2-7	Rib	proximal >1/2 shaft frag	1
	Rib	blade frag	1
	Rib	frag	12
	Rib	proximal frag	2
	Rib	shaft frag	22
	Scapula	blade frag	1
	Scapula	caudal frag	1
	Scapula	frag	1
S3-7	Second Phalanx	complete	1
	Second Phalanx	proximal >1/2 shaft frag	1
	Tibia	anterior crest frag	1
5	Tooth	premolar/molar frag	1
2	Tooth	frag	1
4	Tooth	frag	3
5	Tooth	frag	3
7	Tooth	frag	3
S3-7	Tooth	frag	26
T2-7	Tooth	frag	8
	Tooth	complete incisor	1
	Tooth	complete premolar	1
	Tooth	complete second molar	1
	Tooth	frag	857
	Tooth	incisor frag	13
2	Ulna	distal shaft frag	1
	Ulna	frag	1
	Ulna	shaft frag	2
2	Unknown	frag	44
1	Unknown	frag	27
3	Unknown	frag	3
4	Unknown	frag	64
5	Unknown	frag	16
6	Unknown	frag	9
7	Unknown	frag	13
S3-7	Unknown	articular surface frag	5
S3-7	Unknown	complete	2
S3-7	Unknown	epiphysis frag	1
S3-7	Unknown	frag	1,298
T2-7	Unknown	frag	259
	Unknown	articular surface frag	8
	Unknown	diaphysis frag	1
	Unknown	epiphysis frag	3
	Unknown	frag	24,172
	Unknown	shaft frag	7
4	Vertebra	posterior epiphysis frag	1
S3-7	Vertebra	posterior epiphysis frag	1
	Vertebra	anterior epiphysis frag	2
	Vertebra	articular surface frag	2
	Vertebra	centrum frag	4
	Vertebra	complete	2
	Vertebra	frag	2
	Vertebra	posterior epiphysis frag	1

Table 7-21 Summary of cultural and taphonomic modification to the unidentified bone assemblage.

Cultural Level	Green Fracture	Cut/Impact	Burned	Gnawed	Lightly Weathered	Heavily Weathered	NISP
1	7		1		6	3	31
2	30		9		30	2	54
3	1				2		4
4	51	1	12		11	23	72
5	16		2	2	10	4	25
6	9		1		5	3	10
T3-7	18	1	3		20	1	28
T2-7	144		3	2			269
S3-7	9	3	348	7			1,350
Other	1,183	39	4,659	199			25,544
Total	1,468	44	5,038	210	1173	612	27,387

Table 7-22 Diversity and artiodactyl indexes of cultural levels at Game Creek

Cultural Level	Number of Taxa	NISP	Artiodactyl NISP*	Artiodactyl Index	Shannon Diversity Index
1	5	11	7	0.70	1.48
2	2	17	15	0.88	0.66
3	1	4	4	1.00	0
4	2	42	40	0.95	1.05
5	3	27	25	0.93	1.49
6	1	11	11	1.00	0
7	6	172	164	0.95	0.54
S3	12	643	536	0.83	1.60
Total	12	927	802	0.87	1.40

* includes bison, elk, deer, pronghorn, bighorn sheep, large, medium and undifferentiated artiodactyls

all of Jackson Hole. Sites located nearer the migration corridors used by pronghorn and deer, which are presently located 20 miles north of Game Creek, may well contain more medium artiodactyl remains. Similarly, sites at higher elevations around Jackson Hole could be predicted to produce more bighorn sheep remains due to their proximity to sheep habitat.

The Game Creek faunal assemblage is more diverse than other documented archaeological faunal assemblages in the region (Eakin 1989, 2011; Hughes 2003; Page 2016), which is in part due to the larger number of artiodactyl fauna present in the area. Assemblage diversity was calculated using the Shannon index, which measures both richness and evenness by calculating the distribution of NISP across taxa (Grayson 1991; Hughes 2003). The formula is:

$H' = -\sum pi \log pi / \log_{10} NISP$,

Where *pi* is the proportion of individuals in the ith species, or *pi/N*.

The higher the resulting value the greater the diversity of the assemblage. The Shannon indexes calculated from the Game Creek assemblage range from a low of 0.54 in Cultural Level 7, due in part to the large number of bison bones recovered from the T2 terrace, to 1.60 for the mixed deposits on the S3 landform (Table 9-22). Indexes were not calculated for Cultural Levels 3 and 6 due to small sample sizes. In comparison, the 24 cultural layers at Mummy Cave had Shannon indexes ranging from 0.0 to 0.75 (Hughes 2003). Similar low assemblage diversity was documented at Goff Creek where Early and Middle Archaic levels produced indexes ranging from 0.65 to 0.68 (Page 2016). The mixed Late Archaic, Late Prehistoric level at Goff Creek had a higher Shannon index, 1.34, but still lower than many of the cultural levels at Game Creek.

The Shannon diversity index is typically negatively correlated with the artiodactyl index (Grayson 1991; Hughes 2003). The standard hypothesis is that as productivity of high-ranked artiodactyl prey decreases there is an increase in diet breadth, that is, a greater variety of lower-ranked prey species are taken to supplement the loss of high-rank prey. There is a negative and statistically significant (Spearman's rho= -0.81 $p \leq .05$) correlation between the Shannon and artiodactyl indexes in the cultural levels at Game Creek (Figure 9-1). However, given the small sample sizes, especially from Cultural Levels 1, 2, 3 and 6, this correlation should be viewed with caution.

The data suggest that a greater diversity of fauna and fewer high-ranked prey were exploited during the earliest affirmed occupation of the site at 10,391±61 cal BP. A contemporaneous faunal sample from cultural layer 4 at Mummy Cave, though quite small, also has a low artiodactyl index (0.33), but a low diversity index as well (Hughes 2003). These occupations occurred during an extremely warm and dry period (Eckerle et al. 2014) that may have caused a reduction in high-ranked prey species in the Central Rockies.

There is an increase in artiodactyl indexes for the remainder of the Paleoindian period (ca 9700 cal BP – 8600 cal BP) at both Came Creek and Mummy Cave, which is surprising given the apparent human population collapse that occurred circa 8600 cal BP (Kelly et al. 2013; Chapter 3). There is evidence from Mummy Cave for a decrease in bighorn sheep procurement and increase in diet breadth during the Early Archaic period (ca. 8600 cal BP – 5300 cal BP [Hughes 2003]). At Game Creek, however, there was no significant decrease in the artiodactyl index but an increase in the Shannon diversity index that in part reflects a wider array of high-ranked artiodactyl fauna, including bison, elk and deer found in Cultural Levels 4, and 5. Similar high artiodactyl indexes are present in the Early Archaic assemblages from the Goff Creek site (Page 2016). These data suggest that artiodactyl populations remained relatively stable in the Central Rockies throughout the Mid-Holocene Climatic Optimum (ca. 8300 cal BP – 5700 cal BP) when the climate of many surrounding regions appears to have been much drier and warmer than present (Chapter 2).

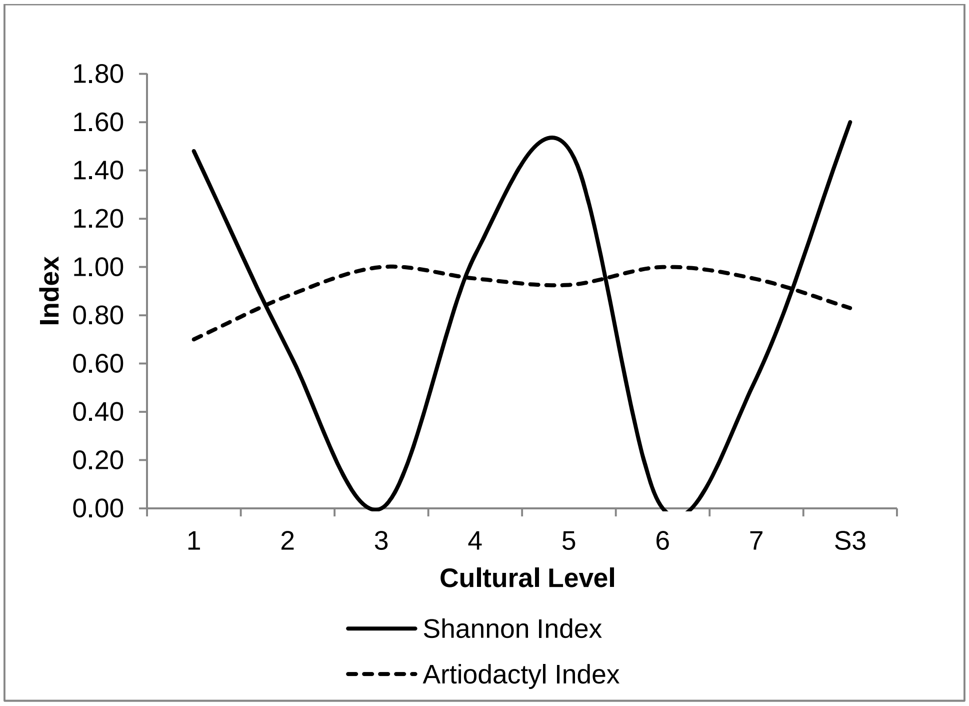


Figure 7-1 Plotted values of Shannon diversity and artiodactyl indexes for the cultural levels at Game Creek.

The Middle and Late Archaic faunal records at Game Creek are inextricably mixed with earlier and later deposits on the S3 landform. There is radiocarbon evidence for at least 10 occupations on the S3 between 5685±42 cal BP and 554±36 cal BP. It is therefore unlikely that the S3 sample mirrors the composition of any one component. However, the aggregate Cultural Level 7 assemblage from the T3, T2 and S3 landforms differs markedly from the sample recovered from mixed deposits on the S3 (Table 9-22). Accordingly, the characteristics of the mixed S3 assemblage is likely attributable to the Middle and/or Late Archaic components. The Middle and Late Archaic-aged levels at Mummy Cave have low Shannon diversity indexes and high artiodactyl indexes (Hughes 2004). Yet, similarly aged deposits from the Goff Creek site more closely resemble the mixed assemblage from the S3 landform at Game Creek, with artiodactyl indexes in the 80s and fairly high diversity indexes (0.68-1.34 [Page 2016]). The question of whether there were demonstrable changes in hunting practices during the Middle and Late Archaic periods in the Central Rockies will have to await the recovery of more data.

The Late Prehistoric-aged Cultural Level 7 at Game Creek (Table 9-22) had a low diversity and high artiodactyl indexes perhaps reflecting an increase in bison populations in Jackson Hole. Similar indexes were found in the Late Prehistoric faunal assemblages from Mummy Cave (Hughes 2003) and Bugas-Holding (Rapson 1990). Much of this period coincided with the Medieval Warm Period (ca. 820 cal BP – 500 cal BP), which in the southern GYE was characterized as warm with relatively stable effective moisture. Such conditions would have supported relatively large and stable populations of ungulates in Jackson Hole.

The “High Country Adaptation Model” was developed to interpret and predict prehistoric subsistence patterns in Jackson Hole and by extension the rest of the Central Rockies. Scheduling of residential moves is believed to have been timed to coincide with the ripening of high-value root crops. Since these crops first ripen at lower elevations, the model retrodicts that people first moved to the valley floor in places like Game Creek in the late spring or early summer. As the summer progressed people moved into higher elevations to exploit the later ripening of root crops, but also to hunt medium artiodactyls, specifically deer and bighorn sheep, that would also be taking advantage of ripening vegetation in the higher elevations. Wright et al. (1980) and Wright (1984) argue that large artiodactyls were either absent from Jackson Hole during much of prehistory or were otherwise scarce and unpredictable. Yet, the faunal assemblages from Game Creek show that bison, and to a lesser degree elk, were the primary targeted and procured species during every occupation. In sharp contrast, deer and bighorn sheep were relatively scarce. The presence fetal bison, and perhaps elk bone, though somewhat equivocal, indicates that people may have camped at Game Creek during the winter, and migratory waterfowl bone also suggest a spring through fall occupation. It is therefore unclear whether Jackson Hole was abandoned each and every winter, or that the valley floor was only occupied during late spring through early summer as is presumed by Wright et al. (1980), Wright (1984) and Bender and Wright (1988. A more thorough review of the “High Country Adaptation Model” is presented in Chapter 8, but suffice it say that the faunal assemblage from Game Creek does not conform to the model as presented by Wright et al. (1980), Wright (1984 and Bender and Wright (1988).

CHAPTER 8 CONCLUSIONS

Michael K. Page

The data recovery plan outlined four primary research goals (Eakin and Eckerle 2004). The first of these pertained to the identification of the Paleoindian projectile point chronology for Jackson Hole. It was hoped that data pertaining to temporal duration and stylistic change of projectile points could determine whether the cultural history during the Paleoindian period of Jackson Hole mirrored that of other parts of the Central Rockies. The second research goal was to develop paleoclimatic models in order to address potential adaptational responses to climate change. The paleoclimatic reconstruction not only provides environmental context, but further offers evidence of "push" and "pull" stimuli that impacted the settlement and subsistence patterns of the people who lived in Jackson Hole throughout prehistory. The paleoclimatic reconstruction also affords a framework within which to assess depositional trends documented at Game Creek. The results of these studies show that southern Jackson Hole was capable of and actually did sustain human populations even during the hottest and driest periods of the Holocene. Evidence for changes in mobility and subsistence of human populations during the transition from the Paleoindian to the Archaic was the third research goal outlined in the data recovery. The evidence from Game Creek, though limited, shows no clear evidence of a significant change in subsistence or mobility throughout the roughly 2,500 years of intermittent occupation during the Paleoindian and Early Archaic periods. The fourth and final research goal was to test the "High Country Adaptation Model" developed by Bender and Wright (1988) and others (Reeve 1986; Wright 1984; Wright et al. 1980) for northern Jackson Hole. Results of the study show that underlying principles of the model are sound, but the interpretations of the historical movements of people into and out of Jackson Hole have no support in the archaeological record from Game Creek or elsewhere.

Chronostratigraphy and Projectile Point Chronology of Jackson Hole

Relatively few Paleoindian sites have been systematically investigated in the region and none in Jackson Hole. Consequently it was, and to some extent remains unclear whether the Paleoindian projectile point chronology of Jackson Hole corresponds with the sequence identified at other sites in the region (Frison 2007a; Husted and Edgar; Kornfeld et al. 2001). The presence of relatively intact and well-dated cultural components at Game Creek provides valuable data the on the emergence and duration of Late Paleoindian complexes and diagnostic artifacts in Jackson Hole. Results show that the culture history of Jackson Hole during the Paleoindian period corresponds closely with the rest of the Central Rockies. However, results of the excavation at Game Creek indicate that that projectile point chronology of the Early Archaic period in Jackson Hole differs from other investigated parts of the Central Rockies, such as the Absaroka (Husted and Edgar; Page 2016) and Big Horn (Frison 2007b; Shaw 1980) Mountains.

Projectile Point Chronology

The chronological sequence of Paleoindian projectile points at Game Creek corresponds closely with other stratified sites in the Central Rockies, such as Mummy Cave, Helen Lookingbill, Medicine Lodge Creek and Sorenson (Table 10-1, Figure 10-1 [Frison 2007a; Husted 1969; Husted and Edgar 2002; Kornfeld et al. 2001]). Although not dated, the Haskett component, identified by point and preform fragments, one of which was recovered from the contact of Stata II and III, is likely the earliest component at Game Creek and may date as early as circa 12,000 cal BP (Kornfeld et al. 2001). The fishtail point recovered from Cultural Level 1 in Block A, dated to 10,391±61 cal BP, most closely resembles the unnamed type from the contemporaneous Culture Layer 4 at Mummy Cave. Several point fragments found in Cultural Level 2, dated to circa 9660±53 cal BP, and other undated contexts, correspond closely to the Angostura type (Bradley 2013; Pitblado 2003). The point base found at the top of Cultural Level 2 is more similar to Late Paleoindian Birch Creek points from the Snake River Plain (Holmer 2009; Plew 2008; Swanson 1972) than to Angostura points from the Central Rockies, but several similar specimens were recovered from Culture Layers 8-12 at Mummy Cave (Husted and Edgar 2002). Although, poorly dated, Birch Creek points in Eastern Idaho range in age from circa 11,500-8500 cal BP (Holmer 2009). A James Allen point fragment was found in Cultural Level 3, bracketed by dates of 9660±53 cal BP and 9009±28 cal BP. Allen points are infrequently found in the Central Rockies, but one was recovered from Medicine Lodge Creek in the same chronological context, dated roughly to circa 9500 cal BP (Frison 2007a). Several Lovell/Pryor stemmed points were found at Game Creek with an associated date of 9009±28 cal BP. Lovell/Pryor points have been recovered from numerous sites in the Central Rockies and dated to circa 9500-8600 cal BP (Frison 1972, 2007a; Frison and Grey 1980; Husted and Edgar 2002; Kornfeld et al. 2001).

The Early Archaic projectile point chronology differs from most, if not all other documented site assemblages (Table 10-1; Figure 10-2) Husted and Edgar 2002; Kornfeld and Barrows 1995; Francis and Widman 1999; Page 2016). The broad stem projectile point found in Block D is of a type found in poorly dated contexts in Stratum III at Trappers Point (Francis and Widman 1999), 48SU2527 (Miner 2001) and 48BH332 (Walker and Bach 2007). The 8390±28 cal BP date from Game Creek demonstrates that this is one of the earliest projectile point styles of the Early Archaic in the Central Rockies. Similar points are found in the Southern Rocky Mountains “especially in early contexts” (Black 1991:11), and a nearly identical form, known as Borax Lake Widestem, occurs in northern California during the Early Archaic (Justice 2002). The temporal duration of the broad stem type is unknown, but given its infrequency may have been used for a relatively brief period.

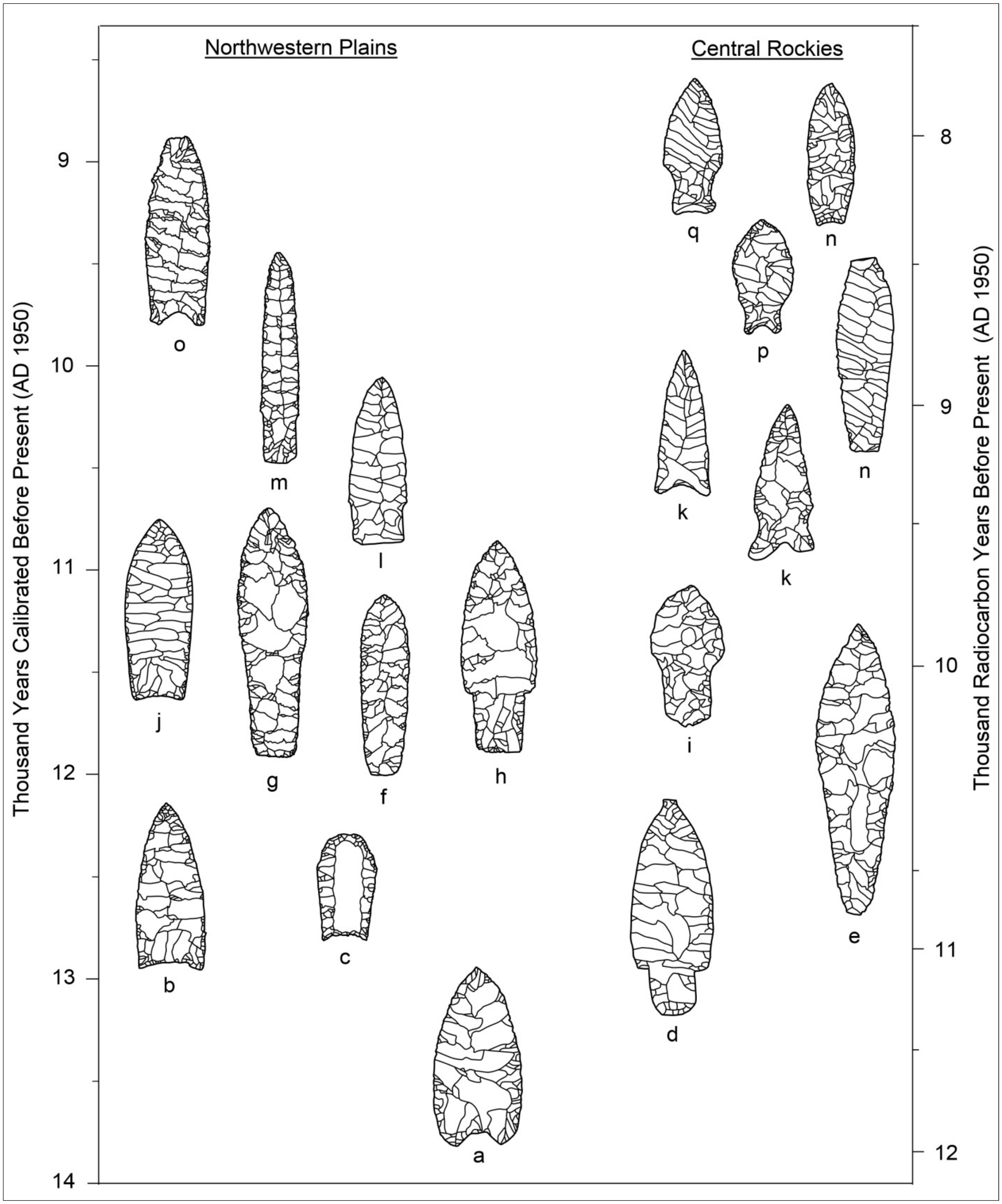


Figure 8-1 Paleoindian projectile point chronology for the Central Rockies and Northwestern Plains: (a) Clovis; (b) Goshen; (c) Folsom; (d) Western Stemmed (e.g. Parmalee/Windust, etc.); (e) Haskett; (f) Agate Basin; (g) Hell Gap; (h) Alberta; (i) Western Stemmed (e.g. Great Basin Stemmed/Lake Mohaje); (j) Plainview; (k) fishtail; (l) Alberta/Cody; (m) Eden; (n) Angostura; (o) James Allen/Frederick; (p) Lovell Constricted; (q) Pryor Stemmed.

Table 8-1 Diagnostic projectile points, context and associated dates from Game Creek.

Period	Projectile Point Type	Landform/ Cultural Level	Associated Dates (median cal BP ± 1σ)
Late Prehistoric	Desert TN	S3	759±22–554±36*
	Desert SN	S3	759±22–554±36*
	Rose Spring CN	S3	759±22–554±36*
Late Archaic	Pelican Lake/Elko CN	T2/S3	2350±39–1878±36*
Middle Archaic	Duncan/Gatecliff ST	S3	5685±42–4154±56*
	Mckean/Humboldt LNC	S3	
Early Archaic	Elko CN	S3	7896±40*
	Bitterrot/Northern/Pahaska	T2/S3	7896±40*
	Elko Eared	T2 CL 4	7951±23–5519±86
	Broad Stem	T2 CL 4	8390±28
Paleoindian	Lovell/Pryor	T2 CL 4	9009±28
	James Allen	T2 CL 3	9660±53–9009±28
	Birch Creek	T2 CL2	9660±53
	Angostura	T2 CL2	9660±53
	Fishtail	T3 CL1	10,391±61
	Hasket	T3 S-II/III	?

*association is speculative because dated sample and projectile points recovered from mixed deposits on the S3.

Side-notched darts, variously known as Blackwater, Pahaska, Bitterroot or Northern, are the most common style of projectile points in each of the Early Archaic cultural layers at Mummy Cave (Husted and Edgar 2002), Helen Lookingbill (Kornfeld and Barrows 1995), Trappers Point (Francis and Widman 1999) Goff Creek (Page 2016) and Little Canyon Creek (Shaw 1980) where they are dated from circa 8400-5700 cal BP. Corner-notched darts are also reported and even common at some of these sites, but rather than a distinct type, appear to form an end of a continuum with side-notched forms (Page 2016). Side-notched dart points were rare at Game Creek, and none were recovered from intact dated deposits. Bartholomew (2001) found that Early Archaic side-notched darts are one of the least frequent point types represented in surface assemblages from Jackson Hole. The most frequent Early Archaic point type in the Game Creek assemblage is the Elko Eared/Hanna type dated from 7951±23 cal BP to 5519±86 Cal BP.

Elko Eared, or Hanna-like points are reported from Trappers Point (Francis and Widman), Mummy Cave (Husted and Edgar 2002), Medicine Lodge Creek (Frison 2007b) and Laddie Creek (Kornfeld et al. 2010), but are infrequent. The presence of Hanna points in good context at least 2,000 years before the appearance of the McKean complex is significant. First and foremost, these findings show that the chronological sequences of projectile point styles developed on the Northwestern Plains (Frison 1991; Kornfeld and Larson 2010) does not accurately reflect the temporal development of projectile point styles in Jackson Hole and perhaps the upper Green River Basin. Second, cultural historical reconstructions of Jackson Hole have invariably relied on frequencies of “diagnostic” artifacts recovered mostly from the surface in undated contexts (Connor 1998; Bartholomew 2001; Bender and

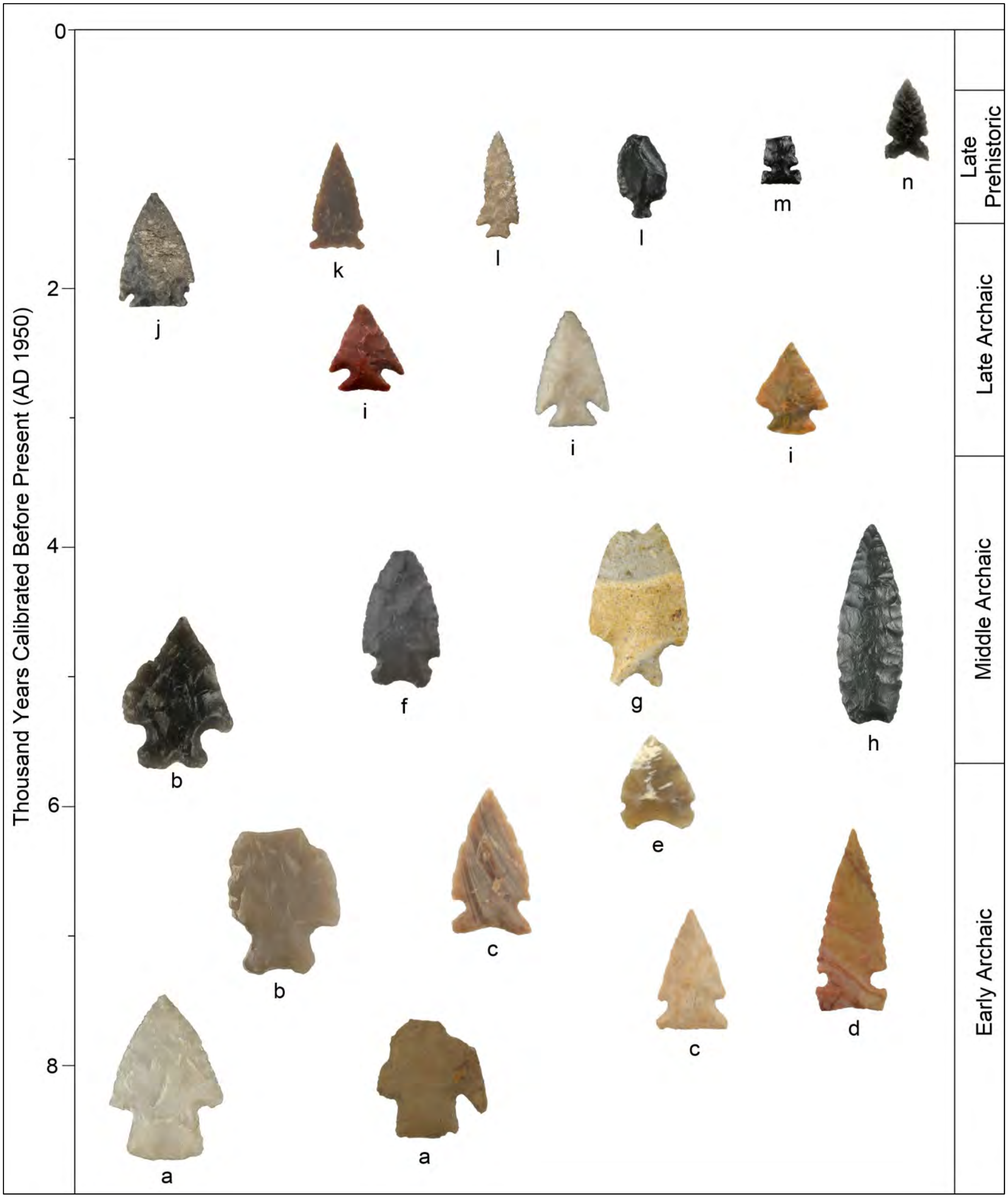


Figure 8-2 Archaic and Late Prehistoric projectile point chronology for the Central Rockies: (a) Broad Stem; (b) Elko Eared; (c) Elko Corner-Notched; (d) Pahaska/Bitterroot/Northern side-notched; (e) Oxbow; (f) Hanna; (g) Duncan/Gatecliff; (h) McKean lanceolate; (i) Pelican Lake/Elko corner-notched; (j) Blue Dome "side-notched"; (k) Avonlea; (l) Rose Spring; (m) Desert/Plains side-notched; (n) Desert tri-notched.

Wright 1988). If Elko Eared/Hanna points date to the Early Archaic in Jackson Hole, then many sites, previously assigned to the Middle Archaic by Bender and Wright (1988) and Bartholomew (2001) may well date to the Early Archaic period. Thus, the intensive occupation ascribed to the Middle Archaic of Jackson Hole (Bender and Wright 1988:634-635), an assessment based almost entirely on "Hanna" points, is likely overstated. Similarly, Bartholomew (2001) concluded that human populations in Jackson Hole were small during the Early Archaic because so few side-notched darts are present, but Middle and Late Archaic sites are disproportionately numerous, because Elko Eared/Hanna points were assigned to later periods.

Although the integrity of the Middle Archaic components on the S3 alluvial fan, where all but two projectile points were recovered, has been severely compromised, radiocarbon dates indicate at least four Middle Archaic components ranging in age from 5685±42 cal BP to 3970±64 cal BP. Duncan/Gatecliff stemmed dart points and one McKean/Humboldt lanceolate were recovered from the S3. Notably, no Elko Eared/Hanna points were found on the S3, suggesting that the type may have been replaced by stemmed forms early in the Middle Archaic period. On the Northwestern Plains, Duncan, Hanna and McKean Lanceolates frequently co-occur in the same components throughout the Middle Archaic period.

The presumptive Late Archaic projectile point assemblage from Game Creek closely corresponds to other dated assemblages in the Central Rockies (Eakin 1989; Husted and Edgar 2002; Kornfeld and Barrows 1995; Kornfeld et al 2001; Page 2016). Corner-notched, Pelican Lake/Elko dart points are the most numerous style in the Game Creek assemblage. There is evidence, mostly from disturbed contexts on the S3, for four Late Archaic components from 2350±39 cal BP to 1878±36 cal BP. Corner-notched dart points were in widespread use throughout western North America between circa 3400-1400 cal BP. A transitional Hanna-Pelican Lake type, known as Yonkee, has been documented on the Northwestern Plains (Frison 1970) but is not reported from the Central Rockies. The Blue Dome "side-notch" type, identified from terminal Late Archaic, circa 1450 cal BP, deposits at Bison and Veratic rockshelters (Swanson 1972), is also present in the Game Creek assemblage and may represent influences from the Avonlea complex and the transition to the bow and arrow.

Late Prehistoric arrow point styles from Game Creek and Jackson Hole appear to have the same temporal duration as in other parts of the Central Rockies (Kornfeld et al. 2010). The Avonlea point type is believed to be one of, if not the, earliest arrow point style in the region and has been recovered from contexts in the Big Horn Mountains dated to circa 1300 cal BP. No Avonlea points were found at Game Creek, but they are reported from Jackson Hole (Connor 1988) and the upper Green River Basin (Frison and Reher 1973). Corner-notched arrow points, generally known as Rose Spring, occur throughout the Central Rockies from circa 1150-700 cal BP (Husted and Edgar 2002; Page 2016; Plew et al. 1987). The 759±22 cal BP pooled mean date may date the Rose Spring points found on the S3 at Game Creek. Desert side and tri-notched points were the last styles of chipped stone projectile point utilized in Jackson Hole and the Central Rockies. A small assemblage of these points was found on the S3 and is likely associated with the 554±36 cal BP and 669±19 cal BP pooled mean dates.

In summary, the Paleoindian projectile point chronology for Jackson Hole appears to correspond with the temporal or stratigraphic sequences documented at other sites in the Central Rockies (Figure 10-1). Although not established at Game Creek, there is evidence of limited occupation in the area by Clovis, Folsom and Cody complex people. The evidence from Game Creek suggests that broad stem point style was the first Early Archaic point type in the area (Figure 10-2). Elko Eared/Hanna points were in common use by circa 7900 cal BP and continued to be used throughout the remainder of the Early Archaic period. Side-notched darts are rare. This stands in marked contrast to other Early Archaic point assemblages from the Central Rockies. Duncan/Gatecliff stemmed and McKean/Humboldt lanceolate points appear during the Middle Archaic period, as at other sites in the region, but missing, at least from the Game Creek sample, are Hanna points. Pelican Lake/Elko and Blue Dome corner-notched darts replaced stemmed and lanceolate forms during the Late Archaic period. A variety of side and corner-notched arrow point styles appear during the Late Prehistoric.

Paleoenvironmental Studies

The MCM model developed for Jackson Hole is generally substantiated by proxy data from the GYE. The balance between high annual but low summer effective moisture throughout the Paleoindian period likely resulted in forage production and game animal densities similar to those documented in the Early Historic period and good food resource production from lowland and upland-adapted plants. Modeled climate and resource availability suggests the potential for a balanced hunting and gathering adaptation with abundant big game and plant resources during the late Paleoindian occupation interval but with somewhat limited winter procurement opportunities compared to historical conditions.

Annual precipitation fell markedly during the Early Archaic period with the onset of the Holocene Climatic Optimum. This would have lowered the water table on the Snake River-Flat Creek bottomland and reduced plant food resource production. Similarly, early-season moisture-dependent root and tuber-producing plants would have produced poorly during this time. Yet, summer moisture-dependent upland plants such as Indian ricegrass would have been much more available during this period. Low annual but high summer moisture may have increased warm season grasses, but overall game animal forage production and game animal densities were probably lower than present.

Although there were several significant dry events, most of the period between circa 5600 cal BP and 800 cal BP was a time of high annual but low warm season (July) effective moisture. High annual precipitation during this time is supported by regional proxy data and would have enhanced the Snake River-Flat Creek bottomland allowing good food resource production from both lowland and upland-adapted greens berries and tubers. However, Indian ricegrass would not have been as available at this

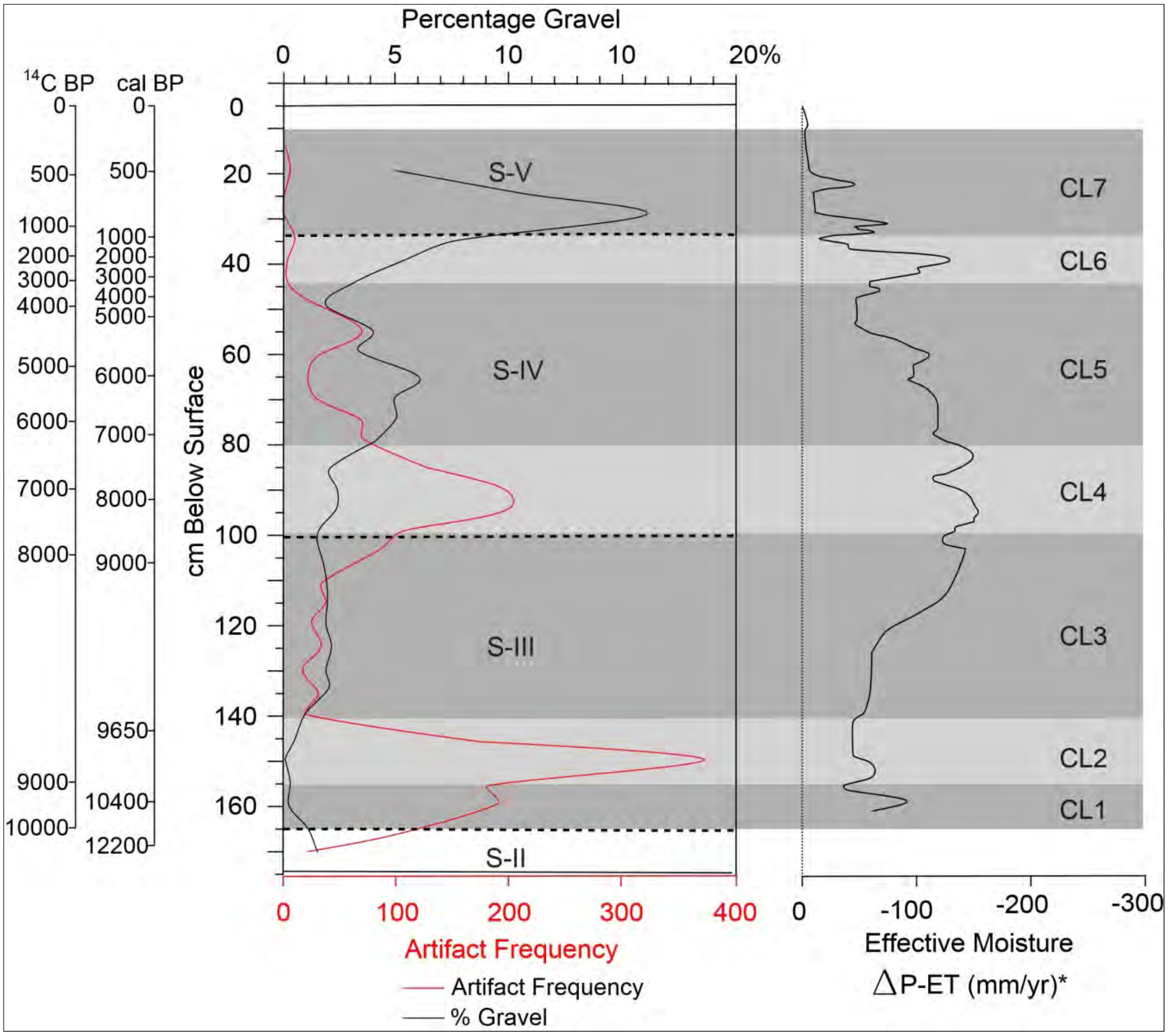


Figure 8-3 Graphs showing the volume of gravel and artifact frequency in Block A, E501, and variations in effective moisture recorded at Lake of the Woods, Wyoming (Shuman 2012; Shuman et al. 2010).

time. The balance between high annual but low summer moisture probably resulted in forage production and game animal densities much like present day conditions that support relatively abundant big game populations.

The sedimentological record from the T2 terrace at Game Creek provides additional proxy data for paleoenvironmental reconstruction of Jackson Hole. The volume of gravel in the stratified deposits of the T2 fluctuated through time. Higher volumes of gravel are believed to have resulted from decreased effective moisture and plant cover that led to denudation of adjacent steep hillsides. Conversely, denser vegetation led to a decrease in erosion during periods of higher effective moisture. Data from Block A on the T2 terrace does generally correspond with proxy data from Lake of the Woods (Shuman 2012; Shuman et al. 2010), located only 60 km from Game Creek (Figure 10-3). The volume of gravel peaks from circa 7500-5000 cal BP and again from circa 1000-800 cal BP. The earlier increase coincides only in part with the paleo-shoreline proxy data from Lake of the Woods, where a steady trend of decreasing effective moisture appears to have begun nearly two millennia earlier at circa 9300 cal BP. Perhaps, Jackson Hole received a greater portion of its annual precipitation during the spring/summer months, which fostered stable plant communities that prevented erosion. Alternatively, Jackson Hole may have been wetter than adjacent parts of the Central Rockies until circa 7500 cal BP. Such conditions would have made the area attractive to hunter-gatherers, and it is during this earlier part, circa 9000-7900 cal BP, of the Holocene Climatic Optimum that Game Creek was repeatedly occupied. The second major peak in gravel volume coincided with a drought event that occurred from circa 1300-1000 cal BP that was followed by at least one extremely wet event or series of events.

The paleoenvironmental studies and interpretations show that Jackson Hole was more than capable of supporting human populations throughout the Holocene. Even during the height of Mid-Holocene drying and warming, Jackson Hole likely produced enough forage to sustain significant numbers of big game and was wet enough to maintain populations of many edible plants. Some plants, such as Indian ricegrass, may have been more abundant in and around Game Creek. Interpretation of the environmental proxy data may indicate that Jackson Hole was less severely impacted than surrounding areas during the earliest portion of the Holocene Climatic Optimum.

Late Paleoindian–Early Archaic Mobility and Subsistence

Mobility

Typically questions of mobility are addressed through identification and analysis of lithic raw materials. Locally available obsidian, chert and metaquartzite comprise the vast majority of the chipped stone assemblages from each cultural level at Game Creek. Stone from distant (>100 km) sources was rare. Most of the identifiable, non-local, chert specimens are believed to be from sources found in the Green River Basin, such as the Tipton and Laney Member cherts from the Green River formation and Bridger formation chert, the closest sources of which are 130-170 km south-southeast of Game Creek (Table 10-2; Figure 10-4). Madison formation chert is also present in considerable quantities at Game Creek, but there are several potential sources in the immediate vicinity of Jackson Hole (Figure 10-4). A sample of 35 obsidian artifacts was submitted for ed-xrf analysis. Sourcing revealed that 88.2% of the sample was made from locally available sources (Table 10-3). The Haskett point fragment was identified as Packsaddle Creek obsidian from eastern Idaho, one source of which is only 50 km west of Game Creek. One Early Archaic Elko Eared point was made from Malad obsidian from southeastern Idaho. A Late Prehistoric Desert side-notch point and a utilized flake from Cultural Level 5 were identified as the Bear Gulch source found in northeastern Idaho and southwestern Montana about 150 km northwest of Game Creek (Table 10-3). The data indicate that the Green River Basin was the source of most of the non-local stone at Game Creek.

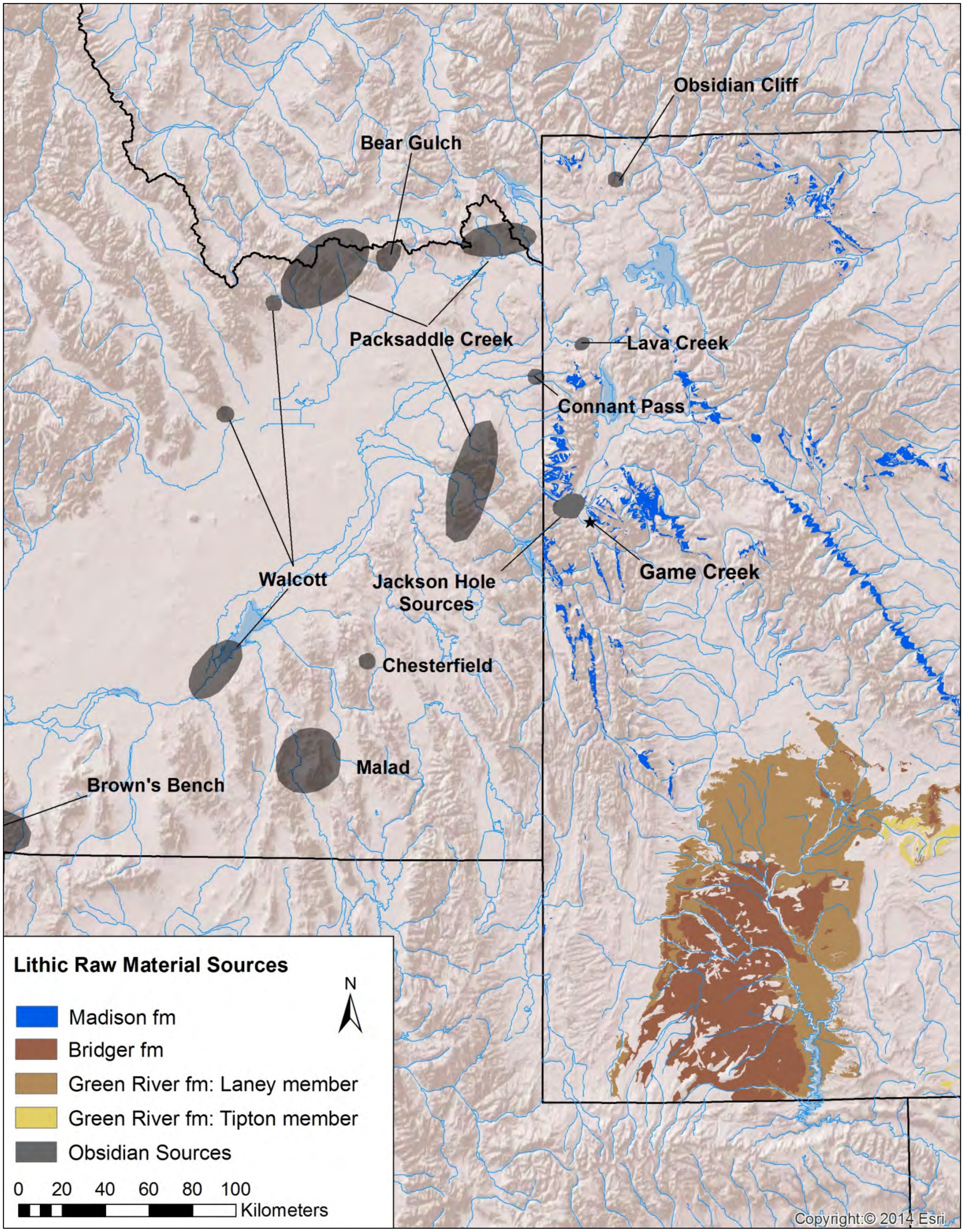


Figure 8-4 Map showing the locations of various lithic raw material sources identified in Jackson Hole.

Table 8-2 Chert artifacts identified to source in the Game Creek assemblage.

Source	Cultural Level							S3	Total %	Total
	1	2	3	4	5	6	7			
Madison fm	1.0%	98.2%	16.7%	28.0%	33.3%	66.7%	23.3%	22.8%	55.4%	437
GRF-Laney member	1.0%	0.0%	16.7%	36.0%	58.3%	0.0%	46.7%	29.3%	8.7%	69
GRF-Tipton member	0.0%	0.0%	0.0%	16.0%	0.0%	0.0%	0.0%	1.6%	0.8%	6
Bridger fm	98.0%	1.8%	66.7%	20.0%	8.3%	33.3%	30.0%	46.3%	35.1%	277
Total	196	391	6	25	12	6	30	123		789

Table 8-3 Results of ed-xrf analysis of obsidian artifact sample from Game Creek.

Source	Paleoindian	Early Archaic	Middle Archaic	Late Archaic	Late Prehistoric	?	Total
Teton Pass	72.7%	57.1%		60.0%		22.2%	17
Crescent H	18.2%	14.3%	100.0%	40.0%		44.4%	11
Lava Cr. Tuff						11.1%	1
W. Gros Ventre Butte						11.1%	1
Bear Gulch		14.3%			100.0%		2
Malad		14.3%					1
Packsaddle Cr.	9.1%						1
Unknown						11.1%	1
Total	11	7	2	5	1	9	35

Table 8-4 Proportion of obsidian sources by age in Jackson Hole Sample of projectile points.

Source Area	Paleoindian	Early Archaic	Middle Archaic	Late Archaic	Late Prehistoric	Source Area %	Total
Jackson Hole	73.3%	76.0%	61.5%	78.9%	72.7%	73.4%	80
Yell/Bear Gulch	16.7%	20.0%	38.5%	15.8%	27.3%	22.0%	24
SE Idaho	10.0%	4.0%	0.0%	5.3%	0.0%	4.6%	5
Total	30	25	13	19	22	109	109

Data from Cannon et al. (2001); Connor and Kunselman (1994); Jamie Schoen, Bridger-Teton National Forest obsidian source database, Teton County.

Table 8-5 Proportion of obsidian sources by age for sample from southwestern Wyoming.

Source Area	Paleoindian	Early Archaic	Middle Archaic	Late Archaic	Late Prehistoric	Source Area %	Total
Jackson Hole	50.0%	86.0%	0.0%	5.1%	17.3%	27.2%	58
Green River B.	0.0%	0.0%	0.0%	15.4%	12.5%	8.9%	19
Yell/Bear Gulch	50.0%	14.0%	20.0%	30.8%	24.0%	23.0%	49
SE Idaho	0.0%	0.0%	80.0%	48.7%	46.2%	40.8%	87
Total	2	43	25	39	104		213

Data from Scheiber and Finley 2011.

Other obsidian sourcing studies conducted in and around Jackson Hole provide additional data and temporal changes in obsidian conveyance that may shed light on mobility patterns (Cannon et al. 2001; Connor and Kunselman 1994; Kunselman et al. 1995; Scheiber and Finley 2011). A sample of 109 diagnostic obsidian projectile points recovered from Jackson Hole and the Teton County portion of the Bridger-Teton National Forest have been analyzed and identified to source (Table 10-4). The data show, not surprisingly, that most obsidian projectile points were made of locally available obsidian, such as Teton Pass, Crescent H Ranch, West Gros Ventre Butte, Engineer's Quarry and Phillips Ridge (Cannon et al. 2001; Connor and Kunselman 1994; Kunselman et al. 1995; Schoen 1997). Obsidian from southeastern Idaho, including Malad, Packsaddle Creek, Chesterfield and Brown's Bench, are only common in the Paleoindian-aged sample (Table 10-4). Obsidian from Obsidian Cliff in Yellowstone and Bear Gulch in northeastern Idaho and southwestern Montana occurs with some regularity in all time periods but is most frequent in the Middle Archaic-aged sample (Table 10-4). Conveyance of obsidian within and between different parts of the Central Rockies appears to have been persistent through time. There is evidence for movement of obsidian and people out of Jackson Hole and into surrounding regions, specifically the Green River Basin, and especially during the Early Archaic Period (Table 10-5).

Based on a sample of 213 diagnostic obsidian projectile points that have been analyzed and identified to source from southwestern Wyoming, Scheiber and Finley (2011) found that 86% of the Early Archaic-aged sample was derived from Jackson Hole obsidian sources. The Middle and Late Archaic-aged samples show dramatically different patterns in obsidian conveyance. The majority of Middle and Late Archaic specimens were identified to southeastern Idaho sources, with Malad being the dominant source. There are also significant proportions of Yellowstone and Bear Gulch obsidian sources, but little to no Jackson Hole obsidian. Obsidian provenance data from eastern Idaho reveal little evidence for the movement of obsidian from Jackson Hole west to the Snake River Plain (Holmer 1997). Only one artifact from a sample of 1,227 obsidian specimens collected from eastern Idaho was sourced to Jackson Hole. Scheiber and Finley (2011) report a similar low proportion (of Jackson Hole obsidian in eastern and southeastern Idaho.

These data, though limited by small sample sizes, show that patterns of obsidian conveyance, and likely hunter-gatherer mobility, changed through time. During the Paleoindian period there appears to have been some degree of movement and/or interaction of people between eastern Idaho and Jackson Hole. Yet, there is also Green River Basin chert in each of the Paleoindian levels at Game Creek, and at least one Jackson Hole obsidian Paleoindian projectile point from the southwestern Wyoming, suggesting connections also to the south. Several sites in the Green River basin have produced evidence of intensive plant harvesting and processing by late Foothill-Mountain complex people (Smith et al. 2003). These sites may mark the beginning of a pattern of seasonal exploitation of the high country and basins that continued throughout the Archaic and Late Prehistoric periods.

There was a pronounced shift during the Early Archaic with decreases in southeastern Idaho obsidian in Jackson Hole and regular transport of Jackson Hole obsidian south into the Green River Basin. According to Francis and Widman (1999:168) the earliest occupations at Trappers Point “show clear ties to the north and west . . . , suggesting that people spent considerable time in the Jackson Hole area prior to their arrival in the upper Green River Basin.” The movement of people during the Early Archaic may well reflect redundant seasonal exploitation of the Green River Basin and Jackson Hole by hunter-gatherers, a strategy that was likely in place earlier in the Paleoindian period. The radiocarbon record indicates that both the upper Green River Basin and the Central Rockies experienced population growth at higher rates than other regions of western Wyoming. Moreover, apparent fluctuations in human populations in the Central Rockies and upper Green River appear to be correlated, with increases in one area coinciding with decreases in the other.

It is difficult to draw many conclusions regarding mobility patterns during the Paleoindian-Archaic transition. There is some evidence from Game Creek and elsewhere (Smith et al. 2003) for seasonal use of the Green River basin, presumably during winter months, by Foothill-Mountain complex foragers. This strategy appears to have become entrenched with groups of hunter-gatherers during the Early Archaic period and likely continued throughout the remainder of prehistory. The territorial boundaries of these people may have changed, perhaps dramatically during the Middle Archaic, with populations in the Green River basin shifting their summer high country territory from Jackson Hole in the north to southeastern Idaho in the west. Alternatively, there may have been an expansion of human populations out of the Great Basin during the Middle Archaic (Wedel 1961) that displaced existing populations to the north. These interpretations are however speculative until more and better data come to light.

Subsistence

The evidence for changes in subsistence strategies during Late Paleoindian times at Game Creek is somewhat equivocal. The transition from specialized big game hunting to broad spectrum foraging that has been postulated for Foothill-Mountain Paleoindian populations (Frison 1997) appears to have been well underway, if not complete, by the time of the first documented occupations at Game Creek. If there was a cultural antecedent-descendent relationship between the Western Stemmed tradition (WST) and the Foothill-Mountain Paleoindian complex, as discussed in Chapter 3, then the search for a major shift in subsistence may well prove futile. The evidence from the Great Basin and Columbia Plateau shows that the people of the WST were successful broad-spectrum foragers during early Paleoindian times (Chatters et al. 2012; Goebel et al. 2011). Furthermore, there is little evidence to suggest that the WST developed out of an earlier big game hunting economy. If there was a significant change in subsistence strategies during the Paleoindian period then it likely occurred when WST people entered the Northwestern Plains, circa 12,000 cal BP, and adapted to the specialized exploitation of bison. These people manufactured

Agate Basin, Hell Gap and Alberta points remarkably similar to the contemporaneous projectiles from the Great Basin, Columbia Plateau and Snake River Plain. There is no clear stratigraphic evidence that the Foothill-Mountain complex emerged from earlier populations of big game hunting specialists. The evidence from Medicine Lodge Creek, Sorenson and Mummy Cave show that WST and fishtail projectile points immediately precede Angostura and the Foothill-Mountain complex.

The faunal assemblages from the Paleoindian levels at Game Creek, though small, are particularly diverse, yet there is a clear emphasis on the procurement of bison. Although the importance of bison to the diets of hunter-gatherers in Jackson Hole has been questioned (Wright 1984; Wright et al. 1980), the evidence from Game Creek and other sites in Jackson Hole show that bison were not only present in Jackson Hole throughout prehistory, but that they were invariably targeted as a high-ranked food source (Cannon et al. 2015). The prevalence of bison in archaeological assemblages from Jackson Hole likely reflects the presence of a sizeable herd(s), rather than some sort of shift in subsistence strategy. In short, bison were hunted in Jackson Hole during the Paleoindian (and all other) period simply because there were many bison. Although the remains of a possible bison jump were noted by an early explorer of Jackson Hole (Ferris 1940), there is no solid evidence for communal bison procurement or mass kills. A small fragment of a metate recovered in association with butchered bison and a Lovell/Pryor point and dated to circa 9000 cal BP provides some evidence for seed or root crop exploitation, a finding that is in accord with data from other Foothill-Mountain complex sites in the Central Rockies (Frison 1973; Frison and Grey 1980; Husted 1969).

There is evidence from other sites in the Central Rockies for a decrease artiodactyl procurement and an increase in diet breadth during the Early Archaic period (Hughes 2003). However the data from Game Creek reveal no significant decrease in the proportion of high-ranked artiodactyls. There was an increase in the diversity of the faunal assemblage, but small sample sizes from earlier and later occupations preclude assessment of temporal trends. These data suggest that artiodactyl populations remained relatively stable in the Central Rockies throughout the Early Archaic period when the climate of many surrounding regions appears to have been much drier and warmer than present. Plant harvesting and processing also occurred during the Early Archaic occupations at Game Creek. The recovery of a well-made and extensively utilized mano indicates processing of small seeds, some of which, such as Indian ricegrass, would have been more widely available in Jackson Hole during the Early Archaic, if in fact Jackson Hole witnessed significant declines in annual precipitation. The large roasting pit found in Block A was likely used to cook roots and tubers. Unfortunately, no data on the season of the Early Archaic occupations was recovered.

There is little evidence for significant changes in mobility or subsistence in the Paleoindian and Early Archaic components at Game Creek. Analysis of lithic raw materials shows a predominant use of locally derived obsidians with minor, but ubiquitous, frequencies of Green River Basin cherts. Bison were the primary high-ranked prey species, but the assemblages are markedly diverse reflecting wide diet breadth. Evidence for intensive plant exploitation first appears in the Foothill-Mountain complex component and continues through the Archaic. The term “archaic” is used not only to denote a temporal period of prehistory, but also a way of life, exemplified by broad-spectrum foraging, high mobility and relatively small group territories. In the latter sense of the term, the Paleoindian-Archaic transition occurred in the Central Rockies perhaps as early as 10,200 cal BP when the first evidence of grinding stone technology appears.

The High Country Adaptation Model

The High Country Adaptation model was first proposed by Wright, Bender and Reeve (1980) and was formulated using data gathered in northern Jackson Hole. The model was further refined and expanded upon by Wright (1984), Reeve (1986) and Bender and Wright (1988). The impetus behind the model was a belief that archaeologists had inappropriately relegated mountainous environments to a marginal status (Bender and Wright 1988). In particular these scholars argued that abrupt changes in elevation common to all mountain environments created subsistence opportunities not found in the surrounding plains and basins. Elevationally delayed maturation and patterning of resource availability, or *periodicity*, of plant resources, especially blue camas, is central to the model (Bender and Wright 1988; Reeve 1986; Wright et al 1980).

To briefly illustrate (Wright et al. 1980), the model retrodicts that bands of hunter-gatherers set out from the Snake River Plain traveling up the Fall River into extreme southwestern Yellowstone Park. The move was timed to coincide with the flowering blue camas. Once this harvest was complete the band traveled over a low pass onto Glade Creek then down the Snake River into northern Jackson Hole where a second harvest of blue camas could be made at a slightly higher elevation. Once plant resources began to ebb on the valley floor bands traveled higher into the northern Tetons via Berry Creek and over either Connant or Jackass Pass to exploit the late summer ripening camas meadows in the high country. Hunting was focused on bighorn sheep, deer and small mammals, because, according to Wright (1984) and Wright et al. (1980) bison and elk were either entirely absent from Jackson Hole during prehistory or were so rare and unpredictable that human populations could not have effectively exploited them. Once this harvest was complete the bands moved westward onto the winter hunting territories on the Snake River Plain. Although this model was formulated with site data from northern Jackson Hole, the same periodicity of plant and animal resources, but not all the same resources, is present in southern Jackson Hole.

The timing of logistical moves to coincide with the availability of predictable, high-ranked resources is a fundamental attribute of hunter-gatherer foraging strategies (Bamforth 1997; Binford 1980; Kelly 1995). Bender and Wright (1988) did not discover these principles and were by no means the first to point out the potential benefits of tailoring a subsistence strategy to the periodicity of plant resources in mountainous environments (Galvan 1976). In short, the High Country Adaptation model merely

Table 8-6 Proportion of obsidian sources in several assemblages from Jackson Hole.

Source Area	Site/Locale							Total %	Total
	Henn TE1291[1]	Jackson Lake[2]	TE1077[3]	TE1079[3]	TE1374[3]	TE1573	BTNF[4]		
Jackson Hole	90.1%	58.8%	93.7%	99.3%	93.7%	88.2%	69.1%	89.3%	677
Yell/Bear Gulch	9.9%	36.3%	3.2%	0.0%	3.2%	5.9%	25.5%	8.6%	65
SE Idaho	0.0%	5.0%	3.2%	0.7%	3.2%	5.9%	5.5%	2.1%	16
Total	152	80	95	279	63	34	55		758

[1]Kunselman et al. 1995; [2]Connor and Kunselman 1997; [3]Cannon et al. 2001; [4] Jamie Schoen, personal communication 2013, Bridger-Teton National Forest obsidian source database, Teton County.

incorporates theories of hunter-gatherer foraging strategies to a specific corner of the Central Rockies. Although the model is sound, there are several reasons to question Bender and Wright's (1988) historical reconstruction of settlement and mobility in Jackson Hole during prehistory.

First, Bender and Wright (1988) presume that the people inhabiting Jackson Hole wintered on the Snake River Plain. If there were patterned and redundant movement of people between the Snake River Plain and Jackson Hole then one would expect some evidence for the conveyance of lithic raw materials. As noted above, obsidian from eastern Idaho is rare in all but the Paleoindian-aged sample from Jackson Hole (Table 10-4). Similarly, Jackson Hole obsidian is exceptionally rare in eastern Idaho (Holmer 1997: Scheiber and Finley 2011). Of a sample of 758 sourced obsidian artifacts recovered from sites in Jackson Hole, only 2.1% are from eastern Idaho (Table 10-6). Thus, there is little evidence for sustained interaction or movement of people between Jackson Hole and the Snake River Plain. Instead the evidence, at least for the Early Archaic period, points to regular seasonal movements of hunter-gatherers between Jackson Hole and the Green River Basin.

Second, Wright et al. (1980) and Wright (1984) argue that elk were rare or entirely absent from Jackson Hole prior to the Historic period and that bison populations were small and unpredictable. They postulate that hunting was of minor importance to the prehistoric summer occupants of Jackson Hole, and when it did occur, was focused on bighorn sheep procurement in the high elevations during the late summer (Wright 1984; Wright et al. 1980). Yet, the large faunal assemblage recovered from the Early Archaic, Late Archaic and Late Prehistoric occupations at Game Creek is dominated by bison and elk remains. Conversely, medium-sized artiodactyls such as bighorn sheep, deer and pronghorn are relatively rare. Bender and Wright (1988) appear to have seriously underestimated the potential of Jackson Hole to support sizeable populations of bison and elk. Moreover, Bender and Wright (1988) may have overestimated the role of high-value roots and tubers.

Third, the High Country Adaptation Model is highly biased towards root crop procurement, almost to the exclusion of all other plant resources. Root crops were typically prepared through roasting in rock-lined pits or platforms. Thus, intensive root crop harvesting produces large volume of fire-cracked-rock (FCR). Bender and Wright (1988) argue that sites with abundant FCR reflect intensive root/tuber processing. Few of the sites identified as root/tuber processing by Bender and Wright (1988) have been excavated, which means their interpretation is based solely on surface scatters of artifacts. At Game Creek, only two unambiguous roasting pits were found during investigations. Large quantities of FCR were recovered, particularly in the mixed components from the Game Creek alluvial fan, but these deposits also produced enormous quantities of crushed bone and small circular features believed to have been used in stone boiling. Thus, the high frequency of FCR was likely due to bone grease production rather than roasting of roots and tubers. In the absence of excavation it is difficult to evaluate the type of subsistence activities carried out at a site based solely on the presence of FCR. Many of the sites identified as root/tuber processing loci by Bender and Wright (1988) may well have been used to for bone grease production in addition. In short, the evidence presented by Bender and Wright (1988) to support their model, is at best equivocal.

Fourth, Bender and Wright (1988) presume that people invariably left the high country for the surrounding basins each and every winter. Yet, there is evidence of winter occupations in other parts of the Central Rockies during the Paleoindian, Early Archaic (Hughes 2003), Middle Archaic (Frison and Walker 1984), Late Archaic (Eakin 1989; Hughes 2003) and Late Prehistoric periods (Rapson and Todd 1999). Furthermore, the fetal bison remains found at Game Creek may indicate a late winter/early spring occupation, which if correct, would indicate that at least one band likely spent a in Jackson Hole because crossing the alpine passes during the dead of winter would have been incredibly arduous. People have adapted to environments far more hostile than the Central Rockies. Although snow may have prevented use of some mountain passes, it would not have been an insurmountable barrier.

Conclusion

The human occupation of the Central Rockies began perhaps 13,000 years ago when small groups of Clovis hunters explored the mountains, passes and valleys. Later, Folsom hunters also ventured into the high country. It is unclear what if any lasting impact these people had on cultural development of the Central Rockies. By at least 12,200 years ago people from the Great Basin, Columbia Plateau and Snake River Plains entered the Central Rockies. There is widespread evidence for the arrival of these people in the form of distinctive large, thick lanceolate and stemmed projectile points (WST tradition) and foraging subsistence pattern. At least one group of these people camped at Game Creek, and the relatively large assemblage of Haskett points from the Lawrence site on Jackson Lake indicates that WST people were familiar with the area and perhaps were attracted to the camas meadows that continued to draw groups of hunter-gatherers for the next 12,000 years. By around 10,600 cal BP a fishtail form of projectile point appears, some of which bear distinctive parallel-oblique flaking. Two very nice examples were found at Game Creek, one of which is dated to circa 10,390 cal BP. Although the course of events is far from clear, a style of projectile point similar in shape to WST lanceolates, but possessing parallel-oblique flaking appears in the archaeological record of the Central Rockies by around 10,500 cal BP and continued to be produced until the end of the Paleoindian period roughly two thousand years later. Several examples of these Angostura points were found at Game Creek with one occupation firmly dated at 9660±53 cal BP. Lovell/Pryor stemmed points were added to the toolkit slightly later, and examples from Game Creek were dated to circa 9000 cal BP. Angostura and Lovell/Pryor are diagnostic artifacts of the Foothill-Mountain Paleoindian complex. The evidence from Game Creek and elsewhere reveal that Foothill-Mountain Paleoindians were foragers who skillfully exploited a broad range of plant and animal resources. Some have argued or suggested (Eakin and Eckerle 2004) that the Foothill-Mountain complex is cultural descendent of earlier big-game hunting specialists, but there is no evidence to demonstrate a cultural transformation.

Temperatures increased and effective moisture declined significantly in western Wyoming with the onset of the Holocene Climatic optimum at circa 9300 cal BP. The evidence suggests that this had a detrimental impact on human populations culminating in an apparent hiatus of human occupation in western Wyoming from circa 8650-8400 cal BP. The first people to emerge from this dark period made a variety of notched and stemmed projectile point styles. The Cultural Level 4 occupation identified in Block D and dated to 8390±28 cal BP, is one of the earliest Early Archaic components documented in western Wyoming. A type of broad stem projectile point, found in other early but poorly dated sites, was identified in the Game Creek assemblage. The temporal duration of the style remains a mystery, but it may prove to be a useful temporal diagnostic. Several centuries later, a group of people camped at Game Creek who used the Elko Eared style of projectile point that is similar to the Hanna type of the McKean complex dated two millennia later on the Northwestern Plains. Almost entirely absent from Game Creek are the stereotypical side-notched darts that dominate most Early Archaic point assemblages at most other sites. These data suggest that the Jackson Hole has a slightly different projectile point chronology than other parts of the Central Rockies and Northwestern Plains. Apart from projectile point styles, however, there was little evidence for significant changes in subsistence or mobility from the preceding Paleoindian occupations.

There is evidence for at least 10 occupations at Game Creek during the Middle Archaic through Late Prehistoric periods. The context of the archaeological deposits that produced this evidence is unfortunately lacking, but the projectile point assemblage suggests that Duncan/Gatecliff and McKean/Humboldt point types were in use during the Middle Archaic, but perhaps not the eared Hanna type. The transition to corner-notched dart forms documented throughout western North America is also in evidence at Game Creek, as is the transition from atlatl and dart to bow and arrow. The people who camped at Game Creek during the later Archaic and Late Prehistoric periods were broad-spectrum, highly mobile foragers whose subsistence practices and mobility patterns differed little from the earlier inhabitants of the site.

The people who inhabited the high country of the Central Rockies developed sophisticated subsistence and settlement strategies that were informed through an intimate understanding of the plants and animals on which they survived. Although, demographic trends appear to have fluctuated through time, due in large part to climate change (Kelly et al. 2013), western Wyoming as a whole, and the Central Rockies in particular, witnessed stable or steady increases in human population throughout most of prehistory. Jackson Hole and its surrounding high country was not a marginal environment used solely for special use or extractive activities. The prehistory of western Wyoming demonstrates that the high country was key to the subsistence strategies and survival of hunter gatherers throughout prehistory.

The data generated from the data recovery project at Game Creek have shed considerable light on the prehistory and human ecology of the Jackson Hole and the Central Rockies by confirming the temporal sequence of Paleoindian complexes and projectile point styles. The investigations led to the identification of one of the earliest Early Archaic sites in the Wyoming and provided valuable data on the temporal parameters of a unique projectile point style. The findings also show that the Early and perhaps Middle Archaic periods of Jackson Hole have a different projectile point sequence than other parts of the Central Rockies and Northwestern Plains. The notion that bison and elk were absent or rare in Jackson Hole and played little role in human subsistence can no longer be seriously entertained given the finding from Game Creek. This finding also calls into question the primary role that Bender and Wright (1988) place on root/tuber crops to prehistoric subsistence and settlement practices. There is still much left unanswered, but the excavations at Game Creek have provided considerable evidence with which to evaluate existing hypotheses and develop new and more precise questions.

WORKS CITED

Ahlbrandt, Thomas S.

1974 Dune Stratigraphy, Archaeology, and the Chronology of the Killpecker Dune Field. In *Applied Geology and Archaeology: The Holocene History of Wyoming*, edited by M. Wilson, pp. 51-60. The Geological Survey of Wyoming: Report of Investigations 10.

Ahler, Stanley A.

1989 Mass Analysis of Flaking Debris: Studying the Forest Rather Than the Tree. In *Alternative Approaches to Lithic Analysis*, edited by D. O. Henry and G. H. Odell, pp.85 – 118. Archaeological Papers 1. Arlington, Virginia: American Anthropological Association.

Aikens, C. Melvin

1970 *Hogup Cave*. Anthropological Papers No. 93. University of Utah, Salt Lake City.

Albanese, John P.

1980 Geologic Report on the 48FR579 Archaeological Site Area. In *Final Report of Archaeological Survey and Test Excavations of the Copper Mountain Development Project, Fremont County, Wyoming, Appendix II*, edited by Anne H. Zier and Christian Zier, pp. 338-353. Archaeological Division of Powers Elevation, Denver, Colorado. Submitted to Rocky Mountain Energy Company. Copies available from the Wyoming State Historic Preservation Office, Cultural Records Office, Laramie.

1987a *Geologic Investigations of the Indian Creek Site (24BW626), Broadwater County, Montana.* John Albanese, Consulting Archeologist. Submitted to the Department of Sociology, Montana State University. Copies available from the Department of Sociology, Montana State University.

1987b Geologic Investigations of the Split Rock Ranch Site (48FR1484), Fremont County, Wyoming. *In Final Report of Salvage Investigations at the Split Rock Ranch Site (48FR1484), Highway Project SCPF-020-2(19), Fremont County, Wyoming*, edited by Daniel H. Eakin, pp. 373-391. Office of the Wyoming State Archaeologist. Submitted to the Wyoming Highway Department. Copies available from the Office of the Wyoming State Archaeologist, Laramie.

Alley, Richard B.

2000 The Younger Dryas Cold Interval as Viewed from Central Greenland. *Quaternary Science Reviews* 19(1-5):213-226.

Alley, R., P. A. Mayewski, T. Sowers, M. Stuiver, K. C. Taylor, and P. U. Clark

1997 Holocene Climatic Instability: A Prominent, Widespread Event 8200 yr Ago. *Geology* 25(6):483- 486.

Ambrose, Stephen E.

1996 *Undaunted Courage: Meriwether Lewis, Thomas Jefferson, and the Opening of the American West*. Simon and Schuster, New York.

Anderson, David G.
1990 The Paleoindian Colonization of Eastern North America: A View from the Southeastern United States,. In *Early Paleoindian Economies of Eastern North America*, edited by K.B. Tankersley and B.L Isaac, pp. 163-216. Research in Economic Anthropology, Supplement 5. JAI Press, Greenwhich, Connecticut.

Andrews, John T.
1987 The Late Wisconsin Glaciation and Deglaciation of the Laurentide Ice Sheet. In *North America and Adjacent Oceans during the Last Deglaciation*, edited by W. F. Ruddiman and H. E. Wright Jr., pp. 13-38. Geology of North America Vol. K-3. The Geological Society of America, Boulder, Colorado.

Antevs, Ernst
1955 Geologic-Climactic Dating in the West. *American Antiquity* 20:317-335.

Baillie-Grohman, William A.
1882 *Camps in the Rockies.* Samson, Low, Marston, Searle & Rivington, London.

Baker, Richard G.
1976 Late Quaternary Vegetation History of the Yellowstone Lake Basin. *U.S. Geological Survey Professional Paper* 729-E.

Bamforth, Douglas B.
1997 Adaptive Change on the Great Plains at the Paleoindian/Archaic Transition. In *Changing Perspectives of the Archaic on the Northwest Plains and Rocky Mountains*, edited by Mary Lou Larson and Julie E. Francis, pp. 14-55.

Barnosky, Cathy W., Patricia M. Anderson, and Patrick J. Bartlein
1987 The Northwestern U.S. During Deglaciation; Vegetational History and Paleoclimatic Implications. In *North America and Adjacent Oceans during the Last Deglaciation,* edited by W. F. Ruddiman and H. E. Wright, Jr., pp. 289-321. Geology of North America, Volume K-3. The Geological Society of America, Boulder, Colorado.

Bartholomew, Alan L.
2001 The Relation of Prehistoric Occupational Intensity to Paleoclimate in Jackson Hole, Northwestern Wyoming. Unpublished Master's thesis, Department of Anthropology, University of Wyoming, Laramie.

Bartlein, P. J. , K. H. Anderson, P. M. Anderson, M. E. Edwards, C. J. Mock, R. S. Thompson, R. S. Webb, T. Webb III, and C. Whitlock
1998 Paleoclimate Simulations for North America over the Past 21,000 Years: Features of the Simulated Climate and Comparisons with Paleoenvironmental Data*.* *Quaternary Science Reviews* 17:549-585.

Bartlein, P. J. and S. W. Hostetler
2004 Modeling Paleoclimates, Chapter 27. In *The Quaternary Period in the United States,* edited by A. Gillespie, S. C. Porter and B. Atwater. (2003 INQUA volume) Elsevier, pp. 563-582.

Beck, Charlotte, and George T. Jones
2007 Early Paleoarchaic Point Morphology and Chronology. In *Paleoindian or Paleoarchaic: Great Basin Human Ecology at the Pleistocene-Holocene Transition*, edited by Kelly E. Graf, and Dave N. Schmitt, pp. 23-41. University of Utah, Salt Lake City.

2010 Clovis and Western Stemmed: Population Migration and the Meeting of Two Technologies in the Intermountain West. *American Antiquity* 75:81-116.

Bender, Susan J., and Gary A. Wright
1988 High-Altitude Occupations, Cultural Process, and High Plains Prehistory. *American Anthropologist* 90:619-639.

Benedict, James B.
1975 The Murray Site: A Late Prehistoric Game Drive System in the Colorado Rocky Mountains. *Plains Anthropologist* 20:165-182.

1981 *The Fourth of July Valley: Glacial Geology and Archeology of the Timberline Ecotone.* Research Report No. 2. Center for Mountain Archeology, Ward, Colorado.

1985 Chronology of Cirque Glaciation, Arapaho Pass: Glacial Geology and Archaeology at the Crest of the Colorado Front Range. Research Report No. 3. Center for Mountain Archeology, Ward, Colorado.

Benedict, James B. and Byron L. Olson
1978 *The Mount Albion Complex: A Study of Prehistoric Man and the Altithermal.* Research Report No. 1. Center for Mountain Archeology, Ward, Colorado.

Benson, Larry
2004 Western Lakes. In *The Quaternary Period of the United States*, *Developments in Quaternary Science 1*, edited by Jim Rose, pp. 185-204. Elsevier, New York.

Bettinger, Robert L. and Martin A. Baumhoff
1982 The Numic Spread: Great Basin Cultures in Competition. *American Antiquity* 47:485-503.

Binford, Lewis R.
1965 Archaeological Systematics and the Study of Culture Process. *American Antiquity* 31:203-210.

1980 Willow Smoke and Dog's Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* 45:1-17.

Birkeland, Peter W.
1999 *Soils and Geomorphology*: Third Edition. Oxford University Press, New York.

Black, Kevin D.
1991 Archaic Continuity in the Colorado Rockies: The Mountain Tradition. *Plains Anthropologist* 36(133):1-29.

Blakeslee, Donald J.
1994 Reassessment of some Radiocarbon Dates from the Central Plains. *Plains Anthropologist* 39:203-210.

1997 Assessing Sets of Radiocarbon Dates: An Example from the Central Plains. *North American Archaeologist* 18(4):303-326.

1999 Waconda Lake: Prehistoric Swidden-Foragers in the Central Plains. *Central Plains Archeology* 7(1):1-170.

Bocek, Barbara
1986 Rodent Ecology and Burrowing Behavior: Predicted Effects on Archaeological Site Formation. *American Antiquity* 51:589-603.

Boeka, Molly S.
2001 Appendix E: An Assessment of Faunalturbation at 48TE1077. In *The Results of Archeological Investigations at Three Sites Along the Wilson-Fall Creek Road Corridor, Teton County, Wyoming*. United States Department of the Interior, National Park Service, Midwest Archeological Center, Lincoln, Nebraska.

Bradley, Bruce A.
2009 Bifacial Technology and Paleoindian Projectile Points. In *Hell Gap: A Stratified Paleoindian Campsite at the Edge of the Rockies*, edited by Mary Lou Larson, Marcel Kornfeld, and George C. Frison, pp. 259-273. University of Utah Press, Salt Lake City.

2010 Paleoindian Flaked Stone Technology on the Plains and in the Rockies. In *Prehistoric Hunter-Gatherers of the High Plains and Rockies*. Third Edition, by Marcel Kornfeld, George C. Frison, and Mary Lou Larson, pp.463-497. Left Coast Press, Walnut Creek, California.

2013 The Angostura Point Type Defined. In *The Archeology, History, and Geomorphology of the Ray Long Site (39FA65), Angostura Reservoir, Fall River County, South Dakota. Manuscript III*, by Austin A. Buhta, Bruce A. Bradley, Marvin Kay, L. Adrien Hannus, and R. Peter Winham, pp. 1-17. Augustana College, Archaeology Laboratory, Archeological Contract Series 254. Sioux Falls, South Dakota.

Bradley, Bruce A. and George C. Frison
1987 Projectile Points and Specialized Bifaces from the Horner Site. In *The Horner Site: The Type Site of the Cody Cultural Complex*, edited by George Frison and Larence Todd, pp. 199-232. Academic Press, Orlando.

Bradley, Raymond S.
1999 *Paleoclimatology: Reconstructing Climates of the Quaternary.* 2nd ed. International Geophysics Series, Vol. 64, Harcourt Academic Press, San Diego.

Broughton, Jack M. and James F. O'Connell
1999 On Evolutionary Ecology, Selectionist Archaeology, and Behavioral Archaeology. *American Antiquity* 64(1):153-165.

Bryson, Reid A.
1994 On Integrating Climatic Change and Culture Studies. *Human Ecology* 22(1):115-128.

1997 The Paradigm of Climatology: An Essay. *Bulletin of the American Meteorological Society* 78(3):449-455.

Bryson, Robert U., and Reid A. Bryson

1997 The Modeled Holocene Climatic History of the Yellowstone Park Area. In *The 1996 Archaeological Investigation of Eight Prehistoric Sites along the Northeast Entrance Road, Yellowstone National Park, Project 785E*, Appendix 1. Office of the Wyoming State Archaeologist. Prepared for National Park Service, Rocky Mountain Region, Denver, Colorado, Project No. 785E. Copies available from Office of the Wyoming State Archaeologist, Laramie.

2000 The Modeled Climate History of Green River, Wyoming, since the Last Glacial Maximum. In *"Seeds-Kee-Dee" Riverine Adaptation in Southwest Wyoming*, edited by Jana V. Pastor, Kevin W. Thompson, Richard K. Talbot, William P. Eckerle, and Eric E. Ingbar, pp. F1-F20. Brigham Young University, Museum of Peoples and Cultures, Technical Series No. 99-3, Provo, Utah.

Bryson, Robert U., Reid A. Bryson and A. Ruter

2006 A Calibrated Radiocarbon Database of Late Quaternary Volcanic Eruptions. *Earth Discussions* 1:123-124.

Bryson, Reid A., and Katherine McEnaney DeWall (editors)

2007 *A Paleoclimatology Workbook: High Resolution, Site-Specific, Macrophysical Climate Modeling*. The Mammoth Site of Hot Springs, South Dakota.

Butler, B. Robert

1965 A Report on Investigations of an Early Man Site Near Lake Channel, South-Central Idaho. *Tebiwa* 6(1):4-32.

1978 *A Guide to Understanding Idaho Archaeology (Third Edition): The Upper Snake and Salmon River Country*. Special Publication. Idaho Museum of Natural History, Pocatello.

Butzer, Karl W.

1982 *Archaeology as Human Ecology: Method and Theory for a Contextual Approach.* Cambridge University Press, London.

Byrnes, Allison

2009 Frederick Component at Locality I. In *Hell Gap: A Stratified Paleoindian Campsite at the Edge of the Rockies*, edited by Mary Lou Larson, Marcel Kornfeld, and George C. Frison, pp. 216-228. University of Utah Press, Salt Lake City.

Cannon, Kenneth P., Dawn Bringelson, William Eckerle, Meghan Sittler, Molly S. Boeka, Jerry Androy, and Harold Roeker

2001 *The Results of Archeological Investigations at Three Sites Along the Wilson-Fall Creek Road Corridor, Teton County, Wyoming*. United States Department of the Interior, National Park Service, Midwest Archeological Center, Lincoln, Nebraska.

Cannon, Kenneth P., Molly Boeka Cannon and Jon Peart

2015 Chapter 7-Prehistoric Bison in Jackson Hole, Wyoming: New Evidence from the Goetz Site. In *Rocky Mountain Archaeology: A Tribute to James Benedict*, pp. 392-419. Plains Anthropologist Memoir 60(236) Memoir 43.

Cannon, Kenneth P. and Elaine S. Hale
2013 From Arnica Creek to Steamboat Point: Prehistoric Use on the West and Northeast Shores of Yellowstone Lake. In *Yellowstone Archaeology: Southern Yellowstone*, edited by Douglas H. MacDonald and Elaine S. Hale, pp. 92-115. Contributions to Anthropology Vol 13, No. 2, University of Montana Department of Anthropology, Missoula.

Cannon, Kenneth P., Richard E. Hughes, and Dawn Bringleson
2001 Material Types and Human Movement. In *The Results of Archeological Investigations at Three Sites Along the Wilson-Fall Creek Road Corridor, Teton County, Wyoming*, edited by Kenneth P. Cannon, Dawn Bringelson, William Eckerle, Meghan Sittler, Molly S. Boeka, Jerry Androy, and Harold Roeker, pp.XVII-I - XVII-14. United States Department of the Interior, National Park Service, Midwest Archeological Center, Lincoln, Nebraska.

Caple, C.
2001 Overview-Degradation, Investigation, and Preservation of Archaeological Evidence. In *Handbook of Archaeological Sciences*, edited by D. R. Brothwell, and A. M. Pollard, pp. 587-593. John Wiley and Sons, Ltd., West Sussex, England.

Chase, J. D., W. E. Howard, and J. T. Roseberry
1982 Pocket gophers. in *Wild Mammals of North America: Biology, Management, Economics*, edited by A. Chapman and G. A. Feldhamer, pp. 239-255. John Hopkins, Baltimore.

Chatters, James C., Steven Hackenberger, Anna M. Prentiss, and Jayne-Leigh Thomas.
2012 The Paleoindian to Archaic Transition in the Pacific Northwest: In Situ Development or Ethnic Replacement? In *From the Pleistocene to the Holocene: Human Organization and Cultural Transformation in Prehistoric North America.*, edited by Britt C. Bousman and Bradley J. Vierra, pp. 37-65. Texas A & M University Anthropology Series No. 17. College Station, TX.

Chomko, Stephen A.
1981 Eagle Shelter, Big Horn County, Wyoming: Preliminary Report. Manuscript on file, Wyoming Cultural Records Office, Laramie.

1990 Chronometric Dates from Eagle Shelter, Big Horn County, Wyoming. *Archaeology in Montana* 31(2):51-58.

Clayton, Carmen
1999 Lithic Raw Material Utilization. In *The Trappers Point Site (48SU1006): Early Archaic Adaptations in the Upper Green River Basin*, edited by Mark E. Miller, Paul H. Sanders and Julie E. Francis, pp. 91-138. Cultural Resource Series No.1, Office of the Wyoming State Archaeologist, Laramie.

Clayton, Lee, and Stephen R. Moran
1982 Chronology of Late Wisconsinan Glaciation in Middle North America. *Quaternary Science Reviews* 1:55-82.

COHMAP Members
1988 Climatic Changes of the Last 18,000 Years: Observations and Model Simulations. *Science* 241:1043-1052.

Coles, Byrony, and John Coles
1989 People of the Wetlands: Bogs, Bodies, and Lake-Dwellers. Thames and Hudson Publishers, New York.

Coles, John
1987 Preservation of the Past: The Case for Wet Archaeology. In *European Wetlands and Prehistory*, edited by John M. Coles and Andrew J. Lawson. Clarendon Press, Oxford, England.

1988 An Assembly of Death: Bog Bodies of Northern and Western Europe. In *Wet Site Archaeology*, edited by Barbara A. Purdy, pp. 219-235. The Telford Press, Caldwell, New Jersey.

Connor, Melissa A.
1998 *Final Report on the Jackson Lake Archeological Project, Grand Teton National Park, Wyoming.* Report prepared for Bureau of Reclamation, Pacific Northwest Office. Boise, Idaho. Technical Report No. 46. United States Department of the Interior, National Park Service, Midwest Archeological Center, Lincoln, Nebraska.

Connor, Melissa A., and Raymond Kunselman
1994 Obsidian Utilization in Prehistoric Jackson Hole. *The Wyoming Archaeologist* 38(1-2):39-52.

Connor, Melissa A., and Raymond Kunselman
1997 Mobility, Settlement Patterns, and Obsidian Source Variation in Jackson Hole, Wyoming. *Tebiwa* 26(2):162-185.

The Cooperative Soil Survey
2014 Soil Structure - Physical Properties. Electronic document, http://soils.missouri.edu/index.asp, accessed February 10, 2014.

Cronyn, J. M.
2001 The Deterioration of Organic Materials. In *Handbook of Archaeological Sciences*, edited by D. R. Brothwell, and A. M. Pollard, pp. 628-636. John Wiley and Sons, Ltd., West Sussex, England.

Currey, Donald R.
1990 Quaternary Paleolakes in the Evolution of Semidesert Basins, with Special Emphasis on Lake Bonneville and the Great Basin, U.S.A. *Palaeogeography, Palaeoclimatology, Palaeoecology* 76:189-214.

Currey, Donald R., and Steven R. James
1982 Paleoenvironments of the Northeastern Great Basin and Northeastern Basin Rim Region: A Review of Geological and Biological Evidence. In *Man and Environment in the Great Basin*, edited by David B. Madsen and James F. O'Connell, pp. 27-52. SAA Papers No. 2. Society for American Archaeology, Washington, D.C.

Davi, Loren G., Alex J. Nyers, and Smauel C. Willis
2014 Context, Provenance and Technology of a Western Stemmed Tradition Artifact Cache from the Cooper's Ferry Site, Idaho. *American Antiquity* 79:596-615

Dahms, Dennis E.
2002 Glacial Stratigraphy of Stough Creek Basin, Wind River Range, Wyoming. *Geomorphology* 42(1-2):59-83.

Davis, Carl M., and James D. Keyser
1999 McKean Complex Projectile Point Typology and Function in the Pine Parklands. *Plains Anthropologist* 44(169):251-270.

Davis, Carl M. and James D. Keyser
1999 McKean Complex Projectile Point Typology and Function in the Pine Parklands. *Plains Anthropologist* 44:251-270.

Davis, Don P.
1991 Pryor-Stemmed Tools: Twisted Technology on the High Plains. *The Wyoming Archaeologist* 34(1-2):1-13.

Davis, Leslie B., Stephen A. Aaberg, William P. Eckerle, John W. Fisher, and Sally T. Greiser
1989 Montane Paleoindian Occupation at the Barton Gulch Site, Ruby Valley, Southwestern Montana. *Current Research in the Pleistocene* 6:7-9.

Davis, Leslie B., Stephen A. Aaberg, and Sally T. Greiser
1988 Paleoindians in Transmontane Southwestern Montana: The Barton Gulch Occupations, Ruby River Drainage. *Current Research in the Pleistocene* 5:9-11.

Davis, Owen K.
1984 Multiple Thermal Maxima During the Holocene. *Science* 225(4662):617-619.

Davis, Thompson, C. John Gosse, Mel Reasoner, and Gregory Zielinski
2003 Abrupt Late Pleistocene Climatic Reversals in Colorado and Wyoming: Evidence from Lake Sediments and Moraines in Cirques. Paper presented at the 2003 Geological Society of America Annual Meeting, Seattle.

Denton, George H., and Wibjorn Karlén
1973 Holocene Climatic Variations-Their Patterns and Possible Cause. *Quaternary Research* 3:155-205.

Doran, Glenn H., and David N. Dickel
1988 Multidisciplinary Investigations at the Windover Site. In *Wet Site Archaeology*, edited by Barbara A. Purdy, pp. 263-289. The Telford Press, Caldwell, New Jersey.

Dutro, J. Thomas, Jr., Richard V. Dietrich, and Richard M. Foose
1982 AGI Data Sheets for Geology in the Field, Laboratory, and the Office. American Geological Institute, Falls Church, Virginia.

Dyck, Ian and Richard E. Morlan
2001 Hunting and Gathering Tradition: Canadian Plains. In *Plains*, edited by Raymond J. DeMallie, pp. 115-130. Handbook of North American Indians, Vol 13, William C. Sturtevant, general editor, Smithsonian Institution, Washington, D.C.

Dyksterhuis, E. J.
1958 Ecological Principles in Range Evaluation. *The Botanical Review* 24:252-272.

Eakin, Daniel H.

1989 *Report of Archaeological Test Excavations at the Pagoda Creek Site, 48PA853*.Office of the Wyoming State Archaeologist. Submitted to the Wyoming Highway Department, Project SCPF-031(21). Copies available from the Wyoming Cultural Records Office, Laramie.

2006 *Evidence for Shoshonean Mountain Sheep Trapping and Early Historic Occupation in the Absaroka Mountains of Northwest Wyoming*. Office of the Wyoming State Archaeologist. Submitted to the University of Wyoming National Park Service Research Center. Copies available from the Office of the Wyoming State Archaeologist, Laramie.

2009 *Report of 2008 Cultural Resource investigations along three sections of the Nez Perce National Historic Trail, Yellowstone National Park.* Office of the Wyoming State Archaeologist. Submitted to the National Park Service. Copies available from the Wyoming Cultural Records Office, Laramie.

2011 Data Recovery Excavations at the Moss Creek Site (48PA919), North Fork Shoshone River. US Highway AY 14-16-29, Park County, Wyoming, WYDOT Project PREB-031-1(44). Prepared for Wyoming Department of Transportation. Submitted by Office of the Wyoming State Archaeologist, Wyoming Department of State Parks and Cultural Resources. Project No. WY-22-95. Copies available from the Wyoming Cultural Records Office, Laramie.

2015 *Report of 2013 Cultural Resource Investigations at four localities along the Nez Perce National Historic Trail, Shoshone National Forest, Park County, Wyoming.* Office of the Wyoming State Archaeologist. Submitted to the National Park Service. Copies available from the Wyoming Cultural Records Office, Laramie.

2016 *2015 Investigations along the Nez Perce National Historic Trail, Clark's Fork of the Yellowstone River, Park County, Wyoming.* Office of the Wyoming State Archaeologist. Submitted to the National Park Service. Copies available from the Wyoming Cultural Records Office, Laramie.

Eakin, Daniel H., and William Eckerle

2004 *Archaeological Testing at 48TE1572 and 48TE1573 Hoback Junction - Jackson Snake River section WYDO project NHS-010-4(66) Teton County, Wyoming*. Office of the Wyoming State Archaeologist (WY-39-01). Submitted to the Wyoming Department of Transportation. Copies available from the Wyoming Cultural Records Office, Laramie.

Eakin, Daniel H., Julie E. Francis and Mary Lou Larson

1997 The Split Rock Ranch Site. In *Changing Perspectives of the Archaic on the Northwest Plains and Rocky Mountains*, edited by Mary Lou Larson and Julie E. Francis, pp. 394-435. University of South Dakota Press, Vermillion.

Eakin, Daniel H. and Steve Sutter

1991 *Final Report of Archaeological Investigations at 48PA852 North Fork of the Shoshone River, Highway 14, 16, 20, Highway Project SCPF-031-1(21), Park County, Wyoming.* Office of the Wyoming State Archaeologist (WY-49-84). Submitted to the Wyoming Department of Transportation. Copies available from the Wyoming Cultural Records Office, Laramie.

Eckerle, William

1988 *Geoarchaeological Analysis of 24MA171: Locality B, 1988 Excavation Area, Early Holocene Section*. Western GeoArch Research. Submitted to Department of Sociology, Montana State University. Copies available from Western GeoArch **Research LLC, Salt** Lake City, Utah.

1990 *Geoarchaeology of the Dead Indian Creek Site (48PA551).* William Eckerle, Consulting Geoarchaeologist. Submitted to the Office of the Wyoming State Archaeologist. Copies available from Western GeoArch Research LLC, Salt Lake City, Utah.

1997 Eolian Geoarchaeology of the Wyoming Basin: Changing Environments and Archaic Subsistence Strategies in the Holocene. In *Changing Perspectives of the Archaic on the Northwestern Plains and Rocky Mountains*, edited by Mary Lou Larson and Julie Francis, pp. 138-167. University of South Dakota Press, Vermillion.

Eckerle, William, Andrea Brunelle, Vachel Carter, Ken Peterson, and Mitchell Power

2014 Paleoenvironmental Analysis of a New Lake Core in the Greater Yellowstone Ecosystem and its Implications for Archaeological Interpretation. Presented at Wyoming Archaeological Society/Wyoming Archaeological Professional Association Meetings. Pinedale, Wyoming. May 3, 2014.

Eckerle, William, Judson Finley, and Rebecca R. Hanna

2011 Data Collection Strategies for Assessing Artifact Zone Spatial and Associational Integrity on Sand Occupational Substrates. In *Archaeology in 3D: Deciphering Buried Sites in the Western U.S.*, edited by Mathew Seddon, Heidi Roberts, and Richard V. N. Ahlstrom, pp. 165-180. SAA Press, Washington, D.C.

Eckerle, William, Rebecca Hanna, and Sasha Taddie

2003 Geoarchaeological Assessment of the Blue Point Site 48SW5734, Sweetwater County, Wyoming: Alberta-Cody Complex Adaptation to the Green River Basin Uplands. In *The Blue Point Site: Paleoindian/Archaic Transition in Southwest Wyoming,* Appendix A. Western Archaeological Services. Submitted to FMC Corporation. Copies available from Western Archaeological Services, Rock Springs, Wyoming.

Eckerle, William, and Janet Hobey

1995 *Geoarchaeological Assessment of the Trappers Point Site (48SU1006), Sublette County, Wyoming.* Western GeoArch Research. Submitted to the Office of the Wyoming State Archaeologist. Copies available from Western GeoArch Research LLC, Salt Lake City, Utah.

Eckerle, William, and Sasha Taddie

2002 Modeled Paleoenvironmental and Archaeo-Resource Frames of Reference for the Southwestern Green River Basin. In *Data Recovery Excavations at Site 48UT375, Uinta County, Wyoming,* edited by Thomas P. Reust and others, 2002, pp. 171-196. Submitted to Pioneer Pipe Line Company by TRC Mariah Associates, Inc. Copies available from TRC Mariah Associates Inc., Laramie, Wyoming.

2003 *Preliminary Geoarchaeological Assessment of Site 48TE1573 (Game Creek Site), Teton County, Wyoming*. Submitted to Office of the Wyoming State Archaeologist. Copies available from Western GeoArch Research LLC, Salt Lake City, Utah.

Eckerle, William P., Marissa Taddie, and Eric Ingbar

2000 Potential Food Resource Distribution in the Seedskadee Land Exchange Area. *Brigham Young University Museum of Peoples and Cultures Technical Series* 99(3):437-450.

Eckles, David and Robert Rosenberg

2002 *A Class III Cultural Resource Survey, Hoback Junction Projects, WYDOT Projects NHS-010-4(6)(65), NHS-010-4(66), NHS-013-3(5), Teton County, Wyoming*. Office of the Wyoming State Archaeologist. Submitted to the Wyoming Department of Transportation. Copies available from the Wyoming Cultural Records Office, Laramie.

Eckles, David and Brian Waitkus

1997 Semi-subterranean Pithouse Structures in Wyoming. In *Changing Perspectives of the Archaic on the Northwest Plains and Rocky Mountains*, edited by Mary Lou Larson and Julie E. Francis, pp. 306-333. University of South Dakota Press, Vermillion.

Envionmental Protection Agency (EPA)

2004 *Level III and IV Ecoregions of Wyoming*. US Environmental Protection Agency, Denver, Colorado. Available online at: ftp://ftp.epa.gov/wed/ecoregions/wy.

Wyman, Francis

1968 The Teshoa, a Shoshonean Woman's Knife: A Study of American Indian Chopper Industries. *Pennsylvania Archaeologist* 34(3-4).

Fenneman, Nevin M., and Douglas W. Johnson

1946 *Physical Divisions of the United States*. Map sheet, scale 1:7,000,000. U.S. Geological Survey Physiographic Committee.

Ferris, W.A.

1940 *Life in the Rocky Mountains: 1830-1835*. Fred A. Rosenstock, Denver.

Fiedel, Stuart J.

2003 Onset of the Younger Dryas Chronozone in the American West and Its Temporal Relationship to Clovis Expansion. Paper presented at the XVI INQUA Congress, Tahoe, Nevada.

Finley, Judson Byrd

2008 Rockshelter Formation Processes, Late Quaternary Environmental Change, and Hunter-Gatherer Subsistence in the Bighorn Mountains, Wyoming. Unpublished Ph.D. dissertation, Department of Anthropology, Washington State University, Pullman.

Finley, Judson B., Marcel Kornfeld, Brian N. Andrews, George C. Frison, Chris C. Finley, and Michael T. Bies

2005 Rockshelter Archaeology and Geoarchaeology in the Bighorn Mountains, Wyoming. *Plains Anthropologist* 50:227-248.

Fisher, John W. Jr.

1984 Medium-Sized Artiodactyl Butchering and Processing. In *The Dead Indian Creek Site: An Archaic Occupation in the Absaroka Mountains of Northwestern Wyoming*, edited by George C. Frison and Danny N. Walker pp. 63-82. Wyoming Archaeologist Vol 27(1-2).

Folk, Robert L.
1980 *Petrology of Sedimentary Rocks.* Hemphill Publishing Company, Austin, Texas. Forman, Steven L., Robert Oglesby, and Robert S. Webb

Forman, Steven L., Robert Ogelsby, and Robert S. Webb
2001 Temporal and Spatial Patterns of Holocene Dune Activity on the Great Plains of North America: Megadroughts and Climate Links. *Global and Planetary Change* 29:1-29.

Fowler, Loretta
2001 Arapaho. In *Plains*, edited by Raymond J. DeMallie, pp. 840-862. Handbook of North American Indians, Vol 13, William C. Sturtevant, general editor, Smithsonian Institution, Washington, D.C.

Francis, Julie E.
1997 The Organization of Archaic Chipped Stone Technology. In *Changing Perspectives of the Archaic on the Northwest Plains and Rocky Mountains*, edited by Mary Lou Larson and Julie E. Francis, pp. 210-241. University of South Dakota Press, Vermillion.

2000 Root Procurement in the Upper Green River Basin: Archaeological Investigations at 48SU1002. In *Intermountain Archaeology*, edited by David B. Madsen and Michael D. Metcalf, pp. 166-175. University of Utah, Salt Lake City.

Francis, Julie E. and Paul Sanders
1999 Chapter 5: Excavation Summary. In *The Trappers Point Site (48SU1006): Early Archaic Adaptations in the Upper Green River Basin*, edited by Mark E. Miller, Paul H. Sanders and Julie E. Francis, pp. 38-57. Cultural Resource Series No.1, Office of the Wyoming State Archaeologist, Laramie.

Francis, Julie E. and Yvette Widman
1999 Variability in the Archaic: Projectile Points From Trappers Point. In *The Trappers Point Site (48SU1006): Early Archaic Adaptations in the Upper Green River Basin*, edited by Mark E. Miller, Paul H. Sanders and Julie E. Francis, pp. 139-170. Cultural Resource Series No.1, Office of the Wyoming State Archaeologist, Laramie.

Frison, George C.
1965 Spring Creek Cave. *American Antiquity* 31:81-94.

1967 *The Piney Creek Sites, Wyoming*. University of Wyoming Publications Vol. 33, No. 1-3. University of Wyoming, Laramie.

1968 Daugherty Cave, Wyoming. *Plains Anthropologist* 13:253-295.

1970 The Kobold Site, 24BH406: A Post-Altithermal Record of Buffalo-Jumping for the Northwestern Plains. *Plains Anthropologist* 15:1-35.

1971 Shoshonean Antelope Procurement in the Upper Green River Basin, Wyoming. *Plains Anthropologist* 16:258-284.

1973 Early Period Marginal Cultural Groups in Northern Wyoming. *Plains Anthropologist* 18(62):300-312.

1974 *The Casper Site: A Hell Gap Bison Kill on the High Plains.* Academic, New York.

1976 Crow Pottery in Northern Wyoming. *Plains Anthropologist* 21:29-44

1978 *Prehistoric Hunters of the High Plains*. Academic, New York.

1983 The Lookingbill Site, Wyoming, 48FR308. *Tebiwa* 20:1-16.

1988 Avonlea and Contemporaries in Wyoming. In *Avonlea Yesterday and Today: Archaeology and Prehistory*, edited by Leslie B. Davis, pp. 155-170. Saskatchewan Archaeological Society, Saskatoon.

1991 *Prehistoric Hunters of the High Plains. 2nd edition*. Academic Press, San Diego.

1997 The Foothill-Mountain Late Paleoindian and Early Plains Archaic Chronology and Subsistence. In *Changing Perspectives of the Archaic on the Northwest Plains and Rocky Mountains*, pp. 84-104. University of South Dakota Press, Vermillion.

1998 The Northwestern and Northern Plains Archaic. In *Archaeology on the Great Plains*, edited by W. Raymond Wood, pp. 140-172.

2004 *Survival By Hunting: Prehistoric Human Predators and Animal Prey*. University of California Press, Berkeley.

2007a Paleoindian Occupations. In *Medicine Lodge Creek: Holocene Archaeology of the Eastern Big Horn Basin, Wyoming,* Vol. 1, edited by George C. Frison and Danny N. Walker, pp 33-68. Clovis Press, Avondale, Colorado.

2007b Archaic, Late Prehistoric and Early Historic Occupations. In *Medicine Lodge Creek: Holocene Archaeology of the Eastern Big Horn Basin, Wyoming,* Vol. 1, edited by George C. Frison and Danny N. Walker, pp 69-106. Clovis Press, Avondale, Colorado.

Frison, George C. and Donald C. Grey
1980 Pryor Stemmed: A Specialized Late Paleo-Indian Ecological Adaptation. *Plain Anthropologist* 25:27-46.

Frison, George C. and Charles A. Reher
1973 *The Wardell Buffalo Trap 48SU301: Communal Procurement in the Upper Green River Basin, Wyoming.* Anthropological Papers No, 48. Museum of Anthropology, University of Michigan, Ann Arbor.

Frison, George C. and Dennis J. Stanford (editors)
1982 *The Agate Basin Site: A Record of the Paleoindian Occupation of the Northwestern High Plains.* Academic, New York.

Frison, George C. and Lawrence Todd
1986 *The Colby Mammoth Site: Taphonomy and Archaeology of a Clovis Kill in Northern Wyoming.* University of New Mexico Press, Albuquerque.

Frison, George C. And Danny N. Walker (editors)
1984 The Dead Indian Creek Site: An Archaic Occupation in the Absaroka Mountains of Northeastern (sic) Wyoming. *The Wyoming Archaeologist* 27(1-2):11-122.

2007 *Medicine Lodge Creek: Holocene Archaeology of the Eastern Big Horn Basin, Wyoming,* Vol. 1. Clovis Press, Avondale, Colorado.

Frison, George C., Michael Wilson, and Diane J. Wilson
1976 Fossil Bison and Artifacts from an Early Altithermal Period Arroyo Trap in Wyoming. *American Antiquity* 41:28-57.

Frison, George C., Alan E. Wimer, William E. Scoggin, Danny N. Walker, and James C. Miller
2015 Multi-Component Paleoindian Surface Sites in the Great Divide Basin of Wyoming. *Plains Anthropologist* 60:172-192.

Fryxell, F. M.
1930 *Glacial Features of Jackson Hole, Wyoming*. Augustana Library Publications No. 13, 129 p., Rock Island, New York.

Gabet, Emmanuel J., O. J. Reichman, and Eric W. Seabloom
2003 The Effects of Bioturbation on Soil Processes and Sediment Transport. *Annual Review of Earth and Planetary Sciences* 31:249-273.

Garling, Mary E.
1964 The Ross Rock Shelter (48NA331) in the Arminto Area, Natrona County, Wyoming. *Wyoming Archaeologist* 7(4):12-35.

Goddard, Ives
2001 The Languages of the Plains: Introduction. In *Plains*, edited by Raymond J. DeMallie, pp. 61-70. Handbook of North American Indians, Vol 13, William C. Sturtevant, general editor, Smithsonian Institution, Washington, D.C.

Goebel, Ted, Bryan Hockett, Kenneth D. Adams, David Rhode, and Kelly Graf
2011 Climate, Environment, and Humans in North America's Great Basin During the Younger Dryas, 12,900-11,600 Calendar Years Ago. *Quaternary International* 242:479-501.

Goebel, Ted and Joshua L. Keene
2014 Are Great Basin Stemmed Points as Old as Clovis in the Intermountain West? A Review of the Geochronological Evidence. In *Archaeology in the Great Basin and Southwest: Papers in Honor of Don D. Fowler,* edited by Nancy J. Parezo and Joel C. Janetski, pp. 35-60. University of Utah Press, Salt Lake City.

Good, John M., and Kenneth L. Pierce
1996 Interpreting the Landscape: Recent and Ongoing Geology of Grand Teton & Yellowstone National Parks. Grand Teton Natural History Association, Moose, Wyoming.

Gosse, J. C., E. B. Evenson, J. Klein, B. Lawn, and R. Middleton
1995 Beryllium-10 Dating of the Duration and Retreat of the Last Pinedale Glacial Sequence. *Science* 268:1329-1333.

Graumlich, Lisa J.
1993 A 1000-Year Record of Temperature and Precipitation in the Sierra Nevada. *Quaternary Research* 39:249-255.

Gray, Stephen, Lisa J. Graumlich, and Julio L. Betancourt
2007 Annual Precipitation in the Yellowstone National Park Region Since AD 1173. *Quaternary Research* 68:18-27.

Grayson, Donald K.
1991 Alpine Faunas from the White Mountains, California: Adaptive Change in the Late Prehistoric Great Basin? *Journal of Archaeological Science* 18:483-506.

2011 *The Great Basin: A Natural Prehistory.* Revised and Expanded Edition. University of California Press.

Green, James P.
1975 McKean and Little Lake Technology: A Problem in Projectile Point Typology in the Great Basin of North America. In *Lithic Technology: Making and Using Stone Tools*, edited by Earl Swanson, pp. 159-171. Mouton Publishers, The Hague.

Greiser, Sally T., T. Weber Greiser, and Susan M. Vetter
1985 Middle Prehistoric Period Adaptations and Paleoenvironment in the Northern Plains: The Sun River Site. *American Antiquity* 50:849-877.

Gruhn, Ruth
1961 *The Archaeology of Wilson Butte Cave, South-Central Idaho.* Occasional Papers of the Idaho State College Museum, Number 6. Pocatello.

Hadly, Elizabeth
1996 Influence of Late-Holocene Climate on Northern Rocky Mountain Mammals. *Quaternary Research* 46:298-310.

Haines, Aubrey (editor)
1955 *Journal of a Trapper, 1834-1843, by Osborne Russel*. University of Nebraska Press, Lincoln.

1996 *The Yellowstone Story: A History of our First National Park, Volume 1*. University Press of Colorado, Niwot

Hakiel, Nicholas, Bridget Hakiel, Ken Sydenstricker and Katherine Huppe
1986 Archaeological Excavations at the Archery Site (48SW5222): A Multiple Component Fremont Site in Southwest Wyoming. Archaeological Rescue, Western Research Archaeology and Western Prehistoric Research. Submitted to the Bureau of Land Management. Copies available from the Wyoming Cultural Records Office.

Hale, Elaine S. and Michael C. Livers
2013 Prehistoric Culture History and Prior Archaeological Research in Southern Yellowstone. In *Yellowstone Archaeology: Southern Yellowstone*, edited by Douglas H. MacDonald and Elaine S. Hale, pp. 2-21. Contributions to Anthropology Vol 13, No. 2, University of Montana Department of Anthropology, Missoula.

Hall, Christopher T.
1998 The Organization of Prehistoric Economies: An Example from the Beehive Site, Wyoming. Unpublished Master's Thesis, Department of Anthropology, University of Wyoming, Laramie.

Hammer, Øyvind
2012 *PAST: Paleontological Statistics, Version 2.17, Reference Manual*. Natural History Museum, University of Oslo.

Hammer, Ø., D. A. T. Harper and P.D. Ryan
2001 PAST: Paleontological Software Package for Education and Data Analysis. *Palaeontologia Electronica* 4(1):9.

Hanson, R. M. and M. J. Morris
1968 Movement of Rocks by northern pocket gophers. *Journal of Mammalogy* 49:391-399.

Harrell, Lynn L., Ted Hoefer III and Scott T. McKern
1997 Archaic Housepits in the Wyoming Basin. In *Changing Perspectives of the Archaic on the Northwest Plains and Rocky Mountains*, edited by Mary Lou Larson and Julie E. Francis, pp. 334-367. University of South Dakota Press, Vermillion.

Harrington, Mark R.
1957 A Pinto Site at Little Lake, California. *Southwest Museum Papers* 17.

Harvey, David C.
2012 A Cost Surface Analysis of Obsidian Use in the Wyoming Basin, USA. Unpublished Master's thesis, University of Memphis.

Haspel, Howard
1984 A Study of Shoshonean Ceramics of Wyoming: The Bugas-Holding Ceramic Assemblage. *Wyoming Archaeologist* 27(3-4):25-40.

Hayen, Hajo
1987 Peatbog Archaeology in Lower Saxony, West Germany. In *European Wetlands and Prehistory*, edited by John M. Coles and Andrew J. Lawson, pp. 117-136. Clarendon Press, Oxford, England.

Haynes, Gary
2002 *Early Settlement of North America. The Clovis Era.* Cambridge University, Cambridge.

Haynes, Gary, David G. Anderson, C. Reid Ferring, Stuart J. Fiedel, Donald K. Grayson, C. Vance Haynes, Jr., Vance T. Holliday, Bruce B. Huckell, Marcel Kornfeld, Davide J. Meltzer, Juliet Morrow, Todd Surovell, Nichole M. Waguespack, Peter Wigand and Robert M. Yohe II
2007 Comment on Redefining the Age of Clovis: Implications for the Peopling of the Americas. *Science* 317:320b.

Haynes, C. Vance, Jr.
1990 Geoarchaeological and Paleohydrological Evidence for a Clovis-Age Drought in North America and Its Bearing on Extinction. *Quaternary Research* 35:438-450.

Hill, Christopher L, John P. Albanese, Robert G. Dundas, Leslie B. Davis, David C. Batten, Dale P. Herbort, James K. Huber, Susan C. Mulholland, James K, Feathers, and Matthew J. Root
2005 *The Merrell Locality (24BE1659 & Centennial Valley, Southwest Montana: Pleistocene Geology, Paleontology & Prehistoric Archaeology.* Submitted to Dillon Resource Office, Butte District, Bureau of Land Management, Cooperative Agreement # 1422Eo50-A4-008. Museum of the Rockies, Montana State University.

Hill, David V. and David Wolfe
2017 Raven's Nest (48SU3871): A Late Prehistoric/Shoshone Lithic Tool and Pottery-Making Site in Southwestern Wyoming. *Plains Anthropologist* 62:67-94.

Hill, Matthew G.
2005 Late Paleoindian (Allen/Frederick Complex) Subsistence Activities at the Clary Ranch Site, Ash Hollow, Garden County, Nebraska. *Plains Anthropologist* 50:249-263.

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

Hill, Matthew G., David W. May, David J. Rapson, Andrew R. Boehm, Erik Otarola-Castillo
2008 Faunal Exploitation by Early Holocene Hunter/Gatherers on the Great Plains of North America: Evidence from the Clary Ranch Sites. *Quaternary International* 191:115-130.

Hillman, Ross
1984 Fire Hearth and Pit Features. In *The Dead Indian Creek Site: An Archaic Occupation in the Absaroka Mountains of Northwestern Wyoming*, edited by George C. Frison and Danny N. Walker, pp. 41-45. Wyoming Archaeologist Vol 27(1-2).

Hoffman, Jack L., Matthew E. Hill, Jr., William C. Johnson and Dean T. Sather
1995 Norton: An Early-Holocene Bison Bone Bed in Western Kansas. *Current Research in the Pleistocene* 12:19-21.

Holmer, Richard N.
1980 Projectile Points. In *Sudden Shelter*. Anthropological Papers No. 103. University of Utah, Salt Lake City.

1986 Common Projectile Points of the Intermountain West. In *Anthropology of the Desert West: Essays in Honor of Jesse D. Jennings*, edited by Carol J. Condle and Don D. Fowler, pp. 89-115. Anthropological Paper No. 110. University of Utah, Salt Lake City.

1997 Volcanic Glass Utilization in Eastern Idaho. *Tebiwa* 26(2):186-204.

2009 *Field Guide: Projectile Points of Eastern Idaho*. Idaho Museum of Natural History, Idaho State University, Pocatello.

Hughes, Susan. S
2003 Beyond the Altithermal: The Role of Climate Change in the Prehistoric Adaptations of Northwestern Wyoming. Unpublished Ph.D. dissertation, Department of Anthropology, University of Washington.

Hunt, Charles B.
1953 *Pleistocene-Recent Boundary in the Rocky Mountain Region: A Contribution to General Geology*. Geological Survey Bulletin 996-A. United States Government Printing Office, Washington, D.C.

Husted, Wilfred M.
1969 *Bighorn Canyon Archeology*. Publications in Salvage Archeology, No. 12. River Basin Surveys, Smithsonian Institution, Lincoln.

Husted, Wilfred M. And Robert Edgar
2002 *The Archeology of Mummy Cave, Wyoming: An Introduction to Shoshonean Prehistory*. Special Report No. 4, Midwest Archeological Center and Technical Reports Series No. 9, Southeast Archeological Center. United States Department of the Interior, National Park Service, Midwest Archeological Center, Lincoln, Nebraska.

Imbrie, John, and John Z. Imbrie
1980 Modeling the Climatic Response to Orbital Variations. *Science* 207:943-953. Johnson, Eileen (editor)

Irwin-Williams, Cynthia, Henry Irwin, George Agogino and C. Vance Haynes
1973 Hell Gap: Paleo-Indian Occupation on the High Plains. *Plains Anthropologist* 18:40-53.

Ives, John W.
2014 Resolving the Promontory Enigma. In *Archaeology in the Great Basin and Southwest: Papers in Honor of Don D. Fowler*, edited by Nancy J. Parezo and Joel C. Janetski, pp. 149-162. University of Utah Press, Salt Lake City.

Ives, John W., Duane G. Froese, Joel C. Janetski, Fiona Brock and Christopher Bronk Ramsey.
2014 A High Resolution Chronology for Steward's Promontory Culture Collections, Promontory Point, Utah. *American Antiquity* 79:616-637.

Janetski, Joel C.
1997 Fremont Hunting and Resource Intensification in the Eastern Great Basin. *Journal of Archaeological Science* 24:1075-1088.

Jefferson, Charles
1984 Bone Tools and Artifacts. In *The Dead Indian Creek Site: An Archaic Occupation in the Absaroka Mountains of Northwestern Wyoming*, edited by George C. Frison and Danny N. Walker, pp. 40-44. Wyoming Archaeologist Vol 27(1-2).

Jennings, Jesse D.
1957 *Danger Cave*. Anthropological Papers No. 27. University of Utah, Salt Lake City.

1964 The Desert West. In *Prehistoric Man in the New World*, edited by J.D. Jennings and E. Norbeck, pp. 149-174. University of Chicago, Chicago.

Johnson, Ann M., Brian O.K. Reeves, and Mack W. Shortt
2004 *Osprey Beach: A Cody Complex Camp on Yellowstone Lake.* Prepared for Yellowstone Center for Resources, Yellowstone National Park. Lifeways of Canada Limited, Calgary, Alberta.

Johnson, Donald. L. and D. Watson-Stegner
1987 Evolution Model of Pedogenesis. *Soil Science.* 143(5):349-366.

Johnson, Donald L., Donna Watson-Stegner, Diana N. Johnson, and Randall J. Schaetzl
1987 Proisotropic and Proanisotropic Processes of Pedoturbation. *Soil Science* 143(4):278-292.

Johnson, Myrtle Elizabeth and Harry J. Snook
1967 *Seashore Animals of the Pacific Coast*. Dover, New York

Jones, George T. and Charlotte Beck
2014 Moving into the Mid-Holocene: The Paleoindian/Archaic Transition in the Intermountain West. In *Archaeology in the Great Basin and Southwest: Papers in Honor of Don D. Fowler,* edited by Nancy J. Parezo and Joel C. Janetski, pp. 61-84. University of Utah Press, Salt Lake City**.**

Jones, Richard W.
2002 Wyoming Geographic Division Map. Electronic document, http://wyoshpo.state.wy.us/Images/geomapljpg, accessed October 31, 2016.

Joussaume, S. and K. E. Taylor
2000 The Paleoclimate Modeling Intercomparison Project. In *Paleoclimate Modelling Intercomparison Project (PMIP), Proceedings of the Third PMIP Workshop*, edited by P. Braconnot, pp. 9-24. WCRP-111, WMO/TD-Np 1007, ICPO Publication Series No. 34.

Justice, Noel D.
1987 *Stone Age Spear and Arrow Points of the Midcontinental and Eastern United State: A Modern Survey and Reference*. Indiana University Press, Bloomington.

2002 *Stone Age Spear and Arrow Points of the Southwestern United States.* Indiana University Press, Bloomington.

Kaestle, Frederika A. and David Glenn Smith
2001 Ancient Mitochondrial DNA Evidence for Prehistoric Population Movement: The Numic Expansion. *American Journal of Physical Anthropology* 115:1-12.

Katz, Paul R.
1973 Radiocarbon Dates from the Sutter Site in Northeastern Kansas. *Plains Anthropologist* 18:167-168.

Kehoe, Thomas F.
1973 *The Gull Lake Site: A Prehistoric Bison Drive Site in Southwestern Saskatchewan*.Publications in Anthropology and History No. 1. Milwaukee Public Museum, Milwaukee.

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

Kelly, Robert L., David A. Byers, William Eckerle, Paul Goldberg, C. Vance Haynes, R. Mark Larsen, John Laughlin, Jim I Mead, and Sage Wall
2006 Multiple Approaches to Formation Processes: The Pine Spring Site, Southwest Wyoming. *Geoarchaeology* 21(6):615-638.

Kelly, Robert L., Todd A. Surovell, Bryan N. Shuman, and Geoffrey M. Smith
2013 A Continuous Climatic Impact on Holocene Population in the Rocky Mountains. *Proceedings of the National Academy of Sciences* 110 :443-447.

Kelly, Robert L. And Larry C. Todd
1988 The three sides of a Biface. *American Antiquity* 53:231-244.

Kessler, M. A., and B. T. Werner
2003 Self-Organization of Sorted Patterned Ground. *Science* 17(299):380-383.

Keyser, James D. and John L. Fagan
1993 McKean Lithic Technology at Lightning Spring. *Plains Anthropologist* 38(145), Memoir 27:37-51.

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

Knell, Edward J., Matthew G. Hill and A. Izeta
2009 The Locality IIIS/V Eden Complex Component. In *Hell Gap: A Stratified Paleoindian Campsite at the Edge of the Rockies*, edited by Mary Lou Larson, Marcel Kornfeld and George C. Frison, pp. 157-179.

Knudson, Ruthann and Marcel Kornfeld
2007 A New Date for the James Allen Site, Laramie Basin, Wyoming. *Current Research in the Pleistocene* 24:112-114.

Kornfeld, Marcel
2007 Rockshelters of the Rocky Mountains: 70 Years of Research. In *Pres du bord d'un abri: Les histories, theories et methodes de recherches sur les abris sous roche/On Shelter's Ledge: Histories, Theories and Methods of Rockshelter Research*, edited by Marcel Kornfeld, Sergey Vasil'ev and Laura Miotti, pp. 51-60. British Archaeological Reports 1655. Oxford, England.

2013 *The First Rocky Mountaineers: Coloradans Before Colorado.* University of Utah Press, Salt Lake City.

Kornfeld, Marcel and Barbara A Barrows
1995 Lookingbill Site Projectile Points. In *High Altitude Hunter-Gatherer Adaptations in the Middle Rocky Mountains, 1988-1994 Investigations*, by Mary Lou Larson, Marcel Kornfeld, and David J. Rapson, pp. 1-29. Department of Anthropology, University of Wyoming, Technical Report No. 4. Laramie.

Kornfeld, Marcel, George C. Frison, and Mary Lou Larson
2010 *Prehistoric Hunter-Gatherers of the High Plains and Rockies.* 3rd ed. Left Coast Press, Walnut Creek, California.

Kornfeld, Marcel, George C. Frison, and Mary Lou Larson (editors)
1995 *Keyhole Reservoir Archaeology: Glimpses of the Past from Northeast Wyoming.* Occasional Papers on Wyoming Archaeology, No. 5. Office of the Wyoming State Archaeologist, Laramie.

Kornfeld, Marcel, George C. Frison, Mary Lou Larson, James C. Miller, and Jan Saysette
1999 Paleoindian Bison Procurement and Paleoenvironments in Middle Park of Colorado. *Geoarchaeology* 14(7):655-674.

Korneld, Marcel, Mary Lou Larson, David J. Rapson, and George C. Frison
2001 10,000 Years in the Rocky Mountains: The Helen Lookingbill Site. *Journal of Field Archaeology* 28:307-324.

Krieger, A. D.
1947 Certain Projectile Points of the Early American Hunters. *Bulletin of the Texas Archaeological and Paleontological Society* 18:7-27.

Küchler, A. W.
1966 *Potential Natural Vegetation.* Map sheet 90, scale 1:7,500,000. U.S. Geological Survey, Washington, D.C.

Kutzbach, J. E., R. Gallimore, S. P. Harrison, P. Behling, R. Selin, and F. Laarif
1998 Climate and Biome Simulations for the Past 21,000 Years. *Quaternary Science Reviews* 17(6-7):473-506.

Lageson, David R., David C. Adams, Lisa A. Morgan, Kenneth L. Pierce, and Robert B. Smith
1999 Neogene-Quaternary Tectonics and Volcanism of Southern Jackson Hole, Wyoming and Southeastern Idaho. In *Guidebook to the Geology of Eastern Idaho,* edited by S. S. Hughes and G. D. Thackery, pp. 115-130. Idaho Museum of Natural History, Pocatello, Idaho.

Lahren, Larry A.
1976 *The Myers-Hindman Site: An Exploratory Study of Human Occupation Patterns in the Upper Yellowstone Valley from 7000 B.C. to A.D. 1200.* Anthropologos Researches International, Livingston, Montana.

Lamb, S
1958 Linguistic Prehistory of the Great Basin. *International Journal of American Linguistics* 25:95-100.

Larson, Mary Lou
1997 Rethinking the Early Plains Archaic. In *Changing Perspectives of the Archaic on the Northwest Plains and Rocky Mountains*, edited by Mary Lou Larson and Julie E. Francis, pp. 106-137. University of South Dakota Press, Vermillion.

2012 The Paleoindian to Archaic Transition: The Northwestern Plains and Central Rocky Mountains. In *From the Pleistocene to the Holocene: Human Organization and Cultural Transformation in Prehistoric North America.*, edited by Britt C. Bousman and Bradley J. Vierra, pp. 149-169. Texas A & M University Anthropology Series No. 17. College Station, TX.

Larson, Mary Lou, Marcel Kornfeld and David J. Rapson
1995 *High Altitude Hunter-Gatherer Adaptations in the Middle Rocky Mountains 1988-1994 Investigations*. Technical Report No. 4. University of Wyoming Department of Anthropology. Copies available from the Frison Institute for Paleoindian Research, Laramie.

Larson, Mary Lou and Julie E. Francis (editors)
1997 Introduction. In *Changing Perspectives on the Archaic on the Northwest Plains and Rocky Mountains*, pp. 1-13. University of South Dakota Press, Vermillion.

Lee, Craig M., Michael Neeley, Mark D. Mitchell, Marcel Kornfeld and Crae O'Connor
2016 Microcores and Microliths in Northwestern Plains and Rocky Mountain Front Lithic Assemblages. *Plains Anthropologist* 61:136-158.

Leidy, Joseph

1873 On Remains of Primitive Art in the Bridger Basin of Southern Wyoming. In *A Geological and Geographical Survey of the Territories, 6th Annual Report*, edited by F.V. Hayden, pp. 651-654, Washington, D.C.

Levy, Jerrold E.

2001 Kiowa. In *Plains*, edited by Raymond J. DeMallie, pp. 907-925. Handbook of North American Indians, Vol 13, William C. Sturtevant, general editor, Smithsonian Institution, Washington, D.C.

Licciardi, Joseph M., Peter U. Clark, Edward J. Brook, Kenneth L. Pierce, Mark D. Kurz, David Elmore, and Pankaj Sharma

2001 Cosmogenic 3He and 10Be Chronologies of the Late Pinedale Northern Yellowstone Ice Cap, Montana, USA. *Geology* 29:1095-1098.

Loendorf, Lawrence

2002 Castle Gardens Ceramic Vessel. *Wyoming Archaeologist* 46(2):24-33.

Love, Charles M.

1972 An Archaeological Survey of the Jackson Hole Region, Wyoming. Unpublished Master's thesis, Department of Anthropology, University of Wyoming, Laramie.

Love, J. D., and Jane M. Love

1988 *Geologic Road Log of Part of the Gros Ventre River Valley Including the Lower Gros Ventre Slide.* Reprint 46, The Geological Survey of Wyoming, Laramie.

Love, J. D. and John de la Montage

1956 *Pleistocene and Recent Tilting of Jackson Hole, Teton County, Wyoming,* in Wyoming Geological Association Guidebook, 11th Annual Field Conference, Jackson Hole Wyoming, 1956, pp 169-178.

Love, J. D., and John C. Reed Jr.

1971 *Creation of the Teton Landscape: The Geologic Story of Grand Teton National Park*. Grand Teton Natural History Association, Moose, Wyoming.

Love, J. D., John C. Reed, and Ann Coe Christiansen

1992 *Geologic Map of Grand Teton National Park, Teton County, Wyoming.* Miscellaneous Investigations Series, U.S. Geological Survey, Denver.

Love, J. D., J. C. Reed Jr., and K. L. Pierce

2007 *Creation of the Teton Landscape, a Geological Chronicle of Jackson Hole and the Teton Range*. Grand Teton Natural History Association, Moose, Wyoming.

Lucius, William A.

1980 Bone and Shell Material. In *Cowboy Cave*, edited by Jesse D. Jennings, pp. 97-108. Anthropological Papers No. 104. University of Utah, Salt Lake City.

Lyford, Mark E., Julio L. Betancourt, and Stephen T. Jackson

2002 Holocene Vegetation and Climate History of the Northern Bighorn Basin, Southern Montana. *Quaternary Research* 58:171-181.

Maas, Lester and Douglas H. MacDonald
2009 *Final Inventory and Evaluation Report, 2008 Boundary Lands Archeological Survey, Gardiner, Montana: 2008 Montana-Yellowstone Archeological Project*. University of Montana. Submitted to the National Park Service. Copies available from the Yellowstone Heritage and Research Center, Gardiner.

MacDonald, Douglas H.
2013 Hunter-Gatherer Use of America's Highest, Largest Lake: Comparative Analysis of Data from 27 Prehistoric Archaeological Features around Yellowstone Lake. In *Yellowstone Archaeology: Southern Yellowstone*, edited by Douglas H. MacDonald and Elaine S. Hale, pp. 212-226. University of Montana Department of Anthropology Contributions to Anthropology , Vol 13(2). Missoula.

Madsen, David B. and Steven R. Simms
1998 The Fremont Complex: A Behavioral Perspective. *Journal of World Prehistory* 12:255-336.

Martin, William
2000 The Carter Site in Northwestern Plains Prehistory. *Plains Anthropologist* 45:305-322.

McFaul, Michael
1985 Geoarchaeology. In *Final Report of Archeological Investigations, Highway Project Number SCCFM-6-28, Sage Creek Road Improvement Project, Carbon County, Wyoming*, edited by William R. Latady, Jr., pp. 141-148. Office of the Wyoming State Archaeologist, Laramie. Submitted to the Wyoming Highway Department. Copies available from the Office of the Wyoming State Archaeologist, Laramie.

Mears, Brainerd, Jr.
1981 Periglacial Wedges in the Late Pleistocene Environment of Wyoming's Intermontane Basins. *Quaternary Research* 15:171-198.

Meltzer, David J.
2004 Modeling the Initial Colonization of the Americas: Issues of Scale, Demography and Landscape Learning. In *The Settlement of the American Continents. A Multidiscplinary Approach to Human Biogeography*, edited by C. Michael Barton, Geoffrey A. Clark, David Yesner and Georges A. Pearson, pp. 123-137. University of Arizona, Tucson.

Metcalf, Michael D.
1987 Contributions to the Prehistoric Chronology of the Wyoming Basin. In *Perspectives on Archaeological Resource Management in the "Great Plains,"* edited by Alan J. Osborn and Robert C. Hassler, pp. 233-261. I & O Publishing Co., Omaha, Nebraska.

Meyer, David and Dale Walde
2009 Rethinking Avonlea: Pottery Wares and Cultural Phases. *Plains Anthropologist* 54:49-73.

Michczynska, Danuta J. and Anna Pazdur
2004 Shape Analysis of Cumulative Probability Density Function of Radiocarbon Dates Set in the Study of Climate Change in the Late Glacial and Holocene. *Radiocarbon* 46(2):733-744.

Michie, James L.
1990 Bioturbation and Gravity as a Potential Site Formation Process: The Open Area Site, 38GE261, Georgetown County, South Carolina. *South Carolina Antiquities* 22(1&2):27-46.

Middleton, Jessica L., Patrick M. Lubinski and Michael D. Metcalf
2007 Ceramics from the Firehole Basin Site and Firehole Phase in the Wyoming Basin. *Plains Anthropologist* 52:29-41.

Miller, Karen G.
1988 A Comparative Analysis of Cultural Materials Recovered from Two Big Horn Mountain Archaeological Sites: A Record of 10,000 Years of Occupation. Unpublished M.A. thesis, Department of Anthropology, University of Wyoming, Laramie.

Miller, Mark and Jean Bedord
1984 Grinding Stones. In *The Dead Indian Creek Site: An Archaic Occupation in the Absaroka Mountains of Northwestern Wyoming*, edited by George C. Frison and Danny N. Walker, pp. 34-40. Wyoming Archaeologist Vol 27(1-2).

Miller, M. E. and Sanders P.
2000 The Trappers Point site (48SU1006): Early Archaic adaptations and pronghorn procurement in the Upper Green River Basin, Wyoming. *Plains Anthropologist* 45(174):39-52.

Miller, Mark E., Paul H. Sanders, and Julie E. Francis (editors)
1999 Intermountain Archaeology and the Trappers Point Site. In *The Trappers Point Site (48SU1006): Early Archaic Adaptations in the Upper Green River Basin*, pp. 476-489. Cultural Resource Series No.1, Office of the Wyoming State Archaeologist. Copies available from the Wyoming Cultural Records Office, Laramie.

Millspaugh, Sarah H., Cathy Whitlock, and Patrick J. Bartlein
2000 Variations in Fire Frequency and Climate Over the Past 17 000 Yr in Central Yellowstone National Park. *Geology* 28(3):211-214.

Miner, Therese L.
2001 *Phase II, Cultural Resource Inventory of the BP Amoco Production Company, Sections 12 and 13, T29N, R108W, Sublette County, Wyoming*. Current Archaeological Research. Submitted to the Bureau of Land Management. Copies available from the Wyoming Cultural Records Office.

Mulloy, William T.
1958 *A Preliminary Historical Outline for the Northwestern Plains.* University of Wyoming Publications 22(1). Laramie.

1959 The James Allen Site, near Laramie, Wyoming. *American Antiquity* 25:112-116.

Osborn, Alan
2014 Through the Eye of the Needle: Winter and Women During the Younger Dryas Cold Event. *American Antiquity* 79:45-68.

Ostahowski, Brian E. and Robert L. Kelly

2014 Alm Rockshelter Lithic Debitage Analysis: Implications for Hunter-Gatherer Mobility Strategies in the Big Horn Mountains, Wyoming. In *Lithics in the West: Using Lithic Analysis to Solve Archaeological Problems in Western North America*, edited by Douglas H. MacDonald, William Andrefsky, Jr., and Pei-Lin Yu, pp. 118-139.

Osterkamp, Waite R., Mark M. Fenton, Thomas C. Gustavson, Richard F. Hadley, Vance T. Holliday, Roger B. Morrison, and Terrence T. Toy

1987 Great Plains. In *Geomorphic Systems of North America*, edited by W. L. Graf, pp. 163-209. Geological Society of America, Centennial Special Volume 2, Boulder, Colorado.

Ottersberg, Robert

1987 *Soils and Sediments of the Indian Creek Site as Related to Environmental History*. Robert Ottersberg, Consultant. Submitted to Montana State University. Copies available from the Department of Sociology, Montana State University, Bozeman.

Page, Michael K.

2007 Appendix B: Pottery from the Crow Component. In *Medicine Lodge Creek: Holocene Archaeology of the Eastern Big Horn Basin, Wyoming Vol. I*, edited by George C. Frison and Danny N. Walker, pp. 245-250. Clovis Press.

2015 *Results of the 2015 Class III Inventory and Testing at Medicine Lodge Creek State Archaeological Site (48BH499)*. Office of the Wyoming State Archaeologist. Submitted to the Wyoming Department of State Parks and Cultural Resources. Copies available from the Wyoming Cultural Records Office.

2016 Discussion and Conclusions. In *The Goff Creek Site (48PA325): Prehistoric Bighorn Sheep Procurement in the Absaroka Mountains of Northwestern Wyoming*, edited by Michael K. Page, pp. 12-1 – 12-39. Cultural Resource Series No.3, Office of the Wyoming State Archaeologist. Copies available from the Wyoming Cultural Records Office, Laramie

Parks, Douglas R.

2001 Arikara. In *Plains*, edited by Raymond J. DeMallie, pp. 365-390. Handbook of North American Indians, Vol 13, William C. Sturtevant, general editor, Smithsonian Institution, Washington, D.C.

Peros, Matthew, C., Samuel E. Munoz, Konrad Gajewski, and Andre E. Viau

2010 Prehistoric Demography of North America Inferred from Radiocarbon Data. *Journal of Archaeological Science* 37:656-664.

Peterson, Michael R.

1991 Obsidian Projectile Points from the Lawrence Site (48TE509) near Jackson Lake in Northwestern Wyoming. *The Wyoming Archaeologist* 34(1-2):51-66.

Pierce, K. L.

2004 Pleistocene Glaciations of the Rocky Mountains. In *The Quaternary Period in the United States,* edited by A. R Gillespie, S. C. Porter, and B. F. Atwater, pp. 63-76. Elsevier.

Pierce, Kenneth L. and John D. Good

1992 *Field Guide to the Quaternary Geology of Jackson Hole, Wyoming*. Open File Report 92-504. U.S. Department of the Interior, U.S. Geological Association, Denver, Colorado.

Pierce, K. L., and L. A. Morgan

1992 The Track of the Yellowstone Hot Spot: Volcanism, Faulting, and Uplift. In *Regional Geology of Eastern Idaho and Western Wyoming*, edited by P. Link, K. Kuntz, M. A. Kuntz, and L. B. Platt, pp. 1-53. Geological Society of America Memoir 179, Denver.

Pierce, Kenneth L., Daniel R. Muhs, Maynard A. Fosberg, Shannon A. Mahan, Joseph G. Rosenbaum, Joseph M. Licciardi, and Milan J. Pavich

2011 A Loess-Paleosol Record of Climate and Glacial History over the past Two Glacial-Interglacial Cycles (~150 ka), Southern Jackson Hole, Wyoming. *Quaternary Research 76:119-141.*

Pitblado, Bonnie L.

2003 *Late Paleoindian Occupation of the Southern Rocky Mountains: Early Holocene Projectile Points and Land Use in the High Country.* University of Colorado Press, Boulder

2007 Angostura, Jimmy Allen, Foothills-Mountain: Clarifying Terminology for Late Paleoindian Southern Rocky Mountain Spear Points. In *Frontiers in Colorado Paleoindian Archaeology: From the Dent Site to the Rocky Mountains,* edited by Robert H. Brunswig and Bonnie L. Pitblado, pp. 311-337. University Press of Colorado, Boulder.

Plager, Sharon, and Richard Holmer

2002 Vegetation Change in the Upper Snake, Yellowstone, and Green River Drainage Basins: The Last 14,000 Years. In *Final Report: Wildfire Effects on Rangeland Ecosystems and Livestock Grazing in Idaho*, edited by K. T. Weber, pp. 148-163. Available online at: http://giscenter.isu.edu/research/techpg/nasa_wildfire/Final_Report/Documents/Chapter12.pdf.

Plew, Mark G.

2008 *The Archaeology of the Snake River Plain.* Department of Anthropology, Boise State University, Boise.

Plew, Mark G., Max G. Pavesic, and Mary Anne Davis

1987 *Archaeological Investigations at Baker Caves I and III: A Late Archaic Component on the Eastern Snake River Plain.* Archaeological Reports No. 15. Boise State University, Boise.

Plimpton, Christine L.

1980 Worked Bone and Antler and Unworked Shell. In *Sudden Shelter*, edited by Jesse D. Jennings, Alan R. Schroedl and Richard D. Holmer, pp. 143-156. Anthropological Papers No. 103. University of Utah, Salt Lake City.

Plummer, Mitchell

2003 Little Ice Age Climate in the Wind River Range, Wyoming, Estimated from Ice-Core Data, Tree Ring Records and Glacier Modeling. Paper presented at the 2003 Seattle Annual Meeting for the Geological Society of America, Seattle.

Porter, Stephen C., Kenneth L. Pierce, and Thomas D. Hamilton

1983 Late Wisconsin Mountain Glaciation in the Western United States. In *The Pleistocene*, edited by Stephen C. Porter, pp. 71-114. University of Minnesota Press, Minneapolis.

Potter, Ben A. and Joshua D. Reuther
2012 High Resolution Radiocarbon Dating at the Gerstle River Site, Central Alaska. *American Antiquity* 77:71-98.

Prasciunas, Mary M.
2008 Clovis First? An Analysis of Space, Time, and Technology. Unpublished Ph.D. dissertation, Department of Anthropology, University of Wyoming, Laramie.

Purdy, Barbara A.
1991 *The Art and Archaeology of Florida's Wetlands*. CRC Press, Boca Raton, Florida.

Raiswell, Rob
2001 Defining the Burial Environment. In *Handbook of Archaeological Sciences*, edited by D. A. Brothwell and A. M. Pollard, pp. 595-603. Wiley, West Sussex, England.

Ramsey, Bronk C.
2009 Bayesian Analysis of Radiocarbon Dates. *Radiocarbon* 51:337-360.

Rapson, David J.
1990 Pattern and Process in Intra-Site Spatial Analysis: Site Structural and Faunal Research at the Bugas-Holding Site. Unpublished Ph.D. dissertation, Department of Anthropology, University of New Mexico, Albuquerque.

1995 Faunal Analysis. In *The Henn Site: Early Archaic to Protohistoric Occupation at the Jackson National Fish Hatchery*, edited by Mary Lou Larson, pp. 133-168. Technical Report No. 7. Department of Anthropology, University of Wyoming, Laramie. Copies available from the Wyoming Cultural Records Office.

Rapson, David J. and Lawrence C. Todd
1999 Linking Trajectories of Intra-Site Faunal Use with Food Management Strategies at the Bugas-Holding Site: Attribute-based Spatial Analysis of a High Altitude Winter Habitation, Wyoming, USA. In *Le Bison: Gibier Et Moyen De Subsistance Des Hommes Du Paleolithique Aux Paleoindiens Des Grandes Plaines*, edited by J.-Ph. Brugal, F. David, J.G. Enloe, J. Jaubert. Actes du Colloque International, Toulouse.

Raspy, Rick
2017 Determining How Much Forage a Beef Cow Consumes Each Day, electronic document, http://beef.unl.edu/cattleproduction/forageconsumed-day, accessed February, 2017.

Raven, Christopher
1990 *Prehistoric Human Geography in the Carson Desert: Part II: Archaeological Field Tests of Model Predictions*. Intermountain Research. Submitted to the U.S. Fish and Wildlife Service. Copies available from Intermountain Research, Silver City, Nevada.

Raven, Christopher and Robert G. Elston
1989 Prehistoric Human Geography in the Carson Desert: Part I: A Predictive Model of Land-Use in the Stillwater Wildlife Management Area. Intermountain Research. Submitted to the U.S. Fish and Wildlife Service. Copies available from Intermountain Research, Silver City, Nevada.

Raynolds, William F.
1868 *Report on the Exploration of the Yellowstone River*. U.S. Army Corps of Engineers, Government Printing Office, Washington D.C.

Reasoner, Mel A., and Margret A. Jodry
2000 Rapid Response of Alpine Timberline Vegetation to the Younger Dryas Climate Oscillation in the Colorado Rocky Mountains, USA. *Geology* 28(1):51-5

Reed, Alan D.
1995 Ute Ceramics. In *Archaeological Pottery of Colorado: Ceramic Clues to the Prehistoric and Protohistoric Lives of the State's Native Peoples*, edited by Bruce Bradley and Susan M. Chandler, pp.120-128. Occasional Papers No. 2. Colorado Council of Professional Archaeologists, Denver.

Reeve, Stuart A.
1986 Root Crops and Prehistoric Social Process in the Snake River Headwaters, Northwestern Wyoming. Unpublished Ph.D. dissertation, Department of Anthropology, State University of New York, Albany.

Reeves, Brian
1973 The Concept of an Altithermal Cultural Hiatus in Northern Plains Prehistory. *American Anthropologist* 75:1221-1253.

1983 *Culture Change in the Northern Plains:1000 B.C. – A.D. 1000.* Occasional Paper No. 20. Archaeological Survey of Alberta, Edmonton.

Reider, Richard G.
1990 Late Pleistocene and Holocene Pedogenic and Environmental Trends at Archaeological Sites in Plains and Mountain Areas of Colorado and Wyoming. In *Archaeological Geology of North America*, edited by Norman P. Lasca and Jack Donahue, pp. 335-360. Geological Society of America, Centennial Special Volume 4. Boulder, Colorado.

Reimer, Paula J., Edouard Bard, Alex Bayliss, J. Warren Beck, Paul G. Blackwell, Christopher Bronk Ramsey, Caitlin E. Buck, Hai Cheng, R. Lawrence Edwards, Michael Friedrich, Pieter M. Grootes, Thomas P. Guilderson, Haflidi Haflidason, Irka Hajdas, Christine Hatte, Timothy J. Heaton, Dirk L. Hoffmann, Alan G. Hogg, Konrad A. Hughen, K. Felix Kaiser, Bernd Kromer, Sturt W. Manning, Mu Niu, Ron W. Reimer, David A. Richards, E. Marian Scott, John R. Southon, Richard A. Staff, Christian S. M. Turney, and Johannes van der Plicht
2013 IntCal13 and Marine13 Radiocarbon Age Calibration Curves 0-50,000 Years Cal BP. *Radiocarbon* 55(4):1869-1887.

Richmond, Gerald M.
1986 Stratigraphy and Correlation of Glacial Deposits of the Rocky Mountains, the Colorado Plateau, and the Ranges of the Great Basin. In Quaternary Glaciations in the Northern Hemisphere, edited by V. Sibrava, D. Q. Bowen, and G. M. Richmond. *Quaternary Science Reviews* (5):129-144.

Rollins, P.A.
1935 *The Discovery of the Oregon Trail: Robert Stuart's Narratives of His Overland Trip.* Edward Eberstadt and Sons, New York.

Russell, Osborne
1921 *Journal of a trapper; or, Nine Years in the Rocky Mountains, 1834-1843; being a general description of the county, climate, rivers, lakes, mountains, etc. and a view of the life led by a hunter in those regions*. 2d ed. Edited from the original manuscript by L. A. York. Boise, Id., Syms-York Company, Inc.

Sanders, Paul H.
2000 *The 1999 Archaeological Test Excavation of Site 24YE14, Yellowstone National Park, Wyoming*. Office of the Wyoming State Archaeologist. Submitted to National Park Service, Cooperative Agreement No. CA 1460-5-9009. Copies available from the Wyoming Cultural Records Office, Laramie.

2013 A Reassessment of Prehistoric Land-Use Patterns within the Yellowstone Lake Basin and Hayden Valley Region, Yellowstone National Park. In *Yellowstone Archaeology: Southern Yellowstone*, edited by Douglas H. MacDonald and Elaine S. Hale, pp. 22-41. Contributions to Anthropology Vol 13, No. 2, University of Montana Department of Anthropology, Missoula.

Sanders, Paul H. and Dale L. Wedel
1999 An Ethnographic and Prehistoric Summary of Pronghorn Procurement and its Relation to Modern Habitat, Pronghorn Behavior, and Archaeological Site Locations in Southwestern Wyoming. In *The Trappers Point Site (48SU1006): Early Archaic Adaptations in the Upper Green River Basin*, edited by Mark E. Miller, Paul H. Sanders and Julie E. Francis, pp. 290-320. Cultural Resource Series No.1, Office of the Wyoming State Archaeologist, Laramie.

Sawada, M., A.E. Viau, G. Vettoretti, W.R. Peltier, and K. Gajewski
2004 Comparison of North-American pollen-based temperature and global lake-status with CCCma AGCM2 output at 6 ka. *Quaternary Science Reviews* 23:225-244.

Scheiber, Laura L., and Judson Byrd Finley
2011 Obsidian Source Use in the Greater Yellowstone Area, Wyoming Basin, and the Central Rocky Mountains. *American Antiquity* 76:372-394.

Schiffer, Michael B.
1987 *Formation Processes of the Archaeological Record*. University of New Mexico Press, Albuquerque.

Schoen, James R.
1997 As Clear as Opaque Obsidian: Source Locations in Jackson Hole, Wyoming. *Tebiwa* 26(2):216-224.

Scott, Karen West and George M. Zeimens
1984 Lithic Materials and Stone Tools. In *The Dead Indian Creek Site: An Archaic Occupation in the Absaroka Mountains of Northwestern Wyoming*, edited by George C. Frison and Danny N. Walker, pp. 28-33. Wyoming Archaeologist Vol 27(1-2).

Sellet, Frederic
1999 *A Dynamic View of Paleoindian Assemblages at the Hell Gap Site, Wyoming: Reconstructing Lithic Technological Systems.* Unpublished Ph.D. dissertation. Department of Anthropology, Southern Methodist University, Dallas.

Sellet, Frederic, James Donahue, and Matthew G. Hill
2009 The Jim Pitts Site: A Stratified Paleoindian Site in the Black Hills of South Dakota. *American Antiquity* 74:735-758.

Shaw, Leslie C.
1980 *Early Plains Archaic Procurement Systems during the Altithermal: The Wyoming Evidence*. Master's thesis, Department of Anthropology, University of Wyoming Laramie. ProQuest Information and Learning Company, Ann Arbor.

Shimkin, Dimitri B.
1986 Eastern Shoshone. *In*, Handbook of North American Indians: Volume 11 Great Basin. Eds. William C. Sturtevant (General) and Deward E. Walker, Jr (Volume):308-335. Smithsonian Institution, Washington, D.C.

Shuman, Bryan
2012 Recent Wyoming Temperature Trends, their Drivers, and Impacts in a 14,00-Year Context. *Climatic Change* 112:429-447.

Shuman, Bryan, Paul Pribly, Thomas A. Minckley, and Jacqueline J. Shinker
2010 Rapid Hydrologic Shifts and Prolonged Droughts in Rocky Mountain Headwaters during the Pleistocene. *Geophysical Research Letters* 37, L06701.

Simms, Steven R.
1984 Aboriginal Great Basin Foraging Systems: An Evolutionary Analysis. Unpublished Ph.D. dissertation, Department of Anthropology, University of Utah, Salt Lake City.

Smith, Craig S.
1988 Seeds, Weeds, and Prehistoric Hunters and Gatherers: The Plant Macrofossil Evidence from Southwest Wyoming. *Plains Anthropologist* 33(120):141-158.

Smith, Craig S., William Martin, and Kristine A. Johnson
2001 Sego Lilies and Prehistoric Foragers: Return Rates, Pit Ovens, and Carbohydrates. *Journal of Archaeological Science* 28:169-183.

Smith, Craig S., Thomas P. Reust, and Russell D. Richard
2003 Site 48UT375: Late Paleoindian Period Subsistence and Land Use Patterns in the Green River Basin, Wyoming. *Plains Anthropologist* 48(186)133-149.

Smith, Robert B., and Lee J. Siegel
2000 *Windows into the Earth: The Geologic Story of Yellowstone and Grand Teton National Parks*. Oxford University Press, New York.

Soil Conservation Service
1981 *Land Resource Regions and Major Land Resource Areas of the United States.* U.S. Department of Agriculture, Soil Conservation Service Agriculture Handbook 296. Washington.

Soil Survey Staff
1999 *Soil Taxonomy: A Basic System of Soil Classification for Making and Interpreting Soil Surveys*. 2nd Edition. U.S. Department of Agriculture, Natural Resources Conservation Service. Agriculture Handbook Number 436. United States Government Printing Office, Washington D.C.

2011a *Soil Survey Geographic (SSURGO) Database for Teton County, Wyoming, Grand Teton National Park Area*. Natural Resources Conservation Service, United States Department of Agriculture. Available online at http://soildatamart.nrcs.usda.gov. Accessed July 11, 2011.

2011b *Soil Survey Geographic (SSURGO) Database for Teton Area, Idaho-Wyoming.* Natural Resources Conservation Service, United States Department fo Agriculture. Available online at http:soildatamart.nrcs.usda.gov. Accessed 7/11/2011.

Stager, J. C., and P. A. Mayewski
1997 Abrupt Early to Mid-Holocene Climatic Transition Registered at the Equator and Poles. *Science* 276(5320):1834-1836.

Steward, Julian H.
1937 *Ancient Caves of the Great Salt Lake Region*. Smithsonian Institution Bulletin 116. Bureau of American Ethnology, Smithsonian Institution, Washington, D.C.

Stuiver, M., and Reimer, P.J.,
1993 Extended 14C Database and Revised CALIB Radiocarbon Calibration Program. *Radiocarbon.* 35:215-230.

Surovell, Todd A., Judson Byrd Finley, Geoffrey M. Smith, P. Jeffrey Brantingham and Robert Kelly
2009 Correcting Temporal Frequency Distributions for Taphonomic Bias. *Journal of Archaeological Science* 36:1715-1724.

Surovell, Todd A. And Nicole M. Waguespack
2007 Folsom Hearth-Centered Use of Space at Barger Gulch, Locality B. In *Frontiers in Colorado Paleoindian Archaeology: From the Dent Site to the Rocky Mountains,* edited by Robert H. Brunswig and Bonnie L. Pitblado, pp.219-259. University Press of Colorado, Boulder.

Swanson, Earl H., Jr.
1972 *Birch Creek: Human Ecology in the Cool Desert of the Northern Rocky Mountains 9,000 B.C. - A.D. 1850.* The Idaho State University Press, Pocatello.

Teller, James T.
1987 Proglacial Lakes and the Southern Margin of the Laurentide Ice Sheet. In *North America and Adjacent Oceans during the Last Deglaciation*, edited by W. F. Ruddiman and H. E. Wright, Jr., pp. 39-70. The Geology of North America vol. K-3. Geological Society of America, Boulder, Colorado.

Thomas, David Hurst
1981 How to Classify the Projectile Points from Monitor Valley, Nevada. *Journal of California and Great Basin Anthropology* 3(1): 7-43.

Thompson, Graham R., and Jonathan Turk
1997 *Modern Physical Geology: 2nd ed.* Saunders College Publishing, New York.

Thompson, Kevin W., and Jana V. Pastor
1995 *People of the Sage: 10,000 Years of Occupation in Southwestern Wyoming.* Cultural Resource Management Report No. 67. Archaeological Services of Western Wyoming College, Rock Springs.

Thompson, Robert S., Cathy Whitlock, Patrick J. Bartlein, Sandy P. Harrison, and W. Geoffrey Spaulding
1993 Climatic Changes in the Western United States since 18,000 yr B.P. In *Global Climates since the Last Glacial Maximum*, edited by H. E. Wright, Jr., pp. 468-513. University of Minneapolis Press, Minneapolis, Minnesota.

Thornbury, William D.
1965 *Regional Geomorphology of the United States*. John Wiley and Sons, New York.

Tilley, D., L. St. John, and N. Shaw
2012 *Plant Guide for arrowleaf balsamroot (Balsamorhiza sagittata)*. USDA-Natural Resources Conservation Service, Aberdeen Plant Materials Center. Aberdeen, Idaho. Electronic document, ftp://ftp-fc.sc.egov.usda.gov/ID/programs/plant/plant_guides/pg_arrowleaf_balsamroot.pdf.

Toohey, Jason L. and Paul H. Sanders
2011 *The 2007 Archaeological Test Excavations of Sites 48YE116 and 48YE406, and the 2008 Test Excavations at 48YE357 along the Mammoth to Norris Junction Road, Yellowstone National Park, Wyoming.* Office of the Wyoming State Archaeologist. Submitted to the National Park Service. Copies available from the Wyoming Cultural Records Office, Laramie.

Toom, Dennis L.
2004 Northeastern Plains Village Complex Timelines and Relations. *Plains Anthropologist* 49:281-297.

United States Department of Agriculture (USDA)
2006 *Land Resource Regions and Major Land Resource Areas of the United States, the Caribbean, and the Pacific Basin.* U.S. Department of Agriculture Handbook 296. Available online <ftp://ftp-fc.sc.egov.usda.gov/NSSC/Ag_Handbook_296/Handbook_296_-low.pdf.> Accessed May 21, 2008.

Van Heeringen, Robert, and E. M. Theunissen
2001 Repeated Water Table Lowering in the Dutch Delta: A Major Challenge to the Archaeological Heritage Management of Pre- and Proto-Historic Wetlands. In *Enduring Records: The Environmental and Cultural Heritage of Wetlands*, edited by Barabara A. Purdy, pp. 271-276. Oxbow Books, Oxford, England.

Van Nest, Julieann
2002 The Good Earthworm: How Natural Processes Preserve Upland Archaic Archaeological Sites of Western Illinois. *Geoarchaeology* 17:53-90.

Vaughan, Sheila J., and Claude N. Warren
1987 Toward a Definition of Pinto Points. *Journal of California and Great Basin Anthropology* 9(2): 199-213.

Voget, Fred W.
2001 Crow. In *Plains*, edited by Raymond J. DeMallie, pp. 695-717. Handbook of North American Indians, Vol 13, William C. Sturtevant, general editor, Smithsonian Institution, Washington, D.C.

Walker, Danny N. and Daniel R. Bach
2007 Two Rockshelters: 48BH331 and 48BH332. In *Medicine Lodge Creek: Holocene Archaeology of the Eastern Big Horn Basin, Wyoming*, Vol. 1, edited by George C. Frison and Danny N. Walker, pp 107-132. Clovis Press, Avondale, Colorado.

Walker, Danny N. and George C. Frison
1984 Conclusions. In *The Dead Indian Creek Site: An Archaic Occupation in the Absaroka Mountains of Northwestern Wyoming*, edited by George C. Frison and Danny N. Walker, pp. 111-114. Wyoming Archaeologist Vol 27(1-2).

Waters, Michael R.
1992 *Principles of Geoarchaeology: A North American Perspective*. University of Arizona Press, Tucson.

Waters, Michael R., Charlotte D. Pevny, David L. Carlson
2011 *Clovis Technology: Investigation of a Stratified Workshop at the Gault Site, Texas.* Texas A&M, College Station.

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

Webster, Sean Michael
2004 A Re-Evaluation of the McKean Series on the Northern Plains. Unpublished Ph.D. dissertation, Department of Archaeology and Anthropology, University of Saskatchewan, Saskatoon.

Wedel, Waldo R.
1961 *Prehistoric Man on the Great Plains.* University of Oklahoma, Norman.

Wheeler, Richard Page
1954 Two New Projectile Point Types: Duncan and Hanna Points. *Plains Anthropologist* 1:7-14.

1995 *Archeological Investigations in three Reservoir Areas in South Dakota and Wyoming, Angostura Reservoir.* Reprints in Anthropology, Vol. 46-49. J & L Reprint Co., Lincoln, Nebraska.

Whitlock, Cathy
1993 Postglacial Vegetation and Climate of Grand Teton and Southern Yellowstone National Parks. *Ecological Monographs* 63(2):173-198.

1994 Long-Term Vegetational Response to Climate Change and Edaphic Conditions in Yellowstone National Park. In *Plants and their Environments: Proceedings of the First Biennial Scientific Conference on the Greater Yellowstone Ecosystem*, edited by Don G. Despain, pp. 301-304. Technical Report NPS/NRYELL/NRTR-93/XX. United States Department of the Interior, National Park Service, Natural Resources Publications Office, Denver, Colorado.

Whitlock, Cathy, and Patrick J. Bartlein
1993 Spatial Variations of Holocene Climatic Change in the Yellowstone Region. *Quaternary Research* 39:231-238.

2004 Holocene Fire Activity as a Record of Past Environmental Change. In *The Quaternary Period in the United States: Developments in Quaternary Science*, edited by A. R. Gillespie, S. C. Porter, and B. F. Atwater, pp. 479-490. Elsevier, Amsterdam.

Whitlock, Cathy, Patrick J. Bartlein, and Kelli J. Van Norman
1995 Stability of Holocene Climate Regimes in the Yellowstone Region. *Quaternary Research* 43:433-436.

Whitlock, Cathy, Walter Dean, Joseph Rosenbaum, Lora Stevens, Sherilyn Fritz, Brandi Bracht, and Mitchell Power
2008 A 2650-Year Long Record of Environmental Change from Northern Yellowstone National Park Based on a Comparison of Multiple Proxy Data. *Quaternary International* 188:126-138.

Whittaker, John C.
1994 *Flintknapping: Making and Understanding Stone Tools*. University of Texas Press, Austin.

Wiessner, Polly
1983 Style and Social Information in Kalahari San Projectile Points. *American Antiquity* 48:253-276.

Wilke, Phillip J., Jeffrey J. Flenniken and T.L. Ozbun
1991 Clovis Technology at the Anzick Site, Montana. *Journal of California and Great Basin Anthropology* 12:242-272.

Williams, Alan N.
2012 The Use of Summed Radiocarbon Probability Distributions in Archaeology: A Review of Methods. *Journal of Archaeological Science* 39:578-589.

Wimer, Alan
2001 Folsom Sites in Southwestern Wyoming. Unpublished Master's thesis, Department of Anthropology, University of Wyoming, Laramie.

Wright, Gary A.
1982 Notes on Chronological Problems on the Northwestern Plains and Adjacent High Country. *Plains Anthropologist* 27(96):145-160.

1984 *People of the High Country: Jackson Hole Before the Settlers.* Peter Lang, Berne, Switzerland.

Wright, Gary A., Susan Bender, and Stuart Reeve
1980 High Country Adaptations. *Plains Anthropologist* 25(89):181-197.

Wright Jr., H. E., J. E. Kutzbach, T. Webb III, W. F. Ruddiman, F. A. Street-Perrott, and P. J. Bartlein (editors)
1993 *Global Climates since the Last Glacial Maximum*. University of Minnesota Press, Minneapolis.

Wright, Steven E.
1995 The Spatial and Temporal Distribution of the Wahmuza Lanceolate. Unpublished Master's thesis, Department of Anthropology, Idaho State University, Pocatello.

Young, Jack F., and Paul C. Singleton
1977 *Wyoming General Soil Map.* Wyoming Agricultural Experiment Station Research Journal 117.

Zeanah, David W., Eric Ingbar, Robert Elson, and Charles D. Zeier
1999 *Archaeological Predictive Model, Management Plan, and Treatment Plans for Northern Railroad Valley, Nevada*. Intermountain Research. Submitted to Bureau of Land Management. Copies available from Intermountain Research Silver City, Nevada.

Zeimens, George M.
1975 48AB301: A Late Period Site in the Shirley Basin of Wyoming. Unpublished Master's thesis, Department of Anthropology, University of Wyoming, Laramie.

Zielinski, G. A.
1987 Paleoenvironmental Implications of Lacustrine Sedimentation Patterns in the Temple Lake Valley, Wyoming. Unpublished Ph.D. dissertation, University of Massachusetts, Amherst.

Zvelebil, Marek
1987 Wetland Settlements in Eastern Europe. In *European Wetlands and Prehistory*, edited by John M. Coles and Andrew J. Lawson, pp. 94-116. Clarendon Press, Oxford.