University of Nevada, Reno

The Core Problem: Examining the Role of Bifacial Cores in Terminal Pleistocene/Early Holocene Lithic Technological Organization in the Great Basin

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Kristina M. Wiggins

Dr. Geoffrey M. Smith/Thesis Advisor

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KRISTINA M. WIGGINS

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Geoffrey M. Smith, Ph.D., Advisor

Bryan Hockett, Ph.D., Committee Member

Kenneth D. Adams, Ph.D., Graduate School Representative

David W. Zeh, Ph.D., Dean, Graduate School

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ABSTRACT

The High-Tech Forager Model (HTFM) was developed in the Great Plains region to model Paleoindian lithic technological organization. The model holds that mobile Paleoindian groups employed a flexible and efficient toolkit centered on bifacial core technology. Superficial similarities in lithic technology led to the widespread adoption of the model in the Great Basin, but its applicability to the region has not been critically evaluated. A number of actualistic, archaeological, and modeling studies challenge the HTFM, and it is with these challenges in mind that I designed this study to explore the organizational role of bifacial technology and, by extension, test the applicability of the HTFM to two regions of the Great Basin. My results suggest that bifacial technology was no more important to Paleoindians in the northwestern Great Basin than it was to later groups in the same region, and bifacial cores may have seen some use in the central Great Basin but not in the northwestern Great Basin. Raw material availability and subsistence strategies (rather than mobility, as the HTFM suggests) appear to have most strongly influenced the use of bifacial technology.

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CHAPTER 1

INTRODUCTION

Many researchers working in the Great Basin (e.g., Beck et al. 2002; Graf 2001; Jones et al. 2003; Kelly 1988; Smith 2006) have traditionally assumed that bifaces played a central role in Paleoindian lithic technology. This assumption is derived from the High-Tech Forager Model (HTFM) developed in the Great Plains region. The HTFM is centered on the idea that bifaces are more efficient sources of flakes than amorphous cores because they produce flakes with more usable edge relative to weight (Bamforth 2002; Kelly and Todd 1988). In theory, the efficiency of bifacial cores allowed mobile Paleoindians to optimize toolstone transportation.

Recently, actualistic and archaeological studies have called into question the assumption that bifaces were efficient cores (Bamforth 2002, 2003; Eren and Andrews 2013; Jennings et al. 2010; Kuhn 1994; Prasciunas 2007; Surovell 2009). Furthermore, there have been few comparisons of the role of bifacial technology in Paleoindian and later period lithic technological organization in the Great Basin (but see Goebel 2007; Jones and Beck 2012). Towards that goal, I test two hypotheses:

1) Bifaces played a more central role in Paleoindian lithic technological organization in the northwestern and central Great Basin than later Archaic technological organization in those same regions;

and

2) Because high quality raw material is rare in the central Great Basin, groups there relied more heavily on bifacial technology throughout time than those in the toolstone-rich northwestern Great Basin.

I test these hypotheses by comparing biface and biface thinning flake indices for assemblages from different periods. The Biface Index (BI) is a measure of the proportion of bifaces in an assemblage relative to all other tool types. Similarly, the Biface Thinning Index (BTI) is a measure of the proportion of biface thinning flakes relative to all other debitage types. To explore the effect of raw material availability on lithic technological organization (*sensu* Andrefsky 1994), I compare data from assemblages in the toolstone-rich northwestern Great Basin to those from assemblages in the toolstone-poor central Great Basin. To account for the possibility that bifacial technology is primarily related to subsistence strategies (e.g., large game hunting) (*sensu* Hildebrandt and McGuire 2002) rather than toolstone availability, I also examine possible correlations between biface/biface thinning flake frequency and faunal remains during different periods.

Background

Great Basin Paleoenvironmental and Archaeological Records

People were well-established in the Great Basin by ca. 12,800 cal BP (Graf 2007) and perhaps as early as ca. 14,500 cal BP (Jenkins et al. 2013). Early groups in the region experienced an environment that was generally cooler and wetter than today (Goebel et al. 2011; Grayson 2011) and, at least initially, population levels were low (Louderback et al. 2010). Based on site location and scant subsistence data, Paleoindians likely centered their settlement-subsistence activities on the pluvial lakes that dominated the Terminal Pleistocene/Early Holocene (TP/EH) landscape (Adams et al. 2008; Bedwell 1973; Duke and King 2014; Duke and Young 2007; Elston et al. 2014; Smith et al. 2015). Low population densities and wetland-focused settlement-subsistence strategies probably allowed Paleoindians to be residentially mobile, moving through extensive foraging ranges in pursuit of lacustrine resources and large game (Elston et al. 2014; Jones et al. 2003, 2012; Smith 2010).

During the Middle Holocene (ca. 8300-6500 cal BP), precipitation declined for long periods, causing wetlands to decrease in size and quality; subsequently, plant (Louderback and Rhode 2009) and animal (Grayson 2000) communities shifted. Human populations declined in some places (Louderback et al. 2010) and groups altered their subsistence strategies (Hockett 2007; Jones and Beck 2012; Louderback et al. 2010; Rhode 2008; Schmitt et al. 2002). These changes are evidenced archaeologically by changes in technology, subsistence residues, land-use, and site type (Elston and Zeanah

2002; Grayson 2011; Jones and Beck 2012; Rhode 2008; Schmitt et al. 2002). Technological changes during the Middle Holocene include the disappearance of Western Stemmed Tradition (WST) and fluted projectile points and the introduction of corner- and side-notched dart points (Jones and Beck 2012). The Middle Holocene also saw increased reliance on groundstone, suggesting greater consumption of seed resources (Rhode 2008). Changes in technology and diet appear to coincide with a shift from high residential to high logistical mobility as groups started to occupy residential bases for longer periods of time (Elston and Zeanah 2002; Grayson 2011).

The climate improved again during the Late Holocene (ca. 4500 cal BP-present), with a return of cooler and wetter conditions punctuated by periods of drought (Bettinger 1999; Mensing et al. 2004). As conditions improved, human populations increased dramatically (Bettinger 1999; Louderback et al. 2010) and people exploited a wider range of environments (Bettinger 1999; Grayson 2011) including high-elevation locales (Bettinger 1991; Thomas 2013). Houses, middens, and storage features are common, suggesting longer-term occupation of residential bases (Bettinger 1999). Artiodactyl populations also increased (Broughton and Bayham 2003; Broughton et al. 2008; Hildebrandt and McGuire 2002, 2003), which has been tied to increased biface production at quarries (Hildebrandt and McGuire 2002) and widespread communal artiodactyl hunting (Hockett 2005). Figure 1.1 summarizes these trends.

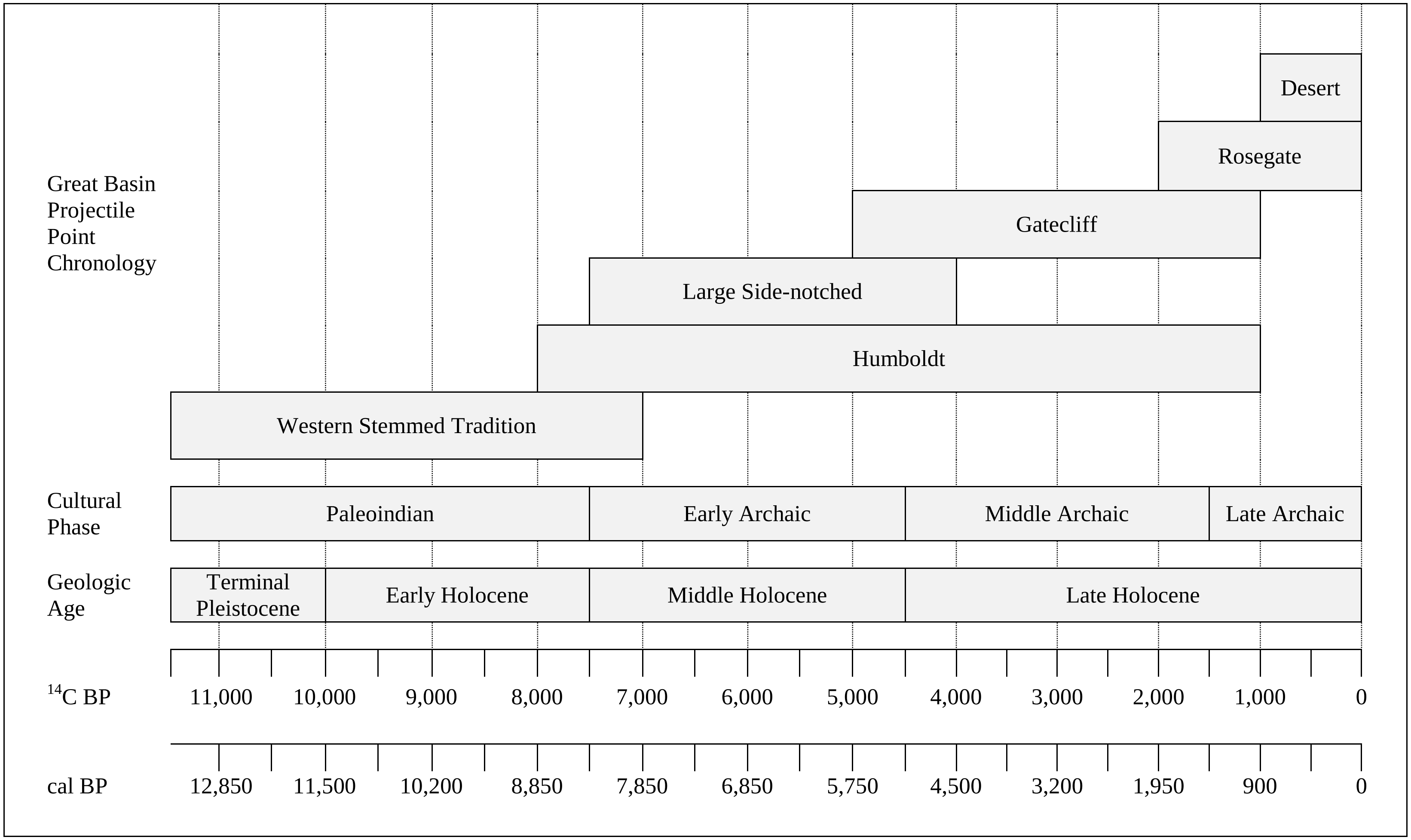

Figure 1.1. Summary of cultural and geological temporal patterns in the Great Basin. After LaValley (2013).

Paleoindian Lithic Technological Organization

In the Great Basin, TP/EH sites are most often near-surface lithic scatters (Beck et al. 2002; Jones et al. 2003). Researchers rely on diagnostic artifacts and typological cross-dating to assign sites to that time period; such artifacts include WST and fluted points, both of which predate ca. 8300 cal BP (Beck and Jones 2009; Grayson 2011; Jones et al. 2003). Source provenance studies of Paleoindian points suggest that early groups were highly mobile, operated within broad foraging ranges, and utilized a wide range of raw materials (Jones et al. 2003, 2012; Smith 2010; Smith and Kielhofer 2011). Many researchers (e.g., Beck et al. 2002; Jones et al. 2003; Kelly 1988; Kelly and Todd 1988; Parry and Kelly 1987; Smith 2006) argue that Paleoindian lithic technology was centered on bifacial technology, which as outlined earlier, is widely perceived as being an efficient means of carrying toolstone. The focus on bifaces as a central component of the Paleoindian toolkit is a key element of the HTFM (Bamforth 2002; Kelly and Todd 1988). Due to superficial similarities with Paleoindian lithic technology on the Plains, Great Basin researchers (e.g., Estes 2009; Graf 2001; Smith 2006) quickly adopted the model; however, its applicability to the region has yet to be directly tested.

The Development and Application of the HTFM

Current research on Paleoindian technological organization emphasizes high residential mobility and, consequently, optimization strategies employed by pedestrian foragers (Jones et al. 2003, 2012; Kelly 1992, 1988; Kelly and Todd 1988; Smith 2010).

Such strategies include a “reliance on easily flakeable stone, extension of tools’ use lives by careful design and recycling, and reduction of the weight of the transported toolkit by producing tools in advance of use and relying on bifacial cores as sources of new tools and for later reduction into finished tools” (Bamforth 2002:58). Kelly and Todd (1988) suggested that efficiency-optimizing behaviors such as these were motivated by high mobility and low population densities and are visible archaeologically as a sophisticated lithic toolkit centered on bifacial technology. These characteristics of North America’s earliest inhabitants are key elements of the HTFM (Bamforth 2002; Kelly and Todd 1988).

The development of the HTFM began with the recognition that bifacial technology was common in many Paleoindian assemblages (Beck and Jones 1990, 1997; Boldurain 1991; Goodyear 1979; Jones et al. 2003, 2012; Kelly 1988; Kelly and Todd 1988; Parry and Kelly 1987; Witthoft 1952). At the Debert Site in Nova Scotia, MacDonald (1968) noted large bifaces were made from chert that originated 50-100 km from the site, suggesting a high degree of mobility and a strong reliance on bifacial technology and high-quality lithic raw material. Similarly, Witthoft (1952) observed that most artifacts at the Shoop Site in Pennsylvania were made from chert found ~300 km away, again suggesting high mobility and a preference for high-quality raw material. Early work at those and other Paleoindian sites laid the foundation for the HTFM by recognizing both the technological sophistication and high residential mobility of early groups. Goodyear (1979:1), who advanced the development of the HTFM model when he pointed out “the striking homogeneity of tool forms…across time and space,” argued that using cryptocrystalline silicates (CCS) to manufacture bifaces provided tools that were flexible, durable, and well-suited to a mobile lifestyle.

Kelly and Todd (1988:239) synthesized previous research about Paleoindian mobility and technological organization and, following Spiess (1984), termed early groups “high-technology foragers”. They suggested that Paleoindians targeted terrestrial fauna and moved frequently in response to game migrations and environmental shifts. Because groups exploited an uncertain and ever-changing landscape, they were probably “technology-oriented” rather than “place-oriented” (Kelly and Todd 1988:239), meaning that they focused more on the animals they hunted than the habitats they inhabited. Although Kelly and Todd (1988) referred to these groups as foragers, they point out that they embodied elements of both Binford’s (1980) foragers and collectors. Like Binford’s (1980) foragers, high-tech foragers were residentially mobile, not place-oriented, and did not use stored resources; however, like his collectors, they used complex technology, practiced logistical mobility, and occupied large territories (Kelly and Todd 1988).

High-technology foragers should have relied upon a flexible and portable toolkit (Goodyear 1979; Kelly 1988; Kelly and Todd 1988). Kelly and Todd (1988:237) noted that Paleoindian groups relied on bifacial technology as the foundation of a toolkit that “maximize[s] the number of tools carried while minimizing the amount of stone carried”. Similarly, Kelly (1988) argued that bifaces were important to the Paleoindian toolkit because they could serve three potential roles: (1) long use-life tools; (2) made-to-fit tools (i.e., tools shaped to fit an existing haft); and (3) cores (Table 1.1). Proponents of the HTFM consider bifaces efficient because they produce thin, sharp flakes with high edge-to-weight ratios, meaning they have more useable cutting edge than flakes struck from amorphous cores (Goodyear 1979; Jennings 2010; Kelly 1988).

The use of high quality raw material is also important to optimizing a mobile toolkit. Goodyear (1979) argued that high-quality lithic materials allowed for a toolkit that was portable, flexible, and adaptable to a range of geographic variability and resource uncertainty. CCS tools are common in Paleoindian assemblages across North America (Goodyear 1979) and that fact, along with typological similarities, likely led researchers working in different regions including the Great Basin to quickly adopt the HTFM.

Table 1.1. Archaeological Expectations for the Three Roles of Bifaces (Kelly 1988).

Role	**Archaeological Expectations**
Cores	Manufacture and use in residential sites: 1. Biface flakes should show positive correlation with all other debitage types. 2. High proportion of utilized biface flakes to other flake tools. 3. Few non-bifacial cores. 4. Few cortical flakes, and high proportion of high-quality toolstone. Manufacture in residential sites, use at logistical sites: 1. Logistical sites have more utilized biface flakes than residential. 2. Residential sites have more evidence of tool maintenance than logistical sites. 3. Residential sites have fewer flake tools made from biface thinning flakes, more made from other flake types.
Long Use-Life Tools	1. Few unifacial examples of formal tools such as projectile points. 2. Similar patterns to "made-to-fit" tools with more evidence for maintenance. 3. Extensive evidence of debitage related to resharpening and recycling, with little having been used as flake tools. 4. Evidence for the manufacture and maintenance of hafts.
Made-to-Fit Tools	1. High frequency of debitage related to biface manufacture. 2. Few flake tools made from biface-reduction flakes. 3. High frequency of unifacial formal tools. 4. Evidence at residential sites for hafted tool maintenance.

Theoretical Orientation of the HTFM. The HTFM's emphasis on optimizing technological organization is implicitly rooted in Human Behavioral Ecology (HBE). Many studies of prehistoric technological organization (e.g., Bamforth and Bleed 1997; Bleed 1986; Nelson 1991; Odell 2001; Surovell 2009) either explicitly or implicitly view behavior in optimal terms and focus on the costs and benefits of choices related to toolstone selection, tool form, reduction patterns, and tool discard (Bird and O'Connell 2006). Kelly (1988), Kuhn (1994), Surovell (2009), and myriad others have written extensively about how efficiency and optimization played important roles in toolkit design: mobile foragers had to balance portability with functionality.

The HTFM in the Great Basin. Like Paleoindian assemblages elsewhere, early Great Basin sites typically contain bifaces (Beck and Jones 1990, 2009; Duke and Young 2007; Jones et al. 2003, 2012; Smith 2010). Beck and Jones (1990, 2009) noted that biface reduction was the dominant activity represented in most assemblages in eastern Nevada and suggested that bifaces may have been used as cores at the Sunshine Locality. Similarly, they suggested that manufacturing bifacial cores was an important activity at many sites and noted similarities between Paleoindian technology in the Great Basin and other regions.

Arguments for high residential mobility among Great Basin Paleoindians are supported by source provenance studies (e.g., Jones et al. 2003, 2012; Smith 2010; Smith and Kielhofer 2011). Jones et al. (2003, 2012) analyzed artifacts from assemblages in the central Great Basin and highlighted "lithic conveyance zones", which they correlated with Paleoindian foraging territories. Similarly, Smith (2010) characterized artifacts from northwestern Nevada and suggested that two extensive lithic conveyance zones existed during the TP/EH. Interestingly, source provenance studies have demonstrated that projectile points were conveyed differently than other tools such as bifaces and unifaces. Smith and Kielhofer (2011) found that in northwestern Nevada, points were carried farther from their toolstone sources and made on a wider variety of raw materials than bifaces and unifaces, suggesting that, at least in toolstone-rich areas, unfinished bifaces were not a central component of a mobile toolkit. High quality raw material (i.e., obsidian) is unevenly distributed in the Great Basin (Figure 1.2), with the majority of sources occurring along the outer edge, while the region's interior has only a small number of obsidian sources. Thomas (2011) refers to these areas as the "Obsidian Rim" and "Chert Core" and recent research shows differences in technological organization for each region, with evidence for greater curation of obsidian tools in the Chert Core (Harvey 2014; Smith 2015).

Similarities between Paleoindian technological organization and mobility in the Great Basin and other parts of North America have led to the (often implicit) adoption of the HTFM in the Great Basin. Although there is evidence for high mobility (e.g., source provenance data) and the prevalence of bifacial core technology (artifact and debitage data), the assumption that Paleoindians within and outside of the Great Basin were particularly dependent on bifacial technology, or more reliant on it than later groups, has only recently been critically evaluated.

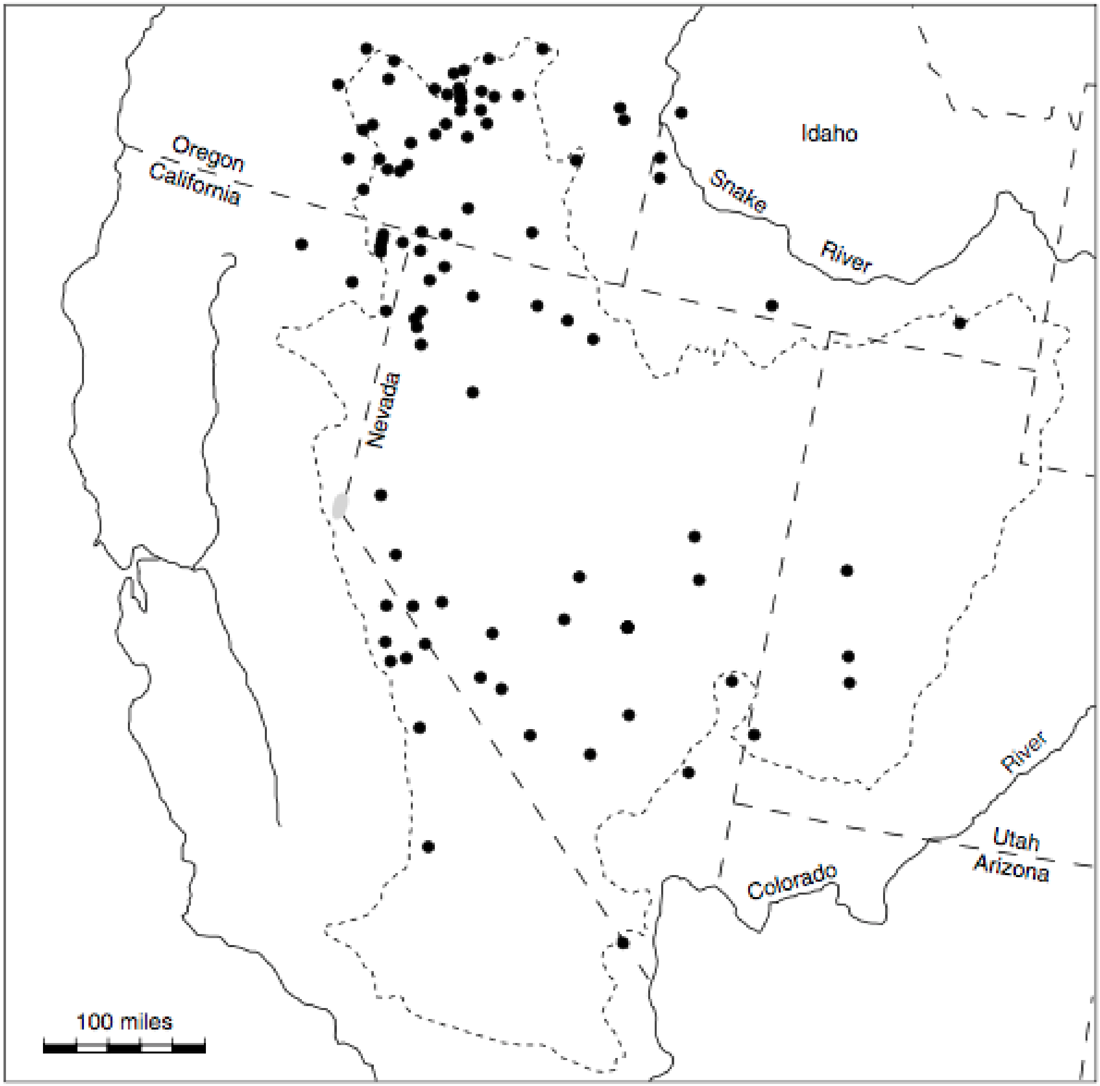

Figure 1.2. Distribution of obsidian sources in the Great Basin. From Grayson (2011).

Questioning the Importance of Bifacial Technology. Bamforth (2002, 2003) investigated the role of bifaces as tools and cores in Paleoindian assemblages on the Great Plains. He offered two objections to the argument that bifaces were used first as cores and then reduced to smaller tools: (1) reduction strategies for cores and bifacial tools are “fundamentally different” (Bamforth 2003:210) and difficult to combine; and (2) the majority of flakes struck from bifaces are “difficult to hold and manipulate for any but fairly delicate work, their edges cannot sustain use on hard materials, and their use as hand-held implements can be nearly as damaging to the user as to the material being worked”(Bamforth 2003:210). Bamforth (2002, 2003) points out that while bifacial cores occasionally occur in Paleoindian assemblages, other core types are far more common and flakes struck from bifacial cores were rarely used for tool production. Furthermore, there are no known examples of tools made from exhausted cores (Bamforth 2003). Ultimately, Bamforth (2002) suggested that there was considerable variability in the degree of Paleoindian mobility and territory size, groups did not rely on bifacial cores, and toolmakers did not extensively resharpen or recycle their tools.

Focusing on Folsom/Goshen bifacial technology, Surovell (2009) found that amorphous cores were rarely transported between sites, hinting that bifacial cores may have served as raw material sources. For this to have been the case, he expected to find a high number of tools made from biface-thinning flakes. Contrary to this expectation, Surovell (2009:149) found that few flake tools were manufactured from biface thinning flakes and concluded that “transport efficiency was not a primary design consideration”. In an earlier study designed to model the optimal mobile toolkit design, Kuhn (1994) found that bifacial cores should play a very minor (if any) role in the mobile toolkit. Instead, people should have carried many finished flake tools.

Given the discordance between archaeological data and expectations derived from the HTFM, replicative studies have started to test the optimality of bifacial cores (Eren and Andrews 2013; Jennings et al. 2010; Prasciunas 2007). Prasciunas (2007) tested the hypothesis that bifacial cores are more efficient sources of raw material than amorphous cores because they produce flakes with higher edge-to-weight ratios. She conducted two experiments to determine the size below which flakes become unsuitable for use as cutting tools and the amount of flake edge produced by bifacial and amorphous cores (Prasciunas 2007). She used 30 replicated unmodified flakes to cut denim for 10 minutes each and concluded that flakes become inefficient as cutting tools when they are <5 g and/or <7 cm^2. Having determined that small flakes are not useful as cutting tools, Prasciunas (2007) then addressed the question of whether bifacial or amorphous cores produce more useable flake edge. She reduced 10 replicated bifacial and 10 replicated amorphous cores to exhaustion, recording the size, weight, and total edge of each flake. Prasciunas (2007) found that bifacial cores did not produce more usable flake edge than amorphous cores when only flakes larger than the experimentally-determined size threshold were included. It was only when flakes smaller than the experimentally-determined size threshold were included that bifaces became the more efficient core type. As Bamforth (2003:210) suggested, small flakes are difficult to manipulate, unsuitable for most tasks, and dangerous to use. Prasciunas (2007) also found that even when the smallest flakes were included, bifacial cores lost significantly more of their weight to waste than amorphous cores, making them less efficient overall.

Assuming that bifaces were used as cores, Eren and Andrews (2013:166) tested whether flake blanks were produced before travel or struck from bifacial cores while "on the move". They produced four bifacial cores and reduced them to the size of a "large cache biface or large fluted point preform" (Eren and Andrews 2013:168). They recorded maximum thickness for all flakes >2.5 cm (*n*=369) while flakes < 2.5 cm were weighed and discarded. By plotting the order of flake removal against maximum thickness, Eren and Andrews (2013) found that flake thickness declined throughout the reduction process. They predicted that there should be a negative relationship between distance from toolstone source and maximum flake thickness, as well as a negative relationship between distance to toolstone source and variability in maximum flake thickness (Eren and Andrews 2013). They evaluated these predictions using data from six Clovis sites in the Lower Great Lakes region and found them to be unsupported. When considered together, these experimental, archaeological, and modeling studies suggest that bifaces may not have been an optimizing strategy employed by mobile groups. Instead, other factors may have led Paleoindians to produce and use bifaces.

Bifacial Technology: Contexts and Expectations

Factors other than their potential to serve as optimal sources of raw material and long use-life tools or cores – an idea that has found little support in the studies outlined above – may have led groups to employ bifacial technology; these include: (1) raw material availability and quality; (2) site type; (3) the degree and type of hunter-gatherer mobility; and (4) subsistence strategies. Where raw material is scarce or of poor quality, Kelly (1988) suggested that people should rely on an efficient toolkit featuring bifacial cores. Conversely, he suggested that bifaces should be uncommon where high-quality raw material is abundant; in such cases, flake tools should be common. Similarly, Andrefsky (1994) found that where raw material was abundant and of high quality, groups produced both formal and informal tools. Informal tools dominated assemblages in areas where raw material was of poor quality, regardless of its abundance, and formal tools dominated assemblages in areas where raw material is uncommon but of high quality. These trends are supported by Beck et al.'s (2002) study of Paleoindian quarries in the central Great Basin, where they found that greater energy (as reflected in the degree of biface reduction) was invested when residential bases were farther from quarries.

Raw material availability also seems to have influenced curation (*sensu* Binford 1979), including stone tool maintenance, resharpening, and recycling. Bamforth (1986:38) defines curated tools as those "that are effective for a variety of tasks, are manufactured in anticipation of use, maintained through a number of uses, transported from locality to locality for these uses, and recycled to other tasks when no longer useful for their primary purposes". He found that raw material availability strongly influenced stone tool maintenance and recycling. Conversely, Kuhn (1991) found that raw material availability had little effect on curation behavior but did influence the consumption of cores. These studies generally support Kelly's (1988) expectations (e.g., bifaces should be rare where high-quality raw material is abundant) and suggest that there was variability in the influence of raw material availability on technological organization.

The contexts in which bifaces were used (and not used) in prehistoric settlement-subsistence systems is also an important consideration. Bifaces were used in specific ways depending on the type of sites at which they occur. Binford's (1980) characterization of different site types – residential bases, locations, and field camps – provides a useful framework within which to develop expectations for how and where bifaces were used. Residential bases are "the hub of subsistence activities, the locus out of which foraging parties originate and where most processing, manufacturing, and maintenance activities take place" (Binford 1980:9). Locations are associated with shorter occupations and were likely places where "extractive tasks" were undertaken (Binford 1980:9). Binford (1980) associated these site types with "forager" subsistence strategies, which are characterized by high residential mobility (Binford 1980:5). "Collectors" practice high logistical mobility and are associated with residential bases and locations, but also with field camps, which are temporary sites associated with logistical forays (Binford 1980:10).

The link between site type/mobility and lithic technology has been explored using a variety of approaches. Kelly (1988) laid out expectations for how bifacial technology should occur at residential and logistical sites (see Table 1.1). Where bifacial cores were produced and used at residential bases, there should be a positive correlation between biface-related debitage (unmodified and utilized biface flakes and biface fragments) and all debitage, lots of utilized biface flakes, few informal or unprepared cores, and evidence for "gearing up" activities at quarries rather than residential bases. Where bifacial cores were manufactured at residential bases for use in logistical sites, there should be a clear division between the two site types: logistical sites should contain more utilized biface flakes than residential bases, residential sites should have more evidence of tool maintenance than logistical sites, and residential bases should contain few flake tools produced from bifacial cores (Kelly 1988). These expectations held true for assemblages in Nevada's Carson Desert. There, Kelly (1988) interpreted the prevalence of bifacial cores during an early period as reflecting logistical use of the area and a later shift away from the use of bifacial cores as reflecting more residential use of the area.

Clearly, settlement strategies influenced lithic technological organization. In general, more expedient tool types are associated with residential bases and reduced residential mobility. Bifacial technology tends to be associated with more mobile groups, but its presence may vary with site type (Kelly 1988; Parry and Kelly 1987). The character of bifacial technology in residential sites should vary depending on whether the tools were intended for use at the residential camp or on logistical forays (Kelly 1988), as well as the intended role of the biface. For example, expectations for bifaces as long use-life tools are similar to those for bifacial cores (see Table 1.1), with the addition of evidence for maintenance, recycling, and possibly haft manufacture (Kelly 1988). Although bifacial technology has a complex set of archaeological signatures, it is worthwhile to tease them apart as the contexts of bifacial technology have the potential to illuminate prehistoric behavior.

Subsistence Strategies. Although raw material availability and settlement systems are clearly important, recent studies have begun to explore other influences on lithic technological organization. Primary among these have been investigations of social behavior such as sexual division of labor, behavior unrelated to mobility and subsistence such as showing off, and hunting practices. Elston and Zeanah (2002) and Elston et al. (2014) explored the seemingly contradictory record of early groups who appear to have employed high residential and logistical mobility. They argued that Paleoindians employed a sexual division of labor in which women focused on reliable, lower-ranked resources while men focused on higher-risk, higher-reward resources such as large game (Elston et al. 2014). Duke and Young (2007) interpreted the lithic record in Utah’s Bonneville Basin, which seems indicative of both high mobility and semi-permanent occupations. They suggested that obsidian bifaces, designed for long-term use and heavily curated, reflected men’s logistical activities while FGV artifacts, which highlighted more expedient tool use, reflected women’s foraging activities closer to home.

Additional research into prehistoric sexual division of labor has focused on men’s motivations for hunting large game. Hildebrandt and McGuire (2002:242) suggested that the prevalence of bifacial technology during California’s Middle Archaic period (ca. 6000-4000 cal BP) is best understood as “the most reliable means to facilitate individual hunting”. They argued that such hunting reflects showing-off behaviors designed to increase individuals’ prestige. Conversely, Broughton and Bayham (2003) suggested that the increased bifacial technology was related to higher artiodactyl populations during the Late Holocene. A similar increase in artiodactyl populations appears to have occurred during the Late Holocene in the Great Basin as well (Byers and Broughton 2004), as evidenced by increased artiodactyl bones in archaeological assemblages, although Hockett (2005) suggested that the increase reflects, at least in part, a rise in communal hunting during the Middle to Late Holocene transition.

Summary

The HTFM argues that because they were highly mobile, Paleoindians relied on bifacial cores as an optimization strategy. Although the model was initially developed in the Great Plains it was quickly adopted in the Great Basin. Recent studies (e.g., Bamforth 2002, 2003; Eren and Andrews 2013; Kuhn 1991; Prasciunas 2007; Surovell

2009) suggest that the model may not adequately explain Paleoindian technological organization on the Plains or anywhere else, and its applicability to the Great Basin remains untested. In the remainder of this study, I explore one aspect of the HTFM – the reliance on bifacial cores as efficient sources of raw material – in the Great Basin. I compare the relative frequency of bifaces in Paleoindian and Archaic assemblages from the Great Basin, in both toolstone-rich and toolstone-poor areas, to investigate the role of bifacial cores in the Paleoindian toolkit and, by extension, the applicability of that aspect of the HTFM in the region.

CHAPTER 2

MATERIALS AND METHODS

In this study, I test two hypotheses related to the use of bifacial cores by Paleoindian groups in the Great Basin: (1) bifaces played a more central role in Paleoindian lithic technological organization in the northwestern and central Great Basin than later Archaic technological organization in those same regions; and (2) because high quality raw material is rare in the central Great Basin, groups there relied more heavily on bifacial technology throughout time than groups in the toolstone-rich northwestern Great Basin. In this chapter, I describe the northwestern and central Great Basin, discuss the sites from which my data are derived, outline how I evaluate the role of bifacial technology across space and time, and lay out my expectations for the two hypotheses.

Chronological Control

Because my sample is derived from a review of published reports featuring both surface and sub-surface assemblages, the chronological resolution of the various components and how researchers assigned age ranges to them varied widely. In all cases I used published dates provided in site reports to assign each component to one of four time periods: (1) Paleoindian (pre-8350 cal BP); (2) Early Archaic (8320-5150 cal BP); (3) Middle Archaic (5150-1380 cal BP); and (4) Late Archaic (post-1380 cal BP).

Most surface sites in the Great Basin lack organic material that can be radiocarbon dated. As a result, researchers usually rely on typological cross-dating, which uses temporally diagnostic artifacts (in this case, projectile points) to assign sites to a time period. Although this method provides only coarse-grained chronological control, it is sufficient for my purpose because it allowed me to assign components to the broad cultural periods outlined above. While several point typologies (e.g., Oetting 1994; Thomas 1981), each with slightly different age ranges for the different point types, were employed in the published reports from which I collected my data, WST, fluted, and Great Basin Concave Base points are universally associated with the Paleoindian period; Large Side-notched points (referred to as Northern Side-notched in the northwestern region) are associated with the Early Archaic period; Elko and Gatecliff projectile points are associated with the Middle Archaic period; and Rosegate, Desert Side-notched, and Cottonwood projectile points are associated with the Late Archaic period (Oetting 1994; Thomas 1981) (Table 2.1). Due to the broad time range associated with them, I excluded Humboldt points from my study. Chronological control for subsurface sites in my sample was generally obtained through radiocarbon dating, the position of artifacts relative to strata of known ages (e.g., Mazama tephra), and/or typological cross-dating. Date ranges for subsurface components were often tighter than those for surface components; however, I still assigned them to the four broad time periods outlined above.

Table 2.1. Projectile Point Types by Time Period (After Pattee 2014).

Paleoindian **Pre-8350 cal BP**	**Early Archaic** **8350-5150 cal BP**	**Middle Archaic** **5150-1380 cal BP**	**Late Archaic** **Post-1380 cal BP**
WST	Large Side-notched	Elko series	Rosegate
Fluted		Gatecliff series	Desert Side-notched
Great Basin Concave Base			Cottonwood Triangular

The Study Areas

The Northwestern Great Basin

The northwestern Great Basin covers northwestern Nevada, northeastern California, and southeastern Oregon (Figure 2.1). It is characterized by volcanic tablelands rather than basin-and-range topography typical of other parts of the Great Basin. Often referred to as the High Rock Country (Layton 1970), the region falls within Thomas' (2011) Obsidian Rim and the majority of the assemblages are dominated by obsidian (see Figure 1.2). I collected data from 105 components from the northwestern Great Basin, which I briefly review below.

Last Supper Cave. Last Supper Cave is located along Hell Creek in northwestern Nevada (Felling 2015; Layton and Davis 1978). It was excavated by Thomas Layton in 1968 and 1973-1974 (Layton and Davis 1978). The cave held a rich record of human occupation spanning the Holocene. Artifacts in my sample were recovered from the two TP/EH strata: The White and Lower Shell layers.

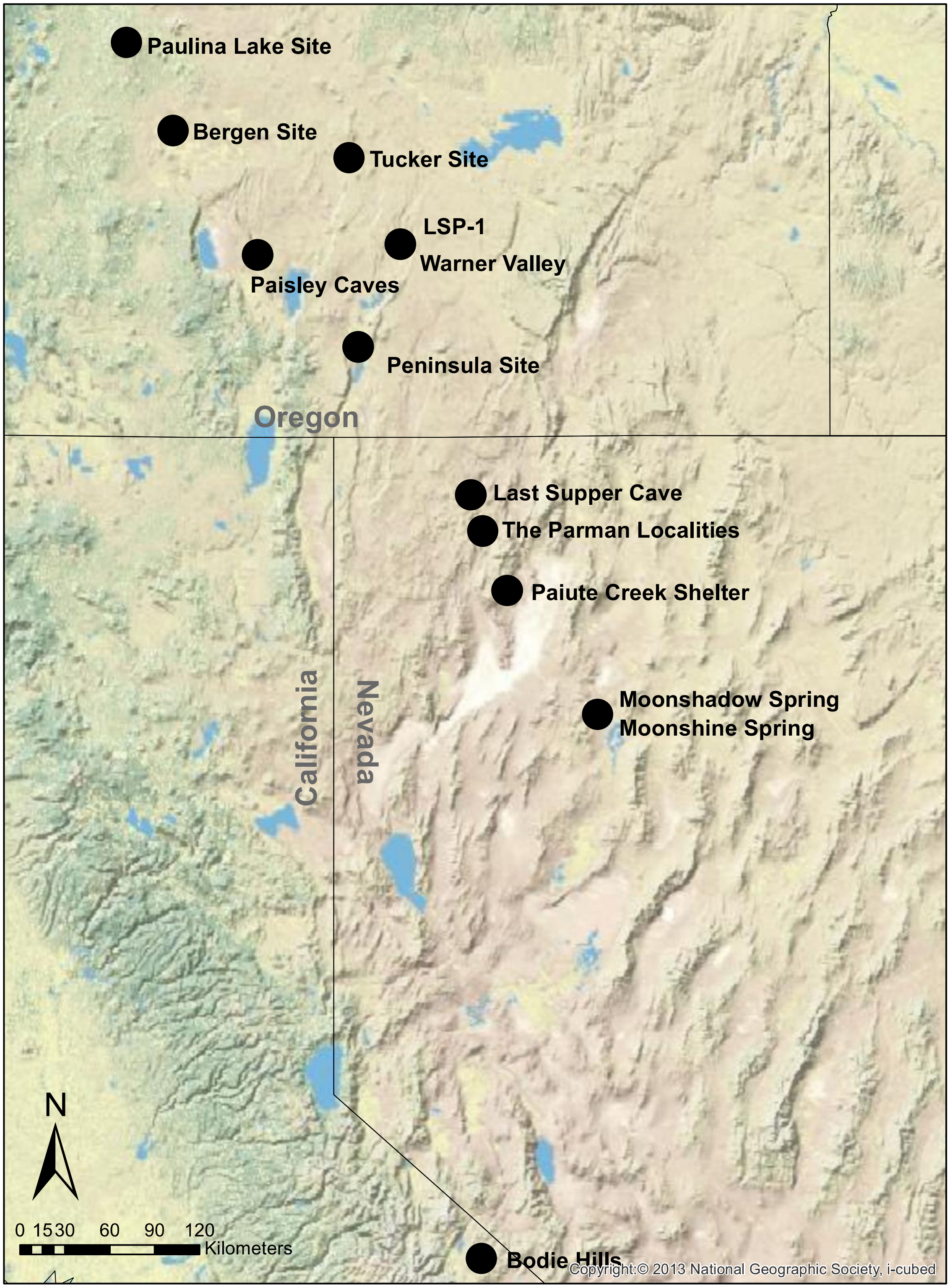

Figure 2.1. Locations of sites in the northwestern Great Basin sample.

Little Steamboat Point-1. Little Steamboat Point-1 (LSP-1) is one of a series of small rockshelters located in northern Warner Valley, Oregon. It was excavated by the Great Basin Paleoindian Research Unit (UNR) between 2010 and 2015. The earliest occupation of the cave dates to the Early Holocene and the artifacts included in my sample were recovered from pre-Mazama deposits (Ware Van der Voort 2016).

Moonshine Spring South (CRNV-22-5540) and Moonshadow Spring (CRNV-22-7636). Moonshine Spring and Moonshadow Spring are two lithic scatters situated around fossil springs on the western edge of the Antelope Range in northwestern Nevada. A crew from UNR tested the sites in 2003 and recovered small numbers of WST points, various tools, and debitage. Both sites represent Paleoindian occupations (Smith et al. 2004).

Paisley Cave 2 (Botanical Lens). The Paisley Five Mile Point Caves are a series of rockshelters in Oregon’s Summer Lake Basin. The caves are famous for the discovery of pre-Clovis human coprolites, which makes it one of the earliest widely-recognized occupations in North America (Gilbert et al. 2008; Jenkins et al. 2013). The caves were first investigated by Luther Cressman between 1938 and 1940. From 2002 to 2011, the University of Oregon conducted field schools and excavated a significant portion of the caves’ remaining deposits. Artifacts included in my study originated in the botanical lens in Cave 2, which is TP/EH in age (Jenkins et al. 2016).

The Parman Localities (CRNV-02-194, CRNV-02-195, CRNV-02-192, and CRNV-02-193). The Parman Localities are four lithic concentrations located in Five Mile Flat, which once held pluvial Lake Parman (Layton 1970; Smith 2006). The sites were investigated by Layton in 1968 and revisited by a crew from UNR in 2004 (Layton 1970;

Smith 2006). Work at the site produced 900+ tools and samples of debitage from the four sites. Based on the predominance of WST points in the assemblages, the sites are Paleoindian in age (Layton 1970; Smith 2006).

Paulina Lake (35DS34). The Paulina Lake Site is located at the western edge of Paulina Lake in central Oregon's Newberry Crater. The crater is home to several sites and was first tested in 1960 and again in 1988. Excavations uncovered cultural material both above and below Mt. Mazama tephra. The site was tested again in 1990-1991 by the University of Oregon and extensively excavated in 1992. Work uncovered a rich archaeological record featuring one of the only Paleoindian residential features found in the Far West. Components 1 and 2 date to the Paleoindian period while components 4 and 5 date to the Middle and Late Archaic periods, respectively (Connolly and Jenkins 1999).

The Tucker Site (35LK3227). The Tucker Site is an open-air site with a subsurface WST component located on the eastern edge the Dietz Basin in south-central Oregon. The site was initially investigated by John Fagan (1986, 1988) and Judith Willig (1988), with more recent work conducted by UNR in 1996-1997. Excavations and backhoe trenching revealed complex stratigraphy and rich record of WST occupation (Pinson 2004).

The Northern Warner Valley Study Area (NWVSA). Located in south-central Oregon, Warner Valley contains a rich archaeological record. The Great Basin Paleoindian Research Unit conducted pedestrian survey in the northern portion of the valley, which became known as the Northern Warner Valley Study Area (NWVSA), from 2011 to 2013 and recorded numerous Paleoindian and later occupations. I included

28 such sites – lithic scatters described by Pattee (2014) – in my sample. Nineteen of the sites date to the Paleoindian period, five date to the Middle Archaic period, and three date to the Late Archaic period.

Bodie Hills. The Bodie Hills lie along the eastern Sierra Nevada and although they are not in the northwestern Great Basin, they do fall firmly within Thomas' (2011) Obsidian Rim and as such I included sites from there in my northwestern Great Basin sample. Carey (2013) analyzed 81 sites ranging in age from the TP/EH through the Late Holocene and I gleaned data from that analysis. Carey (2013) grouped sites into three time periods: (1) Early (pre-5000 cal BP); (2) Middle (5000-1300 cal BP); and (3) Late (post-1300 cal BP). His Middle and Late age ranges are similar to my Middle and Late Archaic periods so I included them in my study; however, because his Early period encompasses both my Early Archaic and Paleoindian periods, I excluded those sites from my sample.

The Bergen Site (35LK3175). The Bergen Site is located in the Fort Rock Basin in south-central Oregon. Two houses and a butchering area were excavated by University of Oregon field schools between 1998 and 2000. Radiocarbon dates obtained from the site indicate that it was occupied from ca. 6000 to 4000 cal BP (Helzer 2004), which places it in my Early Archaic period sample.

Paiute Creek Shelter (26HU147). Paiute Creek Shelter is located along Paiute Creek in northwestern Nevada's Black Rock Desert. The shelter was first recorded by Elston and Davis in 1978 and later tested by UNR in 2006. Numerous strata were lumped into four components: components 1-3 are associated with the Late Archaic period while Component 4 is associated with the Middle Archaic period (LaValley 2013).

The Peninsula Site (35LK2579). The Peninsula Site consists of a series of rock rings and depressions on a peninsula jutting out along the eastern shore of Hart Lake in southern Warner Valley. Excavations conducted by UNR in 1990, 1995, and 1996 revealed that the depressions were remains of residential structures. Based on archaeological and geological evidence, the site appears to have been occupied during the Late Archaic period ca. 700-200 cal BP (Eiselt 1998).

The Central Great Basin

The central Great Basin encompasses central and north-central Nevada (Thomas 2011) (Figure 2.2). The region is generally characterized by basin-and-range topography and unlike the northwestern Great Basin, the central Great Basin (Thomas' [2011] Chert Core) is obsidian-poor (see Figure 1.2). The majority of sites are open-air, rather than cave/rockshelter sites, especially during the Paleoindian period. My central Great Basin sample includes 50 assemblages, each of which I introduce below.

The Eastern Nevada Project Area. The Eastern Nevada Project Area (ENPA) included 17 sites that Jones et al. (2003) used to developed their lithic conveyance zone model for the central Great Basin. The sites are located in Butte and Jakes valleys. Butte Valley sites include the Combs Creek Localities 1-9, the Hunter Point Localities 1-3 and 5, and the White Sage Well Localities 1a-c. Jakes Valley sites include Limestone Peak Locality 1 and Illapah Locality 1. The predominance of WST projectile points in these assemblages led Jones et al. (2003) to conclude that they are Paleoindian in age.

Figure 2.2. Locations of sites in the central Great Basin sample.

The Sunshine Locality. The Sunshine Locality is a well-studied Paleoindian site located in southern Long Valley, ~60 km northwest of Ely, Nevada. Several decades of surface collection and subsurface excavations at the site have produced crescents, fluted and unfluted concave based projectile points, and hundreds of WST projectile points. Artifacts span the Paleoindian through the Late Archaic periods but the overwhelming majority are diagnostic of the Paleoindian period (Beck and Jones 2009).

Gatecliff Shelter. Gatecliff Shelter is located in the Toquima Range in central Nevada. It was excavated as part of a larger archaeological investigation of Monitor Valley that took place from 1970 to 1983 (Thomas 1983). The shelter was extensively excavated and by 1978 excavations had reached a depth of 10 m. The shelter was occupied from the latter half of the Early Archaic period through Late Archaic period and provided data for four Early Archaic components, four Middle Archaic components, and six Late Archaic components.

Pie Creek (CRNV-12-05001) and Tule Valley Rockshelters (CRNV-12-10709). Pie Creek and Tule Valley rockshelters are located in north-central Nevada’s Tule Valley and were excavated between 1998 and 2000 (McGuire et al. 2004). Pie Creek Shelter was occupied from the latter half of the Early Archaic period through the Late Archaic period. Component I is associated with the Late Archaic period, components II and III are associated with the Middle Archaic period, and Component IV is associated with the Early Archaic period. Tule Valley Shelter was occupied during the Late Archaic period (McGuire et al. 2004).

The Pine Nut Mountains. The Pine Nut Mountain sample includes 26 sites located in the Pine Nut Mountains of western Nevada. The sites were investigated by

Summit Envirosolutions, Inc. in 2005 (Johnson 2009). Of the 26 sites, 13 could be assigned to a single time period; three date to the Middle Archaic period and 10 date to the Late Archaic period.

The Vista Site (26WA3017). The Vista Site is located in the eastern Truckee Meadows in northwestern Nevada. The site was discovered when the Nevada Department of Transportation proposed modification of the freeway east of Sparks, Nevada. Beginning in 1982, the site was surface collected, 13 backhoe trenches were opened, and excavations were undertaken. Results of this investigation indicate that the site was occupied primarily during the Late Archaic period (Zeier and Elston 1986).

Materials

My sample of artifacts includes 3,543 tools and 8,103 flakes from 106 sites/study areas in the northwestern Great Basin and 3,207 tools and 35,350 flakes from 51 sites/study areas in the central Great Basin (Table 2.2). I collected these data from published articles, books, and reports produced as part of academic and compliance-related Cultural Resource Management projects. Assemblages from both open-air and cave/rockshelter sites are represented in the sample, as are surface and excavated assemblages. Although not a complete sample of sites from either region, which would be time-prohibitive to collect, my sample is diverse and large enough to accurately characterize the archaeological records of the northwestern and central Great Basin. One exception to this statement is Early Archaic assemblages, which were hard to come by in both areas, perhaps because human population levels were low during that period (Louderback et al. 2010).

Artifacts from Northwestern Great Basin Sites

The northwestern Great Basin Paleoindian sample includes 743 bifaces, 827 non-bifacial tools, 2,348 biface thinning flakes, and 1,436 non-biface thinning flakes from 32 components. The Early Archaic sample includes 50 bifaces and 51 non-bifacial tools from two components. No debitage data were available for Early Archaic components. The Middle Archaic sample includes 229 bifaces, 80 non-bifacial tools, 199 biface thinning flakes, and 25 non-biface thinning flakes from 32 components. Finally, the Late Archaic sample includes 840 bifaces, 723 non-bifacial tools, 1,282 biface thinning flakes, and 2,813 non-biface thinning flakes from 41 components (Table 2.3) Early on in my data collection, I elected to exclude projectile points from my sample because, as I discuss below, they were not likely used as cores

Artifacts from Central Great Basin Sites

The central Great Basin Paleoindian sample includes 706 bifaces, 1,305 non-bifacial tools, 5,889 biface thinning flakes, and 1,737 non-biface thinning flakes from 18 components. The Early Archaic sample includes 35 bifaces, 10 non-bifacial tools, 628 biface thinning flakes, and 1,552 non-biface thinning flakes from five components. The Middle Archaic sample includes 283 bifaces, 143 non-bifacial tools, 2,189 biface thinning flakes, and 5,844 non-biface thinning flakes from nine components. Finally, the Late Archaic sample includes 573 bifaces, 152 non-bifacial tools, 6,385 biface thinning flakes, and 11,126 non-biface thinning flakes from 18 components (Table 2.4)

Methods

Bifaces

Following Andrefsky (2005:253), I define a biface as “a tool that has two surfaces (faces) that meet to form a single edge that circumscribes the tool”. For the purpose of this study, I excluded projectile points from the analysis. I did so because, although they are bifaces by definition, projectile points are finished tools that were likely not commonly used as cores; as Bamforth (2003:210) points out, the reduction sequences for projectile points and cores are “fundamentally different.” Furthermore, Smith and Kielhofer (2011) and others (e.g., Eerkens et al. 2007; Smith 2006) have demonstrated that finished points often display very different source profiles than unfinished/production bifaces. These facts suggest that points should not be lumped together with bifaces or the byproducts of biface manufacture.

Table 2.2. Summary of Assemblages Used in this Study.

Site	Period	Reference
Northwestern Great Basin		
Last Supper Cave: White Stratum	Paleoindian	Felling 2015
Last Supper Cave: Lower Shell Stratum	Paleoindian	Felling 2015
Little Steamboat Point-1	Paleoindian	Ware Van der Voort 2016
Moonshadow Spring (CRNV-22-7636)	Paleoindian	Smith et al. 2004
Moonshine Spring (CRNV-22-5540)	Paleoindian	Smith et al. 2004
Paisley Cave 2 Botanical Lens	Paleoindian	Jenkins et al. 2016
Parman Locality 1 (CrNV-02-194)	Paleoindian	Smith 2006
Parman Locality 2 (CrNV-02-194)	Paleoindian	Smith 2006
Parman Locality 3 (CrNV-02-194)	Paleoindian	Smith 2006
Parman Locality 4 (CrNV-02-194)	Paleoindian	Smith 2006
Paulina Lake (35DS34) Components 1 and 2	Paleoindian	Connolly and Jenkins 1999
Tucker Site (35LK3227)	Paleoindian	Pinson 2004
Warner Valley A1	Paleoindian	Pattee 2014
Warner Valley A6	Paleoindian	Pattee 2014
Warner Valley C3	Paleoindian	Pattee 2014
Warner Valley G13	Paleoindian	Pattee 2014
Warner Valley G14	Paleoindian	Pattee 2014
Warner Valley G19	Paleoindian	Pattee 2014
Warner Valley G31	Paleoindian	Pattee 2014
Warner Valley G43	Paleoindian	Pattee 2014
Warner Valley G43	Paleoindian	Pattee 2014

Site	Period	Reference
Warner Valley J7	Paleoindian	Pattee 2014
Warner Valley P3	Paleoindian	Pattee 2014
Warner Valley T110	Paleoindian	Pattee 2014
Warner Valley T110	Paleoindian	Pattee 2014
Warner Valley T12	Paleoindian	Pattee 2014
Warner Valley T14	Paleoindian	Pattee 2014
Warner Valley T16	Paleoindian	Pattee 2014
Warner Valley T17	Paleoindian	Pattee 2014
Warner Valley T7	Paleoindian	Pattee 2014
Warner Valley T8	Paleoindian	Pattee 2014
Warner Valley T9	Paleoindian	Pattee 2014
Bergen (35LK3175) 2000 House	Early Archaic	Helzer 2004
Bergen (35LK3175) Butchering Area	Early Archaic	Helzer 2004
Bodie Hills 1118	Middle Archaic	Carey 2013
Bodie Hills 1161	Middle Archaic	Carey 2013
Bodie Hills 1284	Middle Archaic	Carey 2013
Bodie Hills 1348	Middle Archaic	Carey 2013
Bodie Hills 1382	Middle Archaic	Carey 2013
Bodie Hills 1395	Middle Archaic	Carey 2013
Bodie Hills 1427	Middle Archaic	Carey 2013
Bodie Hills 1451	Middle Archaic	Carey 2013
Bodie Hills 1457	Middle Archaic	Carey 2013
Bodie Hills 1537	Middle Archaic	Carey 2013

Site	Period	Reference
Bodie Hills 1576	Middle Archaic	Carey 2013
Bodie Hills 1947	Middle Archaic	Carey 2013
Bodie Hills 276	Middle Archaic	Carey 2013
Bodie Hills 3103	Middle Archaic	Carey 2013
Bodie Hills 3131	Middle Archaic	Carey 2013
Bodie Hills 3858	Middle Archaic	Carey 2013
Bodie Hills 4001	Middle Archaic	Carey 2013
Bodie Hills 4375	Middle Archaic	Carey 2013
Bodie Hills 4549	Middle Archaic	Carey 2013
Bodie Hills 4556	Middle Archaic	Carey 2013
Bodie Hills 4558	Middle Archaic	Carey 2013
Bodie Hills 4559	Middle Archaic	Carey 2013
Bodie Hills 4560	Middle Archaic	Carey 2013
Bodie Hills 4583	Middle Archaic	Carey 2013
Bodie Hills 4832	Middle Archaic	Carey 2013
Bodie Hills 4915	Middle Archaic	Carey 2013
Paiute Creek Shelter (26HU147) Component 4	Middle Archaic	LaValley 2013
Paulina Lake (35DS34) Component 4	Middle Archaic	Connolly and Jenkins 1999
Warner Valley C14	Middle Archaic	Pattee 2014
Warner Valley G30	Middle Archaic	Pattee 2014
Warner Valley T20	Middle Archaic	Pattee 2014
Warner Valley T26	Middle Archaic	Pattee 2014
Bodie Hills 1191	Late Archaic	Carey 2013

Site	Period	Reference
Bodie Hills 1349	Late Archaic	Carey 2013
Bodie Hills 1400	Late Archaic	Carey 2013
Bodie Hills 1479	Late Archaic	Carey 2013
Bodie Hills 1549	Late Archaic	Carey 2013
Bodie Hills 1555	Late Archaic	Carey 2013
Bodie Hills 1605	Late Archaic	Carey 2013
Bodie Hills 265	Late Archaic	Carey 2013
Bodie Hills 2749	Late Archaic	Carey 2013
Bodie Hills 2750	Late Archaic	Carey 2013
Bodie Hills 3114	Late Archaic	Carey 2013
Bodie Hills 3116	Late Archaic	Carey 2013
Bodie Hills 3122	Late Archaic	Carey 2013
Bodie Hills 3861	Late Archaic	Carey 2013
Bodie Hills 3863	Late Archaic	Carey 2013
Bodie Hills 3864	Late Archaic	Carey 2013
Bodie Hills 3866	Late Archaic	Carey 2013
Bodie Hills 3867	Late Archaic	Carey 2013
Bodie Hills 3868	Late Archaic	Carey 2013
Bodie Hills 3870	Late Archaic	Carey 2013
Bodie Hills 3997	Late Archaic	Carey 2013
Bodie Hills 4003	Late Archaic	Carey 2013
Bodie Hills 4523	Late Archaic	Carey 2013
Bodie Hills 4572	Late Archaic	Carey 2013

Site	Period	Reference
Bodie Hills 4790	Late Archaic	Carey 2013
Bodie Hills 4795	Late Archaic	Carey 2013
Bodie Hills 4826	Late Archaic	Carey 2013
Bodie Hills 4835	Late Archaic	Carey 2013
Bodie Hills 4914	Late Archaic	Carey 2013
Paiute Creek Shelter (26HU147) Components 1 and 2	Late Archaic	LaValley 2013
Paiute Creek Shelter (26HU147) Component 3	Late Archaic	LaValley 2013
Paulina Lake (35DS34) Component 5	Late Archaic	Connolly 1999
Peninsula (35LK2579) Groundstone Feature	Late Archaic	Eiselt 1998
Peninsula (35LK2579) Structure 1	Late Archaic	Eiselt 1998
Peninsula (35LK2579) Structure 2	Late Archaic	Eiselt 1998
Peninsula (35LK2579) Structure 3	Late Archaic	Eiselt 1998
Peninsula (35LK2579) Structure 4	Late Archaic	Eiselt 1998
Warner Valley C2	Late Archaic	Pattee 2014
Warner Valley G29	Late Archaic	Pattee 2014
Warner Valley P5	Late Archaic	Pattee 2014
Central Great Basin		
Combs Creek Locality 1 (26WP2197)	Paleoindian	George T. Jones*
Combs Creek Locality 2 (26WP2198)	Paleoindian	George T. Jones*
Combs Creek Locality 3 (26WP2199)	Paleoindian	George T. Jones*
Combs Creek Locality 4 (26WP2193)	Paleoindian	George T. Jones*
Combs Creek Locality 5/8 (26WP2200)	Paleoindian	George T. Jones*

Site	Period	Reference
Combs Creek Locality 6 (26WP2201)	Paleoindian	George T. Jones*
Combs Creek Locality 7 (26WP2202)	Paleoindian	George T. Jones*
Combs Creek Locality 9	Paleoindian	George T. Jones*
Hunter Point Locality 1 (26WP2192)	Paleoindian	George T. Jones*
Hunter Point Locality 2 (26WP2194)	Paleoindian	George T. Jones*
Hunter Point Locality 3 (26WP2203)	Paleoindian	George T. Jones*
Hunter Point Locality 5 (26WP2204)	Paleoindian	George T. Jones*
Illapah Locality 1	Paleoindian	George T. Jones*
Limestone Peak Locality 1	Paleoindian	George T. Jones*
Sunshine Locality	Paleoindian	Beck and Jones 2009
White Sage Well Locality 1a (26-WP-2195a)	Paleoindian	George T. Jones*
White Sage Well Locality 1b (26-WP-2195b)	Paleoindian	George T. Jones*
White Sage Well Locality 1c (26-WP-2195c)	Paleoindian	George T. Jones*
Gatecliff Horizon 12	Early Archaic	Thomas 1983
Gatecliff Horizon 14	Early Archaic	Thomas 1983
Gatecliff Horizon 15	Early Archaic	Thomas 1983
Gatecliff Horizon 16	Early Archaic	Thomas 1983
Pie Creek Rockshelter Component 4 (CRNV-12-05001)	Early Archaic	McGuire et al. 2004
Gatecliff Horizon 10	Middle Archaic	Thomas 1983
Gatecliff Horizon 7	Middle Archaic	Thomas 1983
Gatecliff Horizon 8	Middle Archaic	Thomas 1983
Gatecliff Horizon 9	Middle Archaic	Thomas 1983
Pie Creek Rockshelter Component 2 (CRNV-12-05001)	Middle Archaic	McGuire et al. 2004

Site	Period	Reference
Pie Creek Rockshelter Component 3 (CRNV-12-05001)	Middle Archaic	McGuire et al. 2004
Pine Nuts 1029	Middle Archaic	Johnson 2009
Pine Nuts 836	Middle Archaic	Johnson 2009
Pine Nuts 838	Middle Archaic	Johnson 2009
Gatecliff Horizon 1	Late Archaic	Thomas 1983
Gatecliff Horizon 2	Late Archaic	Thomas 1983
Gatecliff Horizon 3	Late Archaic	Thomas 1983
Gatecliff Horizon 4	Late Archaic	Thomas 1983
Gatecliff Horizon 5	Late Archaic	Thomas 1983
Gatecliff Horizon 6	Late Archaic	Thomas 1983
Pie Creek Rockshelter Component 1 (CRNV-12-05001)	Late Archaic	McGuire et al. 2004
Pine Nuts 1028	Late Archaic	Johnson 2009
Pine Nuts 1034	Late Archaic	Johnson 2009
Pine Nuts 1035	Late Archaic	Johnson 2009
Pine Nuts 1036	Late Archaic	Johnson 2009
Pine Nuts 821	Late Archaic	Johnson 2009
Pine Nuts 823	Late Archaic	Johnson 2009
Pine Nuts 835	Late Archaic	Johnson 2009
Pine Nuts 841	Late Archaic	Johnson 2009
Pine Nuts 826	Late Archaic	Johnson 2009
Pine Nuts 847	Late Archaic	Johnson 2009
Tule Valley Rockshelter (CRNV-12-10709)	Late Archaic	McGuire et al. 2004
Vista Site (26WA3017)	Late Archaic	Zeier and Elston 1986

*Personal communication, 2016

Table 2.3. Tool and Flake Counts from Northwestern Great Basin Assemblages.

Assemblage	**Time Period**	**Bifaces**	**Non-Bifaces**	**BTFs**	**Non-BTFs**
Last Supper Cave Lower Shell Stratum	Paleoindian	20	106	131	32
Last Supper Cave White Stratum	Paleoindian	38	36	22	98
Little Steamboat Point 1	Paleoindian	154	198	-	-
Moonshadow Spring (CRNV-22-7636)	Paleoindian	16	57	57	89
Moonshine Spring (CRNV-22-5540)	Paleoindian	8	12	139	246
Paisley Cave 2: Botanical Lens	Paleoindian	3	14	-	-
Parman Locality 1 (CrNV-02-194)	Paleoindian	178	126	238	193
Parman Locality 2 (CrNV-02-195)	Paleoindian	23	11	24	28
Parman Locality 3 (CrNV-02-192)	Paleoindian	62	52	74	113
Parman Locality 4 (CrNV-02-193)	Paleoindian	38	36	22	33
Paulina Lake (35DS34) Components 1 and 2	Paleoindian	126	117	1,370	306
Tucker Site (35LK3227)	Paleoindian	2	7	271	298
Warner Valley A1	Paleoindian	1	8	-	-
Warner Valley A6	Paleoindian	2	11	-	-
Warner Valley C3	Paleoindian	4	1	-	-
Warner Valley G13	Paleoindian	4	0	-	-
Warner Valley G14	Paleoindian	2	2	-	-
Warner Valley G19	Paleoindian	2	4	-	-
Warner Valley G31	Paleoindian	2	2	-	-
Warner Valley G43	Paleoindian	1	0	-	-
Warner Valley G43	Paleoindian	8	3	-	-
Warner Valley J7	Paleoindian	2	1	-	-

Assemblage	Time Period	Bifaces	Non-Bifaces	BTFs	Non-BTFs
Warner Valley P3	Paleoindian	1	2	-	-
Warner Valley T110	Paleoindian	4	0	-	-
Warner Valley T110	Paleoindian	3	2	-	-
Warner Valley T12	Paleoindian	4	5	-	-
Warner Valley T14	Paleoindian	3	1	-	-
Warner Valley T16	Paleoindian	3	1	-	-
Warner Valley T17	Paleoindian	6	1	-	-
Warner Valley T7	Paleoindian	11	10	-	-
Warner Valley T8	Paleoindian	8	0	-	-
Warner Valley T9	Paleoindian	4	1	-	-
Bergen (35LK3175) 2000 House	Early Archaic	33	37	-	-
Bergen (35LK3175) Butchering Area	Early Archaic	17	14	-	-
Bodie Hills 276	Middle Archaic	14	2	-	-
Bodie Hills 1118	Middle Archaic	17	1	-	-
Bodie Hills 1161	Middle Archaic	15	0	-	-
Bodie Hills 1284	Middle Archaic	16	0	-	-
Bodie Hills 1348	Middle Archaic	10	0	-	-
Bodie Hills 1382	Middle Archaic	10	0	-	-
Bodie Hills 1395	Middle Archaic	2	0	-	-
Bodie Hills 1427	Middle Archaic	1	0	-	-
Bodie Hills 1451	Middle Archaic	1	0	-	-
Bodie Hills 1457	Middle Archaic	5	0	-	-
Bodie Hills 1537	Middle Archaic	2	0	-	-

Assemblage	Time Period	Bifaces	Non-Bifaces	BTFs	Non-BTFs
Bodie Hills 1576	Middle Archaic	1	1	-	-
Bodie Hills 1947	Middle Archaic	2	1	-	-
Bodie Hills 3103	Middle Archaic	2	0	-	-
Bodie Hills 3131	Middle Archaic	1	0	-	-
Bodie Hills 3858	Middle Archaic	4	10	-	-
Bodie Hills 4001	Middle Archaic	1	0	-	-
Bodie Hills 4375	Middle Archaic	3	0	-	-
Bodie Hills 4549	Middle Archaic	8	2	-	-
Bodie Hills 4556	Middle Archaic	16	0	-	-
Bodie Hills 4558	Middle Archaic	6	0	-	-
Bodie Hills 4559	Middle Archaic	9	0	-	-
Bodie Hills 4560	Middle Archaic	4	0	-	-
Bodie Hills 4583	Middle Archaic	1	0	-	-
Bodie Hills 4832	Middle Archaic	3	0	-	-
Bodie Hills 4915	Middle Archaic	3	0	-	-
Paiute Creek Shelter (26HU147) Component 4	Middle Archaic	25	16	199	25
Paulina Lake (35DS34) Component 4	Middle Archaic	39	36	-	-
Warner Valley C14	Middle Archaic	3	2	-	-
Warner Valley G30	Middle Archaic	1	4	-	-
Warner Valley T20	Middle Archaic	1	3	-	-
Warner Valley T26	Middle Archaic	3	2	-	-
Bodie Hills 265	Late Archaic	4	0	-	-
Bodie Hills 1191	Late Archaic	1	0	-	-

Assemblage	**Time Period**	**Bifaces**	**Non-Bifaces**	**BTFs**	**Non-BTFs**
Bodie Hills 1349	Late Archaic	3	0	-	-
Bodie Hills 1400	Late Archaic	1	0	-	-
Bodie Hills 1479	Late Archaic	3	0	-	-
Bodie Hills 1549	Late Archaic	9	0	-	-
Bodie Hills 1555	Late Archaic	3	0	-	-
Bodie Hills 1605	Late Archaic	1	0	-	-
Bodie Hills 2749	Late Archaic	4	0	-	-
Bodie Hills 2750	Late Archaic	2	0	-	-
Bodie Hills 3114	Late Archaic	0	2	-	-
Bodie Hills 3116	Late Archaic	9	6	-	-
Bodie Hills 3122	Late Archaic	1	2	-	-
Bodie Hills 3861	Late Archaic	13	3	-	-
Bodie Hills 3863	Late Archaic	3	0	-	-
Bodie Hills 3864	Late Archaic	4	1	-	-
Bodie Hills 3866	Late Archaic	1	3	-	-
Bodie Hills 3867	Late Archaic	7	1	-	-
Bodie Hills 3868	Late Archaic	9	3	-	-
Bodie Hills 3870	Late Archaic	1	4	-	-
Bodie Hills 3997	Late Archaic	1	1	-	-
Bodie Hills 4003	Late Archaic	5	6	-	-
Bodie Hills 4523	Late Archaic	100+	0	-	-
Bodie Hills 4572	Late Archaic	2	0	-	-
Bodie Hills 4790	Late Archaic	5	0	-	-

Assemblage	**Time Period**	**Bifaces**	**Non-Bifaces**	**BTFs**	**Non-BTFs**
Bodie Hills 4795	Late Archaic	2	0	-	-
Bodie Hills 4826	Late Archaic	6	0	-	-
Bodie Hills 4835	Late Archaic	30	0	-	-
Bodie Hills 4914	Late Archaic	19	3	-	-
Paiute Creek Shelter (26HU147) Components 1 and 2	Late Archaic	233	108	294	71
Paiute Creek Shelter (26HU147) Component 3	Late Archaic	128	44	244	97
Paulina Lake (35DS34) Component 5	Late Archaic	14	17	-	-
Peninsula (35LK2579) Groundstone Feature	Late Archaic	5	1	57	50
Peninsula (35LK2579) Structure 1	Late Archaic	9	41	203	475
Peninsula (35LK2579) Structure 2	Late Archaic	5	9	71	151
Peninsula (35LK2579) Structure 3	Late Archaic	2	10	141	316
Peninsula (35LK2579) Structure 4	Late Archaic	16	2	225	536
Warner Valley C2	Late Archaic	4	0	-	-
Warner Valley G29	Late Archaic	7	9	-	-
Warner Valley P5	Late Archaic	1	3	-	-

Table 2.4. Tool and Flake Counts from Central Great Basin Assemblages.

Assemblage	**Time Period**	**Bifaces**	**Non-Bifaces**	**BTFs**	**Non-BTFs**
Combs Creek Locality 1 (26WP2197)	Paleoindian	12	5	76	20
Combs Creek Locality 2 (26WP2198)	Paleoindian	9	2	12	7
Combs Creek Locality 3 (26WP2199)	Paleoindian	14	2	34	9
Combs Creek Locality 4 (26WP2193)	Paleoindian	4	0	123	35
Combs Creek Locality 5/8 (26WP2200)	Paleoindian	48	40	703	195
Combs Creek Locality 6 (26WP2201)	Paleoindian	2	3	2	19
Combs Creek Locality 7 (26WP2202)	Paleoindian	8	6	16	34
Combs Creek Locality 9	Paleoindian	11	8	96	79
Hunter Point Locality 1 (26WP2192)	Paleoindian	18	1	46	26
Hunter Point Locality 2 (26WP2194)	Paleoindian	55	16	161	177
Hunter Point Locality 3 (26WP2203)	Paleoindian	46	23	665	95
Hunter Point Locality 5 (26WP2204)	Paleoindian	108	70	928	137
Illapah Locality 1	Paleoindian	13	6	56	25
Limestone Peak Locality 1	Paleoindian	133	147	1,486	350
Sunshine Locality	Paleoindian	215	975	1,418	472
White Sage Well Locality 1a (26-WP-2195a)	Paleoindian	5	0	29	31
White Sage Well Locality 1b (26-WP-2195b)	Paleoindian	4	0	30	17
White Sage Well Locality 1c (26-WP-2195c)	Paleoindian	1	1	8	9
Gatecliff Horizon 12	Early Archaic	4	1	-	-
Gatecliff Horizon 14	Early Archaic	7	1	-	-
Gatecliff Horizon 15	Early Archaic	3	0	-	-
Gatecliff Horizon 16	Early Archaic	1	0	-	-

Assemblage	Time Period	Bifaces	Non-Bifaces	BTFs	Non-BTFs
Pie Creek Rockshelter Component 4 (CRNV-12-05001)	Early Archaic	20	8	628	1,552
Gatecliff Horizon 10	Middle Archaic	3	0	-	-
Gatecliff Horizon 7	Middle Archaic	98	7	-	-
Gatecliff Horizon 8	Middle Archaic	70	4	-	-
Gatecliff Horizon 9	Middle Archaic	18	6	-	-
Pie Creek Rockshelter Component 2 (CRNV-12-05001)	Middle Archaic	36	6	1,210	2,634
Pie Creek Rockshelter Component 3 (CRNV-12-05001)	Middle Archaic	23	5	696	2,846
Pine Nuts 1029	Middle Archaic	1	2	70	113
Pine Nuts 836	Middle Archaic	18	40	77	81
Pine Nuts 838	Middle Archaic	16	73	136	170
Gatecliff Horizon 1	Late Archaic	11	5	-	-
Gatecliff Horizon 2	Late Archaic	40	1	-	-
Gatecliff Horizon 3	Late Archaic	60	8	-	-
Gatecliff Horizon 4	Late Archaic	100	11	-	-
Gatecliff Horizon 5	Late Archaic	145	16	-	-
Gatecliff Horizon 6	Late Archaic	10	0	-	-
Pie Creek Rockshelter Component 1 (CRNV-12-05001)	Late Archaic	125	10	3,063	6,210
Pine Nuts 1028	Late Archaic	5	13	145	219
Pine Nuts 1034	Late Archaic	4	14	378	563
Pine Nuts 1035	Late Archaic	2	2	2	3
Pine Nuts 1036	Late Archaic	50	44	2,592	3,661
Pine Nuts 821	Late Archaic	0	1	1	1
Pine Nuts 823	Late Archaic	2	2	2	2

Assemblage	**Time Period**	**Bifaces**	**Non-Bifaces**	**BTFs**	**Non-BTFs**
Pine Nuts 835	Late Archaic	9	15	120	178
Pine Nuts 841	Late Archaic	1	0	25	28
Pine Nuts 826	Late Archaic	1	0	8	10
Pine Nuts 847	Late Archaic	0	7	3	4
Tule Valley Rockshelter (CRNV-12-10709)	Late Archaic	8	3	46	247
Vista Site (26WA3017)	Late Archaic	267	444	47	1117

Because my sample is derived from various published sources, there was some inconsistency in how data were originally reported. In several cases, bifaces were subdivided by stage or presumed organizational role while in other cases there was simply a single category for bifaces. Whenever possible, I excluded bifacial tool types such as drills and preforms that were likely not used as cores.

Biface Thinning Flakes

A biface thinning flake (BTF) is defined as "a flake that is removed during biface trimming and often contains a striking platform that is rounded or ground, indicating preparation. It is usually thin relative to width, with a feathered termination" (Andrefsky 2005:253). As was the case with the biface data, debitage data were reported in a number of ways. When platform type (but not flake type) was reported, I categorized flakes with complex or multi-faceted platforms as BTFs and flakes with simple platforms as non-BTFs. I also categorized biface trimming and biface reduction flakes as BTFs. I excluded flake fragments and shatter from my sample. Because they lack some diagnostic features (i.e., platforms or dorsal and/or ventral surfaces), it is impossible to know what production activity these flake types reflect (Andrefsky 2005).

The Biface and Biface Thinning Indices

A key component of the HTFM is that bifaces were a central element of a portable and flexible toolkit employed by mobile Paleoindians. If this was the case, then bifaces and byproducts of biface manufacture should be more common in early assemblages than in later assemblages deposited by groups generally assumed to be more sedentary (Kelly 1988; Parry and Kelly 1987). To determine if this is indeed the case and, in turn, if the HTFM is applicable to TP/EH groups in the Great Basin, I calculated Biface Index (BI) and Biface Thinning Index (BTI) values for components from the various time periods. Indices are common in archaeological studies; for example, the Artiodactyl Index has been used to make arguments about subsistence and settlement (Broughton et al. 2008; Byers and Broughton 2004; Elston and Zeanah 2002; Elston et al. 2014; Pinson 2007). It provides a rough measure of the proportions of large and small game in assemblages. Similarly, studies of technological organization often include biface, projectile point, and/or flake tool indices (e.g., Carey 2013; Pattee 2014). The Biface Index (BI), which produces a value that represents the proportion of bifaces in an assemblage, is calculated using the following equation:

$$BI=\frac{\sum B}{\sum B+N}$$

where the Biface Index (BI) is represented by the number of bifaces (B) divided by the number all chipped stone tools (excluding projectile points), or the number of bifaces plus the number of non-bifaces (N). This equation produces a number between 0 and 1, with 0 representing an assemblage with no bifaces and 1 representing an assemblage comprised entirely of bifaces.

Similarly, the Biface Thinning Index (BTI) provides a sense of the proportion of biface thinning flakes in an assemblage. The BTI is calculated using the following equation:

$$\text{BTI}=\frac{\sum \text{BTF}}{\sum \text{BTF+N}}$$

where the number of biface thinning flakes (BTF) is divided by the sum of non-biface thinning flakes (N) and biface thinning flakes (BTF).

Analyses

Once I calculated BI and BTI values for each component, I compared them across time and between regions. When data were normally distributed (determined using a Shapiro-Wilke test), I used parametric ANOVA or Student's *t*-tests to test for significant differences between samples. When data were not normally distributed, I used non-parametric Kruskal-Wallis or Mann-Whitney tests. I used IBM's SPSS for all statistical comparisons and in all cases I considered a p value of ≤ 0.05 to be significant.

The first set of tests was designed to evaluate my first hypothesis: bifaces played a more central role in Paleoindian lithic technological organization in the northwestern and central Great Basin, respectively than later Archaic technological organization in those same regions. If this was the case, then I expected to find significant differences in BI and BTI values across time in both regions, with the highest values occurring during the Paleoindian period.

The second set of tests was designed to evaluate my second hypothesis: because high quality raw material is rare in the central Great Basin, groups there relied more heavily on bifacial technology throughout time than those in the toolstone-rich northwestern Great Basin. Because obsidian – the favored raw material type in the region – is less common in the central Great Basin than in the northwestern Great Basin, bifacial technology may have been used in a different manner there (e.g., bifaces may have served as cores). To explore the influence of raw-material availability on the role of bifacial technology, I compared BI and BTI values of components from the northwestern and central Great Basin during the various time periods. If raw material availability was an important factor in technological organization, then I expected BI and BTI values to be highest in the central region. Table 2.5 summarizes my hypotheses, tests, and expectations for the BI and BTI analyses.

Table 2.5. Hypotheses, Tests and Measures, and Expectations.

Hypothesis	**Tests and Measures**	**Expectations**
Bifaces played a more central role in Paleoindian lithic technological organization in the northwestern and central Great Basin than later Archaic technological organization in those same regions.	BI: Paleoindian vs. Archaic in each region	BI: Paleoindian > Archaic
	BTI: Paleoindian vs. Archaic in each region	BTI: Paleoindian > Archaic
Because high quality raw material is rare in the central Great Basin, groups there relied more heavily on bifacial technology throughout time than those in the toolstone-rich northwestern Great Basin.	BI: Northwestern vs. Central for each period	BI: Northwestern > Central
	BTI: Northwestern vs. Central for each period	BTI: Northwestern > Central

Bifacial Core Technology and Site Type. In addition to mobility and raw-material availability, site type can also have an influence on the proportion of bifaces in an assemblage (see Table 1.1). To test the relationship between site type and bifaces in my data, I compare the cave/rockshelter and open-air assemblages from the Paleoindian period in the northwestern Great Basin. Because these are different kinds of sites, I expected there to be significant differences in the proportion of bifaces in each sample.

Summary

In this study I test two hypotheses related to the use of bifacial cores by Paleoindian groups in the Great Basin and, by extension, the applicability of the HTFM to the Great Basin. I explore the relative importance of bifacial cores in Paleoindian and Archaic assemblages, the influence of raw-material on the use of bifacial cores, and the relationship between bifacial cores and subsistence strategies. In the following chapter, I present the results of the tests outlined above.

CHAPTER 3

RESULTS

In this chapter, I present the results of my comparisons of bifacial technology across time and space, beginning with the northwestern Great Basin sample. I then present the results of my analysis of the central Great Basin sample, my comparisons between regions, and my comparisons between Paleoindian cave/rockshelter and open-air occupations in the northwestern Great Basin.

Biface and Biface Thinning Indices

Table 3.1 lists the bifaces, non-bifacial tools, biface thinning flakes, all other flake types, and the Biface and Biface Thinning Index (BI and BTI, respectively) values from the assemblages included in my sample. Tables 3.2-3.9 present the means, standard deviations, sample sizes, and ranges of BI and BTI values for each time period in each region, while Table 3.10 lists these measures for cave/rockshelter and open-air sites in the northwestern Great Basin.

The Northwestern Great Basin

Biface Indices: Paleoindian vs. Archaic

If, as the HTFM posits, Paleoindian groups centered their lithic technology on bifacial cores, then assemblages from that time period should exhibit higher BI values than assemblages from the subsequent Archaic periods. There is a significant difference in BI values between periods ($x^2 = 18.241$, $df = 3$, $p < 0.001$) (Table 3.2). The mean BI values for the Paleoindian and Early Archaic samples are similar at 0.557 and 0.510, respectively. The mean value rises to 0.839 in the Middle Archaic sample and falls slightly to 0.736 in the Late Archaic sample. Following Smith (2011), who noted that small assemblages can yield highly variable index values due to sample size alone, I reran the analysis using only those assemblages containing seven or more tools. When I removed those assemblages with fewer than seven tools (i.e., small assemblages), the results were similar. The mean BI value is lowest for the Paleoindian sample ($\bar{x} = 0.462$) and highest in the Middle Archaic sample ($\bar{x} = 0.836$), and there is a significant difference between periods ($x^2 = 13.742$, $df = 3$, $p = 0.003$) (Table 3.2).

Table 3.1. Tool and Flake Counts, and BI and BTI Values by Assemblage.

Assemblage	Region	Time Period	Bifaces	Non-Bifaces	BI	BTFs	Non-BTFs	BTI	Reference
Last Supper Cave Lower Shell Stratum*	NW	P	20	106	0.159	131	32	0.804	Felling 2015
Last Supper Cave White Stratum*	NW	P	38	36	0.514	22	98	0.183	Felling 2015
Little Steamboat Point 1*	NW	P	154	198	0.438	-	-	-	Ware Van der Voort 2016
Moonshadow Spring (CRNV-22-7636)	NW	P	16	57	0.219	57	89	0.390	Smith et al. 2004
Moonshine Spring (CRNV-22-5540)	NW	P	8	12	0.400	139	246	0.361	Smith et al. 2004
Paisley Cave 2 Botanical Lens*	NW	P	3	14	0.176	-	-	-	Jenkins et al. 2016
Parman Locality 1 (CrNV-02-194)	NW	P	178	126	0.586	238	193	0.552	Smith 2006
Parman Locality 2 (CrNV-02-195)	NW	P	23	11	0.676	24	28	0.462	Smith 2006
Parman Locality 3 (CrNV-02-192)	NW	P	62	52	0.544	74	113	0.396	Smith 2006
Parman Locality 4 (CrNV-02-193)	NW	P	38	36	0.514	22	33	0.400	Smith 2006
Paulina Lake (35DS34) Components 1 and 2	NW	P	126	117	0.519	1370	306	0.817	Connolly 1999
Tucker Site (35LK3227)	NW	P	2	7	0.222	271	298	0.476	Pinson 2004
Warner Valley A1	NW	P	1	8	0.111	-	-	-	Pattee 2014

Assemblage	**Region**	**Time Period**	**Bifaces**	**Non-Bifaces**	**BI**	**BTFs**	**Non-BTFs**	**BTI**	**Reference**
Warner Valley A6	NW	P	2	11	0.154	-	-	-	Pattee 2014
Warner Valley C3	NW	P	4	1	0.800	-	-	-	Pattee 2014
Warner Valley G13	NW	P	4	0	1.000	-	-	-	Pattee 2014
Warner Valley G14	NW	P	2	2	0.500	-	-	-	Pattee 2014
Warner Valley G19	NW	P	2	4	0.333	-	-	-	Pattee 2014
Warner Valley G31	NW	P	2	2	0.500	-	-	-	Pattee 2014
Warner Valley G43	NW	P	1	0	1.000	-	-	-	Pattee 2014
Warner Valley G43	NW	P	8	3	0.727	-	-	-	Pattee 2014
Warner Valley J7	NW	P	2	1	0.667	-	-	-	Pattee 2014
Warner Valley P3	NW	P	1	2	0.333	-	-	-	Pattee 2014
Warner Valley T110	NW	P	4	0	1.000	-	-	-	Pattee 2014
Warner Valley T110	NW	P	3	2	0.600	-	-	-	Pattee 2014
Warner Valley T12	NW	P	4	5	0.444	-	-	-	Pattee 2014
Warner Valley T14	NW	P	3	1	0.750	-	-	-	Pattee 2014

Assemblage	Region	Time Period	Bifaces	Non-Bifaces	BI	BTFs	Non-BTFs	BTI	Reference
Warner Valley T16	NW	P	3	1	0.750	-	-	-	Pattee 2014
Warner Valley T17	NW	P	6	1	0.857	-	-	-	Pattee 2014
Warner Valley T7	NW	P	11	10	0.524	-	-	-	Pattee 2014
Warner Valley T8	NW	P	8	0	1.000	-	-	-	Pattee 2014
Warner Valley T9	NW	P	4	1	0.800	-	-	-	Pattee 2014
Bergen (35LK3175) 2000 House	NW	EA	33	37	0.471	-	-	-	Helzer 2004
Bergen (35LK3175) Butchering Area	NW	EA	17	14	0.548	-	-	-	Helzer 2004
Bodie Hills 276	NW	MA	14	2	0.875	-	-	-	Carey 2013
Bodie Hills 1118	NW	MA	17	1	0.944	-	-	-	Carey 2013
Bodie Hills 1161	NW	MA	15	0	1.000	-	-	-	Carey 2013
Bodie Hills 1284	NW	MA	16	0	1.000	-	-	-	Carey 2013
Bodie Hills 1348	NW	MA	10	0	1.000	-	-	-	Carey 2013
Bodie Hills 1382	NW	MA	10	0	1.000	-	-	-	Carey 2013
Bodie Hills 1395	NW	MA	2	0	1.000	-	-	-	Carey 2013

Assemblage	Region	Time Period	Bifaces	Non-Bifaces	BI	BTFs	Non-BTFs	BTI	Reference
Bodie Hills 1427	NW	MA	1	0	1.000	-	-	-	Carey 2013
Bodie Hills 1451	NW	MA	1	0	1.000	-	-	-	Carey 2013
Bodie Hills 1457	NW	MA	5	0	1.000	-	-	-	Carey 2013
Bodie Hills 1537	NW	MA	2	0	1.000	-	-	-	Carey 2013
Bodie Hills 1576	NW	MA	1	1	0.500	-	-	-	Carey 2013
Bodie Hills 1947	NW	MA	2	1	0.667	-	-	-	Carey 2013
Bodie Hills 3103	NW	MA	2	0	1.000	-	-	-	Carey 2013
Bodie Hills 3131	NW	MA	1	0	1.000	-	-	-	Carey 2013
Bodie Hills 3858	NW	MA	4	10	0.286	-	-	-	Carey 2013
Bodie Hills 4001	NW	MA	1	0	1.000	-	-	-	Carey 2013
Bodie Hills 4375	NW	MA	3	0	1.000	-	-	-	Carey 2013
Bodie Hills 4549	NW	MA	8	2	0.800	-	-	-	Carey 2013
Bodie Hills 4556	NW	MA	16	0	1.000	-	-	-	Carey 2013
Bodie Hills 4558	NW	MA	6	0	1.000	-	-	-	Carey 2013

Assemblage	Region	Time Period	Bifaces	Non-Bifaces	BI	BTFs	Non-BTFs	BTI	Reference
Bodie Hills 4559	NW	MA	9	0	1.000	-	-	-	Carey 2013
Bodie Hills 4560	NW	MA	4	0	1.000	-	-	-	Carey 2013
Bodie Hills 4583	NW	MA	1	0	1.000	-	-	-	Carey 2013
Bodie Hills 4832	NW	MA	3	0	1.000	-	-	-	Carey 2013
Bodie Hills 4915	NW	MA	3	0	1.000	-	-	-	Carey 2013
Paiute Creek Shelter (26HU147) Component 4	NW	MA	25	16	0.610	199	25	0.888	LaValley 2013
Paulina Lake (35DS34) Component 4	NW	MA	39	36	0.520	-	-	-	Connolly 1999
Warner Valley C14	NW	MA	3	2	0.600	-	-	-	Pattee 2014
Warner Valley G30	NW	MA	1	4	0.200	-	-	-	Pattee 2014
Warner Valley T20	NW	MA	1	3	0.250	-	-	-	Pattee 2014
Warner Valley T26	NW	MA	3	2	0.600	-	-	-	Pattee 2014
Bodie Hills 265	NW	LA	4	0	1.000	-	-	-	Carey 2013
Bodie Hills 1191	NW	LA	1	0	1.000	-	-	-	Carey 2013
Bodie Hills 1349	NW	LA	3	0	1.000	-	-	-	Carey 2013

Assemblage	Region	Time Period	Bifaces	Non-Bifaces	BI	BTFs	Non-BTFs	BTI	Reference
Bodie Hills 1400	NW	LA	1	0	1.000	-	-	-	Carey 2013
Bodie Hills 1479	NW	LA	3	0	1.000	-	-	-	Carey 2013
Bodie Hills 1549	NW	LA	9	0	1.000	-	-	-	Carey 2013
Bodie Hills 1555	NW	LA	3	0	1.000	-	-	-	Carey 2013
Bodie Hills 1605	NW	LA	1	0	1.000	-	-	-	Carey 2013
Bodie Hills 2749	NW	LA	4	0	1.000	-	-	-	Carey 2013
Bodie Hills 2750	NW	LA	2	0	1.000	-	-	-	Carey 2013
Bodie Hills 3114	NW	LA	0	2	0.000	-	-	-	Carey 2013
Bodie Hills 3116	NW	LA	9	6	0.600	-	-	-	Carey 2013
Bodie Hills 3122	NW	LA	1	2	0.333	-	-	-	Carey 2013
Bodie Hills 3861	NW	LA	13	3	0.813	-	-	-	Carey 2013
Bodie Hills 3863	NW	LA	3	0	1.000	-	-	-	Carey 2013
Bodie Hills 3864	NW	LA	4	1	0.800	-	-	-	Carey 2013
Bodie Hills 3866	NW	LA	1	3	0.250	-	-	-	Carey 2013

Assemblage	Region	Time Period	Bifaces	Non-Bifaces	BI	BTFs	Non-BTFs	BTI	Reference
Bodie Hills 3867	NW	LA	7	1	0.875	-	-	-	Carey 2013
Bodie Hills 3868	NW	LA	9	3	0.750	-	-	-	Carey 2013
Bodie Hills 3870	NW	LA	1	4	0.200	-	-	-	Carey 2013
Bodie Hills 3997	NW	LA	1	1	0.500	-	-	-	Carey 2013
Bodie Hills 4003	NW	LA	5	6	0.455	-	-	-	Carey 2013
Bodie Hills 4523	NW	LA	100+	0	1.000	-	-	-	Carey 2013
Bodie Hills 4572	NW	LA	2	0	1.000	-	-	-	Carey 2013
Bodie Hills 4790	NW	LA	5	0	1.000	-	-	-	Carey 2013
Bodie Hills 4795	NW	LA	2	0	1.000	-	-	-	Carey 2013
Bodie Hills 4826	NW	LA	6	0	1.000	-	-	-	Carey 2013
Bodie Hills 4835	NW	LA	30	0	1.000	-	-	-	Carey 2013
Bodie Hills 4914	NW	LA	19	3	0.864	-	-	-	Carey 2013
Paiute Creek Shelter (26HU147) Components 1 and 2	NW	LA	233	108	0.683	294	71	0.805	LaValley 2013
Paiute Creek Shelter (26HU147) Component 3	NW	LA	128	44	0.744	244	97	0.716	LaValley 2013

Assemblage	Region	Time Period	Bifaces	Non-Bifaces	BI	BTFs	Non-BTFs	BTI	Reference
Paulina Lake (35DS34) Component 5	NW	LA	14	17	0.452	-	-	-	Connolly 1999
Peninsula (35LK2579) Groundstone Feature	NW	LA	5	1	0.833	57	50	0.533	Eiselt 1998
Peninsula (35LK2579) Structure 1	NW	LA	9	41	0.180	203	475	0.299	Eiselt 1998
Peninsula (35LK2579) Structure 2	NW	LA	5	9	0.357	71	151	0.320	Eiselt 1998
Peninsula (35LK2579) Structure 3	NW	LA	2	10	0.167	141	316	0.309	Eiselt 1998
Peninsula (35LK2579) Structure 4	NW	LA	16	2	0.889	225	536	0.296	Eiselt 1998
Warner Valley C2	NW	LA	4	0	1.000	-	-	-	Pattee 2014
Warner Valley G29	NW	LA	7	9	0.438	-	-	-	Pattee 2014
Warner Valley P5	NW	LA	1	3	0.250	-	-	-	Pattee 2014
Combs Creek Locality 1 (26WP2197)	C	P	12	5	0.706	76	20	0.792	George T. Jones**
Combs Creek Locality 2 (26WP2198)	C	P	9	2	0.818	12	7	0.632	George T. Jones**
Combs Creek Locality 3 (26WP2199)	C	P	14	2	0.875	34	9	0.791	George T. Jones**
Combs Creek Locality 4 (26WP2193)	C	P	4	0	1.000	123	35	0.778	George T. Jones**
Combs Creek Locality 5/8 (26WP2200)	C	P	48	40	0.545	703	195	0.783	George T. Jones**

Assemblage	**Region**	**Time Period**	**Bifaces**	**Non-Bifaces**	**BI**	**BTFs**	**Non-BTFs**	**BTI**	**Reference**
Combs Creek Locality 6 (26WP2201)	C	P	2	3	0.400	2	19	0.095	George T. Jones**
Combs Creek Locality 7 (26WP2202)	C	P	8	6	0.571	16	34	0.320	George T. Jones**
Combs Creek Locality 9	C	P	11	8	0.579	96	79	0.549	George T. Jones**
Hunter Point Locality 1 (26WP2192)	C	P	18	1	0.947	46	26	0.639	George T. Jones**
Hunter Point Locality 2 (26WP2194)	C	P	55	16	0.775	161	177	0.476	George T. Jones**
Hunter Point Locality 3 (26WP2203)	C	P	46	23	0.667	665	95	0.875	George T. Jones**
Hunter Point Locality 5 (26WP2204)	C	P	108	70	0.607	928	137	0.871	George T. Jones**
Illapah Locality 1	C	P	13	6	0.684	56	25	0.691	George T. Jones**
Limestone Peak Locality 1	C	P	133	147	0.475	1,486	350	0.809	George T. Jones**
Sunshine Locality	C	P	215	975	0.181	1,418	472	0.750	Beck and Jones 2009
White Sage Well Locality 1a (26-WP-2195a)	C	P	5	0	1.000	29	31	0.483	George T. Jones**
White Sage Well Locality 1b (26-WP-2195b)	C	P	4	0	1.000	30	17	0.638	George T. Jones**
White Sage Well Locality 1c (26-WP-2195c)	C	P	1	1	0.500	8	9	0.471	George T. Jones**
Gatecliff Horizon 12	C	EA	4	1	0.800	-	-	-	Thomas 1983

Assemblage	Region	Time Period	Bifaces	Non-Bifaces	BI	BTFs	Non-BTFs	BTI	Reference
Gatecliff Horizon 14	C	EA	7	1	0.875	-	-	-	Thomas 1983
Gatecliff Horizon 15	C	EA	3	0	1.000	-	-	-	Thomas 1983
Gatecliff Horizon 16	C	EA	1	0	1.000	-	-	-	Thomas 1983
Pie Creek Rockshelter 4 (CRNV-12-05001)	C	EA	20	8	0.714	628	1,552	0.288	McGuire et al. 2004
Gatecliff Horizon 10	C	MA	3	0	1.000	-	-	-	Thomas 1983
Gatecliff Horizon 7	C	MA	98	7	0.933	-	-	-	Thomas 1983
Gatecliff Horizon 8	C	MA	70	4	0.946	-	-	-	Thomas 1983
Gatecliff Horizon 9	C	MA	18	6	0.750	-	-	-	Thomas 1983
Pie Creek Rockshelter Component 2 (CRNV-12-05001)	C	MA	36	6	0.857	1,210	2,634	0.315	McGuire et al. 2004
Pie Creek Rockshelter Component 3 (CRNV-12-05001)	C	MA	23	5	0.821	696	2,846	0.196	McGuire et al. 2004
Pine Nuts 1029	C	MA	1	2	0.333	70	113	0.383	Johnson 2009
Pine Nuts 836	C	MA	18	40	0.310	77	81	0.487	Johnson 2009
Pine Nuts 838	C	MA	16	73	0.180	136	170	0.444	Johnson 2009
Gatecliff Horizon 1	C	LA	11	5	0.688	-	-	-	Thomas 1983

Assemblage	Region	Time Period	Bifaces	Non-Bifaces	BI	BTFs	Non-BTFs	BTI	Reference
Gatecliff Horizon 2	C	LA	40	1	0.976	-	-	-	Thomas 1983
Gatecliff Horizon 3	C	LA	60	8	0.882	-	-	-	Thomas 1983
Gatecliff Horizon 4	C	LA	100	11	0.901	-	-	-	Thomas 1983
Gatecliff Horizon 5	C	LA	145	16	0.901	-	-	-	Thomas 1983
Gatecliff Horizon 6	C	LA	10	0	1.000	-	-	-	Thomas 1983
Pie Creek Rockshelter Component 1 (CRNV-12-05001)	C	LA	125	10	0.926	3063	6210	0.330	McGuire et al. 2004
Pine Nuts 1028	C	LA	5	13	0.278	145	219	0.398	Johnson 2009
Pine Nuts 1034	C	LA	4	14	0.222	378	563	0.402	Johnson 2009
Pine Nuts 1035	C	LA	2	2	0.500	2	3	0.400	Johnson 2009
Pine Nuts 1036	C	LA	50	44	0.532	2592	3661	0.415	Johnson 2009
Pine Nuts 821	C	LA	0	1	0.000	1	1	0.500	Johnson 2009
Pine Nuts 823	C	LA	2	2	0.500	2	2	0.500	Johnson 2009
Pine Nuts 835	C	LA	9	15	0.375	120	178	0.403	Johnson 2009
Pine Nuts 841	C	LA	1	0	1.000	25	28	0.472	Johnson 2009

Assemblage	Region	Time Period	Bifaces	Non-Bifaces	BI	BTFs	Non-BTFs	BTI	Reference
Pine Nuts 826	C	LA	1	0	1.000	8	10	0.444	Johnson 2009
Pine Nuts 847	C	LA	0	7	0.000	3	4	0.429	Johnson 2009
Tule Valley Rockshelter (CRNV-12-10709)	C	LA	8	3	0.727	46	247	0.157	McGuire et al. 2004
Vista Site (26WA3017)	NW	LA	267	444	0.376	47	1,117	0.040	Zeier and Elston 1986

Note. C = Central Great Basin; NW = Northwestern Great Basin; P = Paleoindian; EA = Early Archaic; MA = Middle Archaic; and LA = Late Archaic
*Cave/Rockshelter component; **Personal communication, 2016

Table 3.2. Descriptive Statistics for Biface Indices from Northwestern Great Basin Assemblages. Numbers in Parentheses Represent Results When Only Sites With ≥7 Tools are Included.

	TIME PERIOD			
	Paleoindian	**Early Archaic**	**Middle Archaic**	**Late Archaic**
$\bar{x}$	0.557 (0.462)	0.510 (0.510)	0.839 (0.836)	0.736 (0.663)
s	0.265 (0.248)	0.054 (0.054)	0.254 (0.239)	0.316 (0.277)
n	32 (19)	2 (2)	32 (12)	40 (17)
Range	0.111-0.000 (0.111-1.000)	0.471-0.548 (0.471-0.548)	0.200-1.000 (0.286-1.000)	0.000-1.000 (0.167-1.000)

$x^2 = 18.241$, $df = 3$, $p < 0.001$
($x^2 = 13.742$, $df = 3$, $p = 0.003$)

Because the Early Archaic sample is quite small ($n = 2$), which may skew the results of statistical comparisons, I reran the comparison with that time period excluded. When all Paleoindian, Middle Archaic, and Late Archaic components are included, there is a significant difference in BI values between periods ($x^2 = 17.117$, $df = 2$, $p < 0.001$): again, the mean BI is lowest in the Paleoindian sample and highest in the Middle Archaic sample. When small components are excluded, there is still a significant difference ($x^2 = 13.231$, $df = 2$, $p = 0.001$).

Biface Thinning Indices: Paleoindian vs. Archaic

Table 3.3 shows the mean BTI values, standard deviations, counts, and ranges for components from northwestern Great Basin sites. Because the samples of Early and Middle Archaic components are small, I was unable to run an ANOVA test that included all four time periods. Instead, I ran *t*-tests comparing the Paleoindian samples to the grouped Archaic samples ($t = -0.347$, $df = 16$, $p = 0.733$) and the Paleoindian sample to the Late Archaic sample ($t = -1.961$, $df = 9$, $p = 0.082$) (Table 3.3). There was no significant difference in BTI values in both cases.

Table 3.3. Descriptive Statistics for Biface Thinning Indices from Northwestern Great Basin Assemblages.

	TIME PERIOD				
	Paleoindian	**Early Archaic**	**Middle Archaic**	**Late Archaic**	**All Archaic**
$\bar{x}$ =	0.484	-	0.888	0.468	0.521
s =	0.197	-	-	0.218	0.251
n =	10	-	1	7	8
Range	0.186-0.817	-	-	0.296-0.805	0.296-0.888

Paleoindian vs. Grouped Archaic: $t = -0.347$, $df = 16$, $p = 0.733$
Paleoindian vs. Late Archaic: $t = -1.961$, $df = 9$, $p = 0.082$

Summary

The results of diachronic comparisons of BI values, which reflect the relative abundance of bifaces in archaeological components, reveal a significant change in lithic technological organization in the northwestern Great Basin; however, contrary to expectations derived from the HTFM, the Paleoindian sample showed the lowest mean BI value (when Early Archaic assemblages are excluded), while the Middle Archaic sample showed the highest mean BI value. Additionally, there is no significant difference in BTI values, which reflect the relative abundance of biface thinning flakes in components, between periods, suggesting again that bifaces were no more important to early populations than later groups in the northwestern Great Basin.

The Central Great Basin

As noted in Chapter 1, raw material availability and quality can have a strong influence on the character of a lithic toolkit (Andrefsky 1994; Kelly 1988). To explore the possible influence of raw-material availability on groups' decisions to employ bifacial technology, I repeated the analyses conducted in the obsidian-rich northwestern Great Basin (Thomas' [2011] Obsidian Rim) using components from the central Great Basin (Thomas' [2011] Chert Core).

Biface Indices: Paleoindian vs. Archaic

When large and small components are included, the highest mean BI value occurs in the Early Archaic sample ($\bar{x} = 0.878$). The means are lower for the Paleoindian, Middle Archaic, and Late Archaic samples ($\bar{x} = 0.685$, $\bar{x} = 0.681$, and $\bar{x} = 0.620$, respectively) and there was no significant difference across time ($x^2 = 2.818$, $df = 3$, $p = 0.421$). When only larger assemblages were included, the results were similar: there was no significant difference in BI values across time ($x^2 = 0.962$, $df = 3$, $p = 0.810$) (Table 3.4). It is possible that the higher mean BI value for the Early Archaic sample is a product of small sample size ($n = 5$) but when I excluded that period from a comparison of larger sites there was still no significant difference between the other three periods (x^2 = 0.191, *df* = 2, *p* = 0.909).

Table 3.4. Descriptive Statistics for Biface Indices from Central Great Basin Assemblages. Numbers in Parentheses Represent Results When Only Sites With ≥7 Tools are Included.

	TIME PERIOD			
	Paleoindian	**Early Archaic**	**Middle Archaic**	**Late Archaic**
$\bar{x}$ =	0.685 (0.648)	0.878 (0.795)	0.681 (0.685)	0.620 (0.627)
s =	0.229 (0.196)	0.125 (0.114)	0.316 (0.310)	0.341 (0.327)
n =	18 (13)	5 (2)	9 (7)	19 (14)
Range	0.181-1.000 0.181-0.9470	0.714-1.000 (0.714-0.875)	0.180-1.000 (0.180-0.946)	0.000-1.000 (0.000-1.000)

x^2 = 2.818, *df* = 3, *p* = 0.421
(x^2 = 0.962, *df* = 3, *p* = 0.810)

Biface Thinning Indices: Paleoindian vs. Archaic

Unlike the BI values, BTI values for central Great Basin components do reflect significant change over time (*F* = 10.340, *df* = 35, *p* < 0.001) (Table 3.5). The mean BTI value is highest in the Paleoindian sample ($\bar{x}$ = 0.636) and lowest in the Early Archaic sample ($\bar{x}$ = 0.288); however, because there was only one Early Archaic component in my data, I excluded that time period from the analysis. The Middle Archaic sample shows the next lowest mean BTI value ($\bar{x}$ = 0.365) while the Late Archaic sample is somewhere in the middle ($\bar{x}$ = 0.376). A Tukey's post-hoc test revealed that the significant differences occur between the Paleoindian and Middle Archaic samples (*p* =

0.011), as well as the Paleoindian and Late Archaic samples ($p = 0.001$). There is no difference between the Middle and Late Archaic samples ($p = 0.992$).

Table 3.5. Descriptive Statistics for Biface Thinning Indices from Central Great Basin Assemblages, Excluding Early Archaic.

	TIME PERIOD			
	Paleoindian	**Early Archaic**	**Middle Archaic**	**Late Archaic**
$\bar{x}$ =	0.636	0.288	0.365	0.376
s =	0.206	-	0.115	0.134
n =	18	1	5	13
Range	0.095-0.875	-	0.196-0.487	0.040-0.500

$F = 10.340$, $df = 35$, $p < 0.001$
A Tukey’s post-hoc test indicates a significant difference between the Paleoindian and Middle Archaic samples ($p = 0.011$), and between the Paleoindian and Late Archaic samples ($p = 0.001$). There is no difference between the Middle and Late Archaic samples ($p = 0.992$).

Summary

The central Great Basin shows very different trends in BI and BTI values than the northwestern Great Basin. Unlike the northwestern Great Basin, there are no significant diachronic changes in BI values in the central Great Basin, suggesting that there was no change in the relative importance of bifaces to lithic technological organization in that region. There is, however, a significant difference in the BTI values: as expected, the Paleoindian sample possesses the highest mean BTI value.

The Northwestern Great Basin vs. the Central Great Basin

Because it is sharp, homogenous in texture, and flakes predictably, obsidian was the preferred toolstone type in the Great Basin (Elston 1992; Jones and Beck 1999). While obsidian is widely available in the northwestern Great Basin, it is far less common in the central Great Basin. In the former region, groups discarded obsidian tools with minimal resharpening (Harvey 2014; Smith 2015; Smith et al. 2013) whereas in the latter region, groups extended tools' use-lives by resharpening them (Harvey 2014; Smith 2015). To test the influence of raw-material availability (particularly, obsidian availability) on groups' decisions to employ bifacial technology, I compared northwestern Great Basin and central Great Basin components from various time periods.

The Paleoindian Period

As outlined in Chapter 2, if the availability of high-quality raw material was an important factor in determining the makeup of lithic toolkits, then BI and BTI values should be lower in the obsidian-rich northwestern Great Basin than in the obsidian-poor central Great Basin. My results do not meet this expectation. When small sites are included, there is no significant difference between BI values in the two regions for the Paleoindian period (t = -1.722, df = 48, p = 0.091). I obtained a similar result when I included only the larger sites: the northwestern Great Basin has a lower mean BI value ($\bar{x}$ = 0.462) than the central Great Basin ($\bar{x}$ = 0.615) but the difference is not significant (t = -1.817, df = 31, p = 0.079) (Table 3.6).

Comparisons of Paleoindian BTI values produced results that generally agree with those of the BI values: the mean BTI value in the northwestern Great Basin ($\bar{x}$ = 0.484) is lower than that in the central Great Basin ($\bar{x}$ = 0.636) but they do not differ significantly (t = -1.892, df = 26, p = 0.070) (Table 3.6), suggesting that bifaces played similar organizational roles during the Paleoindian period in both the central and the northwestern Great Basin.

Table 3.6. Descriptive Statistics for the Northwestern vs. Central Great Basin: Paleoindian Period. Numbers in Parentheses Represent Results When Only Sites With ≥7 Tools are Included.

	Biface Index		**Biface Thinning Index**	
	Northwestern	**Central**	**Northwestern**	**Central**
$\bar{x}$ =	0.557 (0.462)	0.685 (0.615)	0.484	0.636
s =	0.265 (0.248)	0.229 (0.226)	0.197	0.206
n =	32 (19)	18 (14)	10	18
Range	0.111-1.000 (0.111-1.000)	0.181-1.000 (0.181-0.947)	0.183-0.817	0.095-0.875
	t = -1.722, df = 48, p = 0.091 (t = -1.817, df = 31, p = 0.079)		t = -1.892, df = 26, p = 0.070	

The Early Archaic Period

Although the sample of Early Archaic components in both regions is small, there are some notable results. When small sites are included, the BI values for the northwestern Great Basin ($\bar{x}$ = 0.510) are lower than those from the central Great Basin ($\bar{x}$ = 0.878) but the difference is not significant (t = -3.835, df = 5, p = 0.120). When only the large sites are included, the mean BI value for the northwestern Great Basin ($\bar{x}$ = 0.510) remains lower than that of the central Great Basin ($\bar{x}$ = 0.795) but the difference is not statistically significant (t = -3.194, df = 2, p = 0.086) (Table 3.7). Because I had only one assemblage with debitage data from the central Great Basin and none from the northwestern Great Basin, I was unable to compare the BTI values of Early Archaic components (Table 3.7).

Table 3.7. Descriptive Statistics for the Northwestern vs. Central Great Basin: Early Archaic Period. Numbers in Parentheses Represent Results When Only Sites With ≥7 Tools are Included.

	Biface Index		**Biface Thinning Index**	
	Northwestern	**Central**	**Northwestern**	**Central**
$\bar{x}$ =	0.510 (0.510)	0.878 (0.795)	-	0.288
s =	0.054 (0.054)	0.125 (0.114)	-	-
n =	2 (2)	5 (2)	-	1
Range	0.471-0.548 (0.471-0.548)	0.714-1.000 (0.714-0.875)	-	-
	t = -3.835, df = 5, p = 0.120 (t = -3.194, df = 2, p = 0.086)		No analysis performed.	

The Middle Archaic Period

Unlike the Paleoindian and Early Archaic samples, the mean BI values in the Middle Archaic period are higher for the northwestern Great Basin than for the central Great Basin. When all sites are considered, the mean BI value for the northwestern Great Basin is 0.839 while the mean value for the central region is 0.681; this difference is statistically significant (U = 80.000, Z = -2.166, p = 0.030). When only the large sites are compared, the mean BI value for the northwestern region rises to 0.836 and the mean BI value for the central Great Basin rises to 0.685, but the difference is not statistically significant (U = 23.000, Z = -1.631, p = 0.103) (Table 3.8). As with the Early Archaic sample, the sample of Middle Archaic BTI values is too small to permit a statistical analysis (Table 3.8).

Table 3.8. Descriptive Statistics for the Northwestern vs. Central Great Basin: Middle Archaic Period. Numbers in Parentheses Represent Results When Only Sites With ≥7 Tools are Included.

	Biface Index		**Biface Thinning Index**	
	Northwestern	**Central**	**Northwestern**	**Central**
$\bar{x}$ =	0.839 (0.836)	0.681 (0.685)	0.888	0.365
s =	0.254 (0.239)	0.316 (0.310)	-	0.115
n =	32 (12)	9 (7)	1	5
Range	0.200-1.000 (0.180-0.946)	0.180-1.000 (0.180-0.946)	-	0.196-0.487
	U = 80.000, Z = -2.166, p = 0.030 (U = 23.000, Z = -1.631, p = 0.103)		No analysis performed.	

The Late Archaic Period

For the Late Archaic samples, the mean BI value remains slightly higher in the northwestern region. When all sites are considered, the mean BI value for the northwestern region is 0.736 and 0.620 for the central region; this difference is not statistically significant (U = 292.000, Z = -1.461, p = 0.144). Similarly, when only large sites are compared, the mean for the northwestern Great Basin ($\bar{x}$ = 0.658) is slightly higher than the mean for the central Great Basin ($\bar{x}$ = 0.633), a difference that is not statistically significant (t = 0.233, df = 29, p = 0.817). The same trend is apparent in the BTI comparison: northwestern Great Basin BTI values are slightly higher than those for the central Great Basin ($\bar{x}$ = 0.468 and $\bar{x}$ = 0.376, respectively) but not significantly so (U = 44.000, Z = -0.119, p = 0.905) (Table 3.9). These results suggest that, like the Paleoindian period, bifaces played a similar organizational role in both regions during the Late Archaic period.

Table 3.9. Descriptive Statistics for the Northwestern vs. Central Great Basin: Late Archaic Period. Numbers in Parentheses Represent Results When Only Sites With ≥7 Tools are Included.

	Biface Index		**Biface Thinning Index**	
	Northwestern	**Central**	**Northwestern**	**Central**
$\bar{x}$ =	0.736 (0.658)	0.620 (0.633)	0.468	0.376
s =	0.316 (0.281)	0.341 (0.324)	0.218	0.134
n =	40 (17)	19 (14)	7	13
Range	0.000-1.000 (0.167-1.000)	0.000-1.000 (0.000-1.000)	0.296-0.805	0.040-0.500
	U = 292.000, Z = -1.461, p = 0.144 (t = 0.233, df = 29, p = 0.817)		U = 44.000, Z = -0.119, p = 0.905	

Caves/Rockshelters vs. Open-Air Sites

Finally, as outlined in Chapter 1 (see Table 1.1), site type may influence the proportion of bifaces in assemblages. To explore that possibility, I compared BI values for cave/rockshelter and open-air sites in the northwestern Great Basin Paleoindian sample. When I included components of all sizes, the mean BI value for the cave/rockshelter sample ($\bar{x}$ = 0.320) is lower than that for the open-air sample ($\bar{x}$ = 0.590), but the difference is not statistically significant at the 0.05 level (t = -1.996, df = 30, p = 0.055). When I included only those components with seven or more tools, the mean cave/rockshelter BI value remains lower than those of open-air components but the difference is still not significant (t = -1.291, df = 18, p = 0.213) (Table 3.10). Unfortunately, my cave/rockshelter sample is fairly small and it is possible that a larger sample size would produce different results. I was unable to run an analysis of BTI values as no flake data were available for either the LSP-1 or Paisley Cave 2 assemblages.

Table 3.10. Descriptive Statistics for Caves/Rockshelters vs. Open Air Sites in the Northwestern Great Basin. Numbers in Parentheses Represent Results When Only Sites With ≥7 Tools are Included.

	Biface Index	
	Cave/Rockshelter	**Open Air**
$\bar{x}$ =	0.320 (0.320)	0.590 (0.492)
s =	0.179 (0.179)	0.260 (0.248)
n =	4 (4)	28 (16)
Range	0.159-0.514 (0.159-0.514)	0.111-1.000 (0.111-1.000)

t = -1.996, df = 30, p = 0.055
(t = -1.291, df = 18, p = 0.213)

Summary

BI values for components from the northwestern Great Basin show a significant change over time, with BI values for the Paleoindian period lower than those from subsequent periods. When the small Early Archaic sample is excluded, the pattern remains essentially unchanged: Paleoindian BI values are significantly lower than those from the Middle and Late Archaic periods. BTI values in the region show no significant change over time, but my analysis was limited by small sample size and I was only able to compare the Paleoindian sample to the grouped Archaic samples and to the Late Archaic sample.

Unlike the northwestern Great Basin, the central Great Basin showed no significant change in BI values over time, but it did show significantly higher BTI values during the Paleoindian period than both the Middle or Late Archaic periods. As was the case in the northwestern Great Basin, the Early Archaic sample in the central Great Basin was too small to include in my analysis. Additionally, the Middle Archaic sample was fairly small (*n*=5), which may be influencing the result of my BTI analysis.

A period-by-period comparison between the northwestern and central Great Basin revealed that although both the BI and BTI values were lower for the northwestern Great Basin, there was no significant difference in either measure during the Paleoindian period. The Early Archaic sample was small for both regions and there was no statistically significant difference in BI values. For the Middle Archaic period, BI values were significantly higher for northwestern Great Basin components when all sites were included. When I included only large components, the difference was not significant.

For the Late Archaic period, BI values are higher for the northwestern Great Basin but the difference is not significant in either the large or the large-and-small component samples. Similarly, the northwestern Great Basin sample possesses higher BTI values for the Late Archaic sample but the difference is not significant.

Although the difference is not statistically significant perhaps due to very small sample sizes, my comparison of cave/rockshelter and open-air sites showed an interesting trend. BI values are lower for the cave/rockshelter components in both the large site sample and the total sample of all components, suggesting that there may have been differences in how groups employed bifacial technology related to site function – a topic I return to in the next chapter.

In sum, differences in BI and BTI data for the northwestern and central Great Basin suggest that groups in those regions used bifacial technology differently throughout time. In the next chapter, I discuss my results in terms of possible influences on bifacial technology (raw material availability and quality, site type, the degree and type of hunter-gatherer mobility and subsistence strategies) discussed in Chapter 1 and the hypotheses and expectations presented in Chapter 2 (see Table 2.5).

CHAPTER 4

DISCUSSION

The HTFM suggests that mobile Paleoindians relied on an efficient and flexible toolkit centered on bifacial cores (Kelly and Todd 1988). In this study, I have explored the role of bifacial technology in the Great Basin by testing two hypotheses: (1) bifaces played a more central role in Paleoindian lithic technological organization in the northwestern and central Great Basin than later Archaic technological organization in those same regions; and (2) because high quality raw material is rare in the central Great Basin, groups there relied more heavily on bifacial technology throughout time than groups in the toolstone-rich northwestern Great Basin.

To test these hypotheses, I calculated Biface Index (BI) and Biface Thinning Index (BTI) values for assemblages in the northwestern and central Great Basin. I compared these values for components across time, region, and site type. I found little support for the second hypothesis and some support for the first in the central, but not the northwestern, Great Basin. Paleoindian assemblages in the northwestern Great Basin exhibit significantly lower BI values than later assemblages in the same region and there is no significant difference in BTI values between periods. In the central Great Basin, there is no significant difference in BI values over time but Paleoindian BTI values are significantly higher than both Middle and Late Archaic BTI values. There are no significant differences in BTI value between the northwestern and central Great Basin, and the Middle Archaic is the only period during which BI values differ significantly between regions. Table 4.1 summarizes these results. In this chapter, I place my results within the broader context of Great Basin lithic technological organization and discuss how they may reflect the various influences on groups' decisions to employ bifacial technology introduced in Chapter 1: (1) raw material availability/quality; (2) mobility; (3) site type; and (4) subsistence strategies.

Table 4.1. Summary of Hypotheses, Expectations, and Results.

Hypothesis	**Expectation**	**Results**	**Expectation Met?**
Bifaces played a more central role in Paleoindian lithic technological organization in the northwestern and central Great Basin than later Archaic technological organization in those same regions.	BI and BTI values should be higher in the Paleoindian assemblages than in the Early, Middle, or Late Archaic.	BI: Middle Archaic > Late Archaic > Paleoindian > Early Archaic*	No
		BTI: No significant difference.	No
Because high quality raw material is rare in the central Great Basin, groups there relied more heavily on bifacial technology throughout time than those in the toolstone-rich northwestern Great Basin.	BI and BTI values should be higher in the central Great Basin than in the northwestern Great Basin.	BI: No significant difference except in Middle Archaic.	No
		BTI: No significant difference.	No

*The small sample size may be influencing this result.

Interpretations

Raw Material

Raw material availability and quality had a strong influence on technological organization. Kelly (1988) found that bifacial technology is common in areas where raw material is rare or of poor quality and uncommon where it is abundant or of high-quality. Similarly, Andrefsky (1994) argued that: (1) formal tools including bifaces are more common where raw material is of poor quality (regardless of its abundance); (2) informal tools are common where raw material is of high quality but scarce; and (3) both tool types are common where raw material is abundant and of high quality (Figure 4.1).

		Quality	
		High	Low
Abundance	High	Formal and Informal Tools	Informal Tools
	Low	Formal Tools	Informal Tools

Figure 4.1. Expectations for lithic technology under various conditions of raw material abundance and quality. After Andrefsky (1994).

My results do not support the hypothesis that bifaces played a more central role in Paleoindian lithic technological organization in the toolstone-rich northwestern Great Basin, but they do suggest that bifaces played an important organizational role in the toolstone-poor central Great Basin. The northwestern region is characterized by volcanic tablelands (Layton 1970) and is rich in obsidian. Rather than having the highest BI values, as predicted by the HTFM, Paleoindian assemblages in the northwestern Great Basin have the lowest values (when Early Archaic assemblages are excluded due to small sample size). This finding is in line with Kelly (1988) and Andrefsky's (1994) expectations for areas with abundant, high-quality raw material and suggests that toolkit design was flexible in the northwestern Great Basin.

In their study of Last Supper Cave and Parman localities 1 and 3, Smith and Kielhofer (2011) found that obsidian WST points (which were probably not used as cores) were made on a wider range of sources and conveyed farther than unfinished bifaces and unifaces; however, 256 of the 362 tools (~71%) in their sample were made from local Massacre Lake/Guano Valley obsidian. Their results suggest that bifacial cores were not an important component of a mobile toolkit in the obsidian-rich northwestern Great Basin. Instead, finished points may have been one of the only artifact types transported between sites – a finding that is in line with the fact that the lowest BI values in the northwestern Great Basin occur among the Paleoindian sample.

BTI values for northwestern Great Basin assemblages further illustrate the influence of raw material availability. While my analysis was limited by small sample sizes, I found no significant difference between periods. For my hypothesis to have found support, BTI values should have been highest in the Paleoindian sample. This was not the case. This lack of diachronic change may reflect the influence of raw material availability on artifact-conserving curation behavior. Specifically, because high-quality raw material is abundant there would have been little need to resharpen tools (Bamforth 1986). Instead, when tools broke it may have been more optimal to simply manufacture new ones (Smith 2015). Both Harvey (2014) and Smith (2015) have noted this pattern in the northwestern Great Basin, where obsidian points were not as heavily curated as those in the central Great Basin.

Results from the central Great Basin contrast with those from the northwestern Great Basin, further supporting the possibility that raw material availability/quality played a prominent role in technological organization and suggesting that groups adopted different organizational strategies in different lithic landscapes. Because obsidian is rare in the central Great Basin, bifaces likely played a more important organizational role there and, because the availability of obsidian did not vary diachronically, the role of bifaces similarly remained unchanged between periods.

Although I did not identify any differences in BI values between the regions except during the Middle Archaic period, bifaces may still have served as cores in the central Great Basin. This possibility is supported by differences in the degree to which flakes driven from bifaces served as tool blanks in the central and northwestern Great Basin. At the Sunshine Locality over half (~52%) of all flake tools were manufactured on biface thinning flakes (Beck and Jones 2009). In nearby Jakes Valley, ~73% of tools were manufactured on biface thinning flakes (Estes 2009). Finally, at the Sadmat Site in the obsidian-poor Carson Desert, ~47% of tools were made on biface thinning flakes (Graf 2001). In contrast, at the Parman Localities in the northwestern Great Basin, only

~7% of tools were manufactured on biface thinning flakes (Smith 2006). Similarly, only ~23% of tools at the Coleman Site, located not far from numerous obsidian sources in northwestern Nevada, were made on biface thinning flakes (Graf 2001). Although derived from only a few sites because researchers generally do not report the types of blanks (e.g., biface thinning flakes) on which tools are made, the pattern is clear: tools made on flakes struck from bifacial cores are more common in the Chert Core than the Obsidian Rim. Despite the lack of diachronic change in BI values, which likely reflects a greater degree of biface curation in the central Great Basin (Harvey 2014; Smith 2015), these results (along with significantly higher BTI values during the Paleoindian period) suggest that bifacial cores may have been used in the central Great Basin.

Further support for the possibility that bifaces may have played a more important role in the central Great Basin comes from data collected during the Ruby Pipeline project. Hildebrandt et al. (2016a) outline four ecological regions along the pipeline corridor across northern Nevada, and their High Rock Country and Upper Lahontan Basin regions roughly correspond to both Thomas' (2011) Obsidian Rim and my northwestern Great Basin area while their Upper Humboldt Plains and Thousand Springs Valley regions correspond to both Thomas' (2011) Chert Core and my central Great Basin area. The Ruby Pipeline biface data generally align with my results and suggest differing roles for bifacial technology in obsidian-rich and obsidian-poor regions (Hildebrandt et al. 2016b). A chi-square analysis of biface frequencies for each region over time shows significantly more bifaces in the central Great Basin for every period except the Middle Archaic, when biface frequencies are significantly higher in the northwestern Great Basin ($x^2 = 328.19$, $df = 3$, $p < 0.001$) (Table 4.2). Their results, like my own, do not support the conclusion that bifaces played a more central role in Paleoindian lithic technological organization in the toolstone-rich northwestern Great Basin, but do suggest that bifacial cores may have been used in the central Great Basin.

Table 4.2. Chi-Square Analysis of Biface Frequencies by Time Period and Region along the Ruby Pipeline Corridor. Numbers in Parentheses Represent Standardized Residuals with Significant Values Bolded. After Hildebrandt et al. (2016a).

	Time Period			
	Paleoindian	**Early Archaic**	**Middle Archaic**	**Late Archaic**
Obsidian Rim	157 (**-2.32**)	314 (**-3.57**)	998 (**+8.02**)	210 (**-6.66**)
Chert Core	151 (**+2.93**)	312 (**+4.50**)	265 (**-10.10**)	330 (**+8.39**)

$x^2 = 328.19$, $df = 3$, $p < 0.001$

Similarly, a comparison of bifaces by stage from the Obsidian Rim and Chert Core pipeline segments illustrates significant differences between regions ($x^2 = 71.76$, $df = 2$, $p < 0.001$) (Table 4.3). In the Obsidian Rim, there are significantly more late-stage bifaces (stages 5 and 6) and significantly fewer mid-stage bifaces (stages 3 and 4) than expected by chance. Conversely, there are significantly fewer early- (stages 1 and 2) and late-stage bifaces and significantly more mid-stage bifaces in the central Great Basin. Many late-stage bifaces likely do not represent bifacial cores; instead, they probably represent nearly complete or finished but broken projectile points (Andrefsky 2005). Likewise, early-stage bifaces with few flakes removed may not represent discarded bifacial cores and instead may mark quarry rejects (Andrefsky 2005; Beck et al. 2002). If mid-stage bifaces represent the primary biface stage transported as cores away from quarries (Beck et al. 2002; Elston 1992), then the patterns outlined above suggest that bifacial core technology may have been more commonly employed in the Chert Core than the Obsidian Rim. It is important to note, however, that the Ruby Pipeline biface analysis collapses all periods into a single dataset and, as a result, provides only a coarse-grained picture of biface technology across the project area.

Table 4.3. Chi-Square of Biface Stages in Hildebrandt et al. (2016a). Numbers in Parentheses Represent Standardized Residuals with Significant Values Bolded.

	Biface Stage		
	1/2	**3/4**	**5/6**
Obsidian Rim	455 (+1.62)	1,134 (**-3.58**)	1,808 (**+2.27**)
Chert Core	136 (**-2.55**)	633 (**+5.65**)	594 (**-3.58**)

$x^2 = 71.76$, $df = 2$, $p < 0.001$

Finally, a comparison of chert and obsidian bifaces by stage within the Chert Core shows that there are significantly fewer early and significantly more mid-stage obsidian bifaces while there are significantly more early-stage chert bifaces in the region ($x^2 =$ 42.04, $df = 2$, $p < 0.001$) (Table 4.4). This suggests that groups carried obsidian bifaces into the Chert Core, where they were ultimately reduced into projectile points ($x^2 = 42.04$, $df = 2$, $p < 0.001$). It also suggests that as imported obsidian bifaces wore out, groups replaced them with chert bifaces made on local materials. These trends, along with my BTI analysis (which showed significantly more biface thinning flakes during the Paleoindian period than the Middle or Late Archaic periods in the central Great Basin) suggest that obsidian bifaces were valued in the Chert Core and likely stayed in the systemic context (*sensu* Schiffer and Skibo 1987) for as long as possible before ultimately being replaced by chert bifaces.

Table 4.4. Chi-Square of Obsidian and Chert Biface Stages in the Chert Core. Numbers in Parentheses Represent Standardized Residuals with Significant Values Bolded. From Hildebrandt et al. (2016a).

	Biface Stage		
	1/2	**3/4**	**5/6**
Obsidian	13 (**-4.92**)	201 (**+2.60**)	157 (-0.01)
Chert	163 (**+2.95**)	432 (-1.56)	437 (+0.00)

$x^2 = 42.04$, $df = 2$, $p < 0.001$

In sum, there is no evidence that early populations relied heavily on bifacial cores in the northwestern Great Basin, probably because high quality raw material is ubiquitous. While I failed to identify any diachronic change in BI values in the central Great Basin, several lines of evidence suggest that Paleoindians used bifacial cores there: (1) BTI values were significantly higher in the Paleoindian samples than later samples; (2) Paleoindian tools in the central Great Basin are more commonly made on biface thinning flakes than in the northwestern Great Basin; and (3) mid-stage bifaces (which are most likely to have been used as cores) are more common in the central Great Basin than the northwestern Great Basin. Table 4.5 summarizes these trends.

Table 4.5. Summary of Analyses and Results Relating to Raw Material Availability/Quality and Bifacial Cores.

Analysis	**Supports the Use of Bifacial Cores?**	
	Northwestern Great Basin	**Central Great Basin**
Paleoindian vs. Archaic BI	No	Maybe
Paleoindian vs. Archaic BTI	No	Yes
Ruby Pipeline Biface Frequencies	No	Yes
Ruby Pipeline Biface Stages	No	Yes
Flake Blank Types	No	Yes

Mobility

Many researchers have approached questions of prehistoric mobility by using source provenance data to reconstruct lithic conveyance zones (LCZs) (Jones et al. 2003, 2012; Smith 2010; Smith and Kielhofer 2011). If LCZs reflect annual or longer-term foraging ranges (*sensu* Jones et al. 2003), then they may provide information about the extent of residential movements across the landscape. It is far more likely, however, that they represent a complex combination of residential and logistical mobility (*sensu* Madsen 2007), repeated occupation of sites, periodic population aggregations, and/or trade (Smith 2016).

While they have some limitations, LCZs do demonstrate that obsidian tools moved considerable distances during the Paleoindian period. Furthermore, they highlight regional differences in toolstone conveyance. Jones et al. (2003) proposed a large LCZ for the central Great Basin that extended ~450 km north/south, which they later revised into two smaller zones (Jones et al. 2012). Similarly, Smith (2010) revised Jones et al.'s

(2003) western LCZ into two smaller zones (Figure 4.2). While it remains unclear exactly what kinds of behavior LCZs reflect, tools conveyed within them moved farther in the central Great Basin than in the northwestern Great Basin. Jones et al. (2012) suggest that these differences may tell us more about raw material availability and groups' efforts to conserve raw material than actual differences in foraging territory size.

Because obsidian availability differs dramatically between the two regions, it is no surprise that artifact source profiles differ in the central and northwestern Great Basin. Jones et al. (2003) note that the three most common obsidian types in their Eastern Nevada Project Area originated 200+ km away. Additionally, many obsidian flakes originated at the same distant sources, which together with the evidence summarized in Table 4.5, suggests that bifacial cores were used to transport obsidian into and within the central Great Basin.

In the northwestern Great Basin, LCZs are smaller and the obsidian types differ from those in the central Great Basin. In his analysis of Paleoindian sites in northwestern Nevada, Smith (2010) found that most projectile points were made on local obsidian, which is unsurprising given the abundance of obsidian there (Figure 4.3). Both the Parman Localities and Last Supper Cave are located within the geographic extent of the most well-represented obsidian type at those sites, Massacre Lake/Guano Valley (Smith 2010). In such a rich lithic landscape, there was likely little need for a toolkit that emphasized efficiency. Together with the observation that points but not unfinished bifaces were transported between sites (Smith and Kielhofer 2011), these trends are consistent with my interpretation of the LCZs in the northwestern Great Basin; in that region, bifacial cores were not a critical element of technological organization.

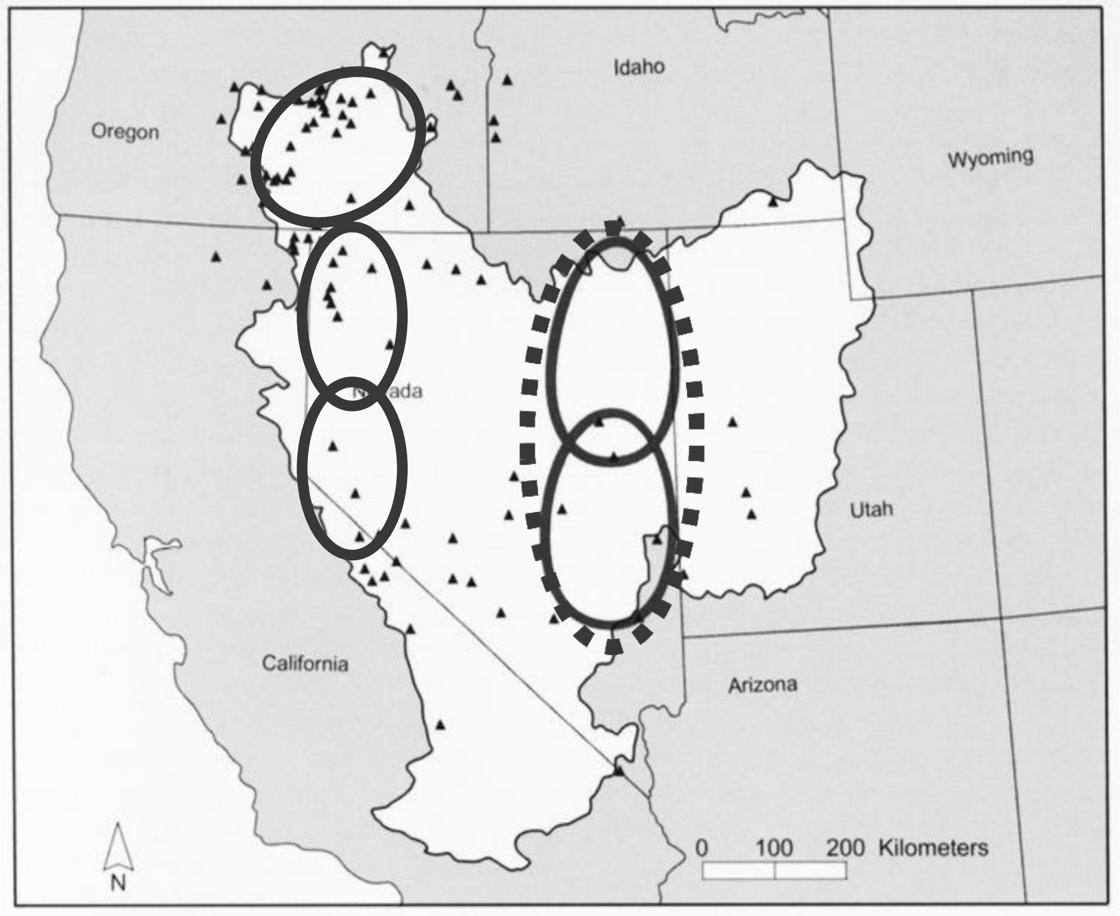

Figure 4.2. Central, northern, and western Great Basin lithic conveyance zones. After Jones et al (2003, 2012) and Smith (2010).

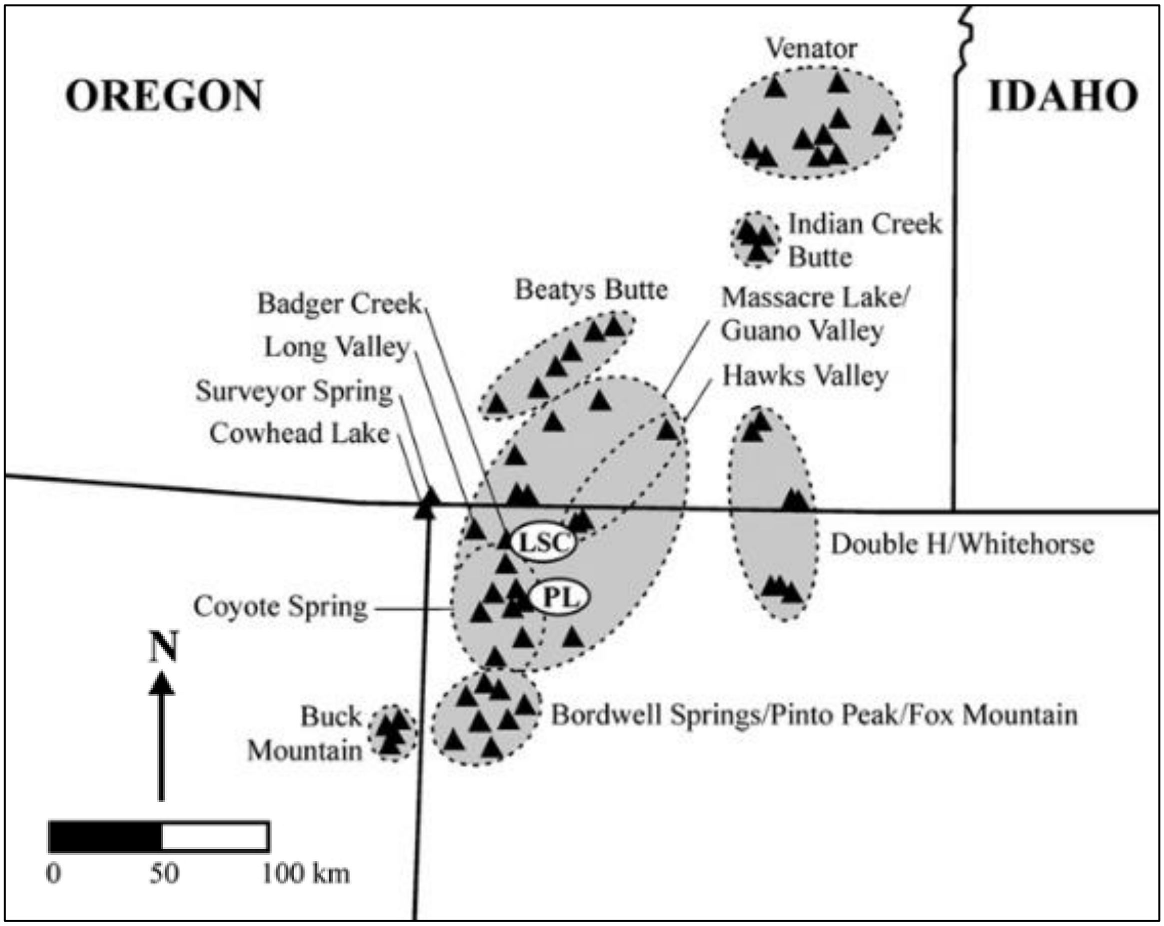

Figure 4.3. Obsidian sources in northwestern Nevada with locations of the Parman Localities and Last Supper Cave. From Smith and Kielhofer (2011).

My results further suggest that, counter to the HTFM, mobility may not have been an important influence on optimal toolkit design. Although LCZs in the northern and western Great Basin are smaller than those in the central Great Basin, they do suggest considerable residential or logistical movements. If mobility was a primary influence on groups' decisions to use bifacial cores, then evidence of that technology should dominate assemblages in both regions. Clearly, this is not the case in the northwestern Great Basin. If bifacial cores were commonly used in the obsidian-poor central Great Basin and not the obsidian-rich northwestern Great Basin, then it seems more likely that raw material availability and not mobility influenced the use of bifacial cores.

Alternatively, if mobility did influence groups' use of bifacial cores, then my results could suggest that northwestern Great Basin populations were less mobile than those in the central Great Basin. Parry and Kelly (1987) have suggested that as groups shifted from mobile to more sedentary lifestyles, bifaces became less important. My Paleoindian data from the northwestern Great Basin include one assemblage from a residential site (Paulina Lake [Connolly and Jenkins 1999]) and although it was not found at one of the previously recorded Parman Localities, an Early Holocene house feature was recently discovered nearby along the shoreline of pluvial Lake Parman (Hildebrandt et al. 2016). Those sites suggest a greater degree of residential investment than is typically attributed to Paleoindian groups in the region. Unfortunately, there are only a few assemblages from such sites, which precludes meaningful statistical comparisons. Why Paleoindian residential sites have been found in the northwestern Great Basin more than the central Great Basin remains unknown, although Hildebrandt and Ruby (2016) argue that of the Ruby Pipeline segments, the High Rock Country was the highest-ranked area and witnessed the longest and heaviest use by prehistoric populations (Figure 4.4). In such a resource-rich region, groups may simply have not needed to remain as residentially mobile as groups living in resource-poor regions.

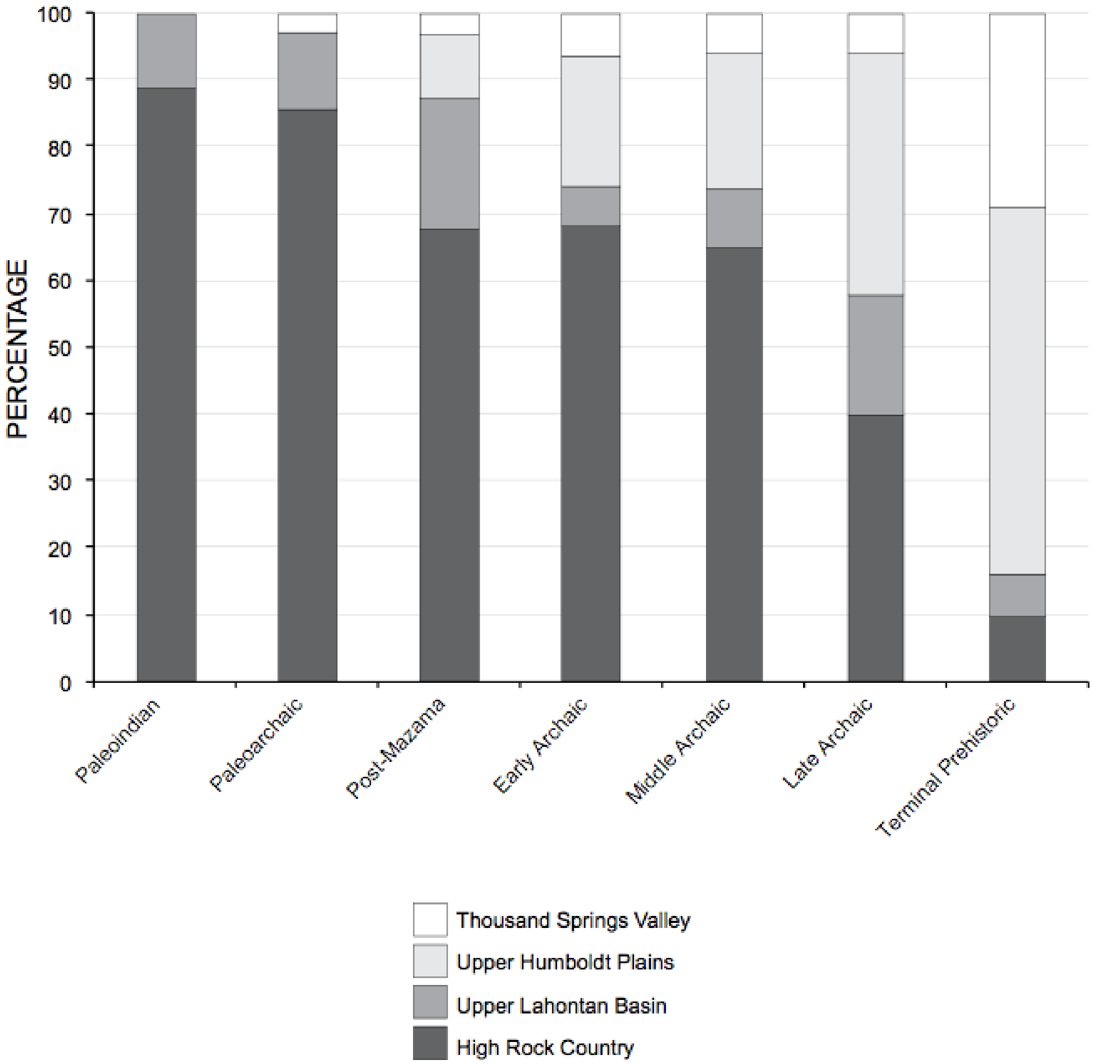

Figure 4.4. Percentage of components per 1,000 years and 1,000 acres of land along the Ruby Pipeline corridor. From Hildebrandt and Ruby (2016).

Site Type

Site type should have also influenced the use of bifacial technology. Kelly (1988) laid out a series of expectations for bifacial technology in residential and logistical sites (see Table 1.1) and Parry and Kelly (1987) expected bifacial technology to decline in frequency as groups become more sedentary. Because only one assemblage is definitely from a residential site (Paulina Lake), I compared Paleoindian assemblages from caves/rockshelters and open-air settings in the northwestern Great Basin. Although those locations do not necessarily always correspond with logistical or residential use, different activities may have occurred at each. The lack of a significant difference in BI values between location type suggests that this was not the case, although it is important to point out that my cave/rockshelter sample was very small (*n*=3). It will be worthwhile to repeat this analysis if more cave/rockshelter data become available. Furthermore, a comparison of residential and logistical assemblages would certainly be informative but remains impossible until more Paleoindian-age residential sites are identified in the northwestern Great Basin.

Subsistence

To explore the relationship between bifacial technology and subsistence strategies, I compiled published faunal data from the assemblages in my sample when such information was available. I also included data from Pinson’s (2007) study of northwestern Great Basin faunal assemblages as well as data from the High Rock Country and Upper Lahontan Basin segments of the Ruby Pipeline (Hildebrandt et al. 2016). When necessary, I calculated Artiodactyl Index (AI) values for each assemblage; otherwise, I used published AI values. I compared AI values to my BI and BTI values for each period in the northwestern Great Basin (Figure 4.5). Because bifacial technology is often associated with large-game hunting (Hildebrandt and McGuire 2002; Hildebrandt et al. 2016), I expected to see a strong positive correlation between bifaces (as measured by BI and BTI values) and AI values.

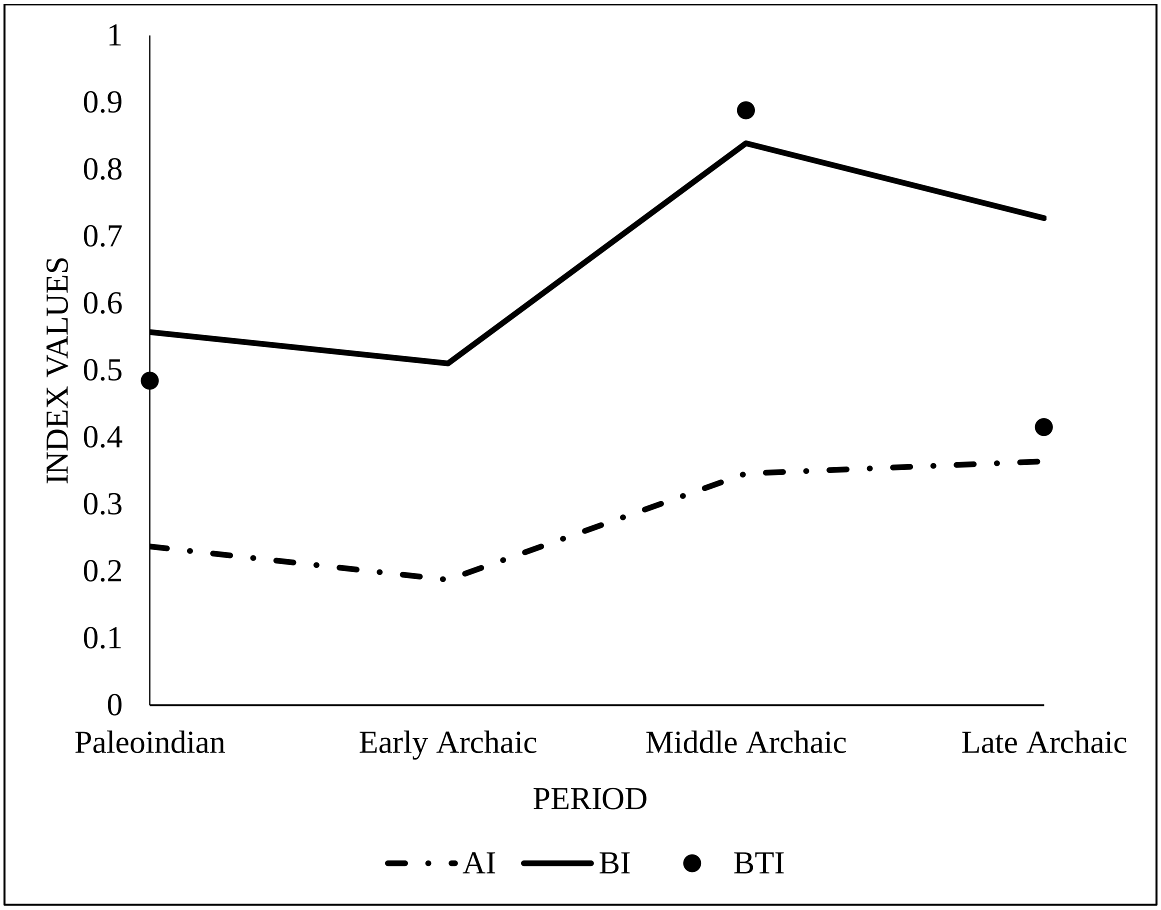

Figure 4.5. AI, BI, and BTI values over time in the northwestern Great Basin.

Figure 4.5 shows that in general, mean AI values track mean BI values across time. Each measure is moderate in the Paleoindian period, drops during the Early Archaic period, and rises sharply during the Middle Archaic period. The mean AI and BI values converge in the Late Archaic period: the mean BI value declines but the mean AI values remains essentially unchanged. My debitage sample was smaller and as a result, the BTI data are less conclusive. The points shown in Figure 4.5 represent BTI data because there is no BTI information for the Early Archaic period (i.e., it is not possible to draw a line with a missing data point). That issue aside, the mean Paleoindian and Middle Archaic BTI values track the BI and AI values well, but the BTI values decline more than the other two measures during the Late Archaic period.

Together the BI, BTI, and AI values suggest a strong link between hunting strategies and bifacial technology. The BI and AI values are relatively low during the Paleoindian and Early Archaic periods, suggesting that both biface use and artiodactyl hunting were lower during those periods. Both indices rise in the Middle Archaic period, which likely reflects a well-documented increase in big-game hunting during that period. Increased artiodactyl hunting may have been fostered by elevated artiodactyl populations (Broughton and Bayham 2003; Broughton et al. 2008) and undertaken either by communal groups using large-scale trapping features (Hockett 2005; Hockett et al. 2013) or prestige-seeking male hunters (Hildebrandt and McGuire 2002). Hildebrandt et al. (2016b) note a similar trend in their Ruby Pipeline data: biface frequencies peak during the Middle Archaic period (Figure 4.6, Table 4.2) before dropping during the Late Archaic period. Biface frequencies are significantly higher during the Middle Archaic period in the Obsidian Rim segments than the Chert Core segments ($x^2 = 328.19$, $df = 3$, $p < 0.001$) (Table 4.2) – a trend that is also apparent in my own dataset.

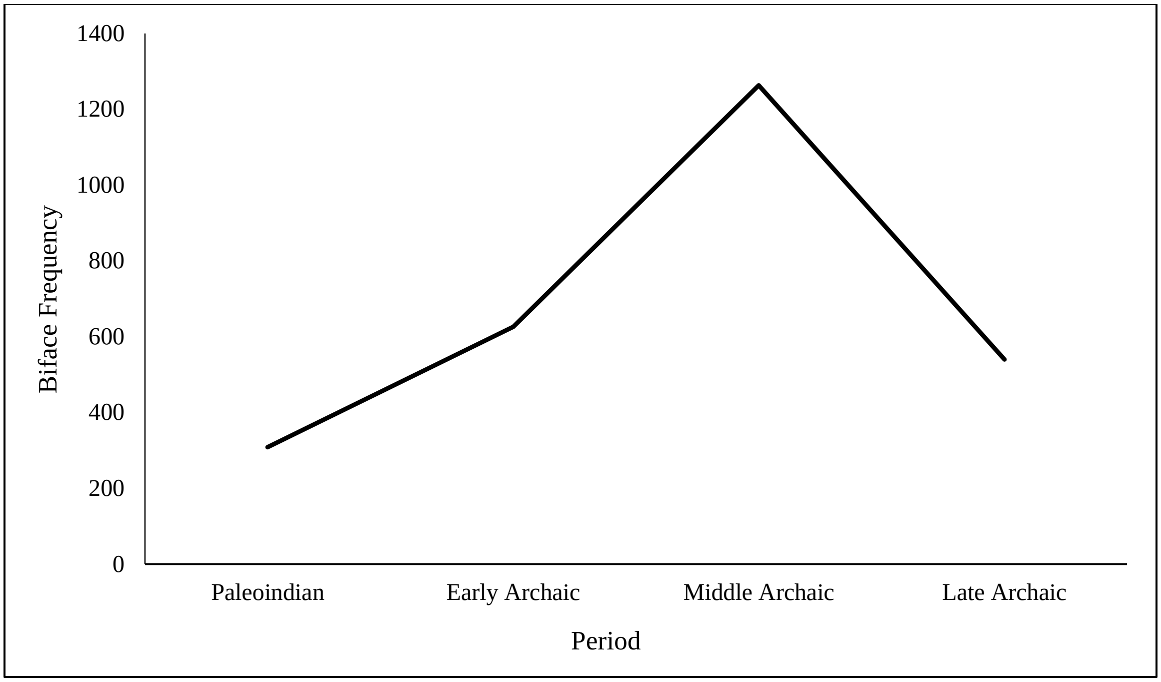

Figure 4.6. Biface frequencies over time along the Ruby Pipeline corridor. After Hildebrandt et al. (2016b).

During the Late Archaic period, BI values drop dramatically while AI values remain about the same. This seemingly contradictory pattern is likely a result of the introduction of bow-and-arrow technology late in time (Bettinger 1999; Elston 1986; Hildebrandt et al. 2016b). Arrow points require less raw material to produce than dart points and can be made on flakes rather than bifaces (Justice 2002; Yohe 1998). Accordingly, bifacial technology became less common and unifacial tools became more common during the Late Archaic period (Bettinger 1999; Elston 1986). The widespread adoption of the bow-and-arrow likely also explains the precipitous drop in BTI values during the Late Archaic period: as bifaces became less common, so too did biface thinning flakes.

Summary

My results suggest that bifaces did not play a more central role in Paleoindian lithic technological organization in the toolstone-rich northwestern Great Basin than later Archaic technological organization in that same region. To the contrary, they suggest that bifaces were less important to early groups than later groups in that region; however, my results do suggest that bifacial cores may have been used by groups in the obsidian-poor central Great Basin. Based on my analyses, raw material availability/quality and subsistence strategies (i.e., big game hunting) seem to have been the driving factors in the organizational role of bifacial technology. Mobility seems to have had a lesser influence than the HTFM suggests. Because there is little evidence to support the use of bifacial cores in the northwestern Great Basin and because raw material availability, not mobility, seems to have motivated the use of bifacial cores in the central Great Basin, my results suggest the HTFM is not a good fit for either region.

CHAPTER 5

CONCLUSIONS

The HTFM holds that mobile Paleoindians employed a lithic toolkit that emphasized efficiency and flexibility (Kelly and Todd 1988). Bifacial cores figure prominently in the HTFM because they are generally assumed to produce flakes with high edge-to-weight ratios. The model was developed on the Great Plains and similarities in technological organization led researchers to quickly adopt it in the Great Basin; however, its applicability to that region has never been critically evaluated. Furthermore, although the HTFM continues to be featured implicitly or explicitly in researchers' interpretations of Paleoindian lifeways, a number of studies have challenged aspects of the model based on actualistic, archaeological, and modeling grounds.

With these challenges in mind, I designed a study to explore bifacial technology in the northwestern and central Great Basin and, by extension, test the applicability of the HTFM to those regions. I developed two hypotheses: (1) bifaces played a more central role in Paleoindian lithic technological organization in the northwestern and central Great Basin than in later Archaic technological organization in those same regions; and (2) because high quality raw material is rare in the central Great Basin, groups there relied more heavily on bifacial technology throughout time than those in the toolstone-rich northwestern Great Basin. To test these hypotheses, I compared two measures of biface abundance in archaeological assemblages – the Biface Index (BI) and Biface Thinning Index (BTI) across four time-periods and two regions. For the first hypothesis to be supported, BI and BTI values should have been higher in Paleoindian assemblages than later Archaic assemblages in each region. For the second hypothesis to be supported, BI and BTI values should have been higher across time periods in the central Great Basin than in the northwestern Great Basin.

The results of my analysis failed to meet these expectations and, in turn, do not provide support for the two hypotheses outlined above. Instead, my results suggest that Paleoindian groups in the northwestern Great Basin were less invested in bifacial technology than later groups in the same region. In a region rich in high-quality raw material (obsidian), these results are unsurprising and it appears that bifacial technology remained relatively unimportant until artiodactyl hunting became common in the Middle Archaic period. In the central Great Basin there is no significant difference in BI values over time, and no difference in BI values between that region and the northwestern Great Basin, except during the Middle Archaic period. The lack of change over time suggests that the role of bifaces in the central region was less sensitive to change in subsistence strategies than in the northwestern region. Instead, raw material availability may have been more important in driving the organizational role of bifaces in the obsidian-poor central Great Basin. This conclusion is supported by my BTI results, as well as the preponderance of tools manufactured on biface thinning flakes, the analyses of biface frequencies, and bifaces stages in the central Great Basin.

Future Research Directions

Although my study produced results for the northwestern and central Great Basin that counter expectations of the HTFM, there are several ways that my research can be expanded upon in the future. First, because raw material availability and quality influenced groups' decisions to use bifaces, future work should focus on how different raw materials were used. Such work will be particularly relevant in the central Great Basin. Because obsidian is rare there, I expect that if BI and BTI values are calculated for different raw material types, then BI values will be higher for obsidian tools than those made on CCS. Furthermore, my results suggest that obsidian bifaces were more heavily curated in the central Great Basin than the northwestern Great Basin. If this is the case, then I expect obsidian BTI values to be higher than CCS BTI values in the central region, which would point to a greater degree of maintenance of obsidian bifaces.

Second, because I was specifically concerned with the role that bifaces played in Paleoindian technological organization, my analysis was limited to bifaces and biface thinning flakes. Additional studies focused on other tool types such as projectile points and flake tools may contribute to our collective understanding of technological organization. As I outlined earlier, projectile points and bifaces exhibit different source profiles in the northwestern Great Basin (Smith and Kielhofer 2011). In the context of my analysis, their results suggest that projectile points were a central component of a portable toolkit but unfinished bifaces were not (the latter trend is something I have noted in my own sample here). Moving forward, it will be worthwhile to examine the role that WST projectile points played in Paleoindian technological organization. Similarly, Beck and Jones (2009) have suggested that because many flake tools at the Sunshine Locality were made on biface thinning flakes, bifaces may have been used as cores by visitors to that site. Future work will benefit from a comparison of the frequencies of flake tools made on bifacial flakes and flakes struck from other core types using a larger sample than the five sites for which I found published data.

Third, X-ray fluorescence data are available for some of the assemblages included in my study. Given the relatively low cost of conducting such analyses, similar data may easily be obtained for others. Future work that addresses questions of how and under what circumstances toolstone was conveyed, as well as how such behavior may have changed across time, will provide additional insight into prehistoric technological organization.

Finally, my analysis of how bifaces were produced, used, and discarded at different site types (residential bases, logistical camps, caves/rockshelters) was limited by my small sample size. It will be worthwhile to conduct a similar analysis using a larger sample of cave/rockshelter sites containing Paleoindian occupations; many such sites (e.g., the Paisley Five Mile Point Caves, the Connley Caves, Rimrock Draw Rockshelter, and LSP-1) are currently being investigated and lithic data will eventually be published. Unfortunately, although a couple of Paleoindian residential features have recently been discovered (Hildebrandt et al. 2016a), such sites remain elusive and I am not optimistic that the sample will ever increase dramatically. As such, understanding how early populations used bifaces in different settlement system contexts may remain a difficult endeavor.

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