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Debitage Attributes, Obsidian Source Analysis, and Prehistoric Mobility in Southeastern Idaho

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DEBITAGE ATTRIBUTES, OBSIDIAN SOURCE ANALYSIS, AND PREHISTORIC MOBILITY IN SOUTHEASTERN IDAHO

by

Ben Joaquin Zumkeller

A dissertation submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Anthropology
(Archaeology and Cultural Resource Management)

Approved:

David Byers, Ph.D. Major Professor	Judson B. Finley, Ph.D. Committee Member
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UTAH STATE UNIVERSITY
Logan, Utah

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ABSTRACT

Debitage Attributes, Obsidian Source Analysis,
and Prehistoric Mobility in Southeastern Idaho

by

Ben Joaquin Zumkeller, Master of Science

Utah State University, 2020

Major Professor: Dr. David Byers
Department: Sociology, Social Work, and Anthropology

This study investigates the use of lithic debitage as an informer of prehistoric hunter-gatherer mobility systems. I combine obsidian source analysis and flake attribute analysis to evaluate the mobility level of Bobcat Rockshelter occupants through time as well as make predictions about how debitage curation intensity should correlate with toolstone source distance. The current literature supports the idea that increasingly curated stone material derives from increasingly farther toolstone sources. To date, no research has utilized sourcing and attribute data from an entire, stratified assemblage of debitage to test this idea, until now. Attribute data were collected from 2,846 artifacts including both obsidian and microcrystalline silicates (98.5% of the total debitage collection) while X-ray fluorescence sourcing data were collected from 1,830 obsidian artifacts (64.3% of the total debitage collection). Archaeological strata's debitage were grouped according to similarity in mean toolstone source distance. Mann Whitney U tests were then used to identify significant differences between compared groups based on ten discrete attribute measurements. Compared groups' median values of specific attribute measurements were used to confirm or deny predicted correlations with toolstone source distance. All significant, Mann Whitney U tests performed on exclusively obsidian samples demonstrate the predicted changes in median values with increasing source distance. Maximum flake width, incomplete flake width, platform width, incomplete platform width and thickness, and dorsal scar count are demonstrated as the better indicators of flake curation intensity here. Bobcat Shelter obsidian material deposited before the Late Archaic/ Late Prehistoric transition originates from farther geological sources than after. Incidentally to my main research goal, I observe a large increase in the proportion of Butte Valley Group A and Browns Bench material at Bobcat Shelter during the end of the Late Archaic (2,950 – 1,650 BP). This was not observed in previous stratified, sourcing samples of Bobcat Shelter material, demonstrating the power of volumous debitage samples in toolstone sourcing. Future research should result in stronger correlations and a more detailed picture of mobility if data are synthesized from several site types occupying the same prehistoric mobility system.

(181 pages)

PUBLIC ABSTRACT

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The purpose of this study is to complement existing knowledge on prehistoric mobility in eastern and southern Idaho. I add specific detail regarding the use of Skull Canyon and its well-known Birch Creek rockshelters during hunter-gatherers' logistical foraging rounds.

In addition, my research is a case study in combining debitage attribute analysis and intensive toolstone sourcing to read prehistoric mobility. Prior research has looked to obsidian toolstone sourcing to understand prehistoric eastern and southern Idaho mobility. However, no prior research has involved sourcing an entire, stratified assemblage of prehistoric debitage.

I collected flake attribute data from all 2,846 pieces of Bobcat Shelter debitage including both obsidian and microcrystalline silicate artifacts. I collected x-ray fluorescence, obsidian sourcing data on all 1,830 pieces of Bobcat Shelter obsidian debitage.

Analysis involved combining strata based on similarity in strata mean toolstone source distance. This was necessary due to strata sample sizing constraints. Mann Whitney U tests were used to find significant differences between groups based on every one of ten disparate debitage attributes. These attributes are expected to change in predictable ways with increasing mean toolstone source distance. Group median attribute values were used to verify predicted differences between groups.

Debitage characteristics appear dependent on distance from toolstone source. As expected, this is especially true for exclusively obsidian samples as 100% of significant Mann Whitney U results are associated with predicted trends in group median attribute values. Obsidian material deposited before the Late Archaic/ Late Prehistoric transition originates from farther geological sources than after, pointing to an important difference in mobility levels. This research also uncovers a large increase in the proportion of specific toolstone sources during the end of the Late Archaic (2,950 – 1,650 BP), detail missed during less intense sampling of Bobcat Shelter sourced obsidian.

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CHAPTER 1

INTRODUCTION

Researchers studying hunter-gatherer mobility focus on the variation in strategies used to exploit landscapes and acquire resources (Kelly 1983). Understanding mobility strategies is a major step towards understanding past peoples within their greater behavioral contexts. For example, mobility conditions settlement practices (Binford 1980). More logistically organized groups of hunter-gatherers are expected to generate site types that more expediently organized groups do not (Binford 1980). Mobility conditions material culture. For example, highly mobile societies invest less in ceramic storage than less mobile societies (Eerkens 2003). In addition, and directly relevant to the research here, mobility conditions hunter-gatherer technological organization, especially the level of curation seen in toolstone (Bamforth 1986, 1991; Binford 1978, 1979, 1980; Kelly 1983, 1988; McCall 2012; Nelson 1991; Shott 1986).

My research investigates the use of lithic debitage as an informer of Idaho hunter-gatherer mobility systems. I add detail to and corroborate what we know about Birch Creek Valley and eastern and southern Idaho archaeology, specifically their mobility systems and technological organization. I accomplish this through combined debitage attribute and obsidian source analysis within a technological organization framework. I work from the broad hypothesis that there is a relationship between the technological strategies of Bobcat Shelter's occupants and their mobility systems, with the specific prediction that if Bobcat Shelter occupants varied in their dependence on logistical mobility strategies, then I will find correlations between strata lithic curation intensity and strata average distance from toolstone source.

Bobcat Shelter

Bobcat Shelter, located within the Caribou-Targhee National Forest, is a large limestone alcove on the floor of Skull Canyon (Arkush 2017). It is situated at 1,948 meters above sea level where a high desert sagebrush-grassland and woodland plant community transitions into a montane forest community.

Idaho State University faculty first test excavated Bobcat Shelter in 1960, and Weber State University conducted full-scale excavations during the summers of 2012 and 2013 (Arkush 2017; Swanson et al. 1959; Swanson and Bryan 1964). These excavations have resulted in 15 intact points, 2,888 flakes, and over 33,000 pieces of bone, largely bighorn sheep, spanning several occupations (Arkush 2017). Features at Bobcat Shelter include a handful of hearths and a roasting pit. Burnt sheep fragments, burnt artiodactyl fragments, and fire-cracked rock are evident among them. Arkush (2017) interprets Bobcat Shelter as a short-term, logistical hunting camp based on the character of its faunal and debitage assemblages and on ethnographic information about bighorn sheep hunters of the Intermountain West.

Bobcat Shelter contains well-defined stratigraphy. It is divided into 20 strata with reliable radiocarbon dates ranging from 7,730 to 980 cal yr BP (Arkush 2017). An AMS date on a charcoal sample from Stratum 7a returned a C14 age of 1,170 ± 30 BP (Arkush 2017). Because over 70% of the debitage is recovered from Strata 7, 8, and 9, this date suggests intense use during the Late Archaic (2,950 to 1,650 BP) and Late Prehistoric (1,650 to 150 BP) Period occupations (Arkush 2017; Swanson 1972).

Birch Creek Valley's archaeological record has not been extensively dated with absolute methods, but a general chronology, based on Idaho State University's 1950's and 1960's excavations, has been applied to the region (Arkush 2017; Swanson 1972). The Paleoindian/Paleoarchaic (13,000 – 8,500 BP) period is represented by Haskett, Plano, and Great Basin Stemmed projectiles with an absence of millingstones (Arkush 2017; Swanson 1972). The Early Archaic (8,500 – 4,500 BP), correlating with the Altithermal, is characterized by the earliest use of the atlatl, dart, and milling technology. During this time foragers increasingly occupied upland ecozones (Arkush 2017; Swanson 1972). In addition to Haskett, Plano, and Great Basin, Northern Side-notched dart points, are Elko series dart points, Mckean, Humboldt, and Stemmed Indented projectile points (Arkush 2017; Swanson 1972). Bear Gulch, Walcott Tuff, and Big Southern Butte were obsidian sources exploited by local foragers (Arkush 2017; Swanson 1972).

The Middle Archaic (4,500 – 2,950 BP) marks the appearance of typical settlement and subsistence practices documented in the regional ethnographic record with Stemmed Indented Base and Humboldt/Mckean falling out of fashion (Arkush 2017; Swanson 1972). Rod and bundle and half rod and splint coiled basketry appear around A.D. 1 during the Late Archaic (2,950 – 1,650 BP), and Elko Eared, Corner-notched, and Wahmuza Lanceolate dominate the period (Arkush 2017; Swanson 1972). The Late Prehistoric (1,650 – 150 BP) is when bow and arrow technology was introduced to the region as evidenced by Avonlea, Rose Spring, and Eastgate Projectile points (Arkush 2017; Swanson 1972). Fremont ceramics are evident at sites on the eastern Snake River Plain (Plew 2016). Shosheonean speakers likely migrated to the region after around A.D. 1,300 (Arkush 2017; Swanson 1972). The Early Historic Period (150-100 BP) marks Shoshonean groups' first interactions with the Anglos, quick cultural change, introduction of new diseases, and the dying out of bison and beaver in the upper Snake River region (Arkush 2017; Swanson 1972).

Research Questions

To better understand the relationship between technological organization and mobility in eastern and southern Idaho, my research organizes around the central question, how does mobility condition technological organization and how is this relationship expressed at Bobcat Shelter? In response to these questions, I compare shifts in assemblage level patterns of debitage attributes with distance from toolstone source in ways allowing me to document relationships between mobility and technological organization.

Through my research I find that there is a relationship between average distance from toolstone source and levels of toolstone curation across the various strata excavated at Bobcat Shelter. In the process, I take a most extensive sample of Bobcat Shelter obsidian for geochemical sourcing, generating XRF readings for nearly all obsidian debitage (n = 1,781). As a result, my research produces the most resolute picture of lithic provenance representing Bobcat Shelter and adjacent sites.

Research Design

Here, I outline the research strategy employed in the following chapters. Analysis of the Bobcat Shelter debitage is divided into three phases. The first phase involves taking x-ray fluorescence (XRF) readings of nearly all (n = 1,781) the Bobcat Shelter obsidian debitage (Chapter 3). Data derived from XRF analysis enables me to document the average distance to toolstone source for the Bobcat Shelter strata and, subsequently, predict the levels of curation across Bobcat Shelter strata. In this way, the XRF data can provide a context for understanding variability in curation signals. The second phase involves measuring a set of variables for all Bobcat Shelter debitage (Chapter 3). These variables are chosen for their responsiveness to increasing reduction intensity. Variables indicating reduction intensity are selected because, within the context of my model, a more logistical mobility system emphasizing curated strategies should exhibit debitage produced later in the reduction sequence. In the third phase of my analysis, I apply Mann Whitney U to test my prediction that there is a relationship between average distance from toolstone source and levels of toolstone curation across the various strata excavated at Bobcat Shelter.

Obsidian Source Analysis, Source Distance, and the Organization of Lithic Technologies

Researchers have successfully used obsidian sourcing to answer questions about mobility systems, trade networks, and technological organization (Arkush and Pitblado 2000; Dello-Russo 2004; Fowler 2014; Henrikson 2008; Hughes and Pavesic 2005; Jones et al. 2012; Logan et al. 2001; Scheiber and Finley 2011; Shackley 1994, 2008, 2011; Smith 1999). For example, Smith (1999) demonstrates that the distribution and availability of raw materials is an important conditioning factor in aspects related to curation, including the production and transport of tools, factors all important to the research I pursue here.

Hunter-gatherers can be expected to treat local and non-local obsidian differently. This is especially dependent on distance from source (Bamforth 1986; Beck et al. 2002; Beck 2008; Feder 1980; Metcalfe and Barlow 1992; Newman 1994; Smith 1999). Occupants of sites closer to toolstone sources are likely to manufacture unrefined, finished products (Bamforth 1986; Beck et al. 2002; Beck 2008; Feder 1980; Metcalfe and Barlow 1992; Newman 1994; Smith 1999). In contrast, occupants of sites farther from toolstone sources are likely to transport, conserve, maintain, and repair toolstone in a more completed state (Bamforth 1986; Beck et al. 2002; Beck 2008; Feder 1980; Metcalfe and Barlow 1992; Newman 1994; Smith 1999). In other words, material that travels farther from its origin is more intensely subject to a range of behaviors collectively referred to as curation.

The relationship between increasing distance to source and increasing levels of curation is why I investigate the level of variation in the average distance to source across the various occupations. If there is variation in the average distance to source across the various occupations, then as distance to source increases, so should levels of curation. Consequently, I expect a relationship between mean source distance and measures of curation intensity on debitage from a given stratum. To test my expectation, I must characterize strata average distance to toolstone source, and this requires x-ray fluorescence analysis.

The literature indicates that obsidian samples wider than 10 mm and thicker than 2 mm are optimal for energy dispersive x-ray fluorescence spectroscopy (Davis et al. 1998; Eerkens et al. 2007; Shackely 2011). The Bobcat Shelter debitage are much smaller than this, averaging 6.5 mm in width and 1 mm in platform thickness and consist of about 90 percent pressure flakes. My research demonstrates that tiny debitage retain value when it comes to informative mobility research. This is best evidenced by the distinctive source clustering apparent on elemental biplots of Bobcat Shelter obsidian debitage (Figure 4.2). In addition, the chemical signatures and source identifications derived from thicker samples of Bobcat Shelter obsidian, such as points and preforms, corroborate the chemical signatures and source assignments resulting from my research (Arkush 2017; Hughes 2014, 2016).

Debitage Attribute Analysis

Several attribute measurements have been demonstrated to correlate with debitage's place in the toolstone curation sequence (Andrefsky 1986, 1994, 2005; Amick et al. 1988; Burton 1980; Carr and Bradbury 2011; Dibble and Whittaker 1981; Dibble 1997; Magne and Pokotylo 1981; Marwick 2008; Mauldin and Amick 1989; Morrow 1984; Odell 1989; Pelcin 1997; Scott 1991; Shott 1994; Stahle and Dunn 1982; Sullivan and Rozen 1985). I focus on the level of curation because previous research has associated higher levels of curation with logistically organized mobility strategies and farther source distances (Andrefsky 1994; Bamforth 1986, 1991; Beck et al. 2002; Beck 2008; Metcalfe and Barlow 1992; Nelson 1991; Shott 1986). Within this context, I record the following attributes for all Bobcat Shelter debitage: percentage of dorsal cortex, dorsal scar count, weight, maximum flake width, striking platform width, striking platform thickness, and ventral curvature.

Data Analysis

In the third phase of my analysis, I employ Mann Whitney U to test my prediction that there is a relationship between strata average source distance and the levels of toolstone curation observed across the various strata excavated at Bobcat Shelter. Mann Whitney U is used to identify significant differences between strata and/or analytical groups of strata based on several curation indicators. Significant results are evaluated against the attribute median values characterizing strata and/or analytical groups. I expect median values to trend in directions that make sense within the context of strata or group mean source distances.

Thesis Organization

My thesis is divided into a series of chapters. I begin by discussing the anthropological concept of mobility, the different ways mobility can be expressed, and the manner in which mobility systems can condition technological organization (Chapter 2). Next, I present the current knowledge on eastern and southern Idaho, prehistoric mobility systems. I then outline a model of how logistically organized mobility systems, like those evidenced in eastern and southern Idaho, should condition technological organization (Chapter 2). In the process I allude to methods that could test my model. Chapter 3 precisely details my methods for testing my model. Chapter 4 reports the results of the analyses and evaluates them within the context of my hypothesis and predictions. Finally, in Chapter 5 I conclude that Bobcat Shelter debitage is conditioned by strata mean source distance in ways I predict, supporting my hypothesis. Chapter 5 also contains discussion on how my research methods might be improved and how my research could be built upon.

CHAPTER 2

BACKGROUND

Chapter 2 outlines the theoretical framework guiding my analysis of the Bobcat Shelter debitage, in this case, the archaeological concept of mobility. I discuss general knowledge on prehistoric mobility. I proceed to model how distance to toolstone source conditions the lithic technology of logistically organized foragers, such as those that likely occupied Bobcat Shelter. As I build my model, I defend it with relevant technological organization research. I then discuss knowledge on eastern and southern Idaho prehistoric mobility as this informs my hypotheses and predictions. Next, I outline how Bobcat Shelter debitage could serve to test my model, justifying my methods in the process. Finally, I state my hypotheses and predictions regarding the Bobcat Shelter debitage.

The Concept of Mobility

Mobility has been defined as “ the nature of the seasonal movements of hunter-gatherers across a landscape: mobility strategies are one facet of the way in which hunter-gatherers organize themselves in order to cope with problems of resource acquisition” (Kelly 1983:277). The main problem of resource acquisition is that hunter-gatherers are often unable to allocate equal amounts of time and energy toward the resources they require (Binford 1979, 1980: Kelly 1983). For example, the pursuit of preferred prey items may result in travel away from preferred toolstone sources. In essence, there are tradeoffs involved in the selection and implementation of mobility strategies (Binford 1979, 1980; Kelly 1983; Metcalfe and Barlow 1992; Nelson 1991).

Researchers have outlined models that encapsulate the variation of strategies for dealing with resource incongruence (Binford 1980; Kelly 1983).

Binford's Forager/Collector Spectrum

Binford (1980) outlines the behavior of foragers on a spectrum of "foragers" to "collectors". As defined by Binford (1980), foragers exploit residential mobility to move their base camps to areas of more homogenously distributed resources (Binford 1980; Kelly 1983). In contrast, collectors use logistical mobility to deal with resource incongruence by sending out specially organized task groups that move resources back to residential bases (Binford 1979; Binford 1980; Kelly 1983).

Mobility strategies condition the diversity of archaeological sites that are generated by hunter-gatherers (Binford 1979; Binford 1980; Kelly 1983). Expediently organized foragers situate themselves relative to resources, so they rarely stray more than a day's travel from the residential base (Binford 1980). As a result, expediently organized foragers generate two site types in the record- residential bases and extractive sites (Binford 1980). On the other hand, because collectors employ logistical strategies, they must travel out several days or weeks, transporting those resources back to their residential bases (Binford 1980). Consequently, logistical mobility results in the creation of field camps, caches, and reconnaissance sites in addition to residential bases and extractive sites (Binford 1980).

Using the examples of Nunamiut and !Kung foragers, Binford (1979) illustrates how logistical mobility strategies typically require travel over greater distances than expedient mobility strategies. The Nunamiut are best described as extremely logistical, owed to the highly seasonal environment in which they occupy (Binford 1979). This seasonal environment demands the incessant transportation of resources across residential bases, hunting camps, and storage sites in order to make a living out of the landscape. They obtain more than seventy percent of their yearly food during just thirty days of the year, half of it during the spring caribou migration and the other half during the fall caribou migration (Binford 1979). Nunamiut life requires great amounts of movement yet most of the time they are eating out of storage (Binford 1979). Binford (1979) contrasts the Nunamiut with extremely non-logistical hunter-gatherers such as the !Kung. These foragers rarely stray more than a day’s travel from the residential base and move their residential bases only when they have depleted their current resource catchment (Binford 1979; Binford 1980).

In general, logistically oriented strategies require greater attention towards the economic variables of resource predictability, periodicity, distribution, and productivity than expedient strategies (Bamforth 1986; Binford 1979, 1980; Nelson 1991). Nunamiut foragers, for example, prepare for future resource shortages whenever given the opportunity, creating a built environment as they cache resources (Binford 1979). In addition, Nunamiut foragers mitigate resource shortages by embedding activities within each other, “Raw materials used in the manufacture of implements are normally obtained incidentally to the execution of basic subsistence tasks” (Binford 1979: 259). Binford (1979) illustrates this point with the example of a fishing party taking the opportunity to extract nearby toolstone when the primary task at hand is obtaining food resources.

How Mobility Conditions Technological Organization

Mobility is relevant to the anthropological concept of technological organization. Technological organization entails the study of the selection and integration of strategies for making, using, transporting, and discarding tools and the materials needed for their manufacture and maintenance (Nelson 1991:57). The selection and integration of technological strategies, like mobility strategies, is conditioned by economic and social variables (Bamforth 1986, 1991; Bleed 1986; Kuhn 1994; Nelson 1991; Shott 1986). For example, the economic and social variables of resource predictability, periodicity, distribution, productivity, and mobility influence technological organization (Bamforth 1986, 1991; Binford 1980; Nelson 1991; Shott 1986). Through a lens of technological organization, different modes of procurement, manufacture, use, and discard are correlated with the manner that hunter-gatherers move about the landscape (Bamforth 1986, 1991; Binford 1980; Kelly 1983, 1988; Nelson 1991; Shott 1986).

Curation vs. Expediency

Just as archaeologists outline a spectrum of variation to understand mobility strategies, so do they with technological organization. On opposite ends of this technological spectrum are strategies that are either expedient or curated (Bamforth 1986; Nelson 1991). Expedient strategies are those that favor minimalized technological effort (Bamforth 1986; Nelson 1991). For example, selecting a largely non-reduced piece of stone to aid in a task and then immediately discarding it afterwards would constitute expediency.

Curated strategies favor greater technological effort and a desire to fully extract toolstone's utility (Bamforth 1986; Nelson 1991). Utility is defined as the degree of usefulness in an object/resource (Metcalfe and Barlow 1992). Behaviors resulting from strategies emphasizing curation include advanced manufacture, transport, reshaping, and caching (Bamforth 1986; Nelson 1991). Intense reduction of stone material and recycling stone tools for other purposes is typical of behavior favoring curation (Bamforth 1986; Nelson 1991).

How foragers organize their technology is influenced by time and material constraints (Andrefsky 1994; Bamforth 1986; Binford 1979, 1980; Nelson 1991; Shott 1986). For example, activities occurring at longer-term residential camps often involve expedient technologies in the presence of sufficient time and materials at the place of tool use (Andrefsky 1994; Bamforth 1986; Binford 1979, 1980; Nelson 1991; Shott 1986). In contrast, those exploiting higher tempo mobility patterns or relying on higher levels of logistical mobility often deploy curated technologies when they anticipate inadequate conditions for tool preparation at the time and place of tool use (Andrefsky; Bamforth 1986; Binford 1979, 1980; Nelson 1991; Shott 1986). Inadequate conditions include lack of time, material, and/or facilities (Nelson 1991). Within such contexts, such as hunting camps placed in relation to food resources as opposed to lithic resources, curated technologies can take the form of advanced manufacture, transport, reshaping, and caching (Andrefsky 1994; Nelson 1991).

Archaeologists compare ethnographic and archaeological data to understand how technology is influenced by time and material constraints (Andrefsky 1994; Bamforth 1986). For example, consider Andrefsky's (1994) use of ethnographic data on stone-tool makers from Australia to demonstrate that more intensely curated tools are more prevalent in areas absent of abundant and suitable quality material while informal tools tend to be more characteristic in regions with ample, high quality material (Andrefsky 1994). Bamforth (1986) echoes this relationship, demonstrating that the intensity of curational strategies like recycling and maintenance vary with raw material availability, and as I discuss next, distance from material source is one factor that conditions toolstone availability.

Distance to Toolstone Source and Curation Intensity

Distance to toolstone sources can be an important factor in the selection of technological strategies favoring either expediency or curation. Previous research suggests that hunter-gatherers will treat local and non-local toolstone differently (Bamforth 1986; Beck et al. 2002; Beck 2008; Feder 1980; Metcalfe and Barlow 1992; Newman 1994; Smith 1999). Occupants of sites closer to toolstone sources are likely to manufacture unrefined, finished tools (Bamforth 1986; Beck et al. 2002; Beck 2008; Feder 1980; Metcalfe and Barlow 1992; Newman 1994; Smith 1999). In contrast, occupants of sites farther from toolstone sources are likely to transport, conserve, maintain, and repair tools in a more completed state (Bamforth 1986; Beck et al. 2002; Beck 2008; Feder 1980; Metcalfe and Barlow 1992; Newman 1994; Smith 1999). In other words, material that travels farther from its geological origin is more intensely subject to a range of behaviors collectively referred to as curation.

The effect of distance to toolstone source on curational intensity is explained by behaviors that allow logistically oriented foragers to mitigate an absence of toolstone availability (Bamforth 1986; Binford 1979, 1980; Feder 1980; Nelson 1991). Fully extracting the utility from toolstone affords logistically organized foragers the ability to travel greater distances from toolstone sources before needing to replenish their toolstone supply (Bamforth 1986; Binford 1979, 1980; Feder 1980; Nelson 1991). In other words, foragers receive the greatest return on their investment by more fully extracting toolstone’s utility.

Mobility in Eastern and Southern Idaho

The Highly Mobile, Logistical Round

Idaho's hunter-gatherers acquired resources within a highly mobile seasonal round (Henrikson 2003, 2008; Holmer 1997; Plew 1986, 2016; Ringe 1992). This seasonal round encompassed the unspecialized use of several plant and animal resources (Henrikson 2008; Plew 1986, 2016). Foragers extracted these resources from a variety of settings including stream valleys, meadows, canyons, and lava edges (Henrikson 2003; Plew 1986; Ringe 1992).

Idaho's hunter-gatherers utilized logistical sites in the upland and sagebrush steppes which contrasted with residential bases situated closer to the Snake River (Dougherty 2014). However, the emphasis on logistics likely varied as evidenced by southwestern Idaho ceramic assemblages (Dougherty 2014).

There were frequent stops at camps and villages and the repeated use of rockshelters on these logistical, seasonal rounds into the uplands and sagebrush steppes (Henrikson 2008, Plew 1986, 2016). Alcoves and rockshelters provided Idaho's hunter-gatherers with shelter from fierce, blowing winds as they made their logistical hunting forays (Henrikson 2008). It was typical of foragers to move from field camp to field camp during spring, summer, and fall and return to a more central, residential camp during winter (Plew 2016). For some foragers, such as those occupying the Owyhee Uplands over the last 2,000 years, logistical ranges may have covered 60 square miles (Plew 2016). Such a pattern of movement and resource use would have dominated the Archaic period and most of the Holocene in Southern Idaho (Plew 1986). This pattern began with the end of the Big Game Hunting tradition about 7,000 years ago and continued until about A.D. 1850 (Plew 1986, 2016).

Obsidian Distribution Studies and the Concept of Direct Procurement

Much of our knowledge on mobility in eastern and southern Idaho results from obsidian distribution studies. Obsidian distribution studies involve assigning geological origins to obsidian artifacts based on distinctive elemental profiles (Arkush and Pitblado 2000; Black 2014; Cann and Renfrew 1964; Dello-Russo 2004; Jack and Carmichael 1969; Jack and Heizer 1968; Logan et al. 2001; Newman and Loendorf 2005; Scheiber and Finley 2011; Shackley 1994, 2008, 2011; Smith 1999). This is accomplished with a technique called x-ray fluorescence spectroscopy, which is comprehensively discussed in the following section.

Obsidian distribution studies frame the movement of obsidian as a proxy for the movement of people (Black 2014; Butler 1981; Fowler 2014; Henrikson 2008; Holmer 1997; Scheiber and Finley 2011; Thompson 2004). This is because there is no direct way to measure the movement of prehistoric people (Black 2014). Measuring the dispersion of their resources, however, is a logically valid stand-in (Fowler 2014). Specifically, archaeologists measure artifacts direction and distance from toolstone source and then, in conjunction with statistical analyses, delineate conveyance zones using this information (Fowler 2014; Scheiber and Finley 2011).

Obsidian distribution research is most appropriate when applied to archaeological regions with strong evidence for direct procurement. This is because trade or down-the-line exchange disassociates toolstone with the foragers that originally procured it from source locations. The research to date suggests that direct procurement was the primary method of acquisition throughout the Holocene in eastern and southern Idaho (Henrikson 2008; Holmer 1997). This is because the local archaeological record lacks any clear evidence for down-the-line exchange, use of toolstone exchange centers, or any other semblance of complex trade systems (Henrikson

2008; Holmer 1997). Other researchers agree that direct procurement was the main method of acquisition throughout the Great Basin more broadly (Jones et al. 2003; Smith 2010).

Eastern and Southeastern Idaho Mobility as Informed by Obsidian Distribution Studies

Obsidian Procurement Distances. Prior research supports the predominant use of localized obsidian sources in southern Idaho (Fowler 2014; Henrikson 2008). Fowler (2014), employing a dataset containing 4,440 artifacts from 640 sites across 33 Idaho counties, found that the mean source distance between source locations and archaeological contexts is 96 km, although single standard deviations were spread far enough that distances of 200 km or even a few dozen km are not unusual. Maximum source distances were found to generally range from 250 to 400 km (Fowler 2014). Henrikson (2008) finds similar results. About two-thirds of 133 projectile points from Craters of the Moon National Monument and Preserve were recovered 65 km or less from source locations (Henrikson 2008). The farthest sources represented in the sample are greater than 200 km away.

Mobility and Climate. Archaeologists have long suspected that prehistoric mobility in Idaho correlates with climatic conditions, particularly with the degree of moisture (Fowler 2014; Holmer 1997). Conveyance zones, statistically generated boundaries of toolstone source utilization, are expected to contract with drier conditions and become more inclusive with moister conditions (Fowler 2014). Based on distance from source and source diversity, archaeologists recognize a decrease in forager mobility as the Early Holocene transitioned into the Middle Holocene when climate became much more xeric (Holmer 1997; Scheiber and Finley 2011). A resurgence of forager mobility is evidenced with the return of more mesic conditions in the Late Archaic and Late Prehistoric (Fowler 2014; Holmer 1997; Scheiber and Finley 2011).

Diversity Measures. Diversity measures, such as the Shannon diversity index and source evenness, also contribute to our understanding of prehistoric mobility in eastern and southern Idaho (Fowler 2014; Scheiber and Finley 2011). The Shannon diversity index accounts for the number of sources in a sample and the distribution of a sample across sources (Beals et al. 2000; Scheiber and Finley 2011). Evenness refers to how evenly sources are represented in a sample (Beals et al. 2000; Scheiber and Finley 2011).

Source diversity and source evenness vary diachronically in eastern and southeastern Idaho (Fowler 2014; Holmer 1997; Scheiber and Finley 2011). Eastern Idaho artifacts exhibit relatively low diversity during Paleoindian times with a relatively even distribution (Scheiber and Finley 2011). Diversity and evenness are high during the Early Archaic (Scheiber and Finley 2011). The Middle Archaic exhibits similar evenness but lower diversity than in the Paleoindian and Early Archaic (Sheiber and Finley 2011). There is a modest increase in diversity during the Late Prehistoric period (Sheiber and Finley 2011). The trends for southeastern Idaho are similar to those for eastern Idaho, most notable being the point of lowest diversity occurring during the Middle Archaic, and the point of highest diversity occurring during the Late Prehistoric (Sheiber and Finley 2011).

Framing source diversity as a proxy for mobility, it appears that eastern and southeastern Idaho foragers were most mobile in the Late Prehistoric and least mobile in the Middle Archaic when climatic conditions were relatively much warmer and drier (Fowler 2014; Holmer 1997; Scheiber and Finley 2011). The Early Archaic was also a time in which the regions' foragers were highly mobile (Scheiber and Finley 2011).

Context/Factors Possibly Relevant to Mobility in Eastern and Southern Idaho

The archaeological record supports the occurrence of several wide-reaching, influential events at the peak of Bobcat Shelter's most intense and consistent usage, the end of the Late Archaic (2,950 to 1,650 BP) and the beginning of the Late Prehistoric (1,650 to 150 BP) Periods. These events include the introduction of the bow and arrow, a possible, light Fremont presence in the area, and the Numic Spread. In addition, various environmental circumstances are worth mentioning. For example, anadromous fish in the Snake River and roots on the Camas Prairie played integral roles in the seasonal round of many Idaho forager groups.

The Introduction of the Bow and Arrow. Experimentation with bow and arrow technology appears to have occurred as early as 3,000 years ago on the western Snake River Plain as evidenced by Elko arrow points from Nahas Cave (Plew 1980, 2016). However, it wasn't until about 1,000 years ago that small corner- and side-notched projectiles, such as Desert Side-Notched and Rosegate points, widely replaced larger atlatl points on the Snake River Plain (Holmer 1986; Plew 2016). This replacement evidences a shift towards the hunting of smaller mammals (Plew 2016).

Possible Fremont Presence. Material culture found at various Snake River Plain sites teases at the possibility of a Fremont periphery. For example, Great Salt Lake Grey pottery has been recovered from Wilson Butte Cave on the eastern plain (Plew 2016). In fact, most arguments for a legitimate Fremont presence in the area stem from occasional Fremont-like pottery (Plew 2016). Plew (2016) entertains that Fremont foragers possibly ranged into southeastern Idaho but sees little evidence for a more serious Fremont occupation. Trapper Cliff Rockshelter in southcentral Idaho is the strongest representation of a Fremont presence due to the abundance of Great Salt Lake Grey sherds (n = 84) and Rosegate materials (Plew 2016). It has also been proposed that Shoshoni ancestors may have adopted and carried Fremont pottery techniques into Idaho during the Numic Spread (Plew 1979).

The Numic Spread. The timing and mechanisms behind the Numic Spread are some of the most contested issues in Great Basin archaeology (Bettinger and Baumhoff 1982; Plew 2016). The Numic Spread was a replacement of indigenous Great Basin peoples by Numic speaking peoples who originated from southeastern California and spread northeast in a fan-like wave, eventually reaching the Snake River Plain (Bettinger and Baumhoff 1982). This likely began and ended within the last 1,000 years. However, there are arguments for a much older and longer Numic spread (Goss 1977). The most intense usage of Bobcat Shelter roughly coincides with or just barely predates suggested time frames for the Numic Spread.

Wahmuza and Holmer's New Shoshonean Expansion Model. Materials from the Wahmuza site, located along Cedar Bluff near the Fort Hall Bottoms, have been used to defend a Shoshonean presence in Idaho dating back to between 3,000 and 4,000 years ago. It is suggested that Altithermal desiccation caused a Shoshonean expansion into Idaho (Holmer 1990). Specifically, Holmer (1990) utilizes a direct historical approach to monitor an ethnic connection between the various occupations at Wahmuza.

Anadromous Fish and the Camas Prairie. Anadromous fish such as salmonids were a predictable and calorie-rich resource that could be extracted from the Snake River during fall months (Plew 2016). Consequentially, the Snake River and its tributaries were taken into consideration by foragers close enough to incorporate them into annual foraging rounds. There is even some evidence, such as within the Payette and Weiser River areas, that anadromous fish along with camas root provided foragers with enough stability to experiment with social complexity- the Western Idaho Archaic Burial complex, for example (Plew 2016). Ethnographic observation reveals camas root, which can be stored, to be of great importance (Plew 2016). Camas meadows are located on the western and eastern plain north of the Snake River. Foragers traveled north in summer months to take part in the camas root harvest. These annual harvests brought together many distinct groups of foragers (Plew 2016).

Geomorphic Factors. In light of the events discussed above, it is important to consider unique features of the landscape that may have conditioned eastern and southern Idaho prehistoric mobility. These features of the landscape may have served as attractants or barriers to Idaho's prehistoric foragers, and therefore, may have influenced their mobility organization. Cold lava tube caves on Idaho's Snake River plain were used for preserving and storing bison meat over the last 8,000 years (Breslawski and Byers 2014; Henrikson 2003). This would likely have served as a mitigating strategy against resource scarcity for logistical foragers (Binford 1979, 1980; Breslawski and Byers 2014; Henrikson 2003). In addition to cold storage lava tubes, Holocene lava flows may have affected how foragers traveled on their seasonal rounds (Henrikson 2008). There were several eruptive periods (7,800 cal yr BP, 6,500 cal yr BP, 6,000 cal yr BP, 3,600 cal yr BP, and 2,200 cal yr BP) in eastern and southern Idaho's prehistoric past that would have created natural barriers to movement (Henrikson 2008). As lava cooled, foragers would likely have had to alter established seasonal rounds for periods of months to years after eruptions (Henrikson 2008). One of the largest of these lava flows is 40 km long and 5-10 km wide (Henrikson 2008).

Using Debitage to Monitor Mobility

Predicting Levels of Curation Using XRF Analyses

My model relates distance from geological source to the degree of tool reduction, the latter a proxy for the extent an artifact was curated. Simply put, as people expect to travel farther from toolstone sources, I expect them to place increasing emphasis on conserving and curating the material they had on hand. Within this context, I hypothesize that if there is variation in the average distance to source across the various occupations, then as distance to source increases, so should levels of curation. Consequently, I expect a relationship between distance from source and measures of curation intensity on debitage from a given occupation.

To provide a context for understanding variability in curation signals, I use data derived from non-destructive X-ray Fluorescence (XRF) spectroscopy to capture distance from toolstone source. As stated in Chapter 1, I will use this information to predict the levels of curation across Bobcat Shelter occupations.

Beginning with the 1960's archaeologists have used XRF analysis to identify the major and trace elements within lithic materials (Arkush and Pitblado 2000; Black 2014; Cann and Renfrew 1964; Dello-Russo 2004; Fowler 2014; Jack and Carmichael 1969; Jack and Heizer 1968; Logan et al. 2001; Shackley 1994, 2008, 2011; Scheiber and Finley 2011; Smith 1999). Lithic material exhibits differing concentrations and combinations of trace elements depending on how and where it was formed (Arkush and Pitblado 2000; Black 2014; Cann and Renfrew 1964; Dello-Russo 2004; Fowler 2014; Jack and Carmichael 1969; Jack and Heizer 1968; Logan et al. 2001; Shackley 1994, 2008, 2011; Scheiber and Finley 2011; Smith 1999). Therefore, XRF can document the chemical signatures of lithic artifacts, allowing researchers to match them with their source locations. In addition, X-ray fluorescence techniques are notable in being non-destructive, fast, easy to use, and cost-effective (Shackley 2011).

X-ray Fluorescence techniques elicit chemical signatures of artifacts and their source locations with the use of X-rays (Newman and Loendorf 2005; Shackley 2011). X-rays are a short wavelength form of electromagnetic radiation between gamma rays and ultraviolet radiation on the electromagnetic spectrum (Shackley 2011). As a sample is barraged with X-rays, the surface atoms of that sample have their inner shell electrons excited to the point of being dislodged, and outer shell electrons move to replace them (Shackley 2011). Photons are released causing a measurable fluorescence while electrons are being replaced, and different elements have characteristic energies (Levy et al. 1974; Newman and Loendorf 2005; Shackley 2011). Therefore, the elemental composition of materials is captured as XRF instruments decipher the fluorescent radiation (Levy et al. 1974; Newman and Loendorf 2005; Shackley 2011).

Assessing Levels of Curation Using Debitage Attributes

My model relates mobility systems to patterns in debitage. I predict that if Bobcat Shelter occupants varied in their dependence on logistical mobility strategies, then I will find correlations between strata average distance from toolstone source and more highly curated toolstone. Based on the results of lithic reduction experiments, I can recognize debitage produced from highly curated toolstone. Lithic analysts have used experiments to monitor changes in debitage attributes (Andrefsky 1986, 1994, 2005; Amick et al. 1988; Burton 1980; Carr and Bradbury 2011; Dibble and Whittaker 1981; Dibble 1997; Magne and Pokotylo 1981; Marwick 2008; Morrow 1984; Pelcin 1997; Scott 1991; Stahle and Dunn 1982). I follow this line of research by collecting observations on specific attributes from the Bobcat Shelter debitage collection. In the following paragraphs I discuss the attributes I collect and justify them as appropriate indicators of reduction intensity.

Percentage of Dorsal Cortex

The percentage of dorsal cortex, the outer chemical and mechanical weathering of rock, is a useful predictor of reduction intensity (Andrefsky 2005; Magne and Pokotylo 1981; Marwick 2008; Morrow 1984; Sullivan and Rozen 1985). Many archaeologists have tested dorsal cortex as a possible indicator of reduction intensity based on simple logic. Because cortex resides on the outer surfaces of a rock, it is most likely to be the first component to go as toolstone is reduced (Andrefsky 2005).

While reduction experiments show dorsal cortex percentage as a reliable indicator of reduction intensity, some researchers caution against the blind use of related proxies (Andrefsky 2005; Sullivan and Rozen 1985). For example, Sullivan and Rozen (1985) take issue with using categories based on arbitrary cortex divisions, such as found in the methods employed in Magne and Pokotylo (1981). Sullivan and Rozen (1985) argue that there are no procedures for replicably partitioning the variation observed in cortex. They also remind that the proportion of cortex defining specific debitage categories is unstandardized, using the example that primary or secondary flakes from one study could be classified as secondary or tertiary in another. Such issues compromise the comparability of research (Sullivan and Rozen 1985). Andrefsky (2005) shares similar concerns, arguing for maximized precision and minimized subjectivity. One way to maximize precision and minimize subjectivity while collecting dorsal cortex percentage is to use an ordinal scale.

Dorsal Scar Count

Dorsal scar count is an indicator of reduction intensity and is closely related to the amount of dorsal cortex (Magne and Pokotylo 1981). Dorsal flake scars are the impressions left on worked pieces where previous flakes were removed (Andrefsky 2005). Lithic analysts test dorsal scar count as a possible indicator of reduction intensity because flakes removed later in the reduction sequence should have incurred more scarring due to prior removals (Magne and Pokotylo 1981).

Although dorsal scar count has been framed by researchers as an indicator of reduction, some authors express skepticism (Mauldin and Amick 1989; Shott 1994). Mauldin and Amick (1989) present the primary concern that dorsal scar count may correlate best with debitage size rather than debitage's place in the reduction sequence. Dorsal scar count may increase up to a point as flakes are removed from a toolstone piece, but only so many scars can fit onto a very small flake (Andrefsky 2005; Mauldin and Amick 1989). However, Andrefsky (2005) simply cautions against using dorsal scar count alone as an indicator of reduction intensity (Andrefsky 2005). Recording observations of a reliable size attribute, such as weight, would help explain and counteract variation resulting from Mauldin and Amick's (1989) concern.

Weight

Size attributes are among the most important when discerning reduction intensity from debitage (Amick et al. 1988; Andrefsky 2005; Magne and Pokotylo 1981; Marwick 2008; Mauldin and Amick 1989; Shott 1994). Investigation into size attributes centers around an undeniable logic. Flintknapping is a subtractive process (Andrefsky 2005). As a flintknapper reduces, or subtracts from a toolstone piece, the dimensions of the toolstone piece can only decrease. Andrefsky (2005) conveys the idea perfectly by saying “It is not possible to remove a flake that has a larger linear dimension or mass than the largest dimension of the objective piece or tool being made” (Andrefsky 2005:98). Andrefsky (2005) warns that this doesn’t mean that larger flakes always precede smaller ones- smaller flakes can be removed to prepare for the removal of a larger one. However, in general, flake size attributes decrease throughout the toolstone reduction process (Andrefsky 2005).

Weight appears to be an excellent indicator of debitage’s place in the reduction sequence (Amick et al. 1988; Andrefsky 2005; Magne and Pokotylo 1981; Marwick 2008; Mauldin and Amick 1989; Shott 1994). For example, Amick et al. (1988) wanted to identify which continuous and non-continuous attributes are the best predictors of place in the reduction sequence. They conducted a highly controlled experiment reducing a Georgetown chert nodule to a bifacial blank using both hard hammer and soft hammer techniques. Weight, being among the attributes of interest, was demonstrated to be a reliable indicator.

Maximum Flake Width

Flake length, width, and thickness are other size-based attributes commonly recorded by lithic analysts (Amick et al. 1988; Andrefsky 2005; Magne and Pokotylo 1981; Mauldin and Amick 1989; Shott 1994). While the selection of these attributes may seem straightforward, they are not (Andrefsky 2005). For example, when recording flake width there is the question of where exactly along the flake’s length one will measure and flake completeness can likewise confound taking meaningful measurements (Andrefsky 2005). In short, broken flakes may not retain the widest part of the flake as it was detached from the core (Andrefsky 2005). For such reasons, size attributes such as length, width, and thickness are most informative when measured on complete flakes.

In addition to weight, I record width. Research has shown that flake length, width, and thickness can provide mixed results when it comes to predicting reduction intensity (Maudlin and Amick 1989; Odell 1989). Of these three measures, however, width has been shown to relate most directly to reduction sequence (Odell 1989). Maximum flake width has been useful at discriminating between core reduction and biface reduction flakes, and width of the flake at midpoint has been useful for discerning variation in biface reduction flakes (Odell 1989).

Striking Platform Width and Thickness

Attributes relating to striking platforms, the point of applied force that removed a detached piece from worked toolstone, have been experimentally related to the stage of tool reduction (Andrefsky 2005; Dibble and Whittaker 1981; Dibble 1997; Magne and Pokotylo 1981; Morrow 1984; Pelcin 1997). Many of these attributes, however, are not worth their trouble (Andrefsky 2005).

Many striking platform attributes are difficult to measure effectively and lack replicability (Andrefksy 2005). For example, Andrefsky (2005) makes convincing arguments against the use of platform facet counts and platform angles. There is a wide range of variability in the morphology of platforms (Andrefsky 2005). For example, many platforms display multiple facets. Given this observation, how does an analyst objectively decide which facet to measure? Platform facets are difficult to count replicably because there is a lack of consensus on the definition of platform facet, and many platform facets are too small to count due to abrasion, grounding, and chipping (Andrefsky 2005). There is also wide variation in the degree of rounding on platform angles, and it is difficult to place a goniometer against platform angles in a perfectly replicable manner (Andrefsky 2005). Different people are also likely to record different measurements for the same platform angle, and even one individual often reproduces different measurements of the same platform angle (Andrefsky 2005).

Platform width and thickness, on the other hand, are easily recorded platform attributes and have been demonstrated to be effective indicators of reduction intensity (Andrefsky 2005; Dibble and Whittaker 1981; Dibble 1997; Magne and Pokotylo 1981; Pelcin 1997). For example, Pelcin (1997) found directly proportional relationships between size attributes known to inform on reduction intensity and platform thickness. Dibble and Whittaker (1981) observed similar relationships between platform size attributes and flake size attributes while employing highly controlled experimentation that involved dropping metallic balls on glass cores. I record platform width and thickness due to such research.

Ventral Curvature

The final variable recorded for my debitage analysis is ventral curvature, a variable demonstrated to decrease throughout the bifacial reduction process, especially as the worked piece approaches its final form (Andrefsky 1986; 2005). The one consideration when recording ventral curvature is the overall size of the flake (Andrefsky 2005). Andrefsky (2005) warns that the more simple measures of ventral curvature, such as the height of the curve on the ventral surface, are likely measure larger just because a flake may be large. However, when considering the overall size of the flake, ventral curvature is a useful indicator of reduction intensity (Andrefsky 1986; 2005).

Reaffirming Bobcat Rockshelter's Site Function

The character of Bobcat Shelter's faunal and debitage assemblages leads Arkush (2017) to interpret Bobcat Shelter as a short-term, logistical hunting camp. Excavations at Bobcat Shelter have produced 2,888 flakes and over 33,000 pieces of bone spanning several occupations. Approximately 90% of the debitage comprises pressure flakes, indicating detachment from objective pieces nearing the tail-end of the toolstone reduction trajectory. Bobcat Shelter has produced only one slab metate fragment and is completely absent of pottery, indicating a non-residential function for the site. At least four of the five features excavated at Bobcat Shelter are prepared hearths/roasting features containing burnt artiodactyl and mountain sheep bones. Bighorn sheep and medium-sized artiodactyl remains are the most common followed by bison and deer (Arkush 2017). While Strata 7, 8, and 9 contain proportionally large amounts of debitage, they also contain large portions of the site's total assemblage of faunal remains (Arkush 2017). Strata 7, 8, 9, and 14 each are associated with over one thousand burnt and unburnt bighorn sheep and sheep-sized long bone fragments, scapulae, teeth, mandibles, and maxilla fragments (Arkush 2017). Arkush (2017) notes an interesting absence of bighorn sheep vertebrae, attributing it to butchering behavior in which crania, fore limbs, hind limbs, and tenderloins were transported to field camps while elements of lower utility were abandoned in the field.

The Model

Because residentially organized foragers exploit habitats characterized by resource homogeneity, resources such as toolstone are close and often readily available (Andrefsky 1994; Bamforth 1986; Binford 1979, 1980; Nelson 1991; Shott 1986). Consequently, we can expect residentially organized foragers to emphasize expediently manufactured toolkits as a result. In contrast, because logistical mobility often results from discontinuous resource distributions, such mobility strategies often require advanced planning for various technologically related contingencies, especially far toolstone source distances, leading to a focus on curated technologies (Andrefsky 1994; Bamforth 1986; Binford 1979, 1980; Nelson 1991; Shott 1986). Because these two organizational strategies are linked with curation intensity, archaeologists can use the residues of tool use and manufacture to differentiate between them.

Curated strategies entail advanced reduction of toolstone (Andrefsky; Bamforth 1986; Binford 1979, 1980; Nelson 1991; Shott 1986). Consequently, debitage, as well as tools, recovered from logistical hunting camps should reflect these strategies as well, and curation intensity should correlate positively with increasing toolstone source distance (Bamforth 1986; Beck et al. 2002; Beck 2008; Feder 1980; Metcalfe and Barlow 1992; Newman 1994; Smith 1999).

Hypotheses and Predictions

To summarize, my research is informed by a technological organization framework. I hypothesize that there is a relationship between the mobility system of Bobcat Shelter occupants and their debitage. The current evidence suggests Bobcat Shelter was a hunting camp for logistically organized foragers (Arkush 2017). Logistically organized task groups often travel greater distances than expediently organized groups so as to deal with incongruent resource distributions (Binford 1979, 1980). Based on the relationship between distance to geological source and the degree of tool reduction, if there is variation in the average distance to toolstone source across the various occupations, then as distance to source increases, so should levels of curation. Consequently, I should expect the below-listed attribute trends for occupations utilizing more material from farther, more logistically acquired sources:

- lower amounts of dorsal cortex
- higher dorsal scar counts
- lower measures of weight
- lower maximum flake widths
- lower incomplete flake widths
- lower platform widths
- lower incomplete platform widths
- lower platform thicknesses
- lower incomplete platform thicknesses
- lower measures of ventral curvature

Identifying obsidian sources and measuring debitage variables requires a specific set of methods and I outline these in Chapter 3.

CHAPTER 3

METHODS

Evaluating my ideas requires collecting source information on obsidian debitage. Source information reveals the level of dependence placed on specific toolstone sources through time as well as the distances that obsidian debitage were transported from their geological origins. In addition, I collect attribute data that can inform on mobility patterns. Because my model correlates curation with distance to source, I collect attributes known to be useful indicators of reduction intensity.

In this chapter, I detail the methods used to quantify the Bobcat Shelter debitage and to generate the data needed to test the model developed in the previous chapter. I begin by detailing my procedure for collecting and evaluating source information using non-destructive, energy dispersive x-ray fluorescence spectroscopy (EDXRF). Next, I explain how I collect data on two variables that partition the debitage by intactness. I then outline my procedure for collecting several attributes that can link debitage characteristics with reduction and, consequently, the organization of technology and mobility. Finally, I illustrate how a variety of statistical tests are used to elicit meaningful relationships between source distance and the Bobcat Shelter debitage.

Predicting Levels of Curation Using XRF Analyses

XRF- Data Collection, Instrument, and Settings

I use data derived from non-destructive, energy dispersive X-ray fluorescence spectroscopy (EDXRF) to predict the levels of curation across Bobcat Shelter occupations. I use EDXRF because of its proven ability to source volcanic glass (Arkush and Pitblado 2000; Black 2014; Cann and Renfrew 1964; Dello-Russo 2004; Fowler 2014; Jack and Carmichael 1969; Jack and Heizer 1968; Logan et al. 2001; Shackley 1994, 2008, 2011; Scheiber and Finley 2011; Smith 1999). I take readings from all of the obsidian debitage (n = 1,781). The XRF data is generated using the Bruker Tracer 5i (900F5321 Dugway) model of portable energy dispersive XRF spectrometer. Operating parameters are set to 50 kilovolts and 35 microamps, and the obsidian/green filter is affixed. I use a count time of 30 seconds for each flake sampled.

Source Assignments

Debitage are assigned a geological origin based on the parts per million (ppm) measurements of Zirconium (Zr), Strontium (Sr), Yttrium (Y), Niobium (Nb), and Rubidium (Rb) and are consulted in that order. I compare artifacts' elemental ppm measurements to obsidian source standards' elemental ppm variation. I utilize the source standard information indexed by Black (2014) as I compare each artifact to every source's accepted range of variation for each of the above listed elements (Table 3.1). Sources' elemental ranges of variation were calculated using the source standard averages and standard deviations indexed by Black (2014) (Table 3.2). I utilize source standard variation at two standard deviations.

The following scenario exemplifies my technique. I might be attempting to assign an artifact that fits within the acceptable 2σ ranges of Zr and Sr variation for both Walcott Tuff and Sinker Canyon. Basing an assignment into one group or the other solely on Zr and Sr is not possible. However, accepted variation in Y sets Walcott Tuff and Sinker Canyon apart. Further consideration of Nb and Rb variation helps to cement an artifact's similarity to a particular source.

When possible, I utilize source standard data from the Idaho Museum of Natural History (IMNH) over the Northwest Research Obsidian Studies Laboratory (NWROSL). When not possible, it is because IMNH lacks data on a particular source. I utilize IMNH data over NWROSL data because the IMNH database contains data on more sources from eastern Idaho (Black 2014). Based on previous Bobcat Shelter source assignments and Bobcat Shelter's location, eastern Idaho sources should be more frequent (Arkush 2017; Hughes 2014, 2016). Furthermore, IMNH uses a portable Bruker Tracer 3-V spectrometer, similar to the instrument I use though not the exact model (Black 2014). The preference for one lab over the other also maximizes consistency when comparing ppm data.

In addition to comparison in ppm measurements, I employ cluster analyses. Cluster analysis is necessary when assigning certain artifacts to a particular source. This is because artifact elemental ppm variation is spread wider than source standard variation, likely the result of the dimensional thinness of Bobcat Shelter debitage. Thickness beyond 2 mm is optimal for precise x-ray fluorescence spectroscopy (Shackley 2011). Although my sample's elemental variation lacks precision, elemental biplots of my total sourcing sample demonstrate recognizable, discernable groupings. These groupings correspond to established source standards, therefore making cluster analyses feasible (Chapter 4). In addition, the chemical signatures and source identifications derived from thicker samples of Bobcat Shelter obsidian, such as points and preforms, corroborate the chemical signatures and source assignments resulting from my research (Arkush 2017; Hughes 2014, 2016).

I cluster artifacts based on similarity in Sr and Zr measurements and on similarity in Sr/Zr ratios before assigning outliers to a particular source. I compare Sr/Zr ratios to those I calculate for source standards indexed by Black (2014). I calculate source standard Sr/Zr ratios using average Sr and Zr ppm data (Table 3.3). By combining cluster analyses with meticulous comparison in ppm measurements, I am able to most confidently assign an artifact to a particular source when comparisons in ppm measurements alone are insufficient in distinguishing between chemically similar sources. Few artifacts, or at least their spectrograph readings, are so anomalous that I refrain from source assignment. These artifacts are removed from my total debitage sample and are not further utilized in my research.

Strata Mean Source Distances

Monitoring change in mean source distance across Bobcat Shelter strata is required to test my prediction that farther, more logistically obtained material will correlate with more intensely curated debitage. If there is variation in the average distance to source across the various occupations, then as distance to source increases, so should levels of curation.

I measure the straight-line distance, in kilometers, between Bobcat Shelter and the obsidian sources represented at Bobcat Shelter. I measure distances using the measure tool on ArcMap 10.5.1 software, and measure between Bobcat Shelter and the closest source standard location indicated by Black (2014). American Falls/Walcott Tuff is an exception. American Falls/Walcott Tuff is characterized by a source distance of 40 km despite its most commonly acknowledged surface exposure roughly 150 km from Bobcat Shelter. This is because geological research has demonstrated the presence of American Falls/Walcott Tuff surface exposures in the southern Lemhi and Beaverhead Ranges much closer to Bobcat Shelter (Arkush 2017; Morgan and McIntosh 2005). Considering the proportion of Bobcat Shelter material originating from Walcott Tuff (Chapter 4), a source distance of 40 km is most valid, especially for hunter-gatherers employing a direct procurement method of resource acquisition.

Source distances are then used to calculate the weighted mean source distance characterizing a stratum's sample of obsidian debitage. Within the context of my model, higher mean source distances indicate higher, more logistical mobility and a tendency toward debitage signaling greater levels of toolstone curation.

Shannon Diversity Index, Source Richness, and Source Evenness

In addition to calculating strata mean source distance, I calculate strata Shannon diversity index, source richness, and source evenness (Beals et al. 2000; Scheiber and Finley 2011). The Shannon diversity index is a diversity measure that accounts for richness, the number of species in a sample, and evenness, the distribution of a sample across species (Beals et al. 2000; Scheiber and Finley 2011).

I calculate Shannon diversity index, source richness, and source evenness because if hunter-gatherers are directly procuring stone material, it is reasonable to postulate that as source diversity increases, hunter-gatherers are covering a wider area of the landscape on subsistence rounds, and therefore mobility increases. The relationship between diversity measures and curation intensity might be evaluated incidentally to my main focus, the relationship between source distance and curation intensity.

Intactness Variables

Completeness

A number of the flake metrics I record for my research only provide meaningful data within the context of a complete flake. For example, measures of width and ventral curvature can provide little meaningful information if recorded from an incomplete or broken specimen (Andrefsky 2005; Sullivan and Rozen 1985). Therefore, some attributes that I utilize have different procedures for measuring complete and incomplete flakes. Completeness is given its own column in my spreadsheet and recorded with either ‘C’ or ‘I’. A complete flake is identified as having feather or hinge termination, a discernable point of applied force, an unbroken platform, and positive percussion features such as ripple marks, force lines, and a bulb of percussion. Although I utilize Sullivan and Rozen’s (1985) description of a complete flake, the completeness variable is independent of the flake type variable (see next section).

Flake Types

Sullivan and Rozen (1985) design interpretation-free methods for extracting useful reduction information from incomplete debitage. I utilize Sullivan and Rozen’s (1985) key for sorting debitage. I utilize such a key because I want clear indicators of whether or not it is appropriate to collect certain attributes on any given flake. For example, it is not possible to collect platform data on debitage absent of platforms.

Sullivan and Rozen’s (1985) key sorts debitage into mutually exclusive, interpretation-free categories. The key has four possible categories and three dimensions of variability. The categories include Debris, Flake Fragment, Broken Flake, and Complete Flake. Debitage is sorted into these categories as they are evaluated on the three dimensions of variability.

The first dimension considers the presence or absence of positive percussion features such as ripple marks, force lines, or a bulb of percussion. If these features are present, the next dimension of variability is considered. If these features are absent or there are multiple occurrences of them, debitage is sorted into the 'Debris' category.

The second dimension considers the point of applied force. The point of applied force occurs where the bulb of percussion intersects the striking platform (Sullivan and Rozen 1985). In the case of fragmentary platforms, a point of applied force is indicated by the origin of force line radiation (Sullivan and Rozen 1985). A completely absent platform means the point of applied force is also absent. If the point of applied force is discernable, the next dimension of variability is considered. If not, debitage is sorted into the 'Flake Fragment' category.

The third dimension considers the intactness of proximal and distal ends, otherwise referred to as margins. Margins are considered intact if the distal end exhibits feather or hinge termination and lateral breaks don't interfere with accurate width measurements. If margins are not intact, debitage is sorted into the 'Broken Flake' category. If margins are intact, debitage is sorted into the 'Complete Flake' category. The status of flakes as either debris, fragment, broken, or complete is recorded in the flake type column within my spreadsheet. The flake type variable is collected independently of the completeness variable (see prior section).

Reduction Intensity Indicators

Percentage of Dorsal Cortex

Several studies have shown that dorsal cortex can monitor reduction stage (Andrefsky 2005; Magne and Pokotylo 1981; Marwick 2008; Morrow 1984; Sullivan and Rozen 1985) and, for this reason, I record this attribute in my study. To do so, I follow Andrefsky (2005) by using a four-level ordinal scale. The lowest rank on the scale, 0, denotes complete lack of cortex coverage. A rank of 1 signifies cortex coverage greater than 0% but less than 50%. A rank of 2 signifies cortex coverage greater than 50% but less than 100%. Finally, the highest rank on the scale, 3, denotes complete cortex coverage. Most debitage falling within the range of 1 or 2 exhibits far greater or far lesser cortex than 50%, making estimation accurate and easy (Andrefsky 2005). The only issue occurs when evaluating debitage with coverage close to 50%. It may be difficult to determine whether or not cortex coverage is over or under 50% just by visual examination. I solve this problem by superimposing dots or grid squares over the cortical portion of a specimen, counting, and then superimposing dots or grid squares over the non-cortical portion of a specimen and then counting (Andrefsky 2005). I observe dorsal cortex percentage using a 40x25mm loupe magnifier. I record dorsal cortex percentage for both complete and incomplete debitage.

Dorsal Scar Count

In this study, I record dorsal scar count because others have shown that this metric can correlate with reduction intensity (Andrefsky 2005; Magne and Pokotylo 1981; Marwick 2008).

To record dorsal scar count, I employ a four-level ordinal scale identical to that presented in Andrefsky (2005). The lowest rank on the scale, 0, represents a completely cortical dorsal surface. A rank of 1 signifies one dorsal scar. A rank of 2 signifies two dorsal scars. Finally, a rank of 3 is recorded for flakes displaying three or more dorsal scars. I am mindful of dorsal surface clutter as I count scars. Here I define clutter following Andrefsky (2005) as the small flake removals resulting from striking platform preparation, breaks, shattering, and modification after detachment. Consequently, I do not count such features in my dorsal flake scar counts. I count dorsal scars while using a 40x25mm loupe magnifier and record this attribute for both complete and incomplete debitage.

Weight

Studies have demonstrated that weight can monitor reduction intensity (Amick et al. 1988; Andrefsky 2005; Magne and Pokotylo 1981; Marwick 2008; Mauldin and Amick 1989; Shott 1994), and therefore, I record this attribute. I use a TL-series professional digital mini scale accurate to .001 of a gram to weigh specimens. I calibrate the scale using a one gram weight and tare the scale between each specimen. I record all weights to the nearest .001 of a gram. Weight is recorded for complete and incomplete debitage.

Maximum Flake Width

Flake width can reliably predict reduction intensity (Odell 1989), and therefore, I employ width in my research. I record flake width at the widest point on the flake along a line perpendicular to flake length, also known as maximum flake width (Figure 3.1). I do so because measuring this way eliminates the most bias, while at the same time providing a replicable measure (Andrefsky 2005). Maximum length is measured as the maximum distance from the proximal to distal end along a line perpendicular to platform width (Figure 3.3). Maximum flake width is recorded for complete flakes.

Width is recorded differently for incomplete debitage. An incomplete flake capable of receiving a width measurement has one or more indicators of directionality. For example, a full or partial platform, hinge or feather termination, a bulb of percussion, and/or ripple marks on the ventral surface. If at least one of these indicators are present, then I proceed to take the widest possible measurement of the flake in a line perpendicular to flake length. Incomplete width is recorded in its own column on my spreadsheet. In the case that directionality cannot be determined, I simply record N/A in the incomplete width column. I use a pair of digital sliding calipers to record width measurements to the nearest .01 of a millimeter.

Striking Platform Width and Thickness

Platform width and thickness are effective indicators of reduction intensity (Andrefsky 2005; Dibble and Whittaker 1981; Dibble 1997; Magne and Pokotylo 1981; Morrow 1984; Pelcin 1997). Therefore, I utilize these attributes in my research. I record platform width as the distance across the striking platform from lateral margin to lateral margin (Figure 3.2). I record platform thickness as a line perpendicular to striking platform width using the greatest distance between the dorsal and ventral surfaces (Figure 3.2).

Platform width and thickness are recorded differently for flakes exhibiting partial platforms. In the case of partial platforms, I simply record the greatest possible width and thicknesses on the platform. Incomplete platform width and incomplete platform thickness are recorded in their own columns on my spreadsheet. In the case of absent platforms, platform width and thickness are each recorded with N/A. I use a pair of digital sliding calipers to record platform width and thickness to the nearest .01 of a millimeter.

Ventral Curvature

Ventral curvature decreases throughout the bifacial reduction process, especially as the worked piece approaches its final form (Andrefsky 1986; 2005). Therefore, I record ventral curvature as yet another way of monitoring reduction intensity and I use Andrefsky's (1986; 2005) methods for recording this metric described below. I use a pair of digital sliding calipers to record measurements to the nearest .01 of a millimeter. Ventral curvature is recorded for complete flakes only.

The only measurements required for Andrefksy's (1986; 2005) ventral curvature calculations are maximum length (L), thickness at midpoint (T), and angle height (A). Maximum length is measured as the maximum distance from the proximal to distal end along a line perpendicular to platform width (Figure 3.3). Angle height is measured by pressing flat edge calipers together along the dorsal and ventral sides (Figure 3.3). Thickness at midpoint is measured halfway along the maximum length (Figure 3.3) The protocol for calculating ventral curvature is defined as follows (Andrefsky 1986; 2005):

$$\text{Ventral Curvature Formula: } c = 2(90 - a)$$

$$Where\ a = tan^{-1}H/M$$

$$and\ M = L/2$$

$$and\ H = A - T$$

Data Storage

Data is recorded on Microsoft Excel spreadsheets. My all-inclusive spreadsheet includes the following variables:

- Spec.No.- Weber State University specimen number.
- Unit- The excavation unit from which the specimen was recovered.
- Stratum- The layer from which the specimen was recovered.
- Material- The geological rock composing the specimen.
- Completeness- Records as either complete or incomplete.
- Flake type- Records as either debris, fragment, broken, or complete.
- Dorsal cortex percentage- Records the percentage of dorsal cortex using an ordinal scale.
- Dorsal scar count- Records the number of scars on the dorsal surface using an ordinal scale.
- Maximum length- Records maximum flake length, which is required for maximum flake width and ventral curvature metrics, to the nearest .01 of a millimeter.
- Maximum width- Records the maximum width on complete flakes to the nearest .01 of a millimeter.
- Incomplete width- Records the widest possible measurement on incomplete flakes to the nearest .01 of a millimeter.
- Platform width- Records platform width on complete platforms to the nearest .01 of a millimeter.
- Platform thickness- Records platform thickness on complete platforms to the nearest .01

of a millimeter.

- Incomplete platform width- Records widest possible measurement on partial platforms to the nearest .01 of a millimeter.
- Incomplete platform thickness- Records thickest possible measurement on partial platforms to the nearest .01 of a millimeter.
- Angle height- records the angle height metric required for ventral curvature calculations to the nearest .01 of a millimeter.
- Midpoint thickness- records the midpoint thickness metric required for ventral curvature calculations to the nearest .01 of a millimeter.
- Weight- Records weight of specimens to the nearest .01 of a gram.
- Ventral height (H)- Records a value produced during and required for ventral curvature calculations. Calculated with functions programmed in Microsoft Excel.
- M value (M)- Records a value produced during and required for ventral curvature calculations. Calculated with functions programmed in Microsoft Excel.
- a value (a)- Records a value produced during and required for ventral curvature calculations. Calculated with functions programmed in Microsoft Excel.
- Ventral Curvature- Records the ventral curvatures of specimens.
- Mean source distance characterizing an artifact’s stratum.
- Source richness characterizing an artifact’s stratum.
- Shannon diversity index characterizing an artifact’s stratum.
- Evenness characterizing an artifact’s stratum.

Data Analysis

Mann Whitney U and the Formation of Analytical Groups

I employ Mann Whitney U to test my prediction that curation intensity should increase with increasing source distance, and therefore, inferred mobility level. Mann Whitney U is a non-parametric test that helps affirm or refute a significant difference between two groups of data when comparing their relationship to the same variable of interest. Put another way, Mann Whitney U is used to determine the likelihood that two samples of data derive from the same population.

Due to sample sizing constraints and to make strata amenable to Mann Whitney U comparisons, I combine strata based on similarity in mean source distance to form new, distinct analytical groups. For certain comparisons, I combine strata based on similarity in time of deposition or archaeological period. Groups combined by time period allow investigation into how debitage attributes, and therefore, inferred mobility levels have changed through time. Analytical groups representing different time periods also contrast sharply in mean source distance. Groups of combined strata are considered discrete, novel groupings. Accordingly, mean source distance, Shannon diversity index, evenness, and source richness are recalculated for groups of combined strata.

I compare the debitage of two strata or analytical groups of contrasting mean source distance to investigate how they differ on measures of curation intensity. I utilize several comparisons and analytical groups and evaluate differences based on each of my curation intensity indicators. Data are converted to Microsoft Excel .csv files and recoded as appropriate for the current statistical test. Tests are conducted in the R computing environment and interpreted using a predetermined alpha level of .05.

When given the opportunity, I compare strata that are similar in mean source distance but markedly different in diversity measures. This allows me to evaluate a possible relationship between diversity, which could be framed as a mobility proxy, and measures of curation intensity indicators.

Medians, Cortex Ratios, and Scar Counts

In the case that Mann Whitney U indicates a significant difference between strata or analytical groups, I compare those groups' median values of the curation intensity indicator of interest. This comparison tells me whether or not median values reflect a significant difference trending in the direction I predict. For example, I predict weight to decrease with increasing mean source distance.

Dorsal cortex percentage and dorsal scar count are collected on an ordinal scale, and therefore, median values taken of these measures do not tend to vary across strata or analytical groups. For example, I record 0 for most observations of dorsal cotex percentage because most Bobcat Shelter flakes do not exhibit cortex, therefore, all strata and analytical groups have a median of 0 for dorsal cortex percentage. For this reason, I use the ratio of cortex flakes vs non-cortex flakes and average dorsal scar count to characterize samples of dorsal cortex percentage and dorsal scar count.

Chapter 3 Summary

I begin Chapter 3 by discussing the data required to test my ideas, the leading idea being that there is a relationship between the debitage of Bobcat Shelter and the mobility of its occupants. I collect source information on obsidian debitage because source information is required to test my prediction that source distance correlates with curation intensity. Because I outline a model linking intense curation with farther distances to source (Chapter 2), I collect attributes that are known predictors of curation intensity. My curation level indicators are dorsal cortex percentage, dorsal scar count, maximum flake width, striking platform width, striking platform thickness, and ventral curvature. Mann Whitney U is used to elicit meaningful relationships between distance to geological origin and my curation intensity indicators.

CHAPTER 4

RESULTS

In Chapter 4, I present the results of my research on the Bobcat Shelter debitage. I first display the distribution of my debitage sample across the Bobcat Shelter strata and discuss the implications for best extracting meaningful information. I then reveal the results of my XRF source analysis. Next, I explore possible relationships between source distance and the debitage variables identified in previous chapters. Finally, I summarize the key results presented in Chapter 4.

Sampling Considerations

Not all of the Bobcat Shelter debitage were utilized in testing my predictions. I collected attribute data from 2,846 artifacts (98.5% of the total debitage collection), and I generated XRF source data on 1,830 artifacts (64.3% of the total debitage collection). However, a portion of the assemblage derives from test pits and lacks vertical provenience, reducing the sample of suitable debitage to 2,464 artifacts. The total sample of XRF sourced material was reduced to 1,507 artifacts after omitting test pit material and non-obsidian artifacts.

Most of the Bobcat Shelter debitage are associated with occupations at Strata 7, 8, and 9 (Figure 4.1). Consequently, the largest obsidian source and flake attribute samples came from these strata. In addition, flake attribute sample sizes were further constrained by flake intactness. For example, platform width cannot be recorded for incomplete or absent platforms. Because of these issues, Stratum 7 (n = 1,349), Stratum 8 (n = 298), and Stratum 9 (n = 363) are the most viable for producing meaningful results. Samples produced from other strata are utilized when combined based on similarity in mean source distance or time of deposition. Strata 1 and 2 data were not used in this analysis because these strata, and their respective artifacts, were largely deposited by overbank flooding from a nearby creek (Brooke Arkush, personal communication 2018). In other words, Strata 1 and 2 have confounded information on human mobility.

The high frequency of Strata 7, 8, and 9 debitage at Bobcat Shelter means that most of the artifacts used to test my predictions were deposited during the Late Archaic (2,950 – 1,650 BP) to Late Prehistoric (1,650 – 150 BP) transition. Charcoal from a roasting area feature at the Stratum 8/9 transition resulted in a C14 age of 1810 ± 30 BP while charcoal recovered from a prepared hearth in upper Stratum 7 produced a C14 age of 1170 ± 30 BP (Arkush 2017). Moreover, Stratum 7 mineral grains subjected to optically stimulated luminescence returned an age of 1380 ± 210 BP (Arkush 2017).

Obsidian Source Analysis

The majority of Bobcat Shelter obsidian debitage are represented by seven primary sources (Figure 4.2, Figure 4.3, Figure 4.4, Table 4.1, and Table 4.2). These include Walcott Tuff, Bear Gulch, Big Southern Butte, Browns Bench, Butte Valley Group A, Obsidian Cliff, and Reas Pass. This largely corroborates previous sourcing studies of the Bobcat Shelter lithic material (Arkush 2017; Hughes 2014, 2016). My analysis, however, identifies several sources not recognized in these earlier studies. Based on comparison in elemental ppm values, Butte

Valley Group A is most likely the same source designated Unknown 1 in previous Bobcat Shelter reports (Arkush 2017; Hughes 2014, 2016).

Bobcat Shelter exhibits a fairly consistent source profile through time. Most strata contain half or more American Falls/Walcott Tuff with Bear Gulch and Big Southern Butte being nearly always represented. Notable inconsistencies in the typical Bobcat Shelter profile are observed. For example, Stratum 14 and 15, associated with the end of the Early Archaic (8,450 – 4,450 BP), contain half or more Bear Gulch. American Falls/Walcott Tuff has little to no representation. It should be noted, however, that Strata 14 and 15 exhibit relatively low sourcing sample sizes, and consequently, are susceptible to sampling error

Strata 8 and 9, deposited at the tail-end of the Late Archaic (2,950 – 1,650 BP), represent an important change in Bobcat Shelter's overall source profile. Together, Browns Bench and Butte Valley Group A make up more than half of the sourced material in each stratum. Butte Valley Group A is chemically and geographically similar to Browns Bench, and therefore, could belong to the ill-defined 'family' of tuff units associated with Browns Bench (Jones et al. 2003). American Falls/Walcott Tuff makes up most of the remainder of these strata profiles. The high frequencies of Browns Bench and Butte Valley Group A in Strata 8 and 9 contribute to the relatively high mean source distances calculated for these strata.

Mean Source Distance and Diversity Measures

This section discusses how mean source distance relates to diversity measures across Bobcat Shelter strata and how diversity measures relate to each other. These relationships reveal insights into forager decision-making, particularly the selection of raw material, an important aspect of technological organization. Mean source distance positively correlates with source richness and the Shannon diversity index (Figure 4.5). In other words, mean source distance, source richness, and diversity tend to increase and decrease congruently through time. The relationship between source richness and diversity is not surprising considering that richness is used to calculate the Shannon diversity index. Mean source distance, source richness, and the Shannon diversity index appear to correlate with sourcing sample size, suggesting that changes in mean source distance and diversity measures could be driven by sample size. This is somewhat expected for diversity and richness due to sample size's established effect on the Shannon diversity index and richness (Grayson 1984; Kintigh 1984; Meltzer et al. 1992). However, the graphical relationship between mean source distance and sourcing sample size is not expected.

Chiefly important to my research, I ran a linear regression and Kendall's Tau b to investigate the relationship between strata mean source distance and sourcing sample size using observations from strata utilized in this research, resulting in $r^2 = 0.0416$, $p = 0.5039$, $df = 11$; $tau = 0.2709$, $p = 0.1993$. The results indicate that sourcing sample size does not confound mean source distance.

In addition, I ran a linear regression and Kendall's Tau b to evaluate the relationship between strata source richness and sourcing sample size, generating $r^2 = 0.6494$, $p = 0.0009$, $df = 11$; $tau = 0.8036$, $p = 0.0002$. I also ran a linear regression to understand the relationship between the Shannon diversity index and sample size, resulting in $r^2 = 0.1952$, $p = 0.1306$, $df = 11$; $tau = 0.4516$, $p = 0.0324$. The results indicate that sourcing sample size explains much of the variation in source richness and possibly in the Shannon diversity index.

I explored evenness and its relationship to mean source distance, other diversity measures, and stratum sample size (Figure 4.6). Evenness is relatively low when mean source distance, source richness, and diversity are relatively high. This occurs during the end of the Late Archaic (2,950 – 1,650 BP) and beginning of the Late Prehistoric (1,650 – 150 BP), and is observed despite relatively large sample sizes. This suggests strong preferences for specific source materials. Other sources, while still incorporated into the toolkit, are represented to a much lesser degree. This is best illustrated with Strata 8 and 9 material. Conspicuously far sources such as Browns Bench and Butte Valley Group A make up a majority of material even though a multitude of much closer sources populate the landscape and are represented in these strata's source profiles.

I ran a linear regression and Kendall's Tau b to evaluate the relationship between strata's evenness and sourcing sample size, outputting $r^2 = 0.05976$, $p = 0.4209$, $df = 11$; $tau = -0.2709$, $p = 0.1993$. As with mean source distance, sample size does not appear to drive evenness.

Analytical Groups

This section discusses the analytical groups formed after combining strata and how they are utilized in various Mann Whitney U tests. Combining strata mitigates sampling error and accentuates the contrast between compared groups. Groups of combined strata are considered discrete, analytical groups. Accordingly, mean source distance, Shannon diversity index, evenness, and source richness were recalculated for groups of combined strata.

Stratum 7 and the Strata 8/9 Grouping

Strata 8 and 9, the largest samples following Strata 7, yielded similar average source distances, which were calculated using the measured distances of sources represented at Bobcat Shelter (Table 4.3, Table 4.4, and Figure 4.7). Furthermore, Strata 8 and 9 yielded nearly twice the mean source distance of Stratum 7. Therefore, Strata 8 and 9 source and attribute data were pooled together and compared with Strata 7 data to observe potential correlations between mean source distance and curation intensity. In other words, the Strata 8/9 samples are used to represent higher, more logistical mobility while Stratum 7 samples are used to represent lower, more residential mobility. Stratum 7 has a mean source distance of 88.08 km while the Strata 8/9 grouping has a mean source distance of 160.89 km.

Low, Medium, and High

Another series of Mann Whitney U tests involved the remaining, less-intensely occupied strata and were combined based on similarity in mean source distance. Strata 5, 10, 11, 19, and 20 samples were combined into one group and represent low mobility with a mean source distance of 51.45 km. Strata 3, 4, 6, 14, and 15 samples were combined into another group and represent moderate mobility with a mean source distance of 88.21 km. Finally, the Strata 8/9 grouping represents high mobility with a mean source distance of 160.89 km.

Late Prehistoric and Archaic

Groups combined by time period, still exhibiting sharp contrast in mean source distance, allow investigation into how debitage attributes, and therefore, inferred mobility levels have changed through time. Strata 3-7 samples were combined into an analytical group representing the Late Prehistoric (1,650 – 150 BP) and were compared with the grouping of Strata 8-20, which represents the Archaic (8,450 – 1,650 BP). The Late Prehistoric group has mean source distance of 87.88 km while the Archaic group has a mean source distance of 143.23 km.

Stratum 8 and Stratum 9

Lastly, I compare Stratum 8 and Stratum 9 samples as separate analytical groups to evaluate a possible relationship between source diversity and curation indicators. Strata 8 and 9 are similar in mean source distance but differ in diversity measures such as source richness and the Shannon diversity index. Accordingly, any differences found between the debitage of Strata 8 and 9 should more readily be attributed to differences in source diversity than mean source distance.

Diversity Measures, Mean Source Distance, and Sample Size

I ran another series of linear regressions and Kendall’s Tau b to evaluate the relationship between group sourcing sample size and recalculated diversity measures and mean source distance. Observations from the five analytical groups and Strata 7, 8, and 9 are utilized. Sample sourcing size does not impact mean source distance ($r^2 = 0.03899$, p = 0.6393, df = 6; tau = -0.0714, p = 0.9049). Sample sourcing size may explain variation in source richness ($r^2 = 4539$, p = 0.06699, df = 6; tau = 0.8486, p = 0.0047), but not in the Shannon diversity index ($r^2 = 0.1309$, p = 0.3785, df = 6; tau = 0.3571, p = 0.2751). Finally, sourcing sample size has no bearing on evenness ($r^2 = 0.0001997$, p = 0.9735, df = 6; tau = -0.1091, p = 0.7084).

Source Distance, Toolstone Curation, and Debitage Attributes

This section evaluates my main hypothesis that there is a positive relationship between mean source distance and levels of curation, using a series of debitage attributes as proxies or the latter variable. I discuss the results by attribute, considering what each says about my hypothesis and predictions. Mann Whitney U results are interpreted using a predetermined alpha level of 0.05 so that p-values lower than 0.05 are considered significant.

Dorsal Cortex Percentage

In Chapter 2, I predict that dorsal cortex percentage will have an inverse relationship with source distance from Bobcat Shelter. The results do not support my prediction (Tables 4.5 through 4.22 and Figures 4.8 through 4.10). Although significant results are observed, the ratio of cortex flakes versus non-cortex flakes increases with increasing mean source distance, opposite of my prediction. These results are produced when comparing Stratum 7 with Strata 8/9 and when comparing the Late Prehistoric with the Archaic. In both sets of comparisons, significant results are only observed when including all material types in the samples or when limiting the samples to microcrystalline silicates.

Stratum 8 samples are significantly different from Stratum 9 samples. The ratio of cortex flakes versus non-cortex flakes decreases with increasing source diversity and source richness (Table 4.24 and Figure 4.11). This significant difference is only observed when limiting samples to obsidian debitage.

Dorsal Scar Count

I predicted a positive relationship between dorsal scar count and source distance. I find support for my prediction in comparisons between the medium and high groups and between the Late Prehistoric and the Archaic groups (Tables 4.9 through 4.22 and Figure 4.12 through 4.14). Both sets of comparisons reveal significant differences when limiting samples to obsidian. Moreover, mean dorsal scar count increases with increasing source distance in both cases.

Weight

In Chapter 2, I predicted that weight will have an inverse relationship with source distance. I observe support for my prediction in comparisons between the low, medium, and high groups (Tables 4.9 through 4.18 and Figures 4.16 through 4.18). Significant differences are found when comparing low and medium, medium and high, and low and high analytical groups. Median weight decreases with increasing source distance in all cases. Samples including all materials, only obsidian, and only microcrystalline silicates support my prediction.

There are significant differences in weight between the Late Prehistoric and Archaic groups. These are found among comparisons involving all materials and only microcrystalline silicates. Median weight values associated with these results do not support my prediction.

Stratum 8 and Stratum 9 show a significant difference in weight among microcrystalline silicates (Table 4.23 and Figure 4.19). However, median weight measurements do not reveal the inverse relationship expected between weight and diversity/richness.

Maximum Flake Width

I predicted an inverse relationship between maximum flake width and source distance. Comparisons among the low, medium, and high groups demonstrate support for my prediction (Tables 4.9 through 4.18 and Figures 4.20 through 4.22). Significant differences are found when comparing low to medium and when comparing medium to high. Median maximum flake width decreases with increasing source distance in both comparisons. While comparing low to medium, these results occur when including all material types in samples and when limiting samples to obsidian. While comparing medium to high, these results are only demonstrated among obsidian samples.

There are significant differences in maximum flake width between Stratum 7 and the Strata 8/9 grouping and between the Late Prehistoric and Archaic groups. In both sets of comparisons, these results are observed when including all materials in samples and when including only microcrystalline silicates. Median maximum flake width values associated with these test results do not support my prediction.

Incomplete Flake Width

I predicted that incomplete flake width will have an inverse relationship with source distance. I observe support for my prediction in comparisons between the low, medium, and high groups (Tables 4.9 through 4.18 and Figures 4.24 through 4.26). Significant differences are found when comparing low and medium, medium and high, and low and high analytical groups. Median incomplete flake width decreases with increasing source distance in all occurrences. Samples including all materials, only obsidian, and only microcrystalline silicates support for my prediction.

There are significant differences in incomplete flake width between the Late Prehistoric and Archaic groups. These results are observed when including all materials in samples and when limiting samples to microcrystalline silicates. Median incomplete flake width values associated with these test results do not support my prediction.

Platform Width

I predicted platform width to have an inverse relationship with source distance. Comparisons between Stratum 7 and the Strata 8/9 grouping and between the Late Prehistoric and Archaic groups support my prediction (Tables 4.5 through 4.8, Tables 4.19 through 4.22 and Figures 4.28 through 4.30). Significant results are observed when limiting samples to obsidian in each set of comparisons. Median platform width values decrease with increasing source distance.

Stratum 8 platform width values are significantly different from Stratum 9 platform width values (Table 4.23 and Figure 4.31). These results occur when including all material types in samples or when limiting samples to microcrystalline silicates. Platform width medians increase with increasing diversity/richness.

Incomplete Platform Width

I expected an inverse relationship between incomplete platform width and source distance. I find support for my prediction in comparisons between Stratum 7 and the Strata 8/9 grouping and between the Late Prehistoric and Archaic groups (Tables 4.5 through 4.8, Tables 4.19 through 4.22 and Figures 4.32 through 4.34). In both sets of comparisons, significant results are only observed when including all material types in the samples or when limiting the samples to obsidian. Median incomplete platform width decreases with increasing source distance for each set of comparisons.

Platform Thickness

In Chapter 2, I predicted platform thickness to inversely relate to source distance. The only support for my prediction occurs when comparing the medium group to the high group and only occurs when limiting samples to microcrystalline silicates (Tables 4.9 through 4.18 and Figures 4.36 through 4.38). This observation is associated with median values that decrease with increasing source distance.

Additionally, Stratum 8 platform thickness values are significantly different from Stratum 9 platform thickness values, but only when limiting samples to microcrystalline silicates (Table 4.23 and Figure 4.39). Median platform thickness increases here with increasing diversity/richness.

Incomplete Platform Thickness

I predicted incomplete platform thickness to have an inverse relationship with source distance. I find support for my prediction in comparisons between Stratum 7 and the Strata 8/9 grouping and between the Late Prehistoric and Archaic groups (Tables 4.5 through 4.8, Tables 4.19 through 4.22 and Figures 4.40 through 4.42). In both sets of comparisons, significant results are only observed when including all material types in the samples or when limiting the samples to obsidian. Median incomplete platform thickness decreases with increasing source distance for each set of comparisons.

Ventral Curvature

I expected ventral curvature to inversely correlate with source distance. Results do not support my expectation because significant correlations are not observed (Tables 4.5 through 4.22 and Figures 4.44 through 4.46).

Greatest and Poorest Curation Indicators

Most curation indicators demonstrate a relationship with mean source distance. However, maximum flake width, incomplete flake width, platform width, incomplete platform width and thickness, and dorsal scar count consistently demonstrate the strongest relationships with mean source distance. Dorsal cortex percentage, weight, platform thickness, and ventral curvature are demonstrated as poorer indicators of curation intensity. Ventral curvature is demonstrated as an especially poor indicator here because it did not produce a single significant result.

Overall Stats

Mean Source Distance and Curation Indicators

I calculate that 25.33% (38/150) of total Mann Whitney U tests resulted in significant p-values at an alpha level of 0.05. Of those significant results, 68.42% (26/38) are associated with medians, cortex flake vs. non-cortex flake ratios, and/or dorsal scar count averages that trend in directions I predict. Of these, I find that 100% (13/13) of significant obsidian results, 60% (9/15) of significant ‘all materials’ results, and 40% (4/10) of significant MCS results are associated with predicted trends.

Considering only obsidian tests, 26% (13/50) tests are significant, and 100% (13/13) of significant results are associated with predicted trends. At an alpha level of 0.10, I find that 34% (17/50) of tests are significant, and 100% (17/17) of significant results are associated with predicted trends.

Diversity/Richness and Curation Indicators

When comparing Stratum 8 with Stratum 9, 16.66% (5/30) of total Mann Whitney U tests resulted in significant p-values at an alpha level of 0.05. Of those significant results, 20% (1/5) are associated with medians, cortex flake vs. non-cortex flake ratios, and/or dorsal scar count averages that trend in directions I predict. That is, that diversity/richness should relate inversely with all curation indicators except dorsal scar count. Dorsal scar count was expected to relate positively with diversity/richness.

Chapter 4 Summary

I begin Chapter 4 by discussing the distribution of debitage across Bobcat Shelter strata. Due to their larger sample sizes, Strata 7, 8, and 9 are the most viable for testing my prediction that curation level indicators should correlate with strata mean source distance. Consequently, my research best monitors diachronic change in source use and curation intensity during the Late Archaic (2,950 – 1,650 BP) to Late Prehistoric (1,650 – 150 BP) transition at Bobcat Shelter.

Most of the Bobcat Shelter obsidian debitage are represented by seven sources. These include Walcott Tuff, Bear Gulch, Big Southern Butte, Browns Bench, Butte Valley Group A, Obsidian Cliff, and Reas Pass. Strata 8 and 9 contain appreciably higher proportions of Butte Valley Group A and Browns Bench material than Stratum 7, contributing strongly to their higher, weighted mean source distances. Based on comparison in elemental ppm values, Butte Valley Group A is likely the same source designated Unknown 1 in previous Bobcat Shelter reports (Arkush 2017; Hughes 2014, 2016).

Mean source distance, source richness, and diversity tend to increase and decrease congruently through time. However, all of these measures positively correlate with sample size as well, indicating that sample size may largely be driving changes. This is not expected in the large samples associated with Strata 7, 8, 9, which demonstrate relatively lower evenness and conspicuous emphasis on certain toolstone sources. Strata 8 and 9 are particularly interesting as they represent a break from Bobcat Shelter's typical source profile and show strong emphasis on the relatively far sources of Browns Bench and Butte Valley Group A.

Strata are combined to form analytical groups that best serve to answer my research question while optimizing sample sizes. Strata 8 and 9 samples are pooled together as one group due to their similar calculated mean source distances. Debitage from the Strata 8/9 sample, which should represent higher mobility based on source distance, is compared with debitage from Stratum 7, which should represent lower mobility. To mitigate sampling error, the less-intensely occupied strata are combined into new analytical groups based on similar mean source distances, which are statistically analyzed against each other and the Strata 8/9 grouping. In addition, Strata 8-20 are combined into a group to represent the Archaic (8,450 – 1,650 BP) and compared with a grouping of Strata 3-7, which represents the Late Prehistoric (1,650 – 150 BP). Lastly, Stratum 8 debitage is analyzed against Stratum 9 to investigate how diversity measures correlate with curation level indicators.

I observe significant results and trends in medians, ratios, and/or scar counts that support my predictions. However, comparison on exclusively obsidian samples demonstrates the strongest support for my predictions. Considering only obsidian tests, 26% (13/50) tests are significant, and 100% (13/13) of significant results are associated with predicted trends at an alpha level of 0.05. At an alpha level of 0.10, I find that 34% (17/50) of tests are significant, and 100% (17/17) of significant results are associated with predicted trends.

Finally, some curation indicators perform better than others. Maximum flake width, incomplete flake width, platform width, incomplete platform width and thickness, and dorsal scar count consistently demonstrate the strongest relationships with mean source distance.

CHAPTER 5

DISCUSSION AND CONCLUSION

This chapter is a thorough consideration of my research results. I begin by restating the goal of my research. I then consider the level of support for my predictions. I proceed to examine the overall implications of my results and how they contribute to our understanding of hunter-gatherer technological organization in eastern and southern Idaho. I also consider implications for the discipline's use of X-ray fluorescence spectroscopy. Next, I discuss the limitations of my Bobcat Shelter dataset and how this possibly affected results. Finally, I make closing remarks and provide suggestions for future research.

Hypothesis and Results

My research investigates the use of lithic debitage as an informer of Idaho hunter-gatherer mobility systems. I work from the broad hypothesis that there is a relationship between the technological strategies of Bobcat Shelter's occupants and their mobility systems, with the specific prediction that if Bobcat Shelter occupants varied in their dependence on logistical mobility strategies, then I will find correlations between strata lithic curation intensity and strata average distance from toolstone source.

Curation Intensity Indicators and Predominant Pressure Flaking

All debitage measures utilized in this research, apart from dorsal cortex percentage, are expected to decrease with increasing source distance. Maximum flake width, incomplete flake width, platform width, incomplete platform width and thickness, and dorsal scar count reliably demonstrate an inverse relationship with strata or analytical group mean source distance. The strong representation of width attributes here is not surprising since width stands out among size attributes as a reduction intensity indicator (Odell 1989).

Dorsal cortex percentage, weight, platform thickness, and ventral curvature, on the other hand, are demonstrated as reliable indicators in the literature but not here (Amick et al. 1988; Andrefsky 2005; Magne and Pokotylo 1981; Marwick 2008; Mauldin and Amick 1989; Morrow 1984; Sullivan and Rozen 1985). Perhaps this is because most of the Bobcat Shelter debitage are described as pressure flakes (Arkush 2017). In other words, there is a narrow range of variation in debitage size and shape across the Bobcat Shelter strata, and, consequently, there might be no measurable differences between groups of flakes based on the less robust indicators.

Mann Whitney U and Materials Types

The narrow range of variation observed in Bobcat Shelter debitage may explain why only 25.33% (38/150) of total Mann Whitney U tests resulted in significant p-values at an alpha level of 0.05. A larger proportion of significant results would be expected had Bobcat Shelter debitage represented more of the toolstone reduction process.

However, it is important to consider that 100% (13/13) of significant obsidian results, 60% (9/15) of significant mixed-materials results, and 40% (4/10) of significant MCS results are associated with predicted trends in median values, cortex flake vs. non-cortex flake ratios, and/or dorsal scar count averages. These results are expected because exclusively obsidian samples should have the strongest relationship with sourcing samples, which are also exclusively composed of obsidian. Mixed material samples and MCS samples provide context for my predicted and observed relationship between obsidian source distance and obsidian curation intensity. At an alpha level of 0.10, this relationship is more evident, as I find that 34% (17/50) of exclusively obsidian tests are significant, and 100% (17/17) of significant results are associated with predicted trends.

Strata and Analytical Groups

The Late Prehistoric vs. the Archaic and Stratum 7 vs. Grouping 8/9. Though highly contrasting in mean source distance, the Late Prehistoric and Archaic groups were designed to monitor mobility changes through time at Bobcat Shelter. This is because I wanted to understand time's possible effect on curation intensity indicators even though source distance is my main focus. Stratum 7 and Grouping 8/9, though representing distinct time periods, exhibit higher contrast in mean source distance than the Late Prehistoric and Archaic groups.

Mann Whitney U tests comparing the Late Prehistoric and Archaic groups and comparing Stratum 7 with Grouping 8/9 produced similar results. The Late Prehistoric grouping is largely composed of Stratum 7 samples and the Archaic grouping is largely composed of Strata 8 and 9 samples. Due to sampling constraints, these two sets of comparisons seem to capture the same changes. The takeaway from these comparisons is that Bobcat Shelter occupants produced more highly curated debitage before the Archaic to Late Prehistoric transition than after. In addition, strata mean source distance is demonstrated as a conditioning factor in debitage curation intensity.

Low, Medium, and High Comparisons. My low, medium, and high groups were designed to have the sharpest possible contrast in mean source distance while optimizing sample sizes. These groups were created without regard to chronological order of strata. What's interesting here is that all significant Mann Whitney U results produced from low, medium, and high comparisons are associated with predicted trends in median values, cortex flake vs. non-cortex flake ratios, and/or dorsal scar count averages. Put another way, the material types included in samples did not affect the number of significant tests results that support my predictions. As is expected, the largest number of significant differences are observed among the low to high comparisons. I conclude here that low, medium, and high comparisons demonstrate that higher mean source distances are associated with more intense debitage curation.

Stratum 8 and 9 Comparisons. My comparison of Stratum 8 samples with Stratum 9 samples were not meant to elicit a relationship between mean source distance and curation intensity. Stratum 8 and Stratum 9 have virtually identical mean source distances but differ in diversity and richness. I wanted to observe how source diversity and source richness affect debitage curation intensity incidentally to my main focus. If increased diversity and richness are proxy measures for greater mobility, then increased mobility doesn't drive debitage curation here in the manner expected. My results show mean source distance as a better indicator of mobility and a more important factor in debitage curation. The high density of obsidian sources in Idaho explains how Bobcat Shelter foragers could incorporate many toolstone sources into their toolkits with relatively little travel cost. While richness and diversity may be suitable proxy measures for mobility in other contexts, they are not useful measures at Bobcat Shelter.

Mobility and Technological Organization in Eastern and Southern Idaho

My research was designed to add detail to our understanding of mobility systems and technological organization in the prehistoric Birch Creek Valley and eastern and southern Idaho more broadly. As informed by the curation intensity of Bobcat Shelter debitage and its relationship with strata mean source distance, Bobcat Shelter occupants varied in their level of logistical mobility through time. The highest level of logistical mobility occurred during the end of the Late Archaic (2,950 – 1,650 BP) and is associated with Strata 8 and 9. Logistical mobility decreases as Bobcat Shelter transitions into the beginning of the Late Prehistoric (1,650 – 150 BP), which is associated with Stratum 7. Its difficult to defend statements regarding other time periods due to sample size constraints.

Bobcat Shelter occupants consistently favored specific obsidian sources through time. Considered as whole, their toolkits were primarily composed of American Falls/Walcott Tuff, Bear Gulch, Big Southern Butte, Browns Bench, Butte Valley Group A, Obsidian Cliff, and Reas Pass. Walcott Tuff is the most frequently selected material and is known to have surface exposures some 40-50 kilometers away from Bobcat Shelter in the Southern Lemhi and Beaverhead Ranges (Arkush 2017; Morgan and McIntosh 2005).

The source profile of Bobcat Shelter obsidian debitage does not appear significantly different from previously sourced formal tools (Arkush 2017; Hughes 2014, 2016). A pronounced difference would have had important implications for mobility and technological organization. For example, consider the hypothetical scenario that debitage were generally discarded earlier than tools and at different locations after the point of toolstone extraction. We might have inferred disparate episodes of discard and therefore, site visitation/use.

Approximately 55% (5/9) of sourced formal tools bear the Walcott Tuff signature. Approximately 33% (3/9) of formal tools represent Bear Gulch. Finally, about 11% (1/9) of formal tools originated from the Browns Bench “family”.

Some researchers suggest that Great Basin foragers generally embedded toolstone procurement within hunting excursions (McGuire 2002; Smith 2010). The close proximity of Walcott Tuff and the observation that it is one of the more common materials in Bobcat Shelter, a hunting camp, lends support to this idea.

Several researchers have documented an increase in large game hunting during the archaic in several regions of North America, including the Great Basin and adjacent regions (Byers and Broughton 2004; Byers et al. 2005; Byers and Smith 2007; Hildebrandt and McGuire 2002; Mcguire and Hildebrandt 2005; Smith 2010). Although they do not all agree on the prime mover behind this pattern, the Bobcat Shelter occupations, do nonetheless, appears to illustrate this phenomenon as well. This is because the designated time period overlaps with Bobcat Shelter’s most intense use at the Late Archaic (2,950 – 1,650 BP) to Late Prehistoric (1,650 – 150 BP) transition. Smith (2010) suggests that behavioral changes, such as that proposed by McGuire and Hildebrandt (2005), may encourage a trend towards higher levels of logistical mobility and a narrowing focus towards specific toolstone sources. An increased focus towards the farther obsidian sources of Butte Valley Group A and Browns Bench in the Late Archaic indicates higher levels of logistical mobility by Bobcat Shelter occupants. However, I think the consistent, high representation of Walcott Tuff through time just as easily fits into a notion of increased large-game hunting and a focus on specific sources.

We also must consider climate’s role in Bobcat Shelter occupants’ selection and curation of material. Idaho’s climate was markedly xeric in the Middle Holocene and is associated with decreases in toolstone source diversity, richness, and distance, indicating decreased forager mobility (Grayson 1993; Holmer 1997; Scheiber and Finley 2011). A resurgence of forager mobility is evidenced with the return of more mesic conditions in the Late Archaic and Late Prehistoric (Fowler 2014; Holmer 1997; Scheiber and Finley 2011). The large representation of far sources like Butte Valley Group A and Browns Bench during the Late Archaic reflects this resurgence of forager mobility. Additionally, I find it interesting that Bobcat Shelter underwent little use until the Late Archaic and Late Prehistoric (Arkush 2017). We might infer that moister conditions afforded an increase in forager mobility and permitted forager use of Bobcat Shelter as foragers ventured from residential sites closer to the Snake River. Specifically, increases in late Holocene moisture likely resulted in expanding game populations that would have pulled people into the Birch Creek resource catchment (Byers and Broughton 2004; Byers et al. 2005; Byers and Smith 2007). Many of the rockshelters within the vicinity of Bobcat were also frequented during similar spans of time (Arkush 2017).

X-ray Fluorescence Spectroscopy and Tiny Debitage

The literature indicates that obsidian samples wider than 10 mm and thicker than 2 mm are optimal for energy dispersive x-ray fluorescence spectroscopy (Davis et al. 1998; Eerkens et al. 2007; Shackely 2011). The average maximum flake width and incomplete flake width measurements of obsidian flakes used in this study are 6.61 mm and 6.66 mm, respectively. Although I did not record flake thickness measurements, I did record platform thickness. The average platform thickness and incomplete platform thickness measurements of obsidian flakes used in this research are 0.97 mm and 0.96 mm, respectively. This is because 89% of Bobcat

Shelter's debitage are pressure flakes (Arkush 2017). In other words, Bobcat Shelter flakes fall under the category of "tiny debitage".

In this research, I observed that elemental variation is generally spread wider than source standard variation, likely the result of the dimensional thinness of Bobcat Shelter's tiny debitage. However, when plotted element by element, obsidian debitage group into distinct clusters (Chapter 4, Figure 4.2). This allowed me to confidently assign artifacts to sources by clustering based on similarity in elemental measurements. Furthermore, the chemical signatures and source identifications derived from thicker samples of Bobcat Shelter obsidian, such as points and preforms, corroborate the chemical signatures and source assignments resulting from my research (Arkush 2017; Hughes 2014, 2016).

Tiny debitage are volumous in the archaeological record and therefore, likely to provide a more detailed view of prehistoric mobility than objective pieces like points and preforms. This is especially true for regions known for high mobility because foragers will trend towards refinement of smaller and smaller objective pieces rather than procuring new material (Bamforth 1986; Binford 1979, 1980; Eerkens et al. 2007; Feder 1980; Nelson 1991).

My research demonstrates the value of tiny debitage in obsidian distribution studies. For example, Arkush (2017) documents a stratified sample (n=60) of sourced Bobcat Shelter obsidian. This sample spans nearly all strata at Bobcat Shelter and contains a mixture of tools and flakes. Browns Bench and Butte Valley Group A (Unknown #1) are poorly represented in Bobcat Shelter's source profile as presented by Arkush (2017; Hughes 2014, 2016). However, my research monitors an explosion in the use of Browns Bench and Butte Valley Group A towards the end the Late Archaic (2,950 – 1,650 BP), with these two sources comprising more than half of the material.

Limitations of the Bobcat Shelter Debitage and Minding Our Assumptions

As mentioned earlier in this chapter, I suspect that the narrow variation in size and shape among Bobcat Shelter debitage affected my number of significant Mann Whitney U results and my number of proven curation indicators. About 90% of Bobcat Shelter's debitage are pressure flakes. I would expect more drastic support for my model had these methods been applied to a sample of debitage more representative of the toolstone reduction trajectory.

Bobcat Shelter occupies one place in a prehistoric mobility system, the seasonal hunting camp. Occupants likely visited Bobcat according to a predictable, seasonal schedule. Foragers likely procured material in a predictable manner and arrived at Bobcat Shelter with their toolstone reduced to a consistently similar state. Therefore, Bobcat Shelter is expected to exhibit narrow debitage variation.

Finally, it is easiest to think of Bobcat Shelter as belonging to one, distinct society of foragers through time with convenient continuation between ancestors and descendants. In reality, Bobcat Shelter may have been part of many mobility systems belonging to many distinct groups of foragers. The end of the Late Archaic (2,950 – 1,650 BP), when the proportion of far sources like Browns Bench and Butte Valley Group A material drastically increases, may be interpreted in several ways. For example, we might infer a greater coverage of the landscape by the typical groups of foragers that utilized the shelter, likely permitted by increasingly mesic conditions. On the other hand, perhaps those mesic conditions afforded other groups, with residential bases closer to the Browns Bench locality, to venture into Skull Canyon.

Concluding Remarks

Bobcat Shelter occupants varied in their level of logistical mobility through time. This is informed by the curation intensity of Bobcat Shelter debitage and its relationship with strata mean source distance.

My research methods are innovative for several reasons. First, they involve sourcing an entire archaeological assemblage of obsidian debitage. Second, the obsidian debitage is a stratified sample. Finally, I look to the archaeological record's vast accumulation of debitage to produce a high-resolution picture of prehistoric human behavior.

I would predict stronger correlations between debitage curation and source distance should my methods be applied to debitage assemblages from other site types. Likewise, I'd expect stronger correlations and a more detailed picture of mobility if data were synthesized from several site types occupying the same prehistoric mobility system.

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APPENDICES

Appendix 1: Chapter 3 Figures and Tables

Table 3.1 Lower and upper limits of elemental ppm variation for Idaho obsidian sources.

Source	Zr 2 Sigma Below Mean	Zr 2 Sigma Above Mean	Sr 2 Sigma Below Mean	Sr 2 Sigma Above Mean	Y 2 Sigma Below Mean	Y 2 Sigma Above Mean	Rb 2 Sigma Below Mean	Rb 2 Sigma Above Mean	Nb 2 Sigma Below Mean	Nb 2 Sigma Above Mean
American Falls/Walcott (IMNH)	207.199	245.9958	22.8545	33.5965	51.0679	58.8119	158.8257	189.1153	41.0471	48.1055
Bear Gulch (IMNH)	269.6891	317.0719	43.5073	52.3661	37.4436	46.6744	151.2961	177.9181	46.7083	54.4715
Big Southern Butte (IMNH)	294.8611	340.4323	5.6603	9.8843	191.7878	226.2794	247.4872	284.1004	306.4206	370.8098
Browns Bench (IMNH)	397.634	490.4328	47.1964	61.6508	50.3139	65.7375	169.7655	207.0415	38.8267	46.8103
Browns Bench Area (NWROSL)	299.704	401.896	20.1846	30.6154	56.2534	62.9466	224.3432	244.8568	41.2222	48.3778
Butte Valley Group A (IMNH)	464.34	572.74	66.68	79.12	60.1	73.22	147.18	163.7	48.16	51.28
Cannonball Mountain 1 (IMNH)	988.2673	1115.8613	6.6307	13.2935	106.388	119.4504	315.9035	356.7663	106.599	122.707
Cannonball Mountain 2 (IMNH)	590.0383	739.5451	6.7005	11.9529	88.9735	117.6591	249.7133	337.5945	90.9476	119.0924
Cedar Butte (IMNH)	607.0063	729.7871	7.4786	12.2502	194.1586	232.6254	201.6235	236.6571	264.7486	331.7898
Chesterfield (IMNH)	175.1888	187.0096	201.9369	234.7189	21.3667	25.0071	75.3364	81.1216	10.0476	14.8488
Conant Creek (IMNH)	173.5962	199.9734	12.1805	49.2933	58.6793	70.4053	153.4136	168.198	50.4678	57.3794
Deadhorse Ridge (NWROSL)	315.3028	356.0972	18.8472	25.9528	61.954	76.246	168.592	203.808	50.9274	62.2726
Jordan Creek (NWROSL)	135.224	221.176	70.0816	89.7184	22.4328	31.3672	158.2756	193.5244	6.9746	13.8254
Kelly Canyon (NWROSL)	257.1238	277.6762	19.2157	23.7177	75.7904	87.8096	168.645	196.555	59.8601	69.8733
Malad (IMNH)	82.4019	108.2579	70.0608	85.4532	27.5302	33.6558	112.935	125.6598	13.4517	17.4897
Murphy Hot Springs (IMNH)	344.5557	387.2849	25.4284	29.0296	55.6548	64.8476	200.9297	228.4117	40.4047	47.0051
Obsidian Cliff (IMNH)	157.15	170.03	6.83	8.11	73.44	82.4	224.66	250.02	39.08	45.32
Owyhee (IMNH)	102.8238	120.7234	28.7092	38.1324	25.7358	28.4398	178.404	208.2068	11.1722	13.1558
Pack Saddle (IMNH)	313.991	363.8582	20.5967	29.0895	54.7288	66.756	146.5624	172.4188	46.3592	54.4468
Reas Pass (NWROSL)	275.0516	309.9484	20.1609	31.9105	61.7037	70.8677	176.104	200.2532	50.2084	60.7916

Table 3.1 Lower and upper limits of elemental ppm variation for Idaho obsidian sources (Cont.).

Source	Zr 2 Sigma Below Mean	Zr 2 Sigma Above Mean	Sr 2 Sigma Below Mean	Sr 2 Sigma Above Mean	Y 2 Sigma Below Mean	Y 2 Sigma Above Mean	Rb 2 Sigma Below Mean	Rb 2 Sigma Above Mean	Nb 2 Sigma Below Mean	Nb 2 Sigma Above Mean
Reynolds (NWROSL)	170.5545	197.8621	1.1033	11.4681	104.2647	121.8187	294.8033	374.1133	34.9455	46.4711
Sinker Canyon (NWROSL)	202.8516	233.9104	17.1392	29.0512	86.0834	99.869	246.3938	263.5586	36.494	44.506
Teton Pass 1 (IMNH)	74.7015	87.2671	118.3181	140.3277	20.9377	28.3857	100.4419	125.4771	12.3828	16.4472
Timber Butte (IMNH)	44.2	55.32	16.08	18.88	36.56	45.72	168.31	184.23	26.16	29.68
Wedge Butte (IMNH)	136.5062	173.3054	10.4702	14.6942	161.7282	181.5934	456.5799	524.9319	114.3388	129.8584

Table 3.2 Source standard (ppm) averages and standard deviations for Idaho obsidian sources.

Source	Zr Avg	Zr SD	Sr Avg	Sr SD	Y Avg	Y SD	Rb Avg	Rb SD	Nb Avg	Nb SD
American Falls/Walcott (IMNH)	226.5974	9.6992	28.2255	2.6855	54.9399	1.936	173.9705	7.5724	44.5763	1.7646
Bear Gulch (IMNH)	293.3805	11.8457	47.9367	2.2147	42.059	2.3077	164.6071	6.6555	50.5899	1.9408
Big Southern Butte (IMNH)	317.6467	11.3928	7.7723	1.056	209.0336	8.6229	265.7938	9.1533	338.6152	16.0973
Browns Bench (IMNH)	444.0334	23.1997	54.4236	3.6136	58.0257	3.8559	188.4035	9.319	42.8185	1.9959
Browns Bench Area (NWROSL)	350.8	25.548	25.4	2.6077	59.6	1.6733	234.6	5.1284	44.8	1.7889
Butte Valley Group A (IMNH)	518.54	27.1	72.9	3.11	66.66	3.28	155.44	4.13	49.72	0.78
Cannonball Mountain 1 (IMNH)	1052.0643	31.8985	9.9621	1.6657	112.9192	3.2656	336.3349	10.2157	114.653	4.027
Cannonball Mountain 2 (IMNH)	664.7917	37.3767	9.3267	1.3131	103.3163	7.1714	293.6539	21.9703	105.02	7.0362
Cedar Butte (IMNH)	668.3967	30.6952	9.8644	1.1929	213.392	9.6167	219.1403	8.7584	298.2692	16.7603
Chesterfield (IMNH)	181.0992	2.9552	218.3279	8.1955	23.1869	0.9101	78.229	1.4463	12.4482	1.2003
Conant Creek (IMNH)	186.7848	6.5943	30.7369	9.2782	64.5423	2.9315	160.8058	3.6961	53.9236	1.7279
Deadhorse Ridge (NWROSL)	335.7	10.1986	22.4	1.7764	69.1	3.573	186.2	8.804	56.6	2.8363
Jordan Creek (NWROSL)	178.2	21.488	79.9	4.9092	26.9	2.2336	175.9	8.8122	10.4	1.7127
Kelly Canyon (NWROSL)	267.4	5.1381	21.4667	1.1255	81.8	3.0048	182.6	6.9775	64.8667	2.5033
Malad (IMNH)	95.3299	6.464	77.757	3.8481	30.593	1.5314	119.2974	3.1812	15.4707	1.0095
Murphy Hot Springs (IMNH)	365.9203	10.6823	27.229	0.9003	60.2512	2.2982	214.6707	6.8705	43.7049	1.6501
Obsidian Cliff (IMNH)	163.59	3.22	7.47	0.32	77.92	2.24	237.34	6.34	42.2	1.56
Owyhee (IMNH)	111.7736	4.4749	33.4208	2.3558	27.0878	0.676	193.3054	7.4507	12.164	0.4959
Pack Saddle (IMNH)	338.9246	12.4668	24.8431	2.1232	60.7424	3.0068	159.4906	6.4641	50.403	2.0219
Reas Pass (NWROSL)	292.5	8.7242	26.0357	2.9374	66.2857	2.291	188.1786	6.0373	55.5	2.6458
Reynolds (NWROSL)	184.2083	6.8269	6.2857	2.5912	113.0417	4.3885	334.4583	19.8275	40.7083	2.8814
Sinker Canyon (NWROSL)	218.381	7.7647	23.0952	2.978	92.9762	3.4464	254.9762	4.2912	40.5	2.003

Table 3.2 Source standard (ppm) averages and standard deviations for Idaho obsidian sources (Cont.).

Source	**Zr Avg**	**Zr SD**	**Sr Avg**	**Sr SD**	**Y Avg**	**Y SD**	**Rb Avg**	**Rb SD**	**Nb Avg**	**Nb SD**
Teton Pass 1 (IMNH)	80.9843	3.1414	129.3229	5.5024	24.6617	1.862	112.9595	6.2588	14.415	1.0161
Timber Butte (IMNH)	49.76	2.78	17.48	0.7	41.14	2.29	176.27	3.98	27.92	0.88
Wedge Butte (IMNH)	154.9058	9.1998	12.5822	1.056	171.6608	4.9663	490.7559	17.088	122.0986	3.8799

Table 3.3 Sr/Zr ratios of Idaho obsidian sources.

Source	**Zr Avg**	**Sr Avg**	**Zr Avg/Sr Avg**	**Sr Avg/Zr Avg**
American Falls/Walcott (IMNH)	226.5974	28.2255	8.028109334	0.124562329
Bear Gulch (IMNH)	293.3805	47.9367	6.120164717	0.163394295
Big Southern Butte (IMNH)	317.6467	7.7723	40.8690735	0.024468379
Browns Bench (IMNH)	444.0334	54.4236	8.15883918	0.122566456
Browns Bench Area (NWROSL)	350.8	25.4	13.81102362	0.072405929
Butte Valley	518.54	72.9	7.11303155	0.140587033
Cannonball Mountain 1 (IMNH)	1052.0643	9.9621	105.6066793	0.009469098
Cannonball Mountain 2 (IMNH)	664.7917	9.3267	71.27834068	0.014029507
Cedar Butte (IMNH)	668.3967	9.8644	67.75847492	0.014758301
Chesterfield (IMNH)	181.0992	218.3279	0.829482627	1.205570759
Conant Creek (IMNH)	186.7848	30.7369	6.076891294	0.164557823
Deadhorse Ridge (NWROSL)	335.7	22.4	14.98660714	0.066726244
Jordan Creek (NWROSL)	178.2	79.9	2.23028786	0.448372615
Kelly Canyon (NWROSL)	267.4	21.4667	12.4565024	0.080279357
Malad (IMNH)	95.3299	77.757	1.225997659	0.815662242
Murphy Hot Springs (IMNH)	365.9203	27.229	13.43862426	0.074412379
Obsidian Cliff (IMNH)	163.59	7.47	21.89959839	0.045662938
Owyhee (IMNH)	111.7736	33.4208	3.34443221	0.299004416
Pack Saddle (IMNH)	338.9246	24.8431	13.64260499	0.073299784
Reas Pass (NWROSL)	292.5	26.0357	11.23457407	0.08901094
Reynolds (NWROSL)	184.2083	6.2857	29.30593251	0.034122784
Sinker Canyon (NWROSL)	218.381	23.0952	9.455687762	0.105756453
Teton Pass 1 (IMNH)	80.9843	129.3229	0.626217785	1.596888533
Timber Butte (IMNH)	49.76	17.48	2.846681922	0.351286174
Wedge Butte (IMNH)	154.9058	12.5822	12.31150355	0.081224848

Figure 3.1 Maximum flake width.

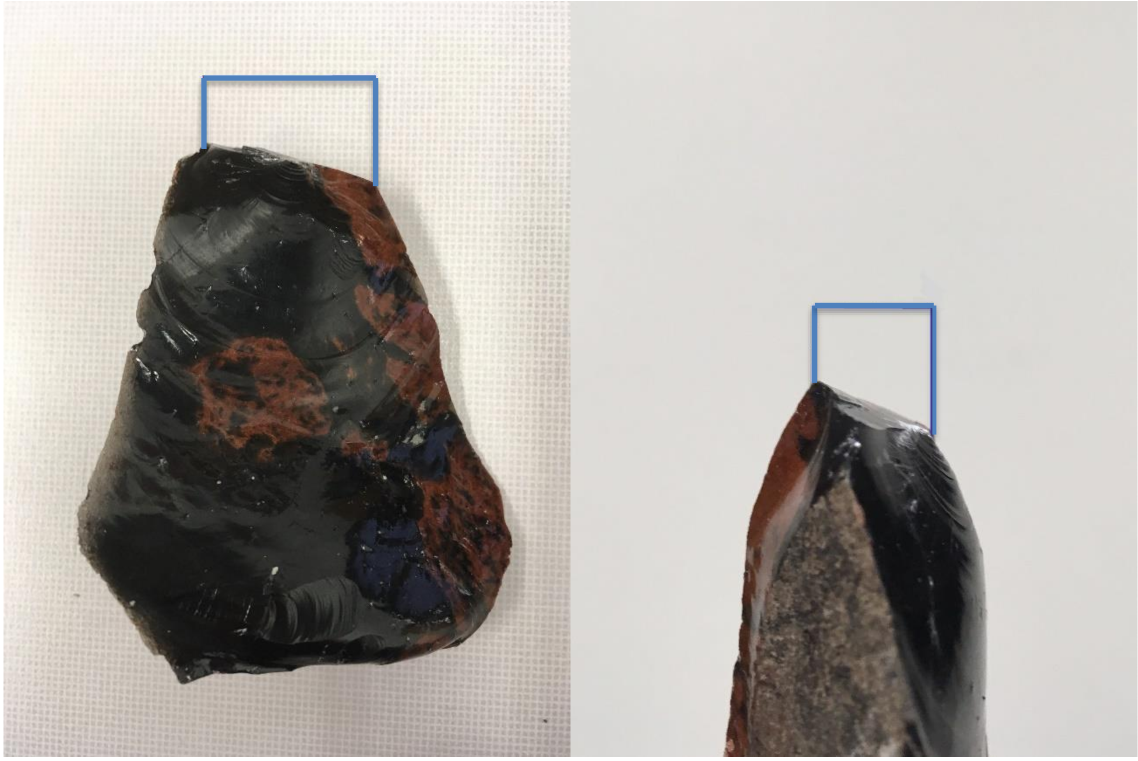

Figure 3.2 Platform width (left) and platform thickness (right).

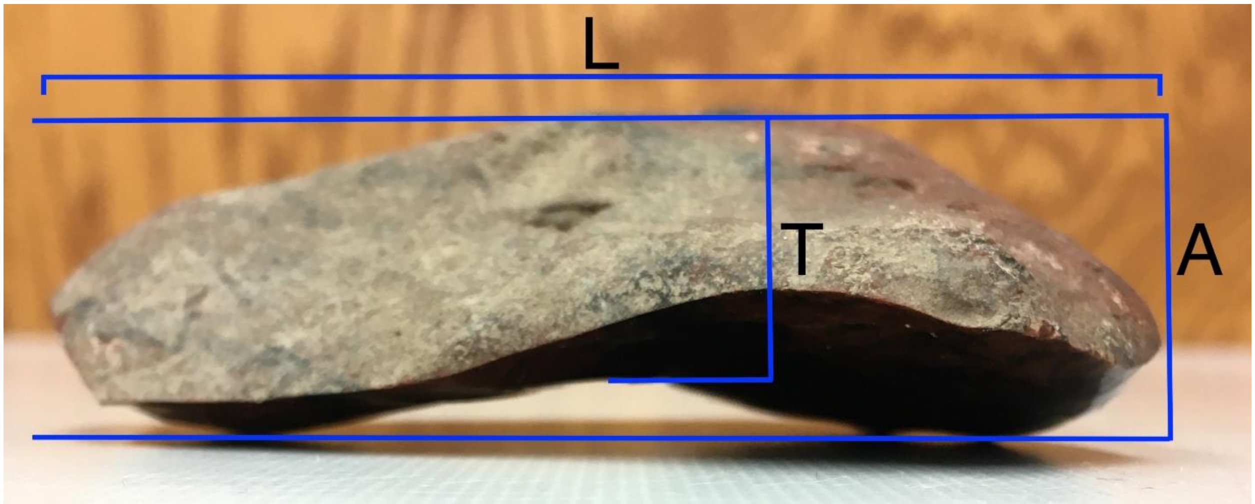

Figure 3.3 Ventral Curvature Metrics.

Appendix 2: Chapter 4 Figures and Tables

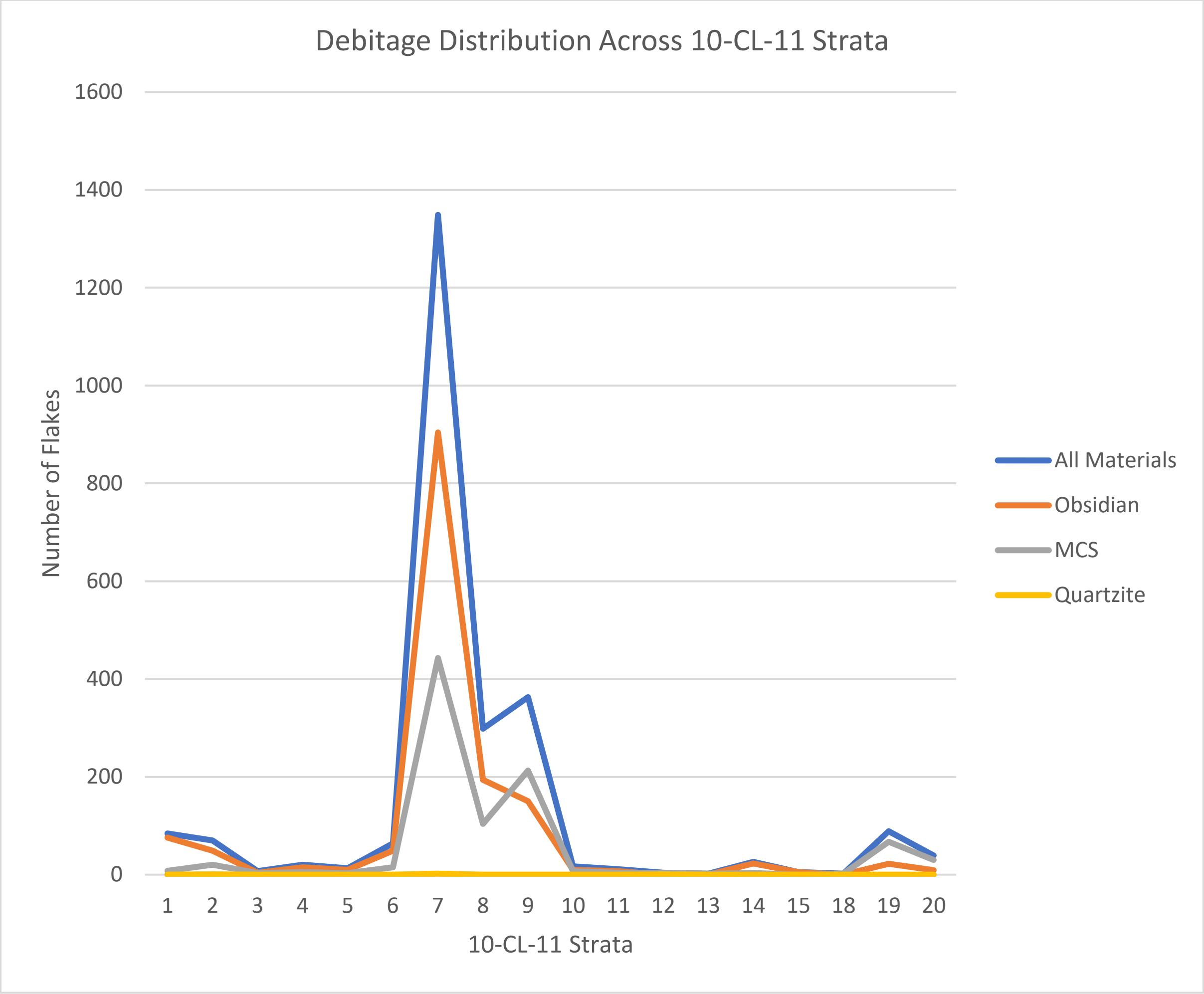

Figure 4.1 Debitage distribution across Bobcat Shelter strata.

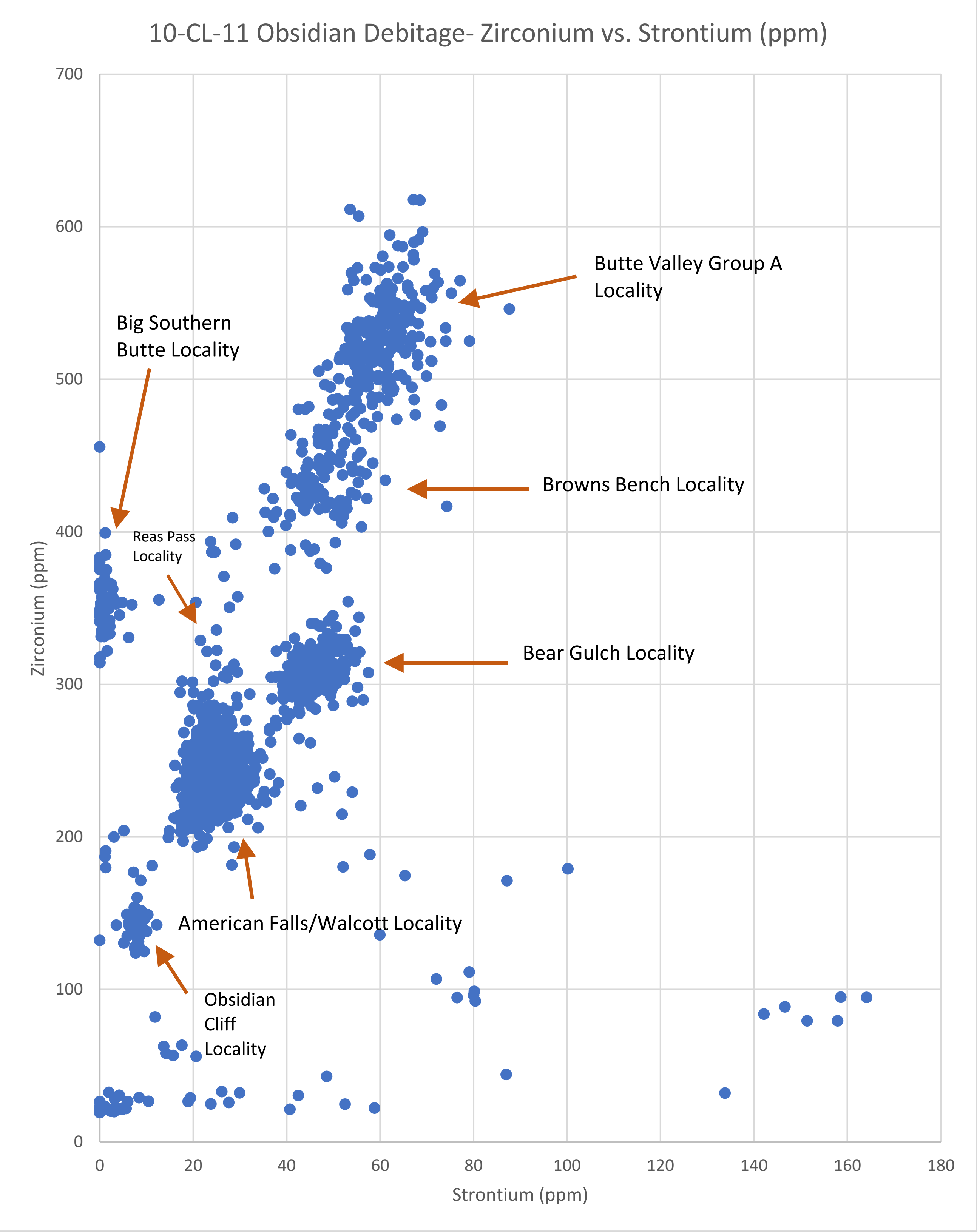

Figure 4.2 Bobcat Shelter obsidian debitage- Zirconium (ppm) plotted against strontium (ppm).

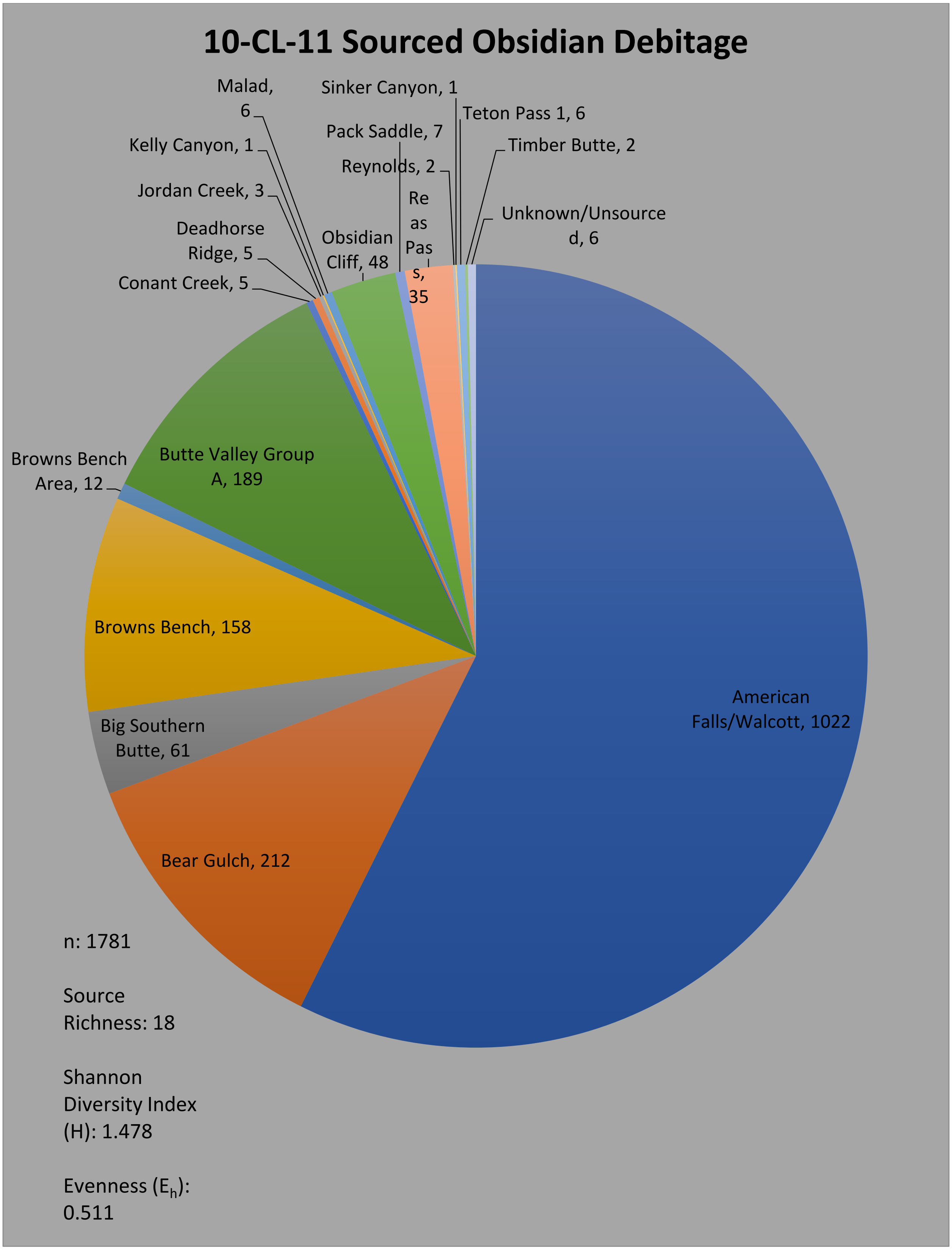

Figure 4.3 Bobcat Shelter obsidian source profile (Includes test pit obsidian debitage).

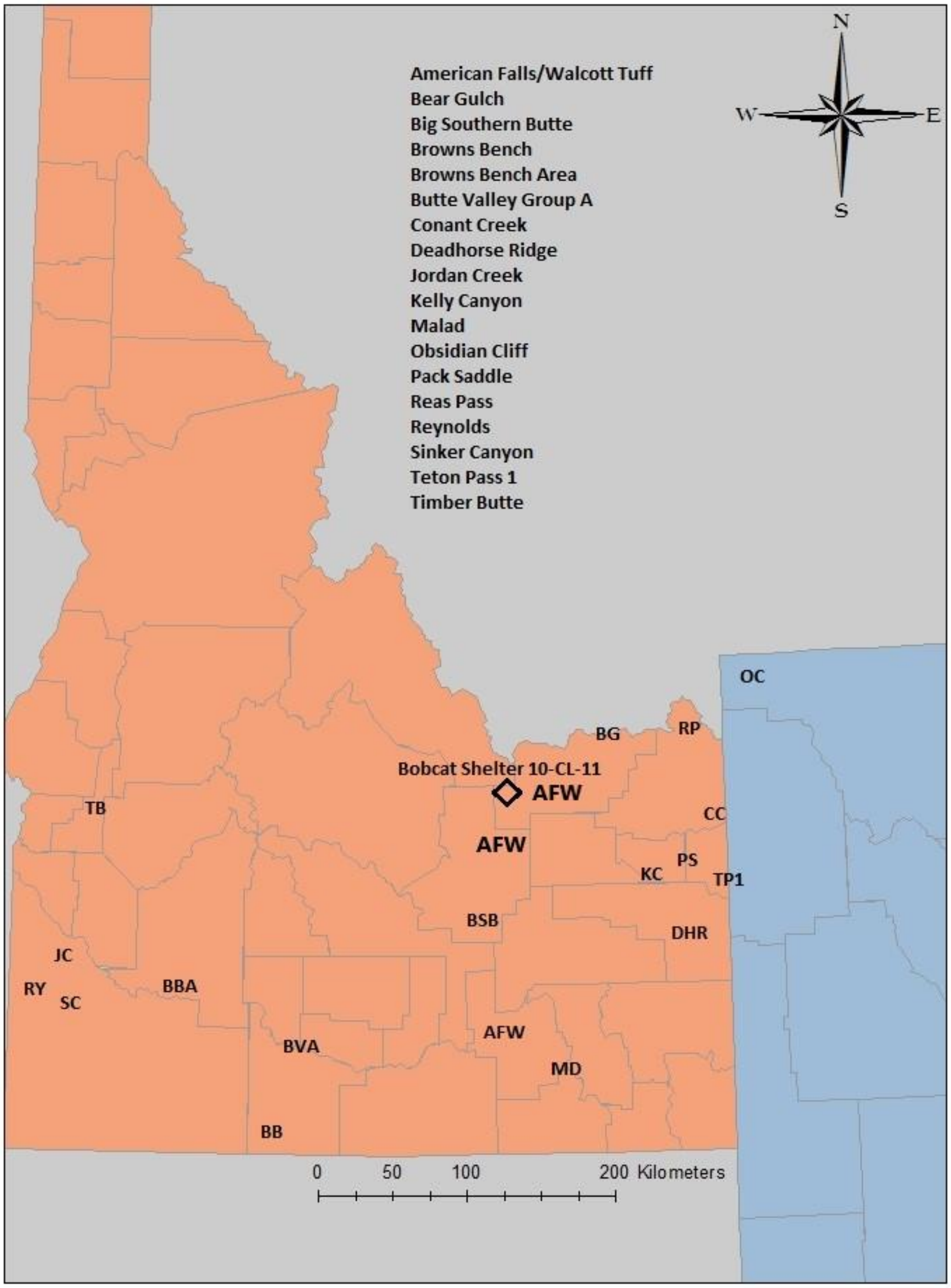

Figure 4.4 Bobcat Shelter site location and locations of sources identified in this study. Shows AFW's most commonly recognized exposure (far south) and multiple AFW exposures much closer to Bobcat. AFW (Walcott) is known to have multiple exposures within 40-50 km of Bobcat Shelter (Arkush 2017; Morgan and McIntosh 2005).

Stratum	# American Falls/Walcott Tuff	# Bear Gulch	# Big Southern Butte	# Browns Bench	# Browns Bench Area	# Butte Valley Group A	# Conant Creek	# Deadhorse Ridge	# Jordan Creek	# Kelly Canyon	# Malad	# Obsidian Cliff	# Pack Saddle	# Reas Pass	# Reynolds	# Sinker Canyon	# Teton Pass 1	# Timber Butte
1	58	2	0	3	2	6	1	0	0	0	0	1	0	1	0	1	0	0
2	24	5	2	4	2	4	0	0	0	0	2	2	0	1	0	0	1	1
3	3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
4	6	2	1	3	0	0	0	1	1	0	0	0	0	1	0	0	0	0
5	8	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
6	30	5	1	4	0	0	0	0	0	0	0	1	0	0	0	0	1	0
7	528	143	40	90	2	22	2	3	2	0	1	37	7	14	0	0	1	0
8	72	6	5	31	2	72	2	1	0	0	1	1	0	2	2	0	0	0
9	57	2	1	19	0	63	0	0	0	1	0	0	0	1	0	0	0	0
10	6	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
11	6	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	4	15	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1
15	0	4	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	20	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	8	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Site totals	830	187	56	154	8	168	5	5	3	1	6	43	7	21	2	1	3	2

Table 4.1 Obsidian source counts by 10-CL-11 strata.

Stratum	% American Falls/Walcott Tuff	% Bear Gulch	% Big Southern Butte	% Browns Bench	% Browns Bench Area	% Butte Valley Group A	% Conant Creek	% Deadhorse Ridge	% Jordan Creek	% Kelly Canyon	% Malad	% Obsidian Cliff	% Pack Saddle	% Reas Pass	% Reynolds	% Sinker Canyon	% Teton Pass 1	% Timber Butte
1	77.3	2.7	0.0	4.0	2.7	8.0	1.3	0.0	0.0	0.0	0.0	1.3	0.0	1.3	0.0	1.3	0.0	0.0
2	50.0	10.4	4.2	8.3	4.2	8.3	0.0	0.0	0.0	0.0	4.2	4.2	0.0	2.1	0.0	0.0	2.1	2.1
3	75.0	0.0	0.0	0.0	0.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	40.0	13.3	6.7	20.0	0.0	0.0	0.0	6.7	6.7	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0	0.0
5	80.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0	0.0	10.0	0.0	0.0	0.0	0.0
6	71.4	11.9	2.4	9.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0	2.4	0.0
7	59.2	16.0	4.5	10.1	0.2	2.5	0.2	0.3	0.2	0.0	0.1	4.1	0.8	1.6	0.0	0.0	0.1	0.0
8	36.5	3.0	2.5	15.7	1.0	36.5	1.0	0.5	0.0	0.0	0.5	0.5	0.0	1.0	1.0	0.0	0.0	0.0
9	39.6	1.4	0.7	13.2	0.0	43.8	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0
10	66.7	11.1	11.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.1	0.0	0.0	0.0	0.0	0.0	0.0
11	85.7	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	17.4	65.2	8.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.3	0.0	0.0	0.0	0.0	0.0	0.0	4.3
15	0.0	80.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	90.9	4.5	4.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	88.9	11.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 4.2 Obsidian source percentages by 10-CL-11 strata.

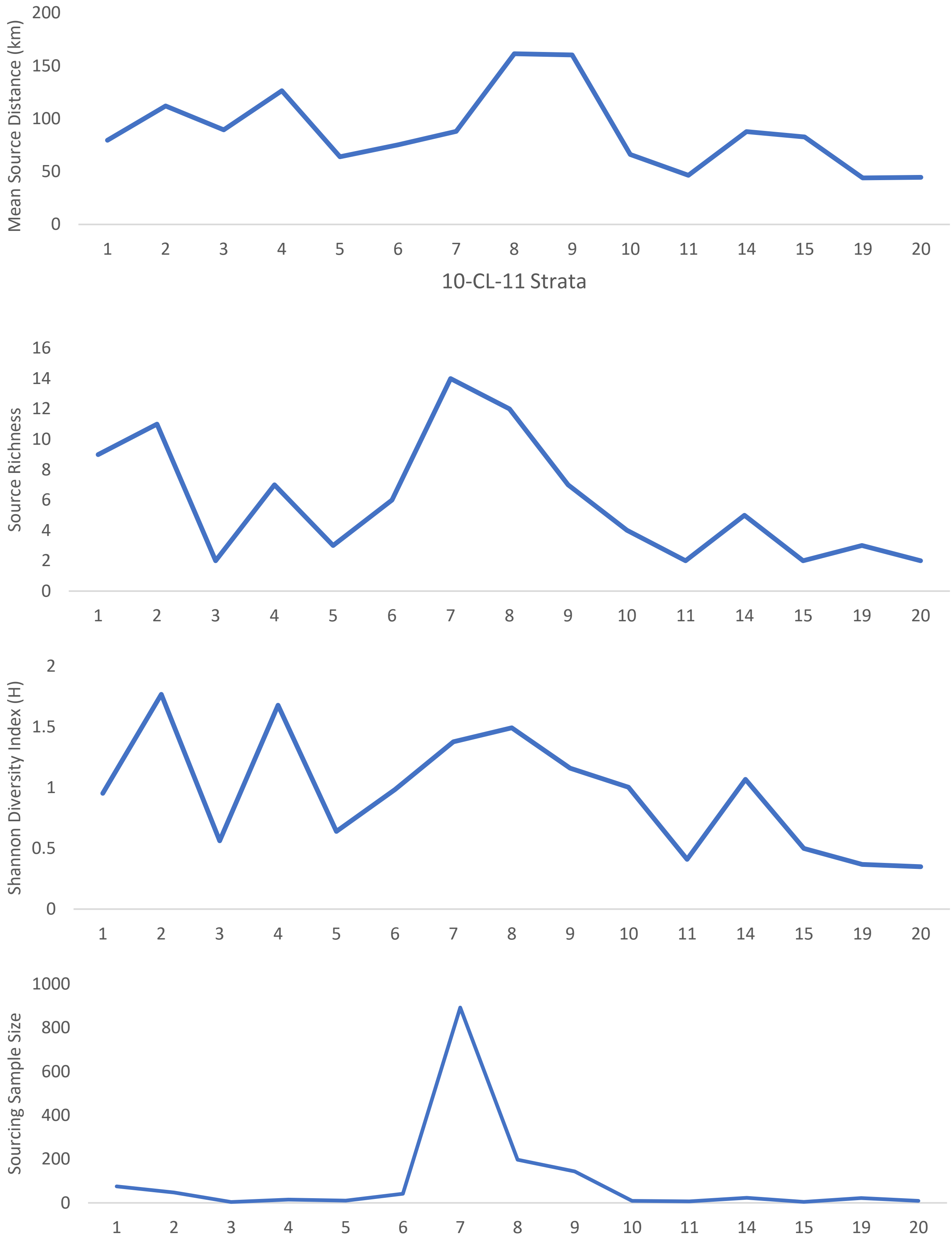

Figure 4.5 Mean source distance, richness, Shannon diversity index and sourcing sample size across Bobcat Shelter strata.

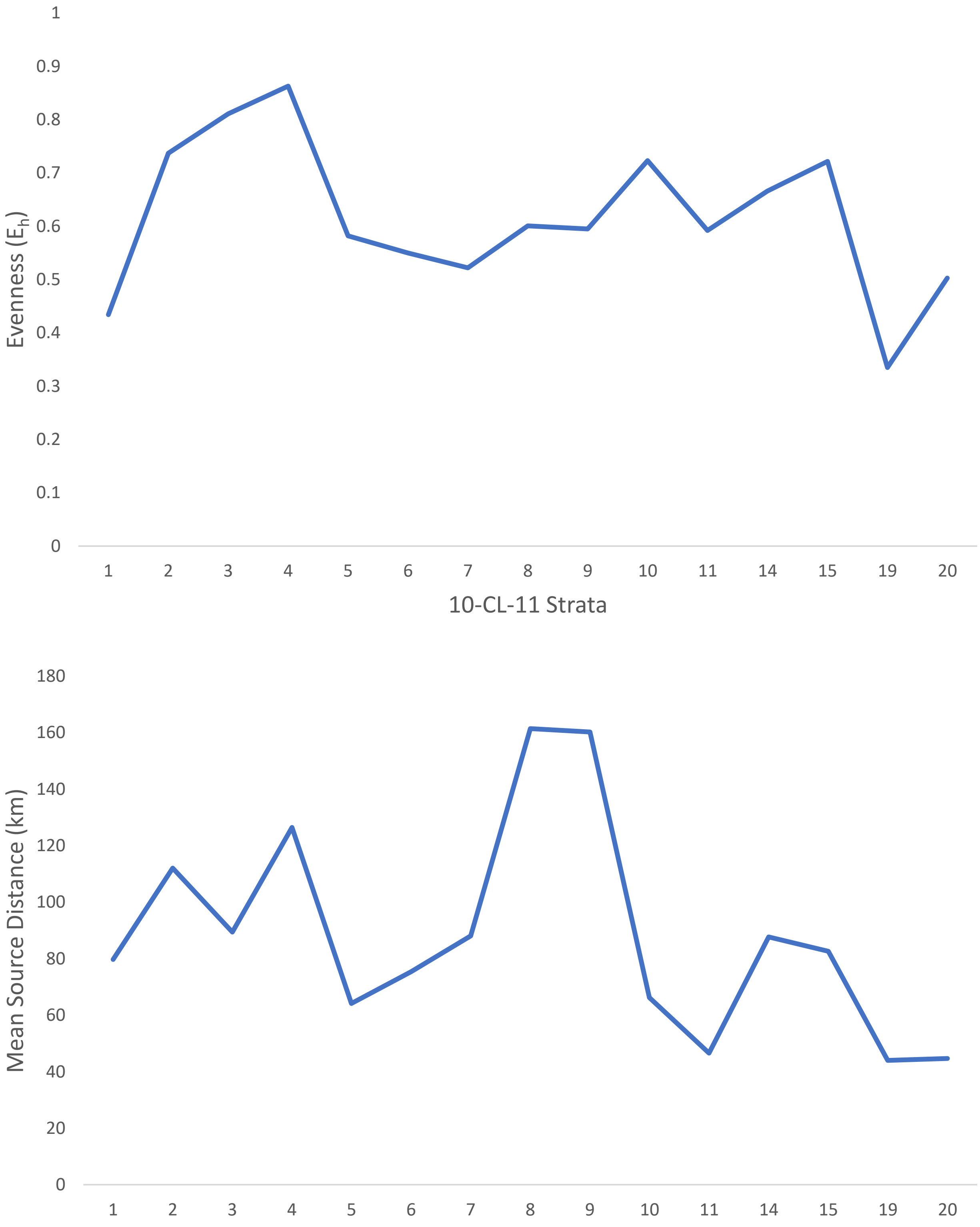

Figure 4.6 Evenness and mean source distance across Bobcat Shelter strata.

Table 4.3 Bobcat Shelter strata ages, mean source distances, and diversity measures.

Stratum/Grouping	Mean Source Distance (km)	Richness	Diversity	Evenness	Sourcing Sample Size	C14 Age	2 Sigma Calendar Ages
1	79.694	9	0.953	0.434	75	-	-
2	112.06	11	1.768	0.737	48	-	-
3	89.425	2	0.562	0.811	4	-	-
4	126.44	7	1.679	0.863	15	-	-
5	64.109	3	0.639	0.582	10	-	-
6	75.406	6	0.985	0.55	42	-	-
7	88.078	14	1.378	0.522	892	1170 ± 30 BP	AD 780-900 and AD 920-970
8	161.41	12	1.493	0.601	197	1810 ± 30 BP (8/9 transition)	AD 130-260 and AD 300-320 (8/9 transition)
9	160.177	7	1.159	0.595	144	1810 ± 30 BP (8/9 transition)	AD 130-260 and AD 300-320 (8/9 transition)
10	66.228	4	1.003	0.723	9	-	-
11	46.563	2	0.41	0.592	7	-	-
14	87.678	5	1.068	0.666	23	4290 ± 30 BP	2920-2882 BC
15	82.636	2	0.5	0.722	5	-	-
19	43.989	3	0.368	0.335	22	6840 ± 40 BP	5780-5660 BC
20	44.646	2	0.349	0.503	9	-	-
5, 10, 11, 19, 20 (Low Distance)	51.45	6	0.667	0.373	57	-	-
3, 4, 6, 14, 15 (Moderate Distance)	88.215	12	1.476	0.594	89	-	-

Table 4.3 Bobcat Shelter strata ages, mean source distances, and diversity measures (Cont.).

Stratum/Grouping	Mean Source Distance (km)	Richness	Diversity	Evenness	Sourcing Sample Size	C14 Age	2 Sigma Calendar Ages
8, 9 (High Distance)	160.889	13	1.376	0.536	341	-	-
3, 4, 5, 6, 7 (Late Prehistoric)	87.879	14	1.407	0.533	963	-	-
8, 9, 10, 11, 14, 15, 19, 20 (Archaic)	143.232	14	1.568	0.594	416	-	-

Table 4.4 Measured source distances and flake count for sources represented at Bobcat Shelter.

Source	Distance from 10-CL-11 (km)	Number of Flakes	% of Total Obsidian Sample
American Falls/Walcott Tuff	40	1022	57.4
Bear Gulch	81.81	212	11.9
Big Southern Butte	85.94	61	3.4
Browns Bench	279.62	158	8.9
Browns Bench Area	224.06	12	0.7
Butte Valley Group A	237.7	189	10.6
Conant Creek	146.42	5	0.3
Deadhorse Ridge	153.52	5	0.3
Jordan Creek	283.97	3	0.2
Kelly Canyon	117.4	1	0.1
Malad	190.4	6	0.3
Obsidian Cliff	188.3	48	2.7
Pack Saddle	141.7	7	0.4
Reas Pass	130.69	35	2.0
Reynolds	340	2	0.1
Sinker Canyon	314.85	1	0.1
Teton Pass 1	165.28	6	0.3
Timber Butte	267.17	2	0.1

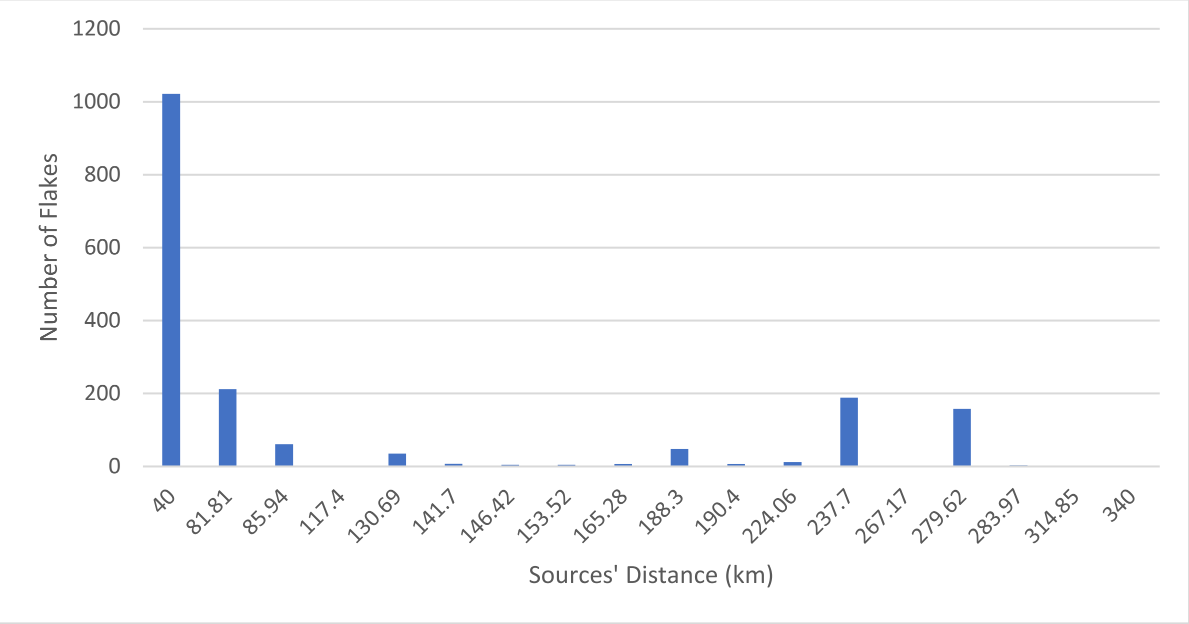

Figure 4.7 Number of Flakes vs. Source Distance (km) from 10-CL-11.

Table 4.5 Medians and Mann Whitney Wilcoxon p-values- Stratum 7 and Grouping 8/9.

Curation Intensity Indicator	**Median-Stratum 7 (All Materials)**	**Median-Strata 8&9 (All Materials)**	**p-value (Mann Whitney Wilcoxon) (All Materials)**	**Median-Stratum 7 (Obsidian)**	**Median-Strata 8&9 (Obsidian)**	**p-value (Mann Whitney Wilcoxon) (Obsidian)**	**Median-Stratum 7 (MCS)**	**Median-Strata 8&9 (MCS)**	**p-value (Mann Whitney Wilcoxon) (MCS)**
Weight	0.039	0.042	0.1169	0.036	0.037	0.6897	0.047	0.048	0.1021
Maximum Flake Width	6.21	6.945	0.003369	5.855	6.27	0.4346	6.67	7.345	0.01715
Incomplete Flake Width	6.19	6.29	0.6289	6	5.965	0.2572	6.72	6.67	0.3069
Platform Width	2.99	2.85	0.7077	2.99	2.69	0.04277	2.995	3.01	0.3495
Incomplete Platform Width	2.48	2.18	0.02468	2.405	1.88	0.04395	2.99	2.42	0.1879
Platform Thickness	0.9	0.88	0.8351	0.91	0.81	0.2988	0.865	0.92	0.394
Incomplete Platform Thickness	0.92	0.83	0.008985	0.91	0.8	0.008587	0.99	0.885	0.2623
Ventral Curvature	179.808324	179.803034	0.8992	179.833025	179.785769	0.2355	179.772738	179.814571	0.2426

Table 4.6 Cortical flakes vs non-cortical flakes ratios and Mann Whitney Wilcoxon p-values- Stratum 7 and Grouping 8/9.

Curation Intensity Indicator	**Ratio- Stratum 7 (All Materials)**	**Ratio- Strata 8&9 (All Materials)**	**p-value (Mann Whitney Wilcoxon) (All Materials)**	**Ratio- Stratum 7 (Obsidian)**	**Ratio- Strata 8&9 (Obsidian)**	**p-value (Mann Whitney Wilcoxon) (Obsidian)**	**Ratio- Stratum 7 (MCS)**	**Ratio- Strata 8&9 (MCS)**	**p-value (Mann Whitney Wilcoxon) (MCS)**
Dorsal Cortex Percentage	0.01504891	0.04094488	0.0004636	0.01801802	0.01775148	1	0.00907029	0.06734007	2.49E-05

Table 4.7 Average dorsal scar count and Mann Whitney Wilcoxon p-values- Stratum 7 and Grouping 8/9.

Curation Intensity Indicator	**Avg- Stratum 7 (All Materials)**	**Avg- Strata 8&9 (All Materials)**	**p-value (Mann Whitney Wilcoxon) (All Materials)**	**Avg- Stratum 7 (Obsidian)**	**Avg- Strata 8&9 (Obsidian)**	**p-value (Mann Whitney Wilcoxon) (Obsidian)**	**Avg- Stratum 7 (MCS)**	**Avg- Strata 8&9 (MCS)**	**p-value (Mann Whitney Wilcoxon) (MCS)**
Dorsal Scar Count	2.32765011	2.32677761	0.5624	2.38163717	2.44186047	0.08642	2.21896163	2.20189274	0.9755

Table 4.8 Debitage frequencies by stratum and flake attributes- Stratum 7 and Strata 8/9.

Curation Intensity Indicator	**Stratum 7 Sample Size (All Materials)**	**Strata 8/9 Sample Size (All Materials)**	**Stratum 7 Sample Size (Obsidian)**	**Strata 8/9 Sample Size (Obsidian)**	**Stratum 7 Sample Size (MCS)**	**Strata 8/9 Sample Size (MCS)**
Dorsal Cortex Percentage	1,349	661	904	344	443	317
Dorsal Scar Count	1,349	661	904	344	443	317
Weight	1,349	661	904	344	443	317
Maximum Flake Width	221	82	132	28	87	54
Incomplete Flake Width	1,009	493	703	280	305	213
Platform Width	560	229	361	96	198	133
Incomplete Platform Width	219	117	146	73	73	44
Platform Thickness	560	229	361	96	198	133
Incomplete Platform Thickness	218	116	146	72	72	44
Ventral Curvature	220	79	133	25	87	54

Table 4.9 Medians and Mann Whitney Wilcoxon p-values- Low and Medium.

Curation Intensity Indicator	Median-Low (All Materials)	Median-Medium (All Materials)	p-value (Mann Whitney Wilcoxon) (All Materials)	Median-Low (Obsidian)	Median-Medium (Obsidian)	p-value (Mann Whitney Wilcoxon) (Obsidian)	Median-Low (MCS)	Median-Medium (MCS)	p-value (Mann Whitney Wilcoxon) (MCS)
Weight	0.094	0.0445	8.08E-05	0.0475	0.0395	0.2156	0.162	0.102	0.6625
Maximum Flake Width	8.67	6.25	0.04191	7.88	5.075	0.04747	9.01	12.23	0.1624
Incomplete Flake Width	7.95	6.5	0.002471	6.63	6.4	0.639	9.9	7.4	0.1854
Platform Width	3.1	3.045	0.8194	2.1	2.98	0.08988	3.71	4.06	0.2457
Incomplete Platform Width	2.235	1.82	0.2554	1.89	1.77	0.8094	2.635	3.02	1
Platform Thickness	0.92	0.84	0.2555	0.76	0.77	0.5637	1.14	1.35	0.1358
Incomplete Platform Thickness	0.86	0.85	0.7973	0.75	0.84	0.4693	0.985	1.25	0.7341
Ventral Curvature	179.815461	179.764301	0.05524	179.860137	179.792745	0.3571	179.815461	179.691007	0.08111

Table 4.10 Cortical flakes vs non-cortical flakes ratios and Mann Whitney Wilcoxon p-values- Low and Medium.

Curation Intensity Indicator	**Ratio- Low (All Materials)**	**Ratio- Medium (All Materials)**	**p-value (Mann Whitney Wilcoxon) (All Materials)**	**Ratio- Low (Obsidian)**	**Ratio- Medium (Obsidian)**	**p-value (Mann Whitney Wilcoxon) (Obsidian)**	**Ratio- Low (MCS)**	**Ratio- Medium (MCS)**	**p-value (Mann Whitney Wilcoxon) (MCS)**
Dorsal Cortex Percentage	0.05625	0.03389831	0.3975	0.01754386	0.04347826	0.4228	0.0776699	0	0.1621

Table 4.11 Average dorsal scar count and Mann Whitney Wilcoxon p-values- Low and Medium.

Curation Intensity Indicator	**Avg- Low (All Materials)**	**Avg- Medium (All Materials)**	**p-value (Mann Whitney Wilcoxon) (All Materials)**	**Avg- Low (Obsidian)**	**Avg- Medium (Obsidian)**	**p-value (Mann Whitney Wilcoxon) (Obsidian)**	**Avg- Low (MCS)**	**Avg- Medium (MCS)**	**p-value (Mann Whitney Wilcoxon) (MCS)**
Dorsal Scar Count	2.4260355	2.31967213	0.225	2.5	2.27083333	0.06078	2.38738739	2.5	0.4277

Table 4.12 Medians and Mann Whitney Wilcoxon p-values- Medium and High.

Curation Intensity Indicator	**Median-Medium (All Materials)**	**Median-High (All Materials)**	**p-value (Mann Whitney Wilcoxon) (All Materials)**	**Median-Medium (Obsidian)**	**Median-High (Obsidian)**	**p-value (Mann Whitney Wilcoxon) (Obsidian)**	**Median-Medium (MCS)**	**Median-High (MCS)**	**p-value (Mann Whitney Wilcoxon) (MCS)**
Weight	0.0445	0.042	0.4742	0.0395	0.037	0.3719	0.102	0.048	0.03686
Maximum Flake Width	6.25	6.945	0.154	5.075	6.27	0.04812	12.23	7.345	0.171
Incomplete Flake Width	6.5	6.29	0.1376	6.4	5.965	0.03888	7.4	6.67	0.3083
Platform Width	3.045	2.85	0.4157	2.98	2.69	0.3444	4.06	3.01	0.07799
Incomplete Platform Width	1.82	2.18	0.4998	1.77	1.88	0.6118	3.02	2.42	0.6634
Platform Thickness	0.84	0.88	0.6648	0.77	0.81	0.3608	1.35	0.92	0.04024
Incomplete Platform Thickness	0.85	0.83	0.5583	0.84	0.8	0.5554	1.25	0.885	0.267
Ventral Curvature	179.764301	179.803034	0.0957	179.792745	179.785769	0.5806	179.691007	179.814571	0.1508

Table 4.13 Cortical flakes vs non-cortical flakes ratios and Mann Whitney Wilcoxon p-values- Medium and High.

Curation Intensity Indicator	Ratio- Medium (All Materials)	Ratio- High (All Materials)	p-value (Mann Whitney Wilcoxon) (All Materials)	Ratio- Medium (Obsidian)	Ratio- High (Obsidian)	p-value (Mann Whitney Wilcoxon) (Obsidian)	Ratio- Medium (MCS)	Ratio- High (MCS)	p-value (Mann Whitney Wilcoxon) (MCS)
Dorsal Cortex Percentage	0.03389831	0.04094488	0.7025	0.04347826	0.01775148	0.1686	0	0.06734007	0.1886

Table 4.14 Average dorsal scar count and Mann Whitney Wilcoxon p-values- Medium and High.

Curation Intensity Indicator	**Avg- Medium (All Materials)**	**Avg- High (All Materials)**	**p-value (Mann Whitney Wilcoxon) (All Materials)**	**Avg- Medium (Obsidian)**	**Avg- High (Obsidian)**	**p-value (Mann Whitney Wilcoxon) (Obsidian)**	**Avg- Medium (MCS)**	**Avg- High (MCS)**	**p-value (Mann Whitney Wilcoxon) (MCS)**
Dorsal Scar Count	2.31967213	2.32677761	0.7398	2.27083333	2.44186047	0.03195	2.5	2.20189274	0.07949

Table 4.15 Medians and Mann Whitney Wilcoxon p-values- Low and High.

Curation Intensity Indicator	**Median-Low (All Materials)**	**Median-High (All Materials)**	**p-value (Mann Whitney Wilcoxon) (All Materials)**	**Median-Low (Obsidian)**	**Median-High (Obsidian)**	**p-value (Mann Whitney Wilcoxon) (Obsidian)**	**Median-Low (MCS)**	**Median-High (MCS)**	**p-value (Mann Whitney Wilcoxon) (MCS)**
Weight	0.094	0.042	8.04E-11	0.0475	0.037	0.01889	0.162	0.048	2.28E-07
Maximum Flake Width	8.67	6.945	0.2871	7.88	6.27	0.2558	9.01	7.345	0.942
Incomplete Flake Width	7.95	6.29	1.50E-09	6.63	5.965	0.007708	9.9	6.67	3.29E-06
Platform Width	3.1	2.85	0.3616	2.1	2.69	0.1473	3.71	3.01	0.2061
Incomplete Platform Width	2.235	2.18	0.469	1.89	1.88	0.866	2.635	2.42	0.3229
Platform Thickness	0.92	0.88	0.2482	0.76	0.81	0.2288	1.14	0.92	0.1878
Incomplete Platform Thickness	0.86	0.83	0.6987	0.75	0.8	0.7187	0.985	0.885	0.4845
Ventral Curvature	179.815461	179.803034	0.4483	179.860137	179.785769	0.5212	179.815461	179.814571	0.6514

Table 4.16 Cortical flakes vs non-cortical flakes ratios and Mann Whitney Wilcoxon p-values- Low and High.

Curation Intensity Indicator	**Ratio- Low (All Materials)**	**Ratio- High (All Materials)**	**p-value (Mann Whitney Wilcoxon) (All Materials)**	**Ratio- Low (Obsidian)**	**Ratio- High (Obsidian)**	**p-value (Mann Whitney Wilcoxon) (Obsidian)**	**Ratio- Low (MCS)**	**Ratio- High (MCS)**	**p-value (Mann Whitney Wilcoxon) (MCS)**
Dorsal Cortex Percentage	0.05625	0.04094488	0.4541	0.01754386	0.01775148	0.9978	0.0776699	0.06734007	0.8069

Table 4.17 Average dorsal scar count and Mann Whitney Wilcoxon p-values- Low and High.

Curation Intensity Indicator	**Avg- Low (All Materials)**	**Avg- High (All Materials)**	**p-value (Mann Whitney Wilcoxon) (All Materials)**	**Avg- Low (Obsidian)**	**Avg- High (Obsidian)**	**p-value (Mann Whitney Wilcoxon) (Obsidian)**	**Avg- Low (MCS)**	**Avg- High (MCS)**	**p-value (Mann Whitney Wilcoxon) (MCS)**
Dorsal Scar Count	2.4260355	2.32677761	0.2143	2.5	2.44186047	0.6689	2.38738739	2.20189274	0.06318

Table 4.18 Debitage frequencies by stratum and flake attributes- Low, Medium, and High.

Curation Intensity Indicator	Low-Sample Size (All Materials)	Medium-Sample Size (All Materials)	High-Sample Size (All Materials)	Low-Sample Size (Obsidian)	Medium-Sample Size (Obsidian)	High-Sample Size (Obsidian)	Low-Sample Size (MCS)	Medium-Sample Size (MCS)	High-Sample Size (MCS)
Dorsal Cortex Percentage	169	122	661	58	26	344	111	26	317
Dorsal Scar Count	169	122	661	58	26	344	111	26	317
Weight	169	122	661	58	26	344	111	26	317
Maximum Flake Width	19	23	82	3	7	28	15	7	54
Incomplete Flake Width	137	93	493	53	17	280	47	17	213
Platform Width	69	56	229	15	13	96	53	13	133
Incomplete Platform Width	24	19	117	13	3	73	12	3	44
Platform Thickness	69	56	229	15	5	96	53	13	133
Incomplete Platform Thickness	24	19	116	13	3	72	12	3	44
Ventral Curvature	17	22	79	4	7	25	13	7	54

Table 4.19 Medians and Mann Whitney Wilcoxon p-values- Late Prehistoric and Archaic.

Curation Intensity Indicator	Median- Late Prehistoric (All Materials)	Median- Archaic (All Materials)	p-value (Mann Whitney Wilcoxon) (All	Median- Late Prehistoric (Obsidian)	Median- Archaic (Obsidian)	p-value (Mann Whitney Wilcoxon) (Obsidian)	Median- Late Prehistoric (MCS)	Median- Archaic (MCS)	p-value (Mann Whitney Wilcoxon) (MCS)
Weight	0.038	0.048	1.10E-06	0.036	0.04	0.3469	0.047	0.068	3.89E-05
Maximum Flake Width	6.21	7.135	5.31E-05	5.73	6.34	0.2026	6.8	8.44	0.003292
Incomplete Flake Width	6.26	6.505	0.0001473	6	6.15	0.4678	6.74	7.14	0.001484
Platform Width	2.99	2.895	0.7529	2.98	2.67	0.03094	3.015	3.165	0.1273
Incomplete Platform Width	2.425	2.2	0.04394	2.28	1.87	0.02557	3.005	2.445	0.2664
Platform Thickness	0.9	0.88	0.4041	0.9	0.8	0.09971	0.89	0.95	0.1057
Incomplete Platform Thickness	0.92	0.83	0.02092	0.89	0.8	0.00806	1.01	0.905	0.3127
Ventral Curvature	179.807052	179.805718	0.8468	179.825388	179.788235	0.2877	179.772738	179.815814	0.1344

Table 4.20 Cortical flakes vs non-cortical flakes ratios and Mann Whitney Wilcoxon p-values- Late Prehistoric and Archaic.

Curation Intensity Indicator	**Ratio- Late Prehistoric (All Materials)**	**Ratio- Archaic (All Materials)**	**p-value (Mann Whitney Wilcoxon) (All Materials)**	**Ratio- Late Prehistoric (Obsidian)**	**Ratio- Archaic (Obsidian)**	**p-value (Mann Whitney Wilcoxon) (Obsidian)**	**Ratio- Late Prehistoric (MCS)**	**Ratio- Archaic (MCS)**	**p-value (Mann Whitney Wilcoxon) (MCS)**
Dorsal Cortex Percentage	0.01679496	0.04305043	0.000282	0.02079002	0.01694915	0.6698	0.00856531	0.07	5.42E-06

Table 4.21 Average dorsal scar count and Mann Whitney Wilcoxon p-values- Late Prehistoric and Archaic.

Curation Intensity Indicator	**Avg- Late Prehistoric (All Materials)**	**Avg- Archaic (All Materials)**	**p-value (Mann Whitney Wilcoxon) (All Materials)**	**Avg- Late Prehistoric (Obsidian)**	**Avg- Archaic (Obsidian)**	**p-value (Mann Whitney Wilcoxon) (Obsidian)**	**Avg- Late Prehistoric (MCS)**	**Avg- Archaic (MCS)**	**p-value (Mann Whitney Wilcoxon) (MCS)**
Dorsal Scar Count	2.32690984	2.34345794	0.2919	2.3706721	2.44761905	0.03122	2.23667377	2.24137931	0.7201

Table 4.22 Debitage frequencies by stratum and flake attributes- Late Prehistoric and Archaic.

Curation Intensity Indicator	Late Prehistoric Sample Size (All Materials)	Archaic Sample Size (All Materials)	Late Prehistoric Sample Size (Obsidian)	Archaic Sample Size (Obsidian)	Late Prehistoric Sample Size (MCS)	Archaic Sample Size (MCS)
Dorsal Cortex Percentage	1453	848	982	420	469	428
Dorsal Scar Count	1453	848	982	420	469	428
Weight	1453	848	982	420	469	428
Maximum Flake Width	241	104	146	33	93	70
Incomplete Flake Width	1085	647	763	351	322	260
Platform Width	603	311	391	123	210	187
Incomplete Platform Width	238	141	163	86	76	56
Platform Thickness	603	311	193	123	210	187
Incomplete Platform Thickness	237	140	163	85	75	56
Ventral Curvature	239	99	146	31	93	68

Table 4.23 Medians and Mann Whitney Wilcoxon p-values- Stratum 9 and 8.

Curation Intensity Indicator	**Median- 9 (All Materials)**	**Median- 8 (All Materials)**	**p-value (Mann Whitney Wilcoxon) (All Materials)**	**Median- 9 (Obsidian)**	**Median- 8 (Obsidian)**	**p-value (Mann Whitney Wilcoxon) (Obsidian)**	**Median- 9 (MCS)**	**Median- 8 (MCS)**	**p-value (Mann Whitney Wilcoxon) (MCS)**
Weight	0.04	0.044	0.2845	0.0375	0.036	0.868	0.042	0.072	0.002486
Maximum Flake Width	7	6.89	0.4783	4.73	6.34	0.1245	7.07	11.52	0.08613
Incomplete Flake Width	6.31	6.2	0.9899	6.075	5.905	0.7994	6.56	7.04	0.197
Platform Width	2.67	3.28	0.01902	2.57	2.85	0.2047	2.79	3.81	0.00261
Incomplete Platform Width	2.18	2.195	0.7477	1.63	2.17	0.1179	2.435	2.29	0.7518
Platform Thickness	0.82	0.905	0.1284	0.84	0.78	0.7969	0.795	1.03	0.0145
Incomplete Platform Thickness	0.83	0.8	0.5162	0.765	0.805	0.3767	0.915	0.76	0.336
Ventral Curvature	179.803186	179.800849	0.6132	179.774272	179.787002	0.7226	179.810849	179.827578	0.6311

Table 4.24 Cortical flakes vs non-cortical flakes ratios and Mann Whitney Wilcoxon p-values- Stratum 9 and 8.

Curation Intensity Indicator	**Ratio- 9 (All Materials)**	**Ratio- 8 (All Materials)**	**p-value (Mann Whitney Wilcoxon) (All Materials)**	**Ratio- 9 (Obsidian)**	**Ratio- 8 (Obsidian)**	**p-value (Mann Whitney Wilcoxon) (Obsidian)**	**Ratio- 9 (MCS)**	**Ratio- 8 (MCS)**	**p-value (Mann Whitney Wilcoxon) (MCS)**
Dorsal Cortex Percentage	0.04310345	0.03832753	0.7631	0.03448276	0.00518135	0.04725	0.04926108	0.10638298	0.09166

Table 4.25 Average dorsal scar count and Mann Whitney Wilcoxon p-values- Stratum 9 and 8.

Curation Intensity Indicator	**Avg- 9 (All Materials)**	**Avg- 8 (All Materials)**	**p-value (Mann Whitney Wilcoxon) (All Materials)**	**Avg- 9 (Obsidian)**	**Avg- 8 (Obsidian)**	**p-value (Mann Whitney Wilcoxon) (Obsidian)**	**Avg- 9 (MCS)**	**Avg- 8 (MCS)**	**p-value (Mann Whitney Wilcoxon) (MCS)**
Dorsal Scar Count	2.33057851	2.32214765	0.8366	2.5	2.39690722	0.1572	2.21126761	2.18269231	0.88

Table 4.26 Debitage frequencies by stratum and flake attributes- Stratum 9 and 8.

Curation Intensity Indicator	Stratum 9 Sample Size (All Materials)	Stratum 8 Sample Size (All Materials)	Stratum 9 Sample Size (Obsidian)	Stratum 8 Sample Size (Obsidian)	Stratum 9 Sample Size (MCS)	Stratum 8 Sample Size (MCS)
Dorsal Cortex Percentage	363	298	150	194	213	104
Dorsal Scar Count	363	298	150	194	213	104
Weight	363	298	150	194	213	104
Maximum Flake Width	35	47	3	25	32	22
Incomplete Flake Width	269	224	128	152	141	72
Platform Width	127	102	39	57	88	45
Incomplete Platform Width	57	60	25	48	32	12
Platform Thickness	127	102	39	57	88	45
Incomplete Platform Thickness	56	60	24	48	32	12
Ventral Curvature	35	44	3	22	32	22

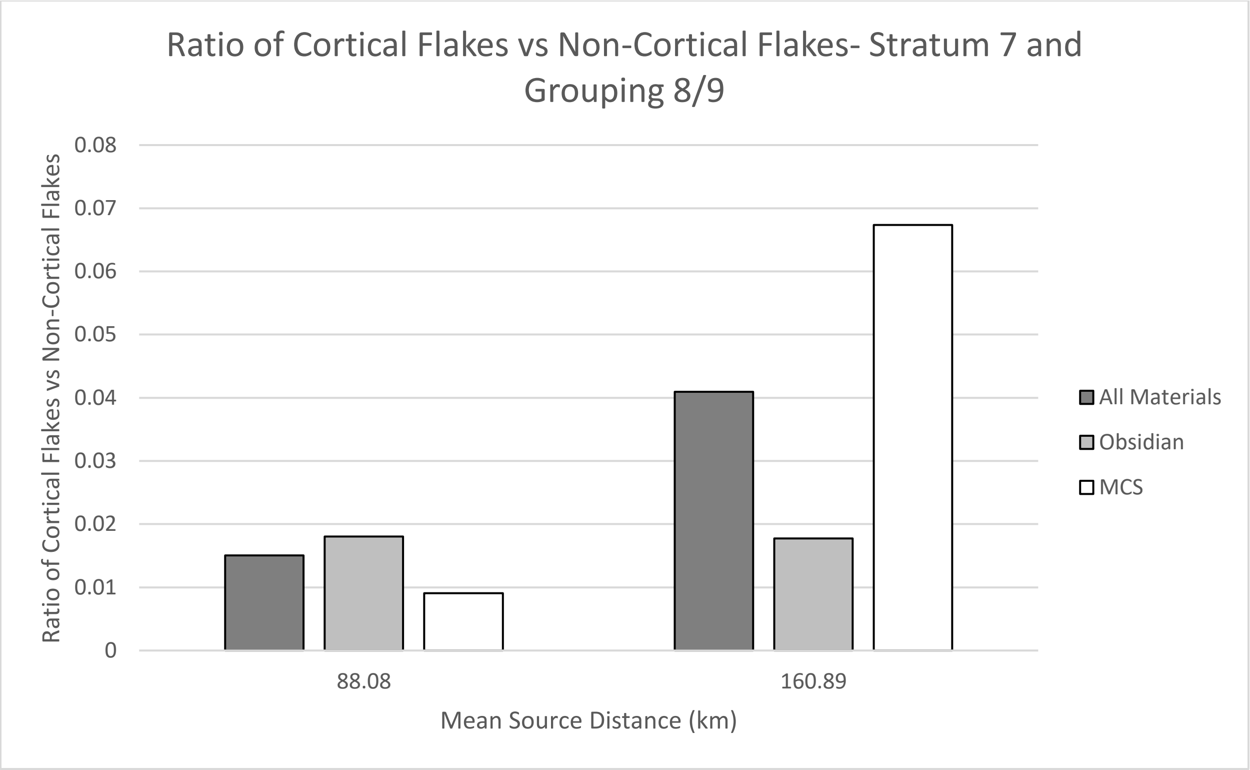

Figure 4.8 Ratio of cortical flakes vs. non-cortical flakes- Stratum 7 (left) and Grouping 8/9 (right).

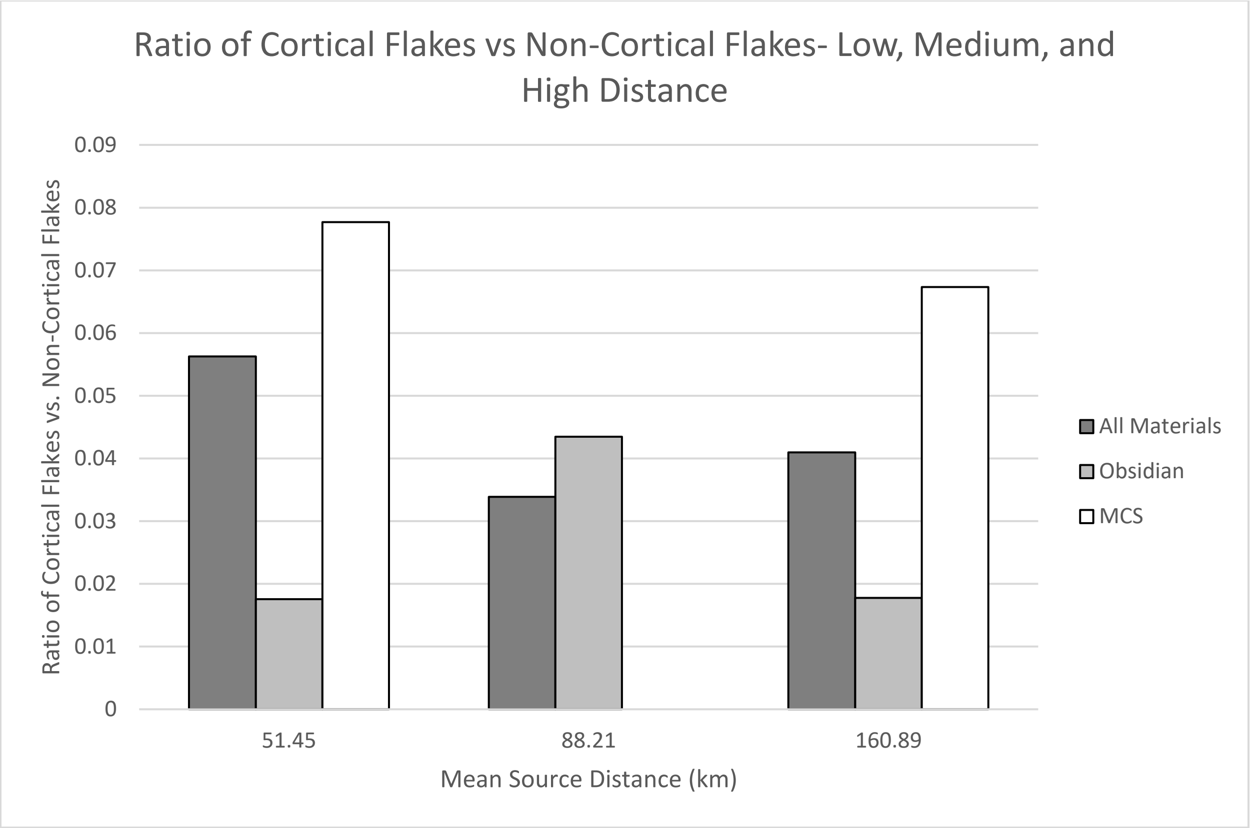

Figure 4.9 Ratio of cortical flakes vs non-cortical flakes- Low, Medium, and High distance.

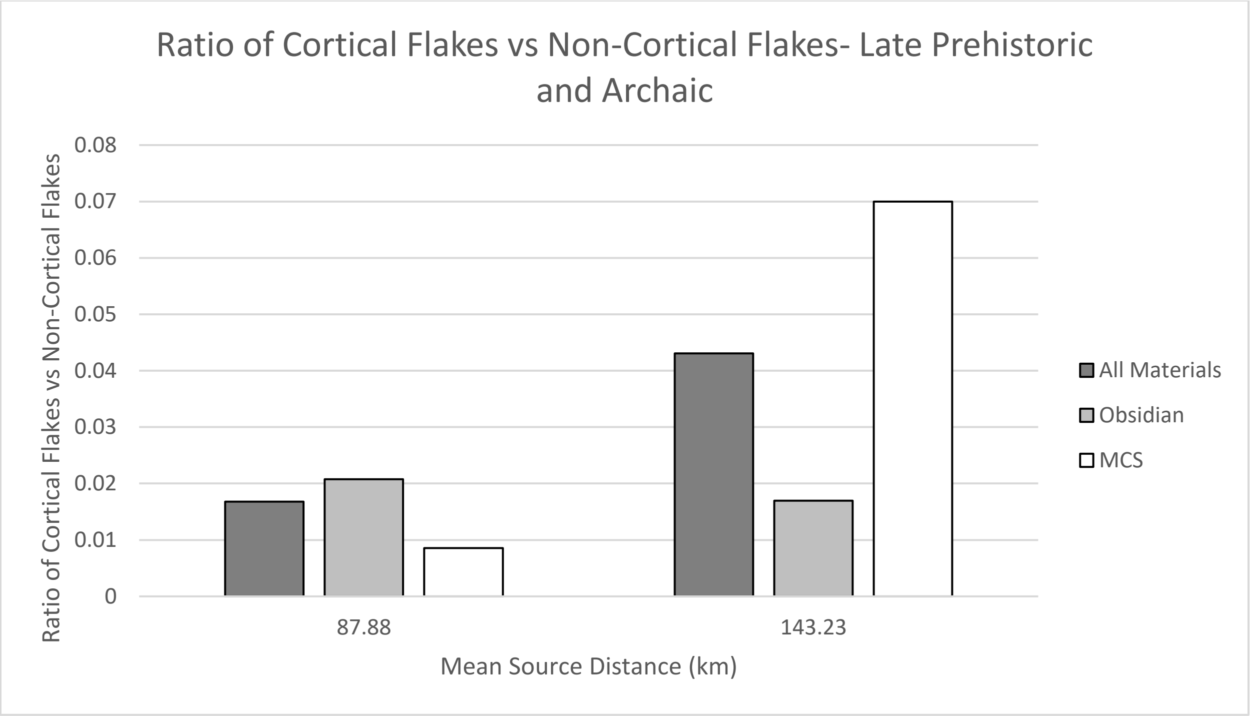

Figure 4.10 Ratio of cortical flakes vs non-cortical flakes- Late Prehistoric (left) and Archaic (right).

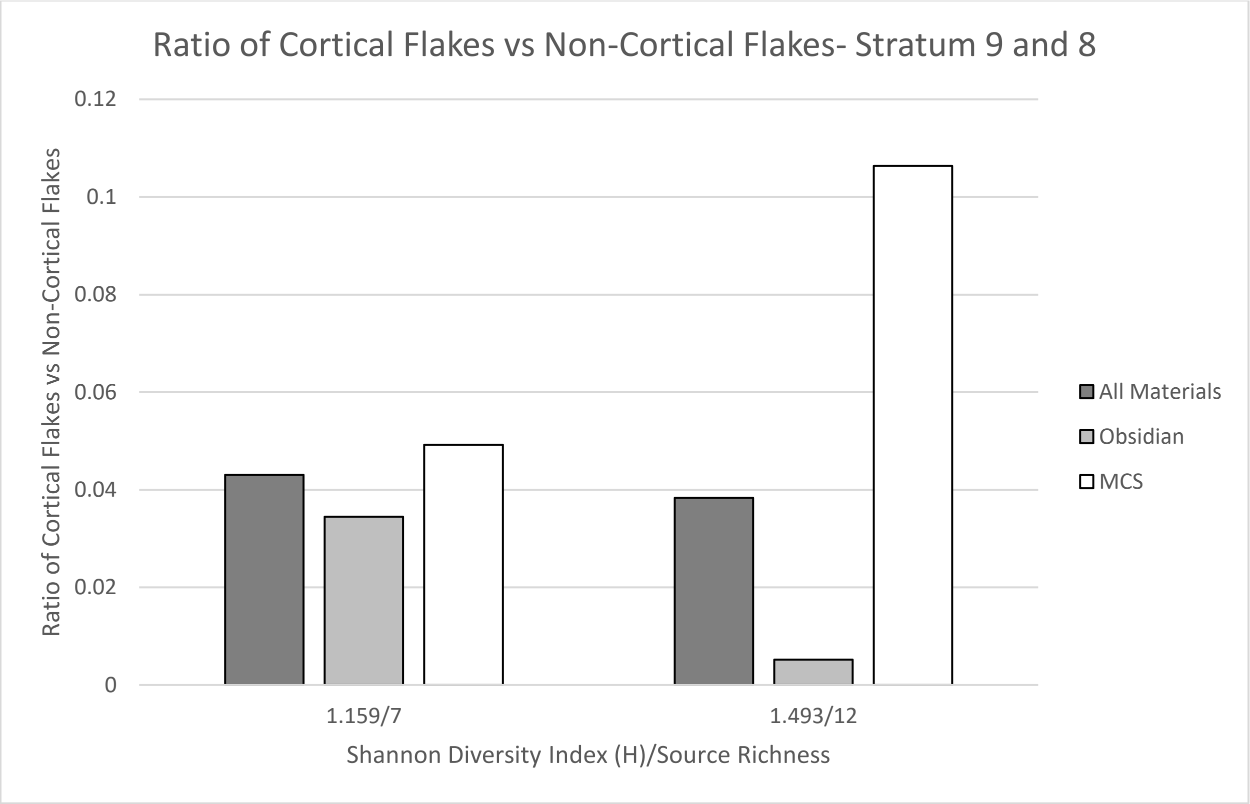

Figure 4.11 Ratio of cortical flakes vs non-cortical flakes- Stratum 9 (left) and 8 (right).

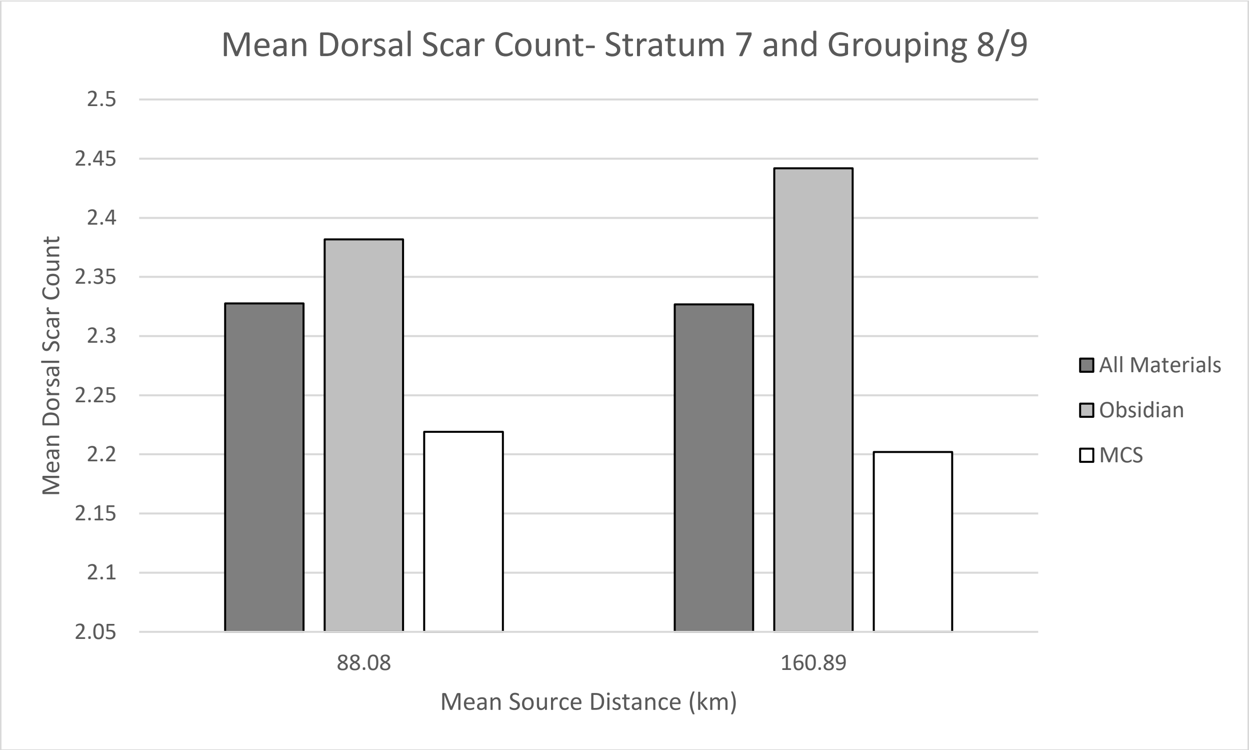

Figure 4.12 Mean dorsal scar count- Stratum 7 (left) and Grouping 8/9 (right).

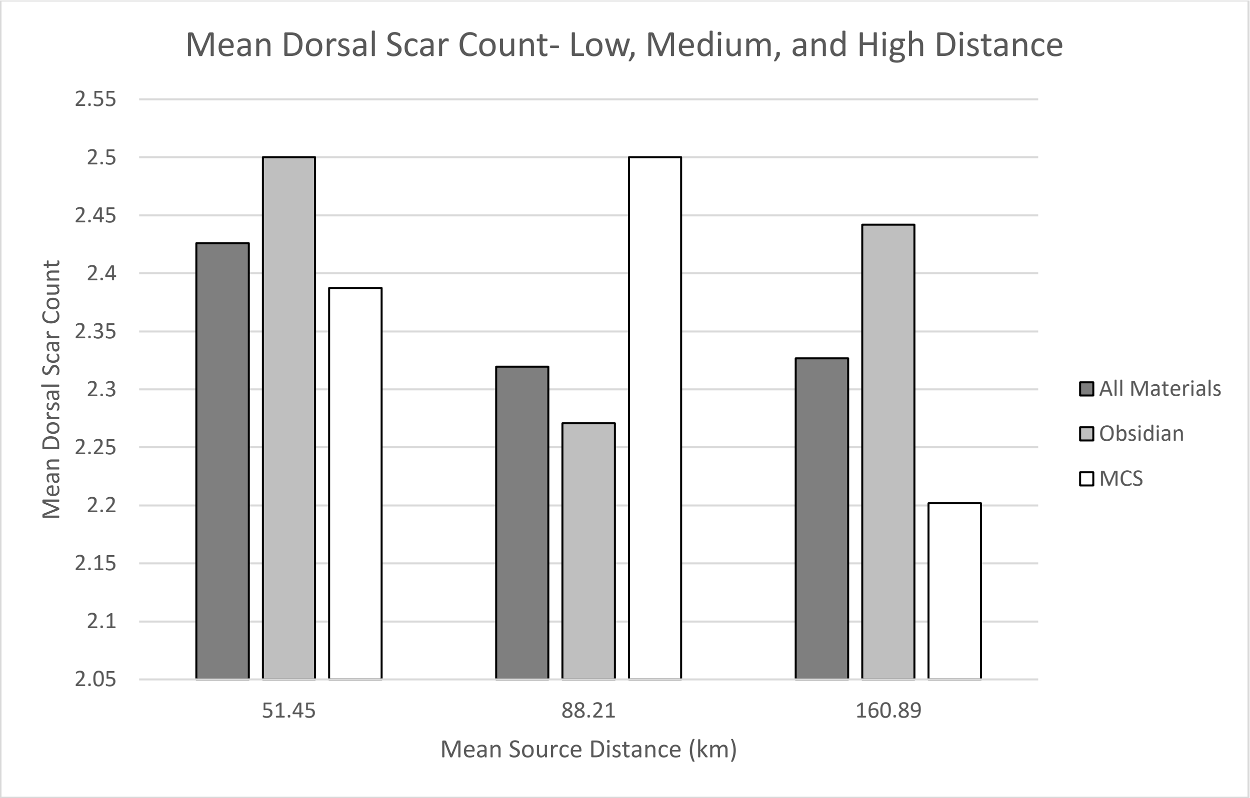

Figure 4.13 Mean dorsal scar count- Low, Medium, and High distance.

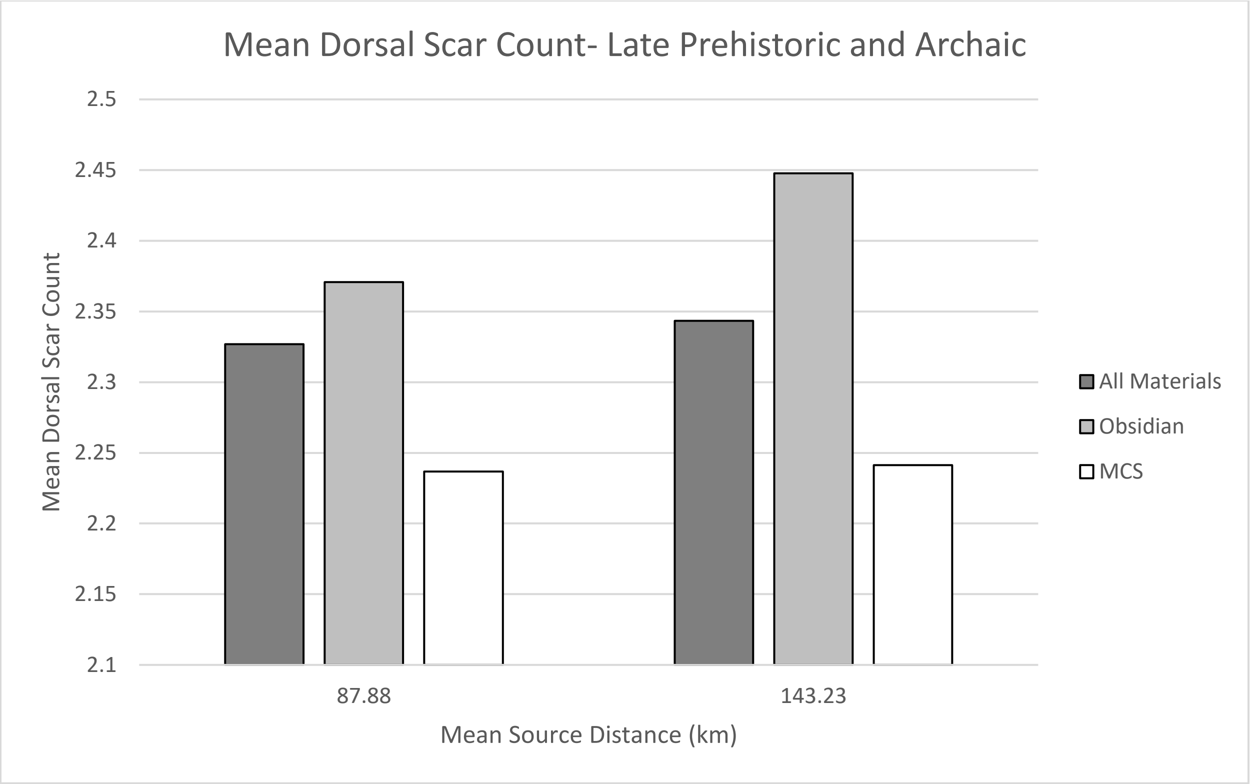

Figure 4.14 Mean dorsal scar count- Late Prehistoric (left) and Archaic (right).

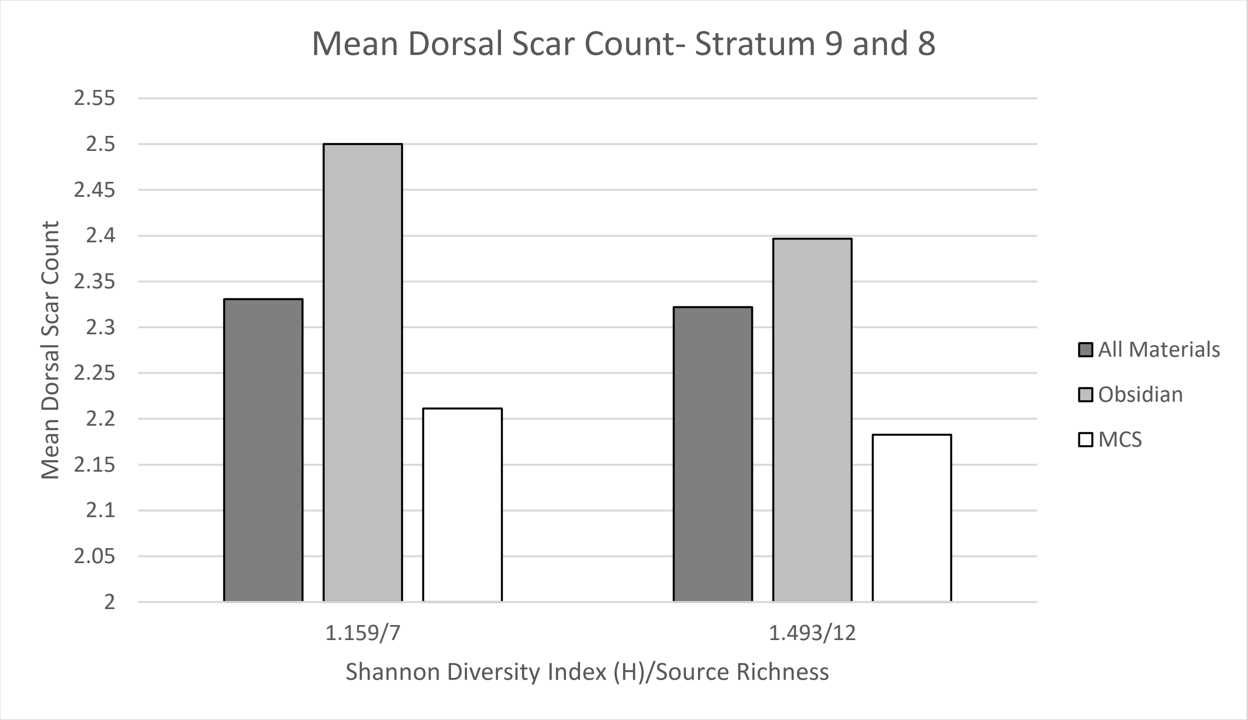

Figure 4.15 Mean dorsal scar count- Stratum 9 (left) and 8 (right).

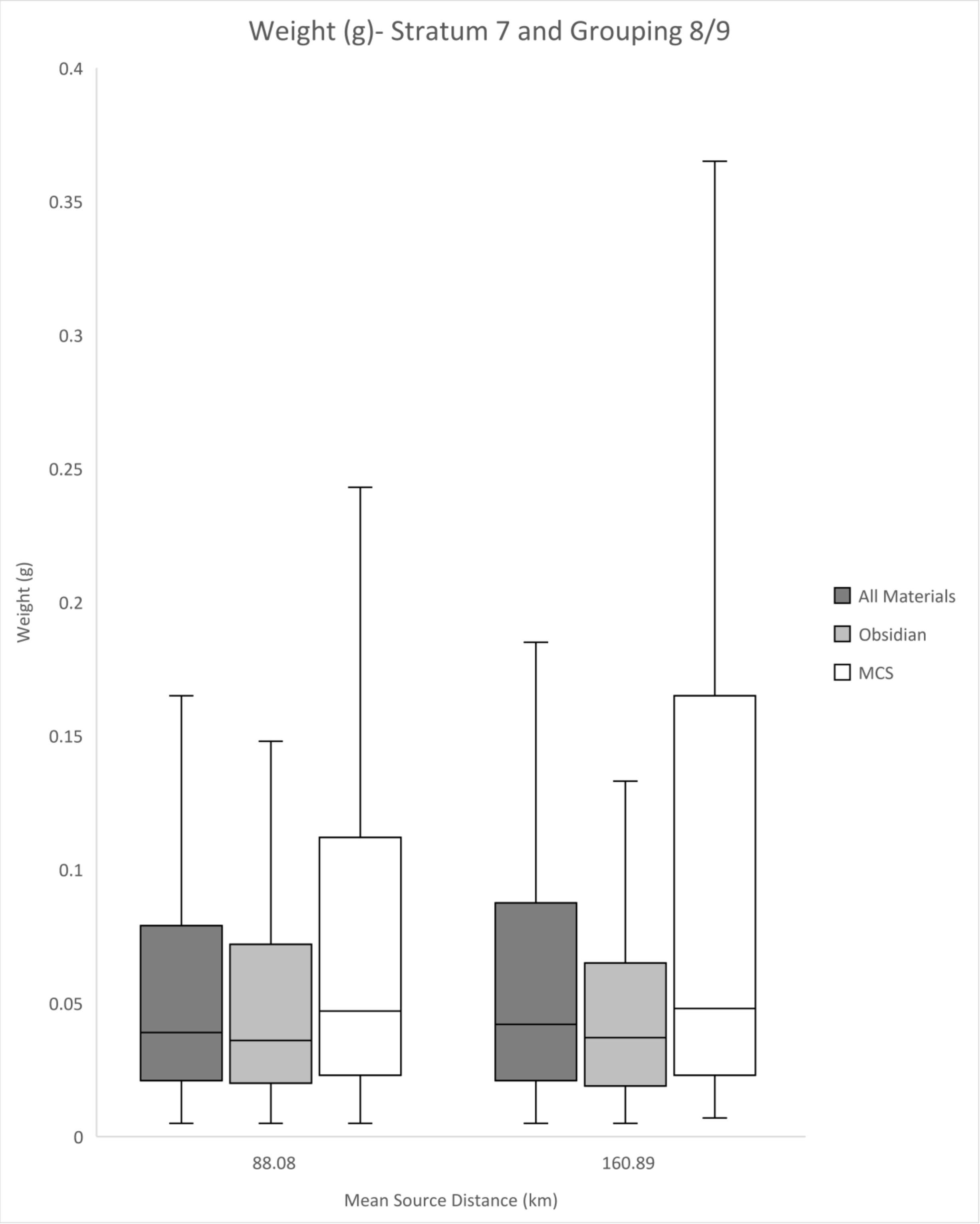

Figure 4.16 Weight (g)- Stratum 7 (left) and Grouping 8/9 (right).

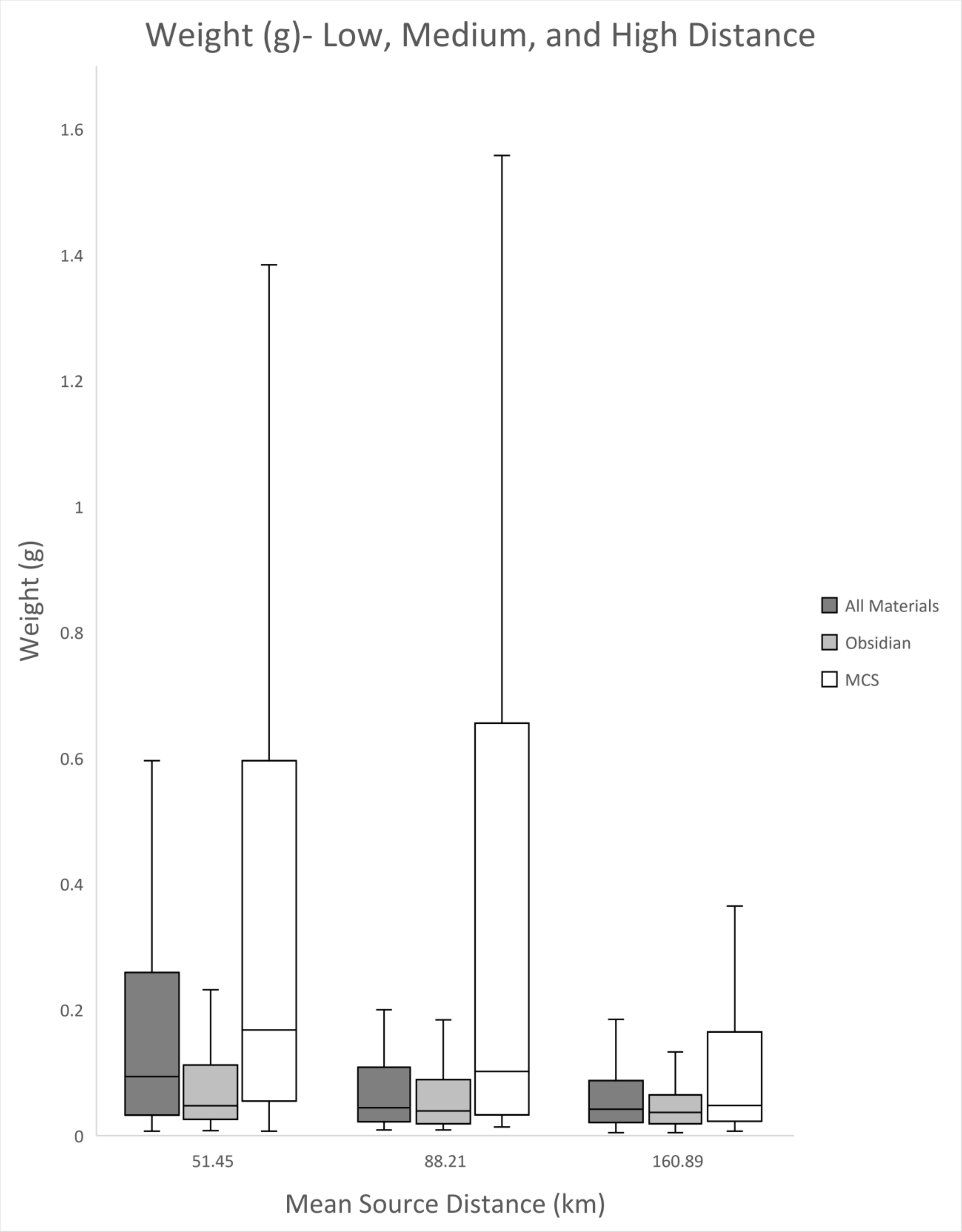

Figure 4.17 Weight (g)- Low, Medium, and High distance.

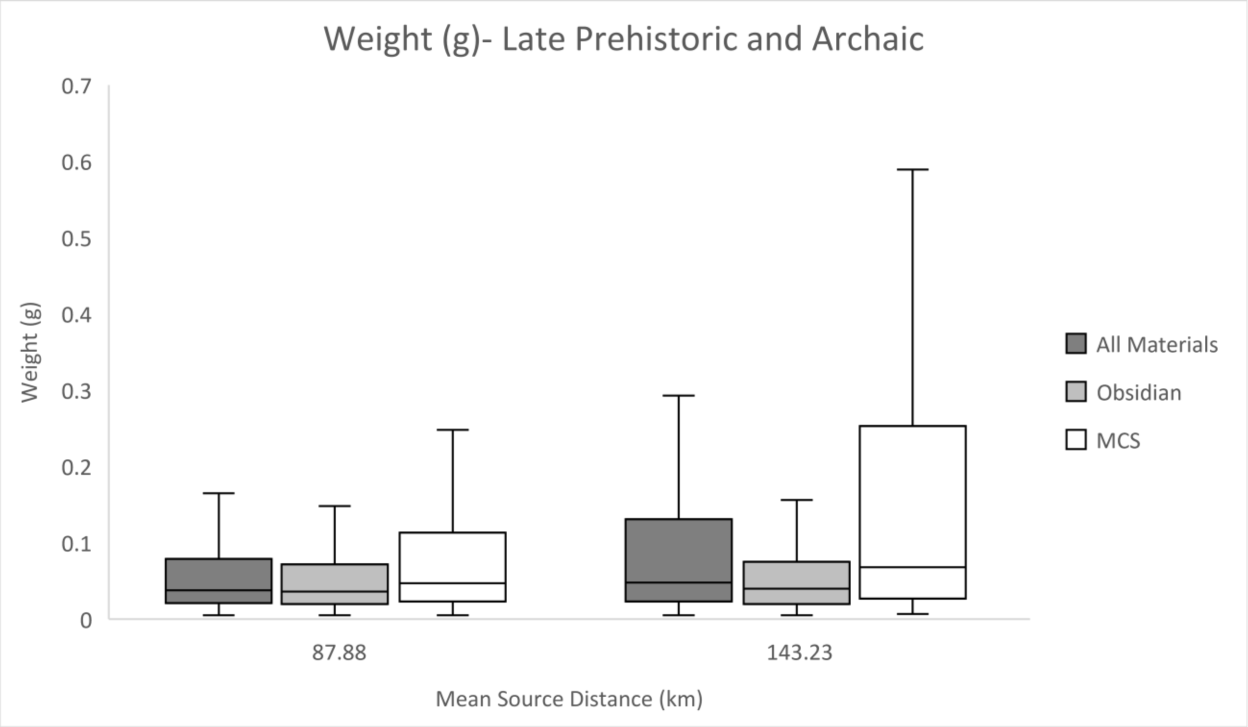

Figure 4.18 Weight (g)- Late Prehistoric (left) and Archaic (right).

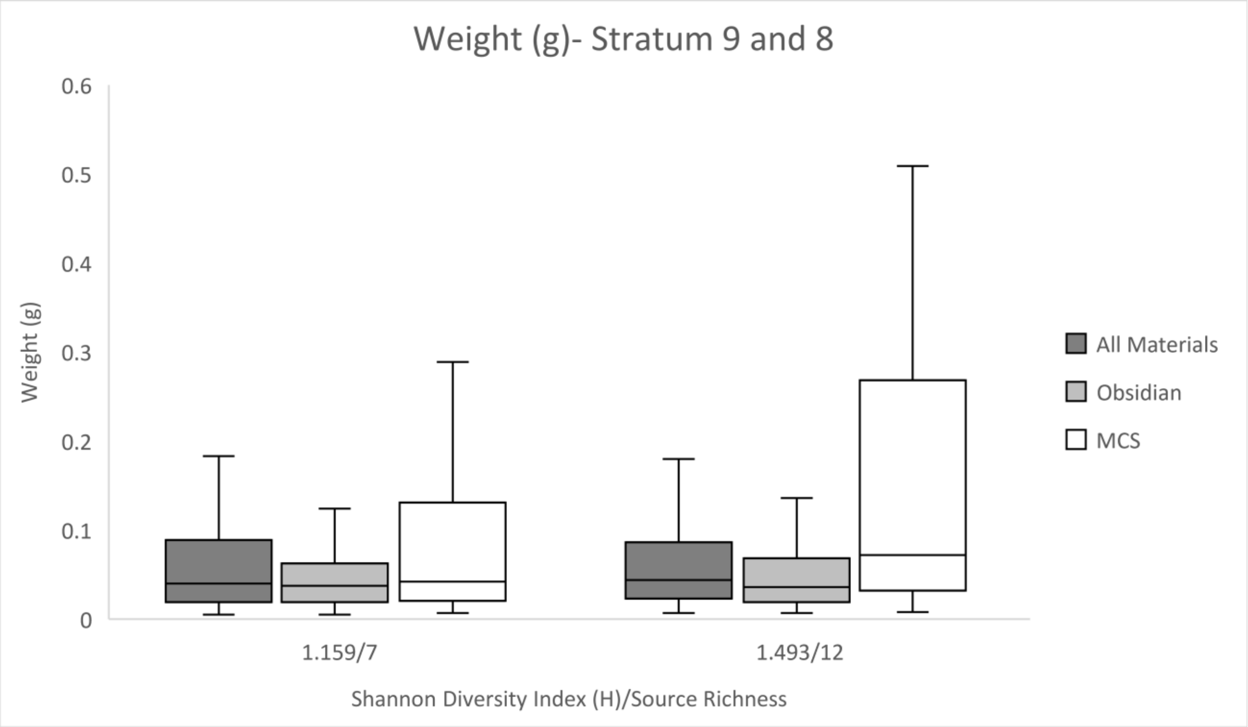

Figure 4.19 Weight (g)- Stratum 9 (left) and 8 (right).

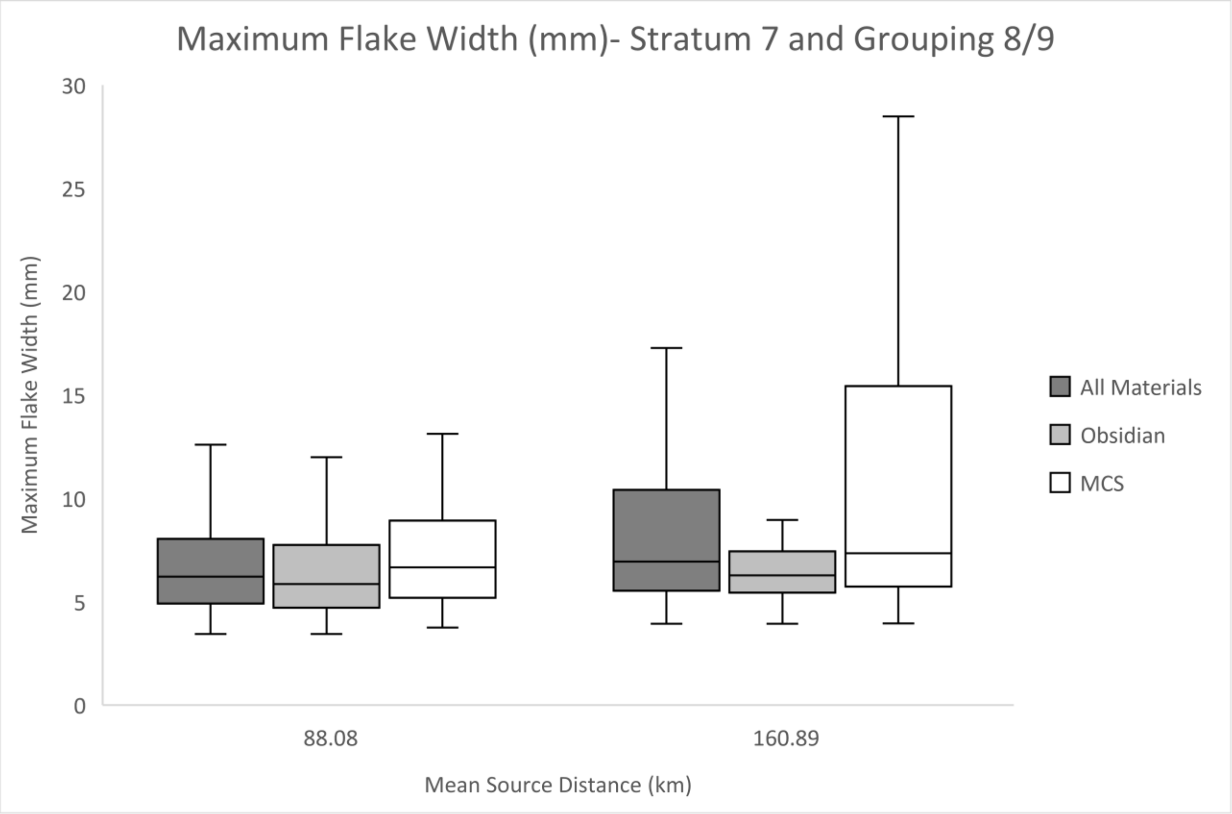

Figure 4.20 Maximum flake width (mm)- Stratum 7 (left) and Grouping 8/9 (right).

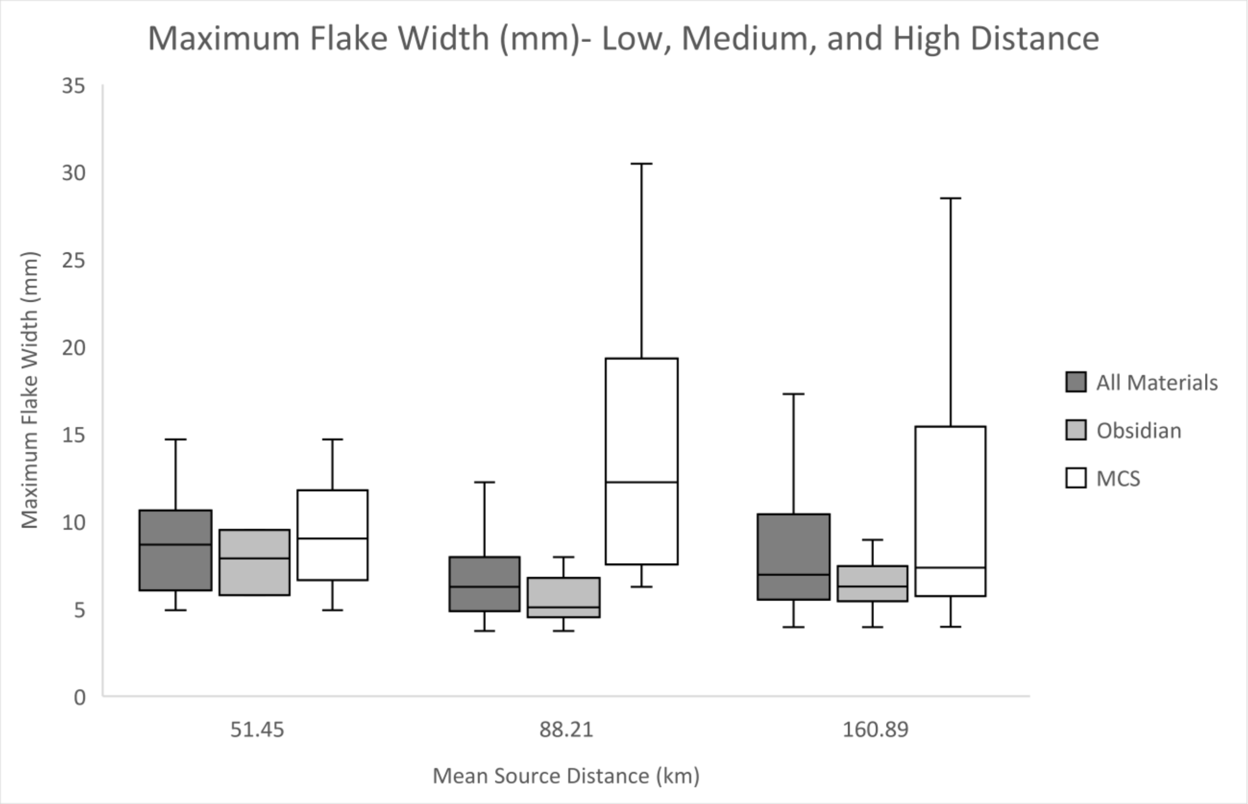

Figure 4.21 Maximum flake width (mm)- Low, Medium, and High distance.

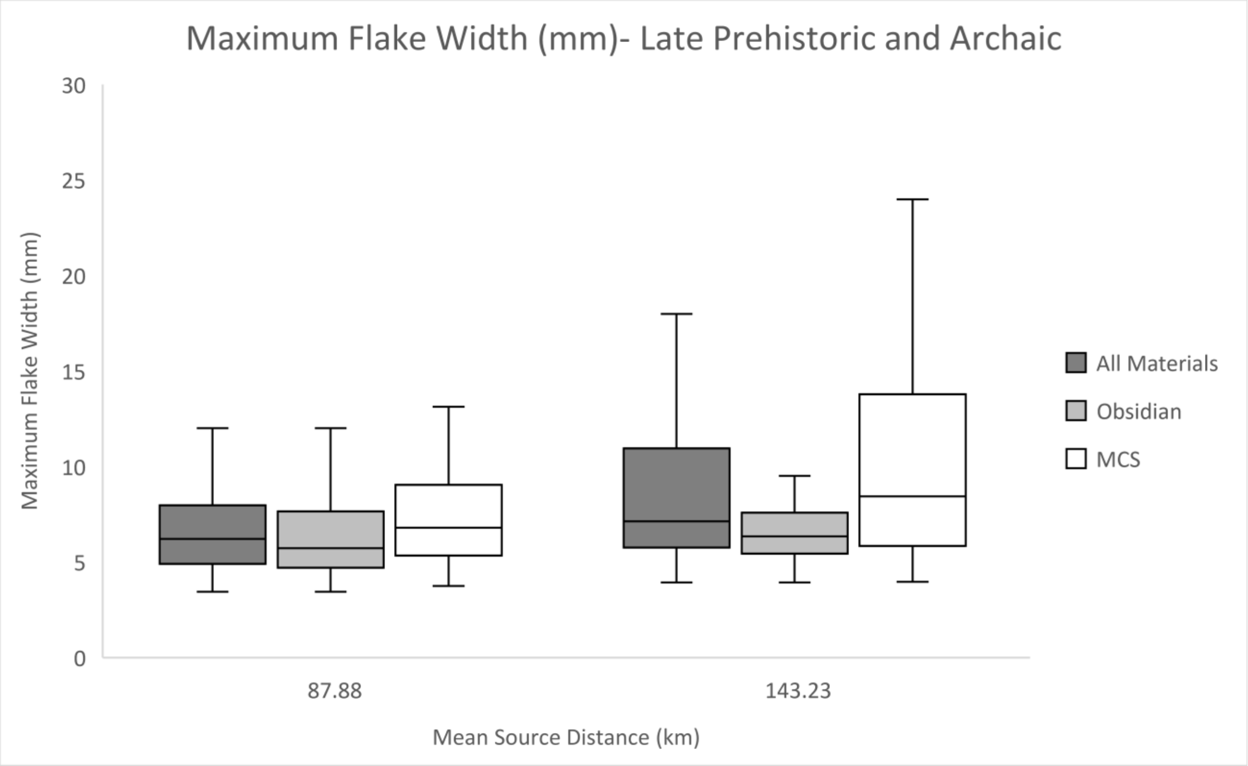

Figure 4.22 Maximum flake width (mm)- Late Prehistoric (left) and Archaic (right).

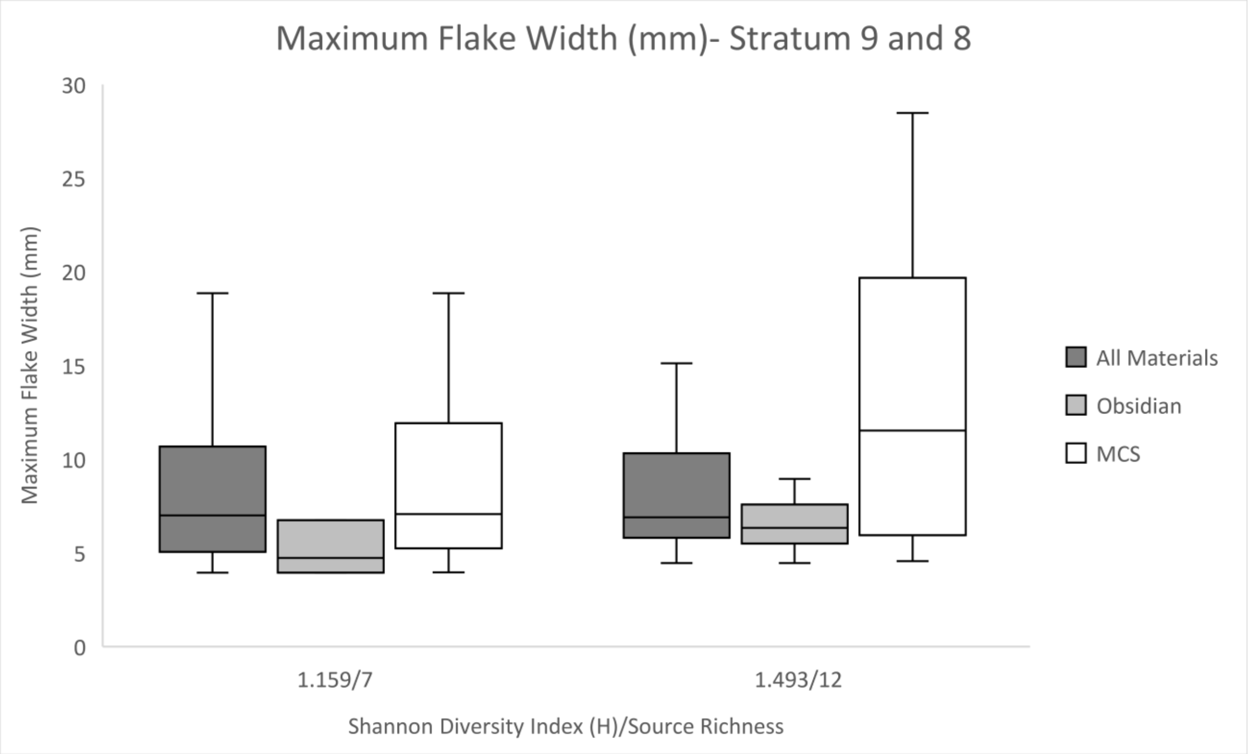

Figure 4.23 Maximum flake width (mm)- Stratum 9 (left) and 8 (right).

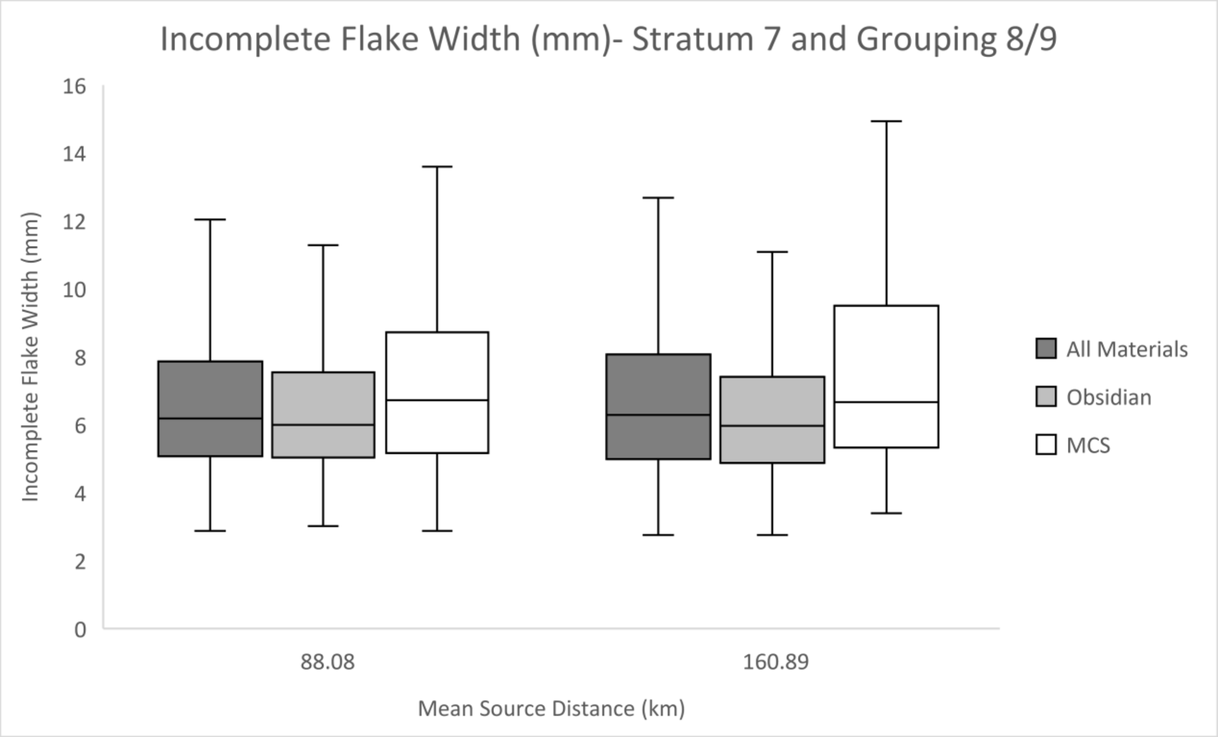

Figure 4.24 Incomplete flake width (mm)- Stratum 7 (left) and Grouping 8/9 (right).

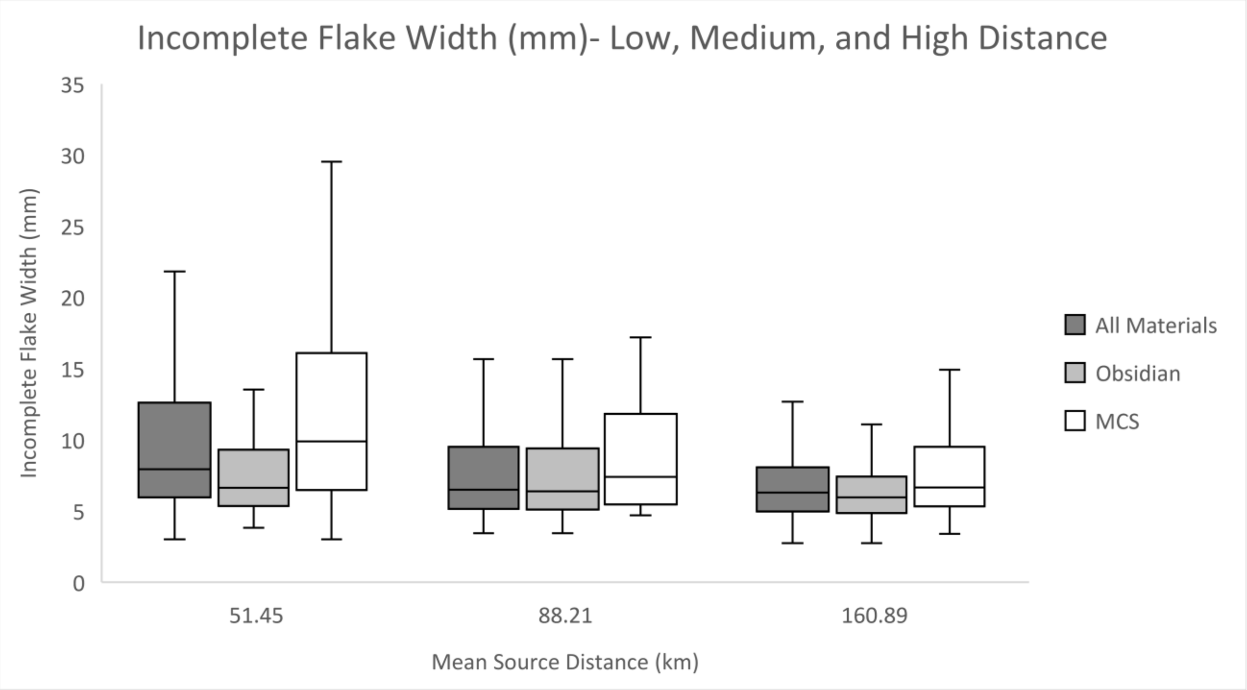

Figure 4.25 Incomplete flake width (mm)- Low, Medium, and High distance.

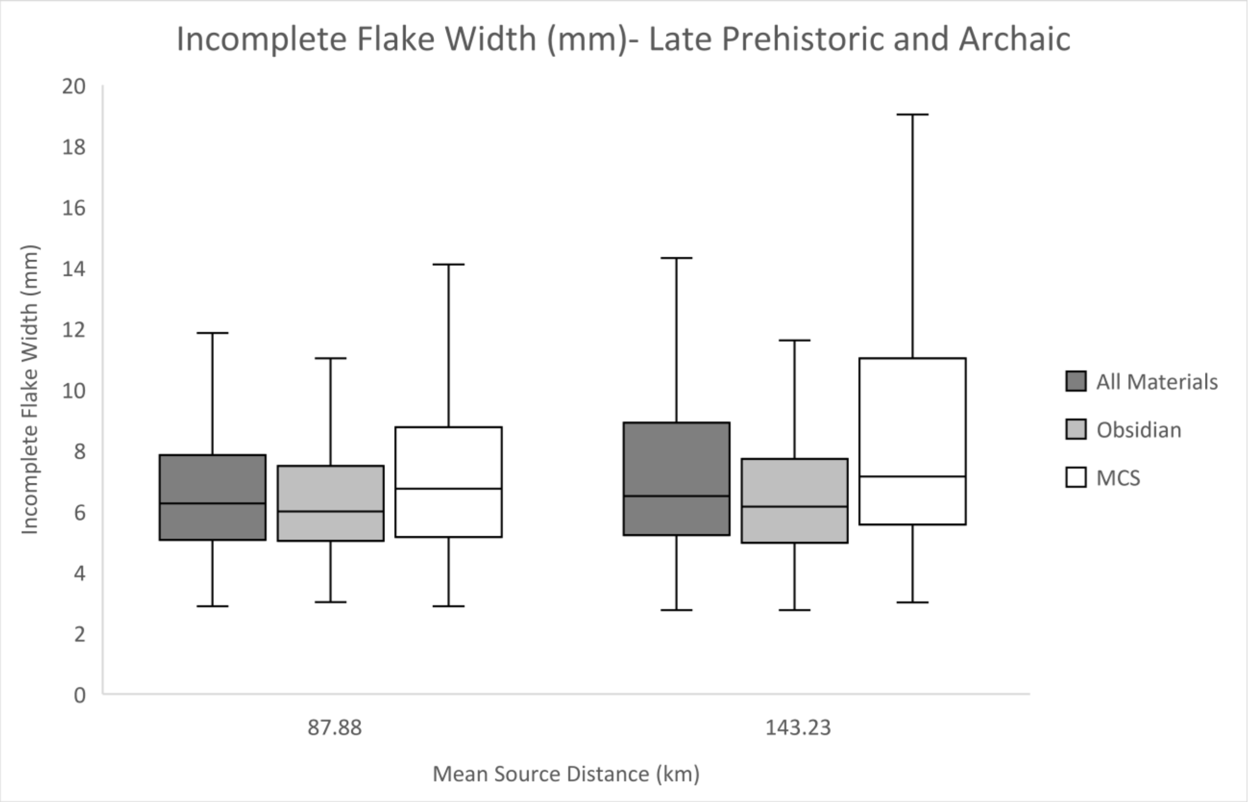

Figure 4.26 Incomplete flake width (mm)- Late Prehistoric (left) and Archaic (right).

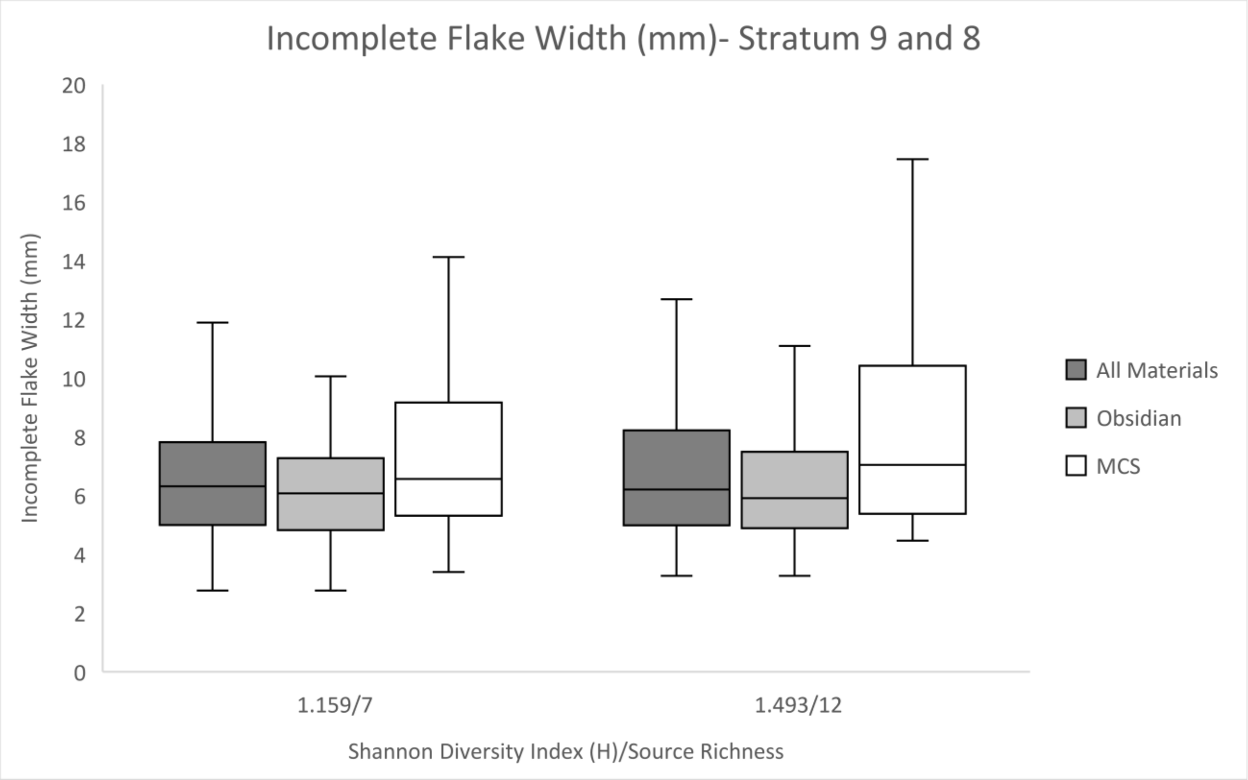

Figure 4.27 Incomplete flake width (mm)- Stratum 9 (left) and 8 (right).

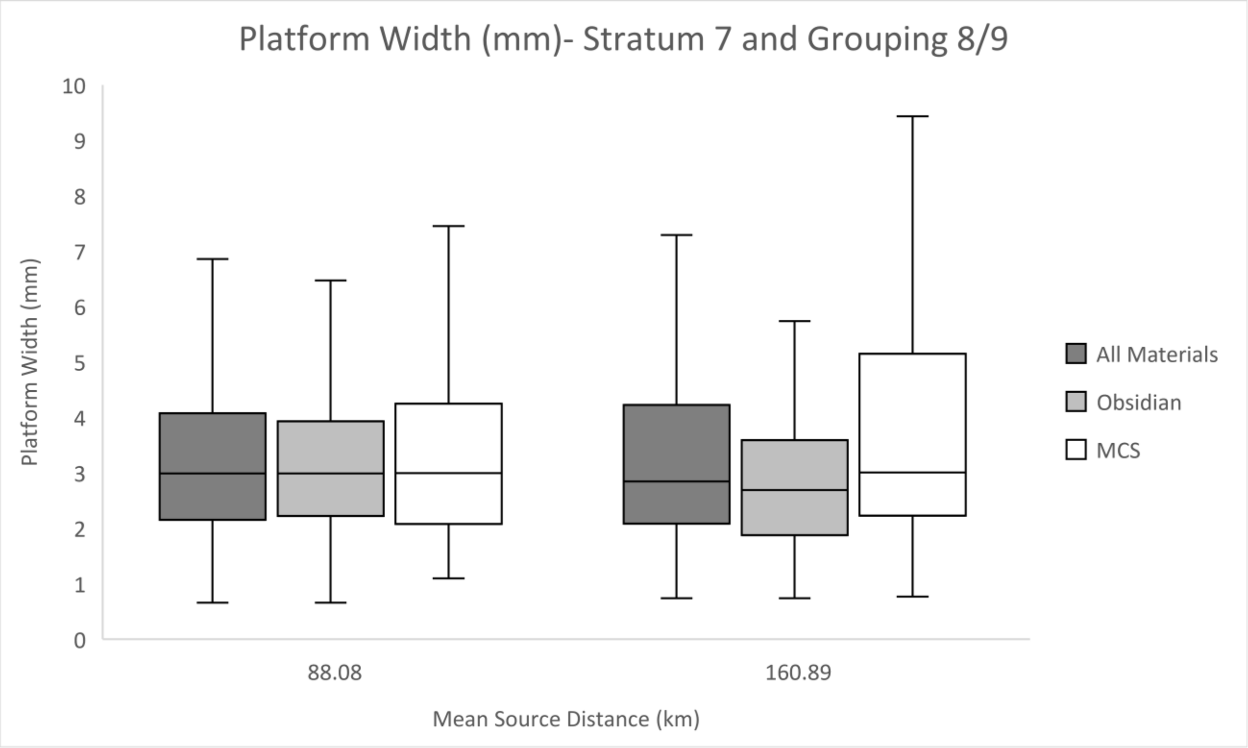

Figure 4.28 Platform width (mm)- Stratum 7 (left) and Grouping 8/9 (right).

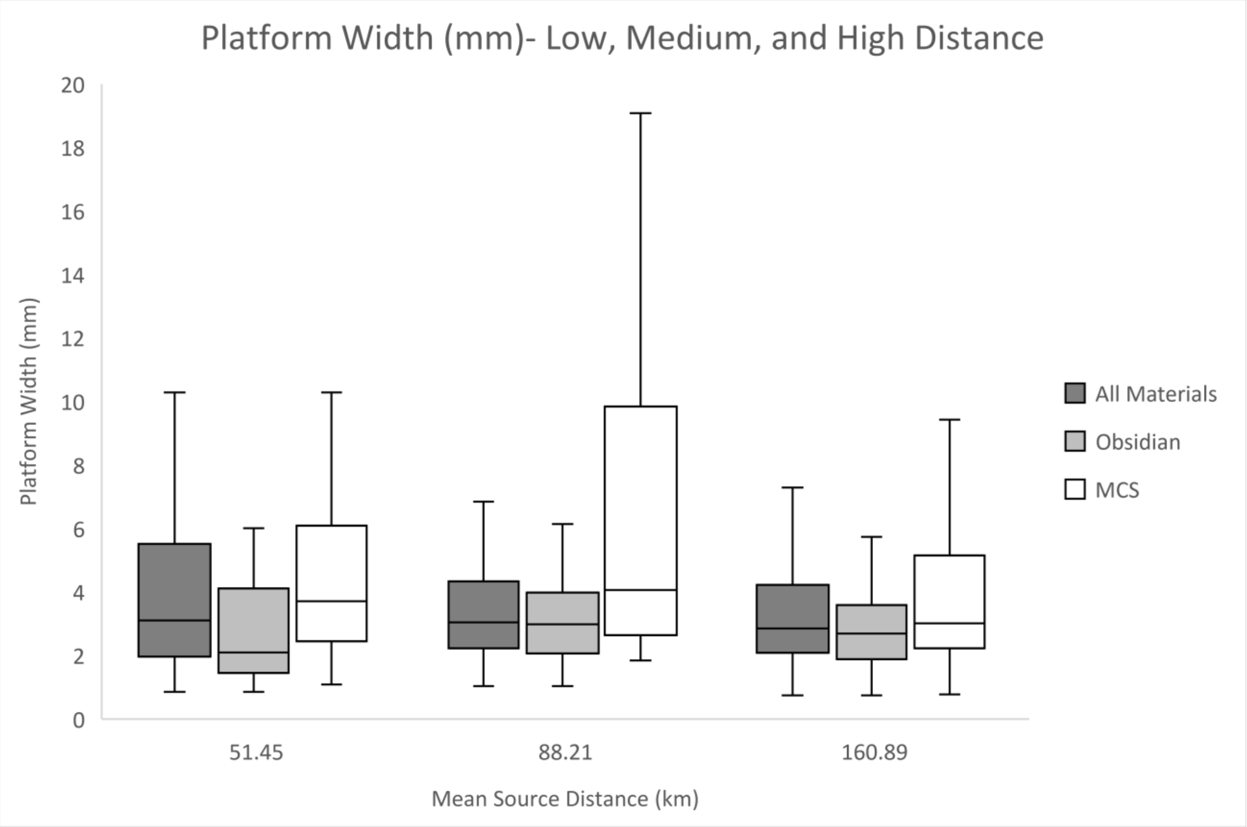

Figure 4.29 Platform width (mm)- Low, Medium, and High distance.

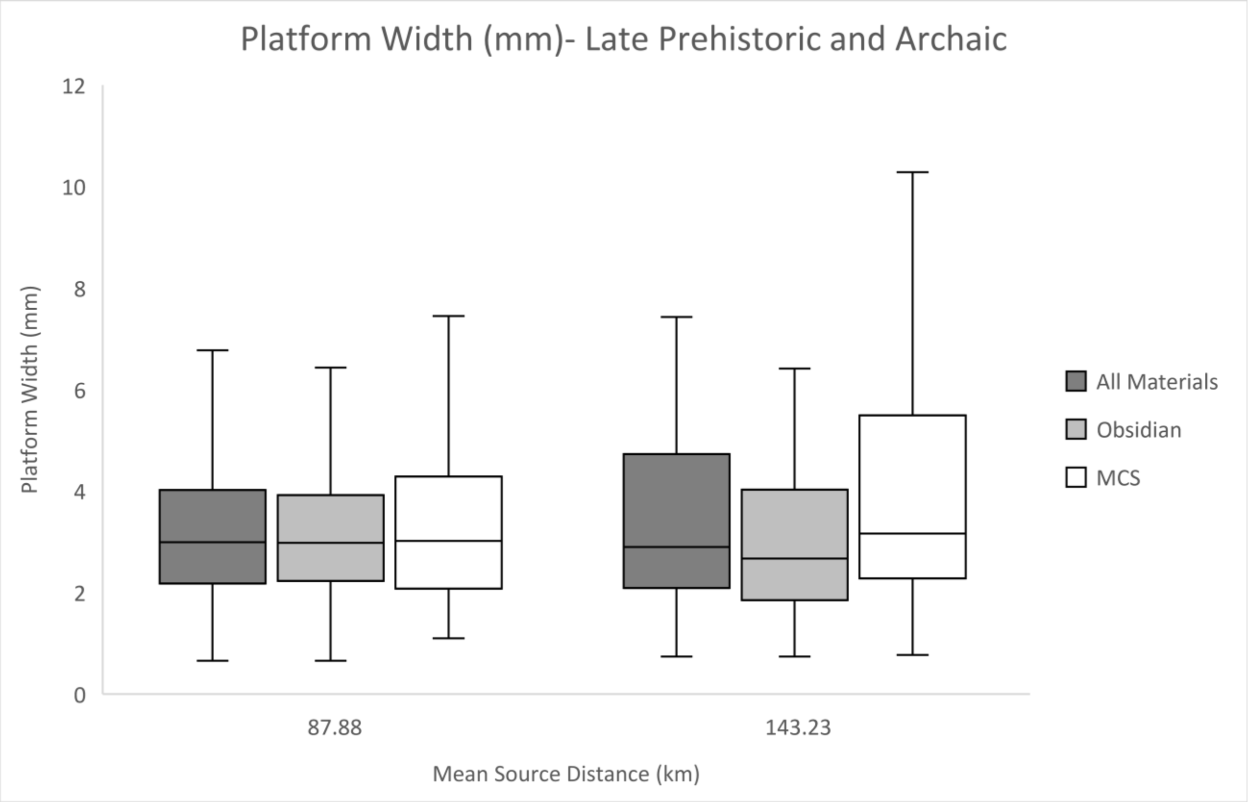

Figure 4.30 Platform width (mm)- Late Prehistoric (left) and Archaic (right).

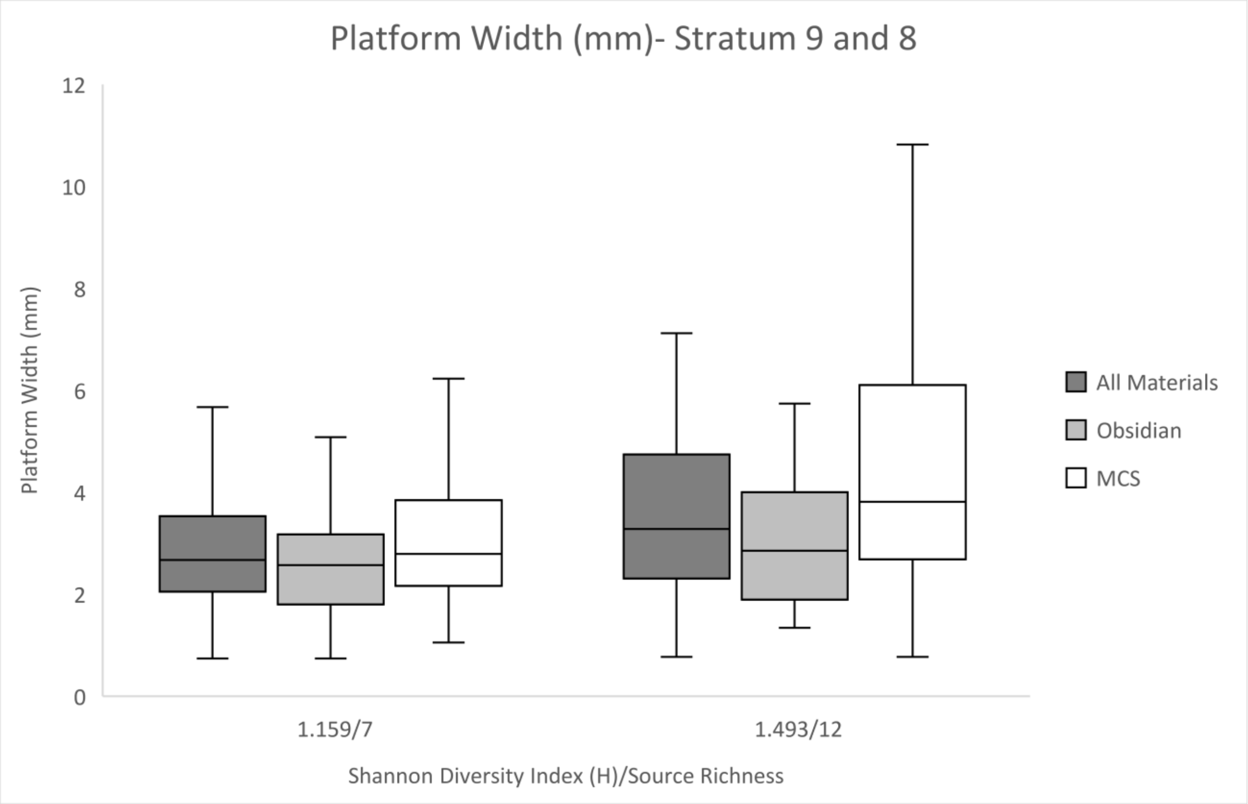

Figure 4.31 Platform width (mm)- Stratum 9 (left) and 8 (right).

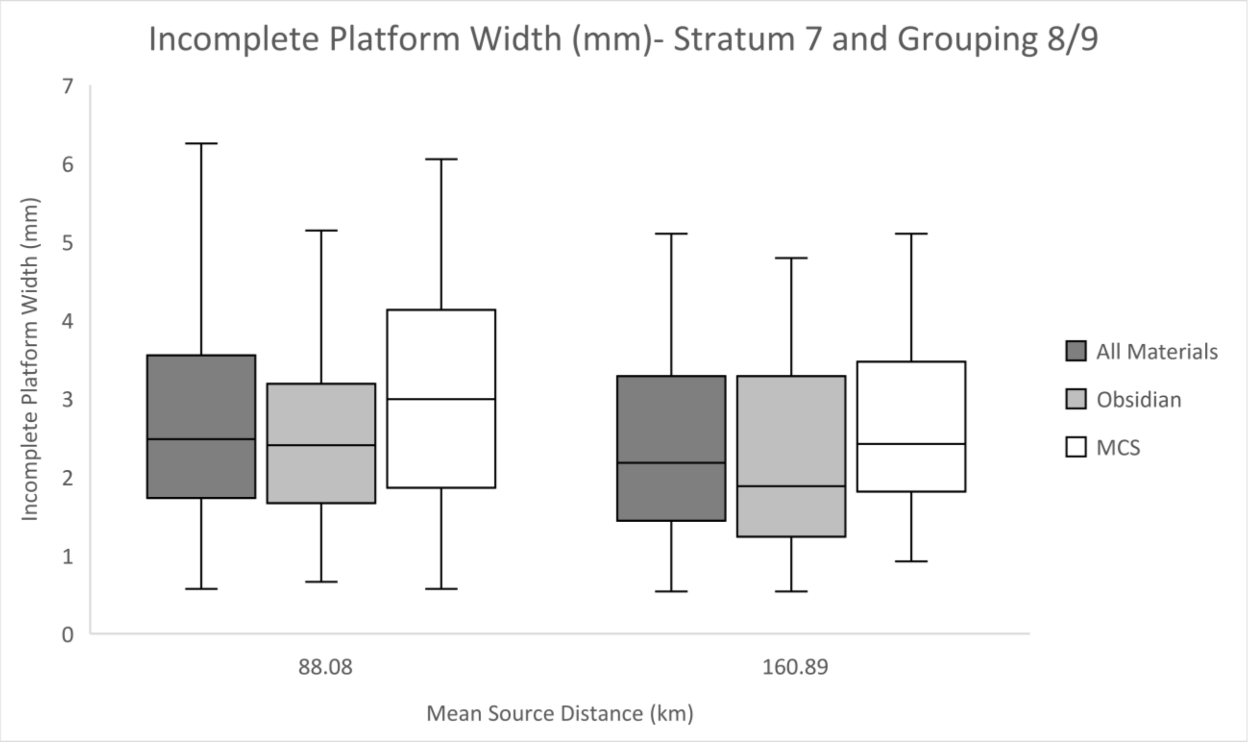

Figure 4.32 Incomplete platform width (mm)- Stratum 7 (left) and Grouping 8/9 (right).

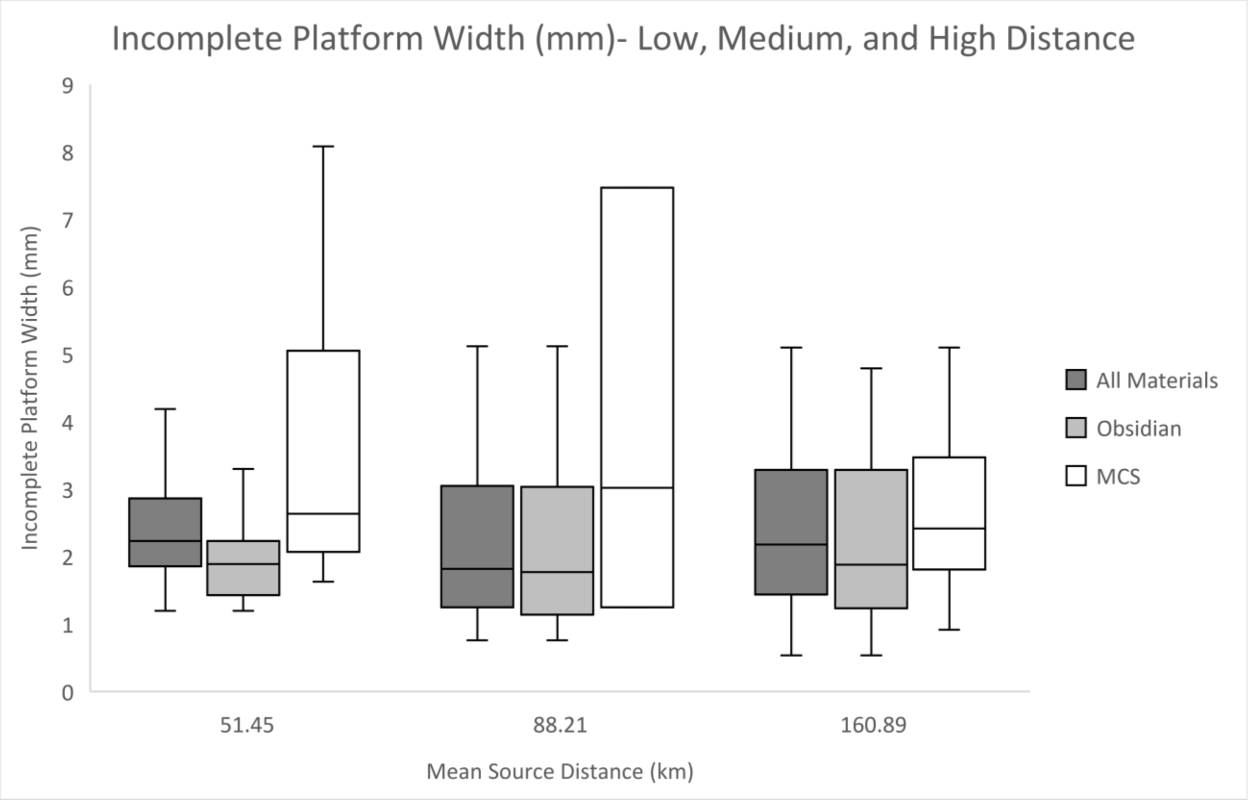

Figure 4.33 Incomplete platform width (mm)- Low, Medium, and High distance.

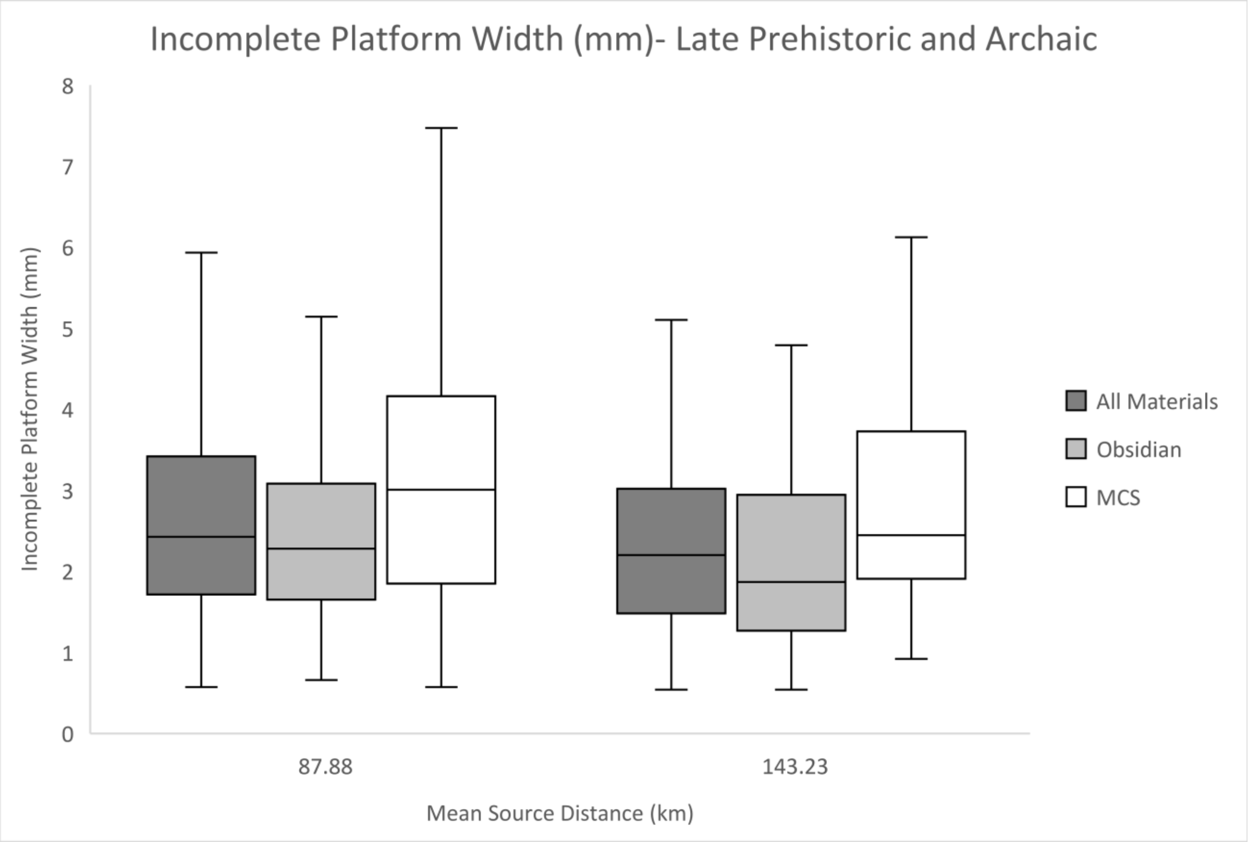

Figure 4.34 Incomplete platform width (mm)- Late Prehistoric (left) and Archaic (right).

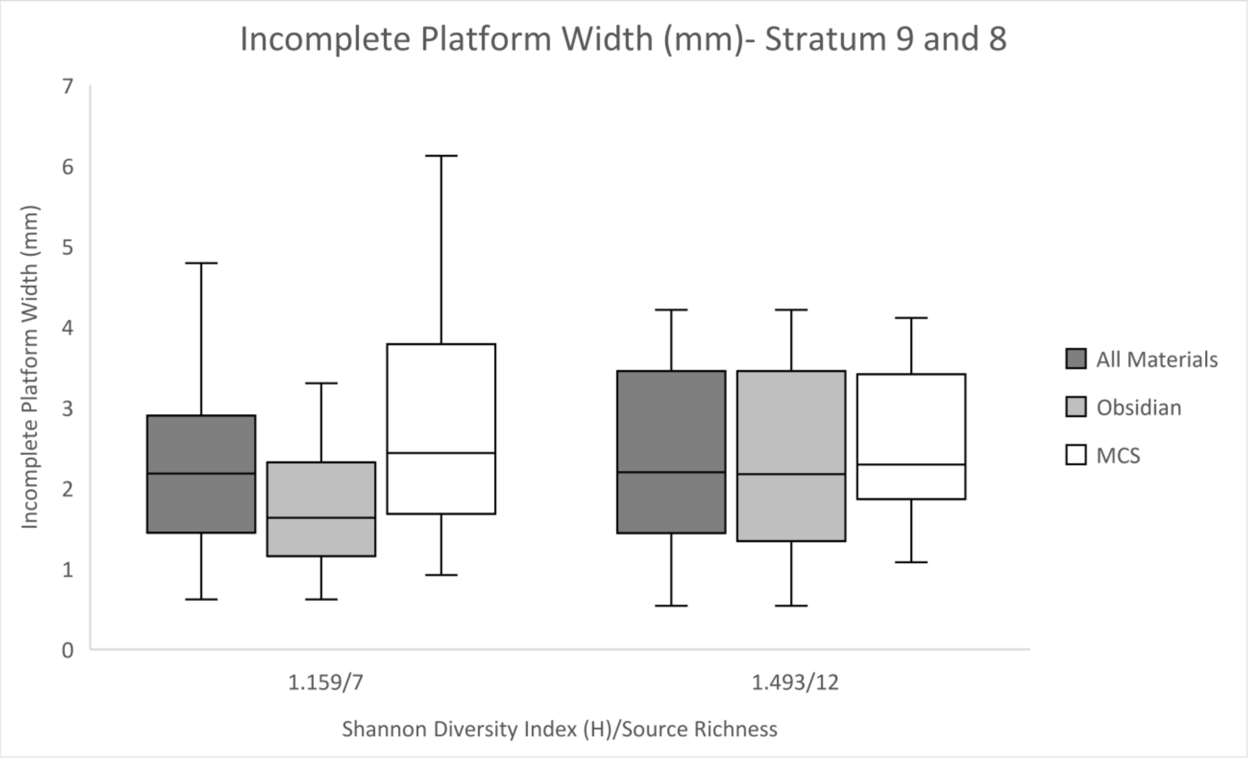

Figure 4.35 Incomplete platform width (mm)- Stratum 9 (left) and 8 (right).

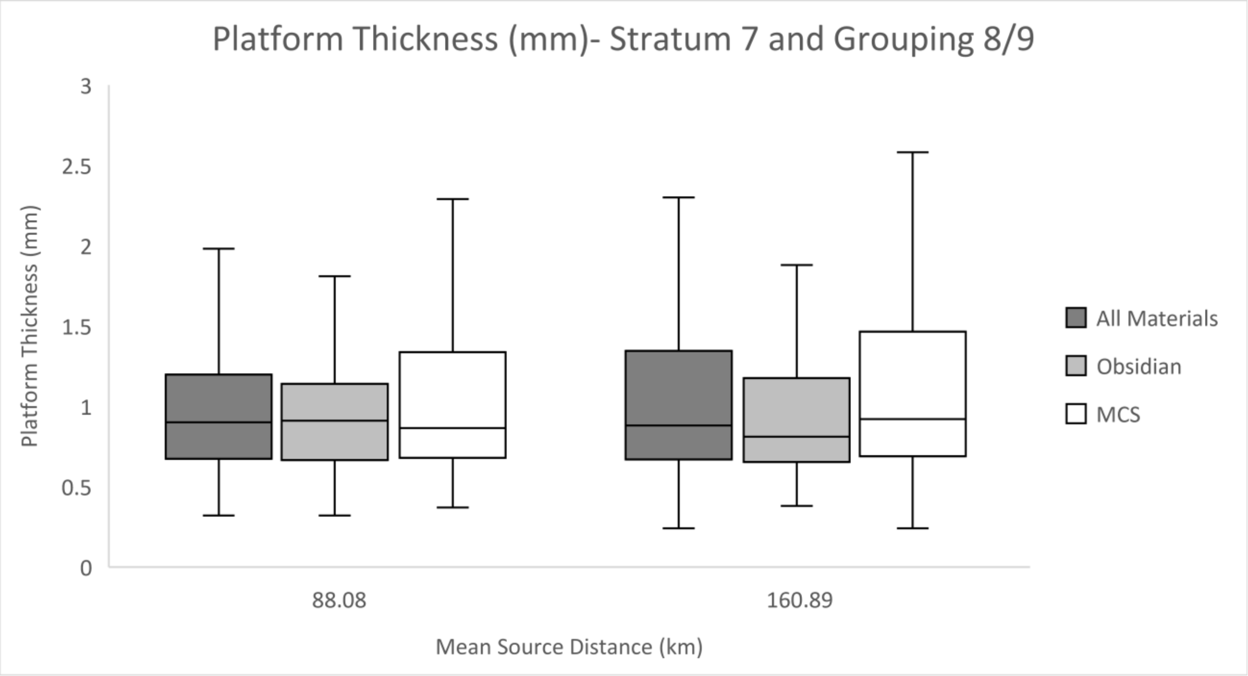

Figure 4.36 Platform thickness (mm)- Stratum 7 (left) and Grouping 8/9 (right).

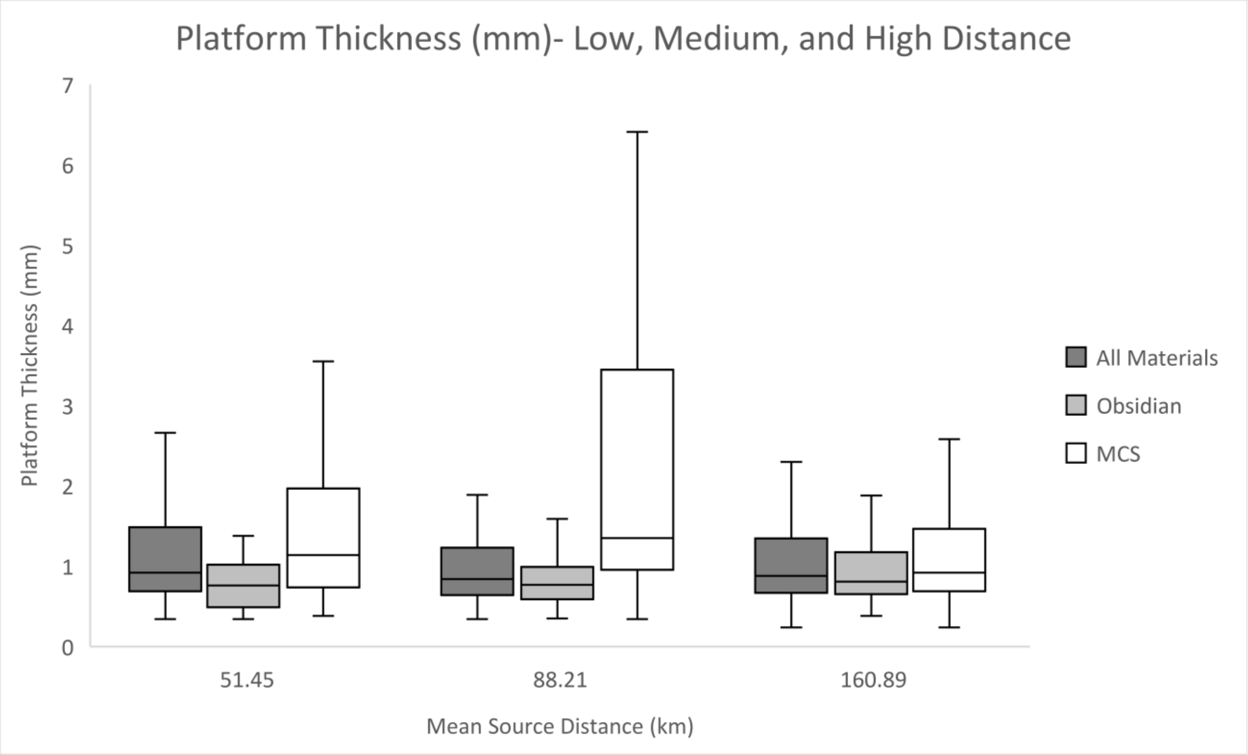

Figure 4.37 Platform thickness (mm)- Low, Medium, and High distance.

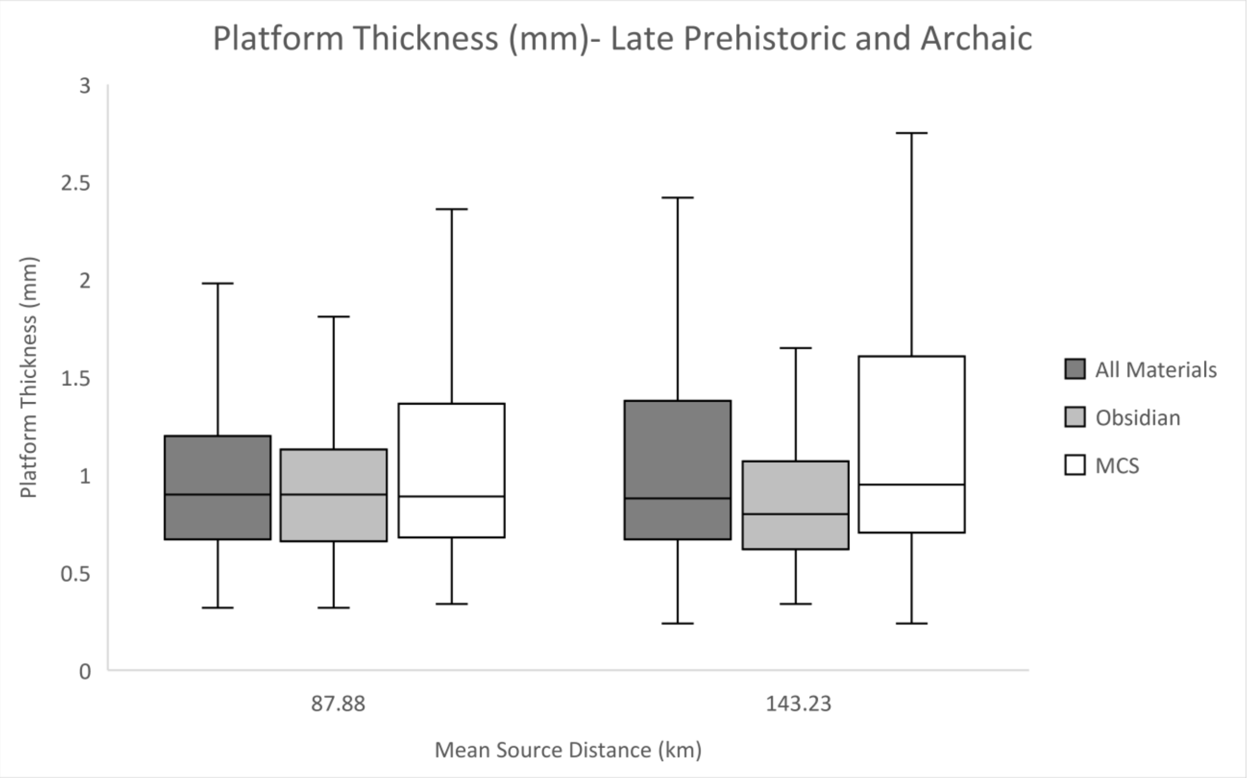

Figure 4.38 Platform thickness (mm)- Late Prehistoric (left) and Archaic (right).

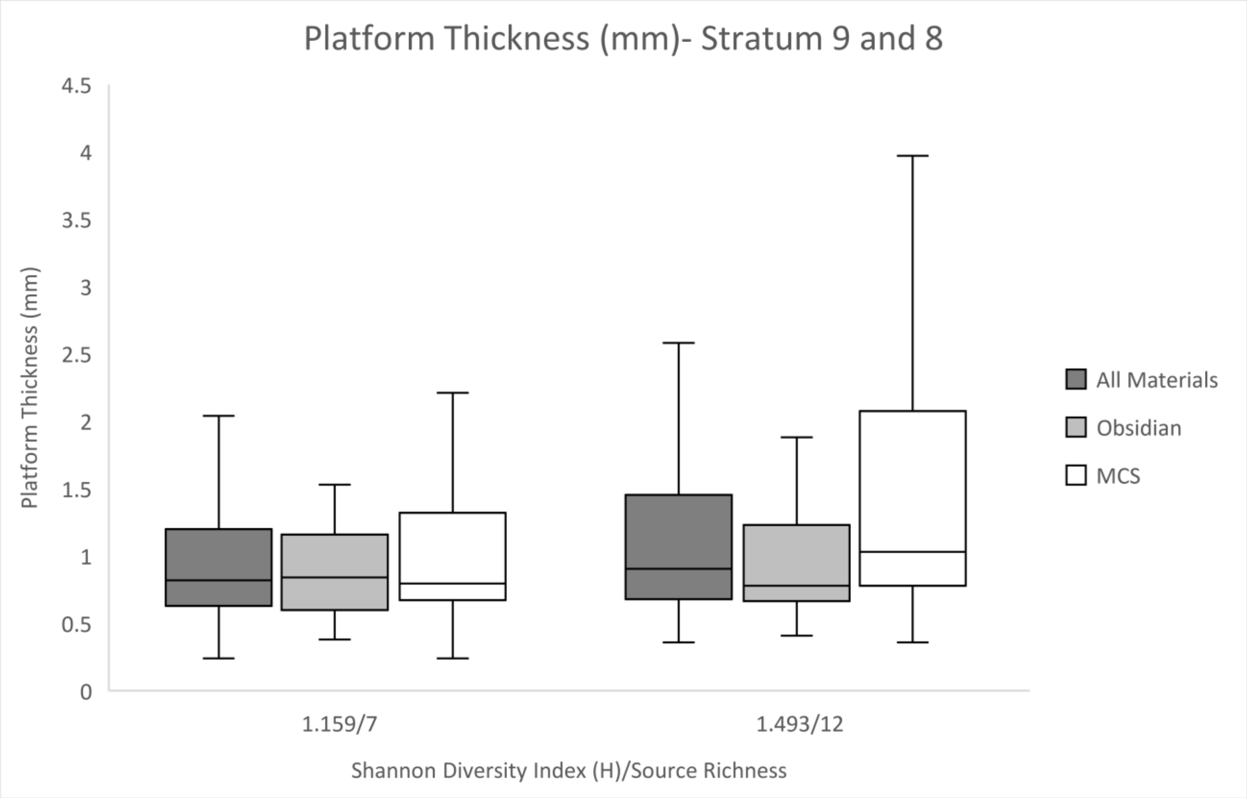

Figure 4.39 Platform thickness (mm)- Stratum 9 (left) and 8 (right).

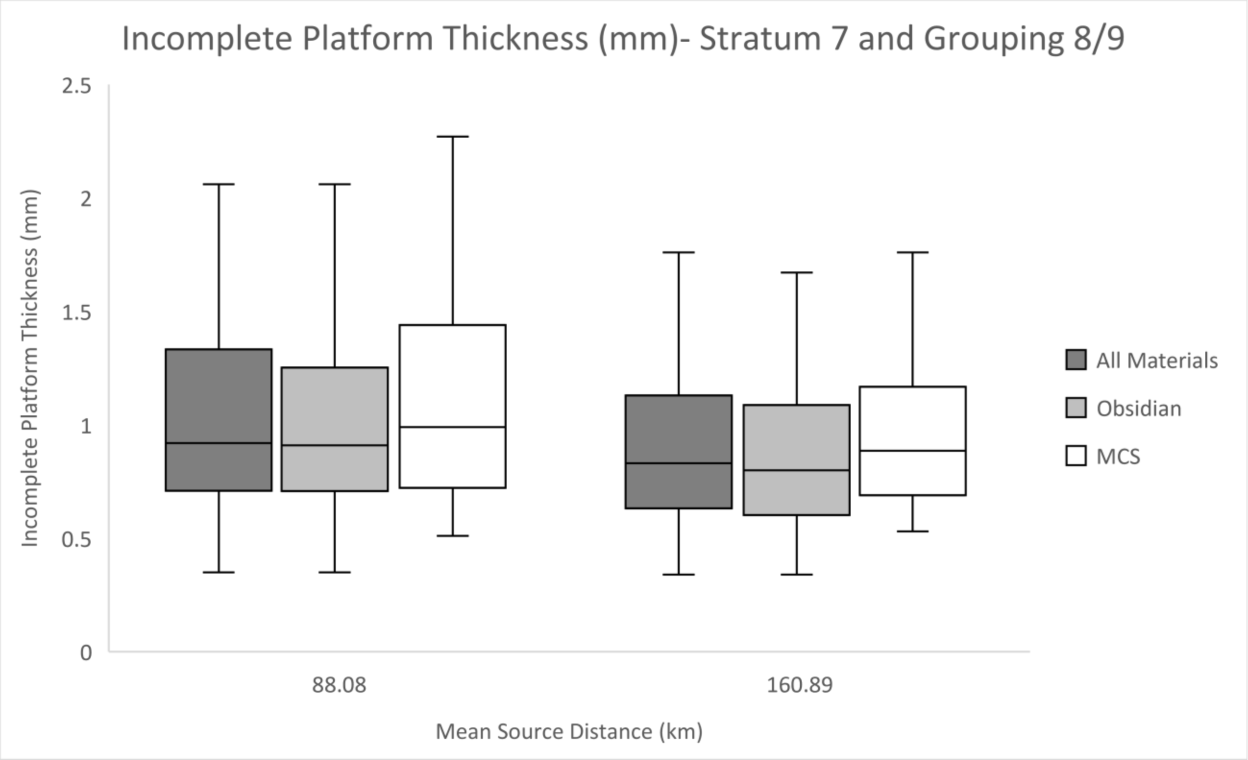

Figure 4.40 Incomplete platform thickness (mm)- Stratum 7 (left) and Grouping 8/9 (right).

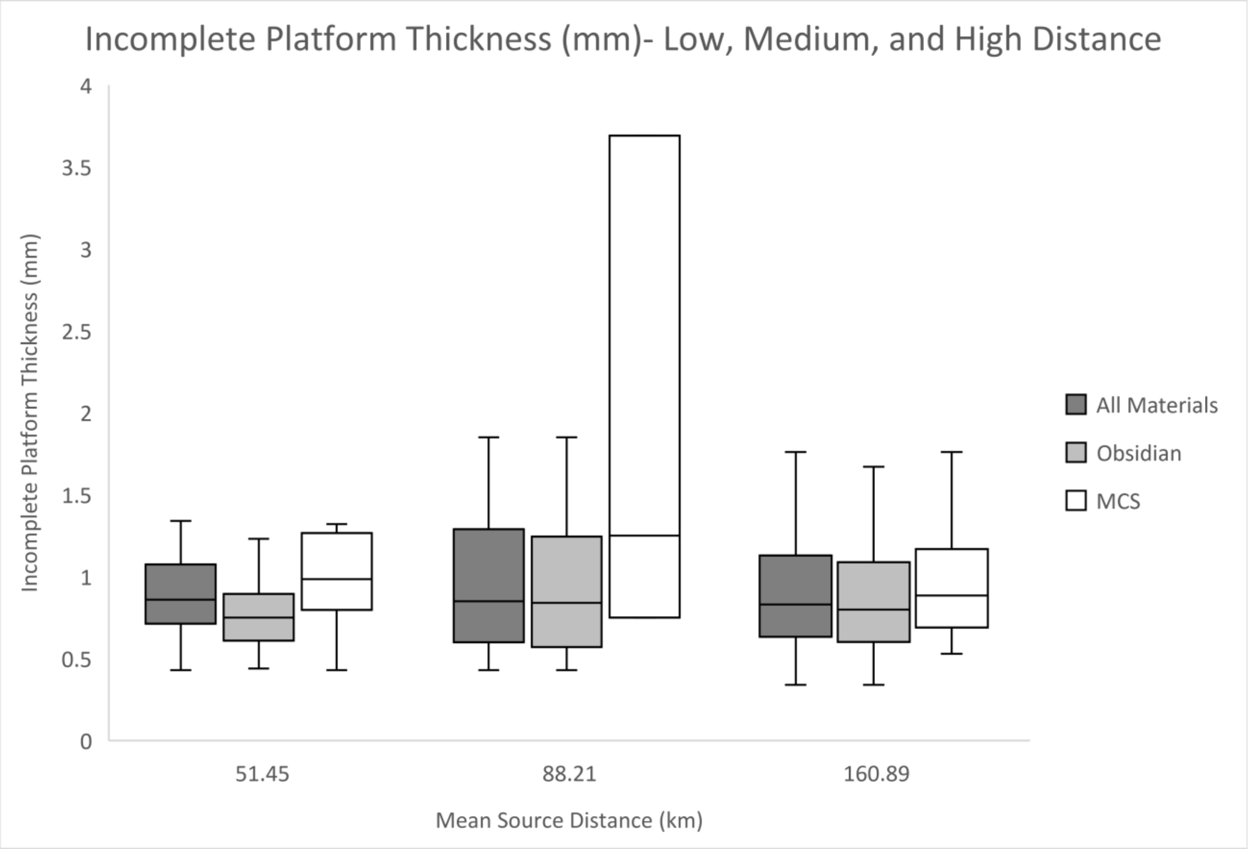

Figure 4.41 Incomplete platform thickness (mm)- Low, Medium, and High distance.

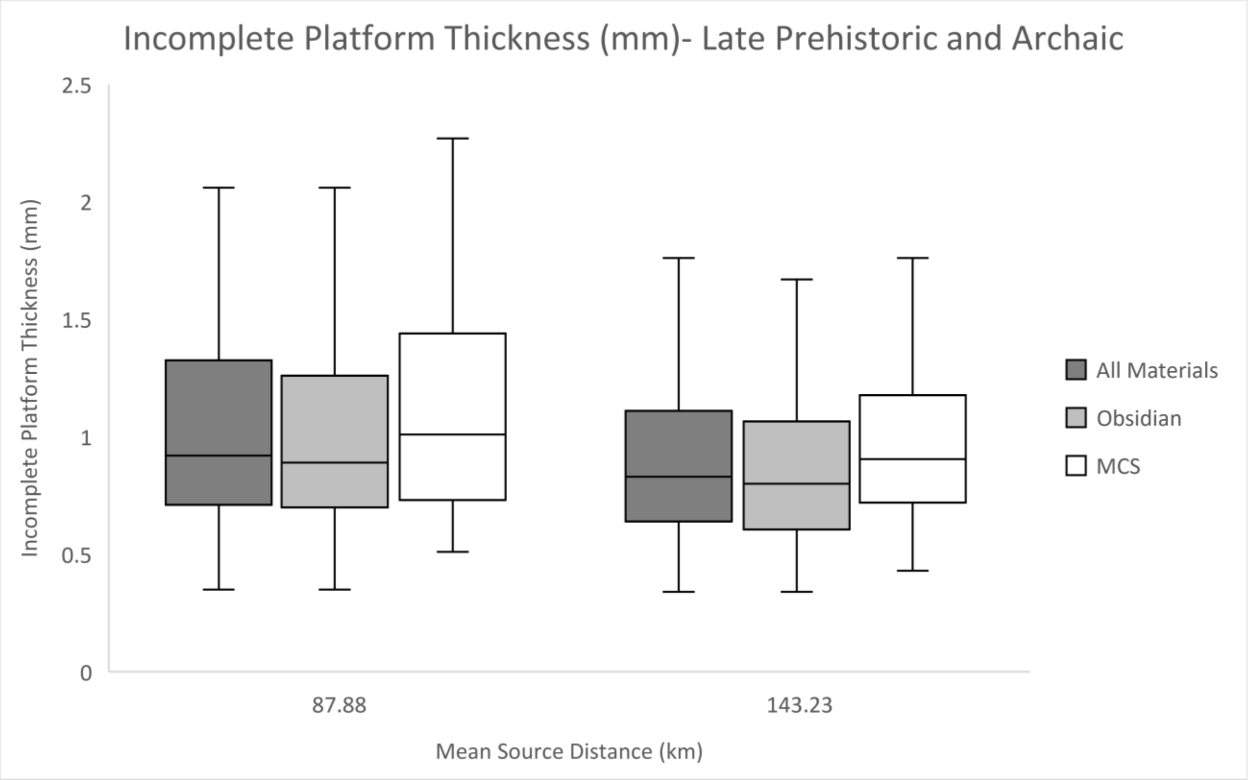

Figure 4.42 Incomplete platform thickness (mm)- Late Prehistoric (left) and Archaic (right).

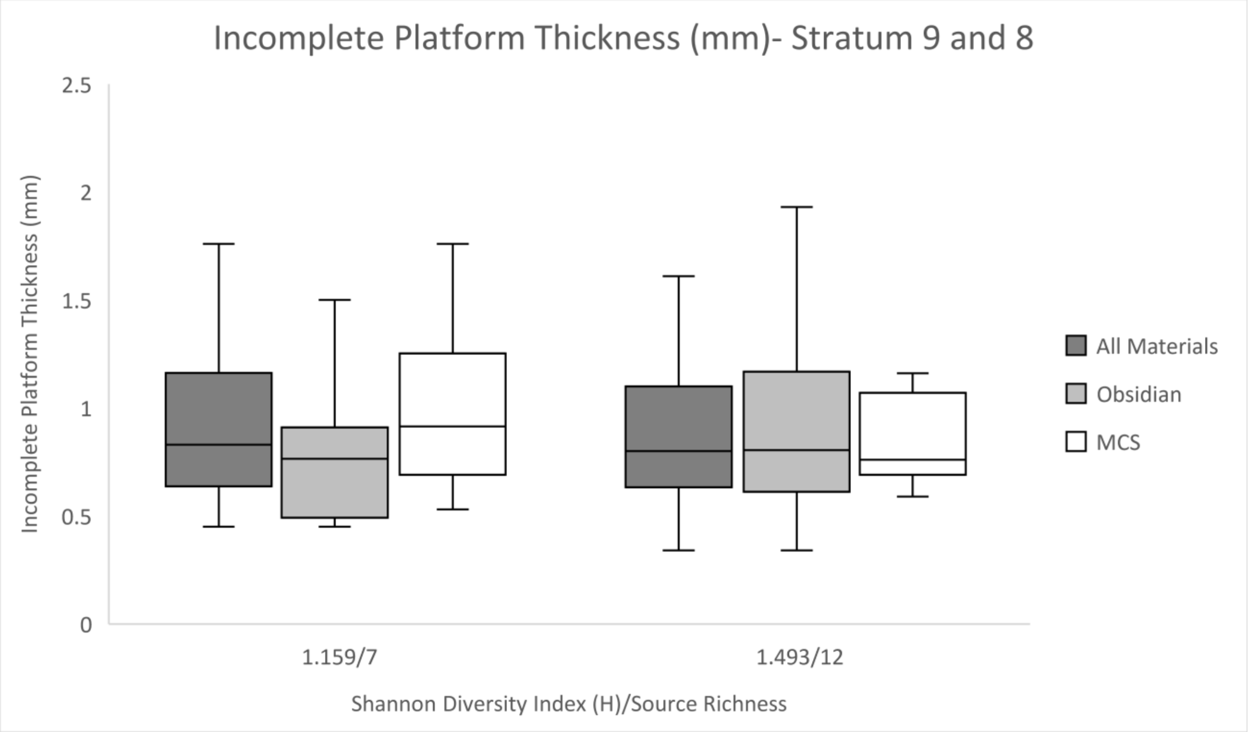

Figure 4.43 Incomplete platform thickness (mm)- Stratum 9 (left) and 8 (right).

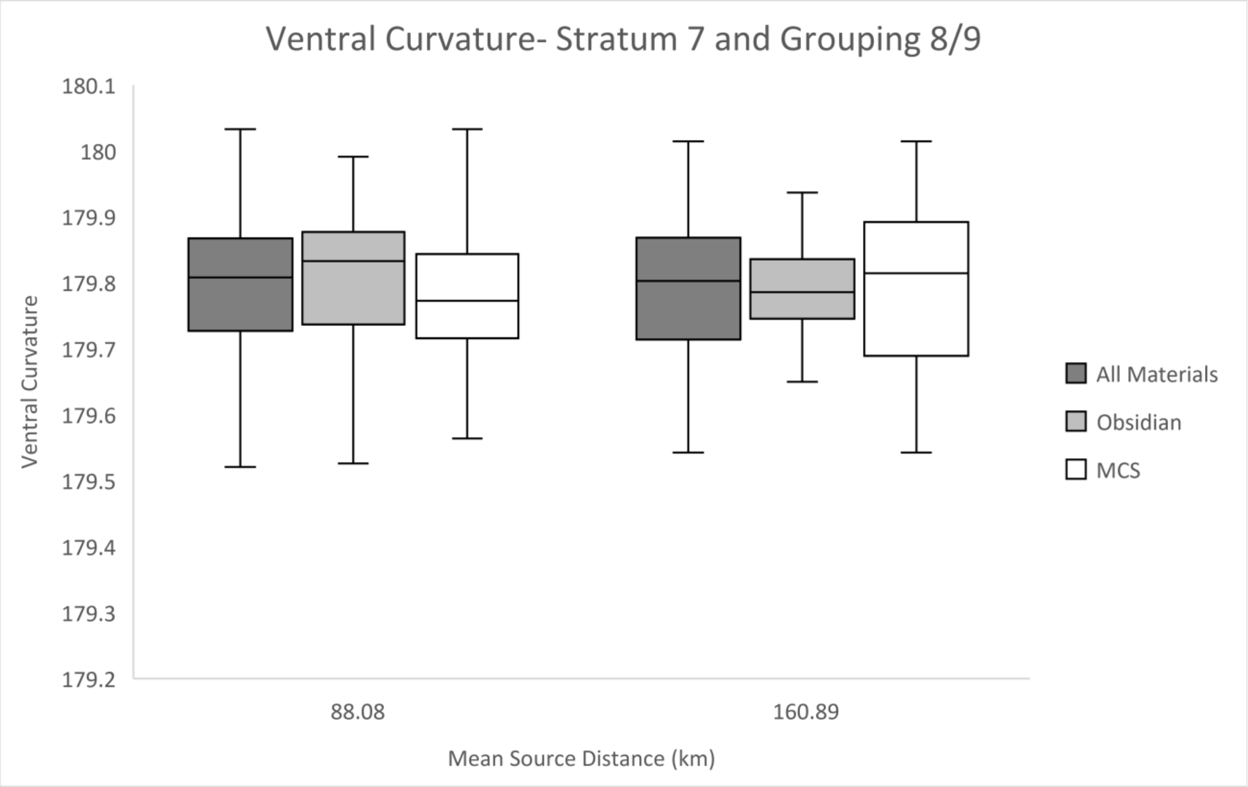

Figure 4.44 Ventral curvature- Stratum 7 (left) and Grouping 8/9 (right).

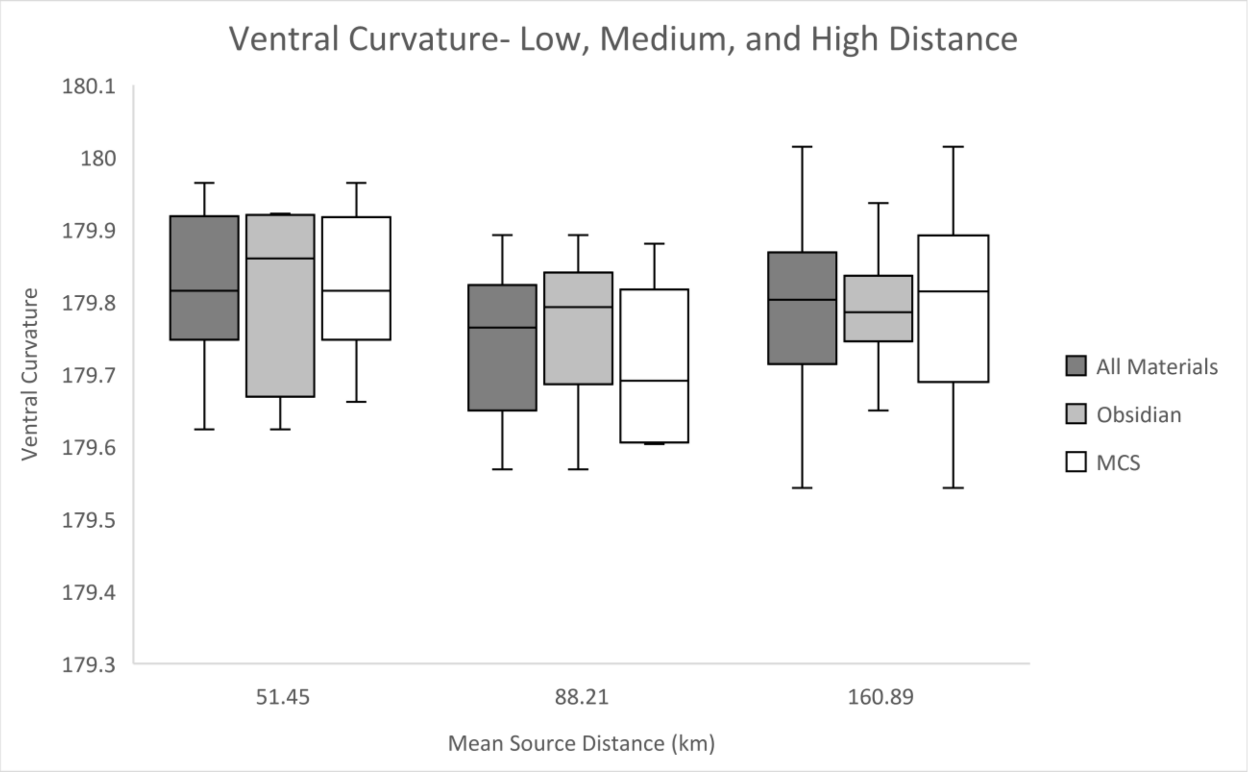

Figure 4.45 Ventral curvature- Low, Medium, and High Distance.

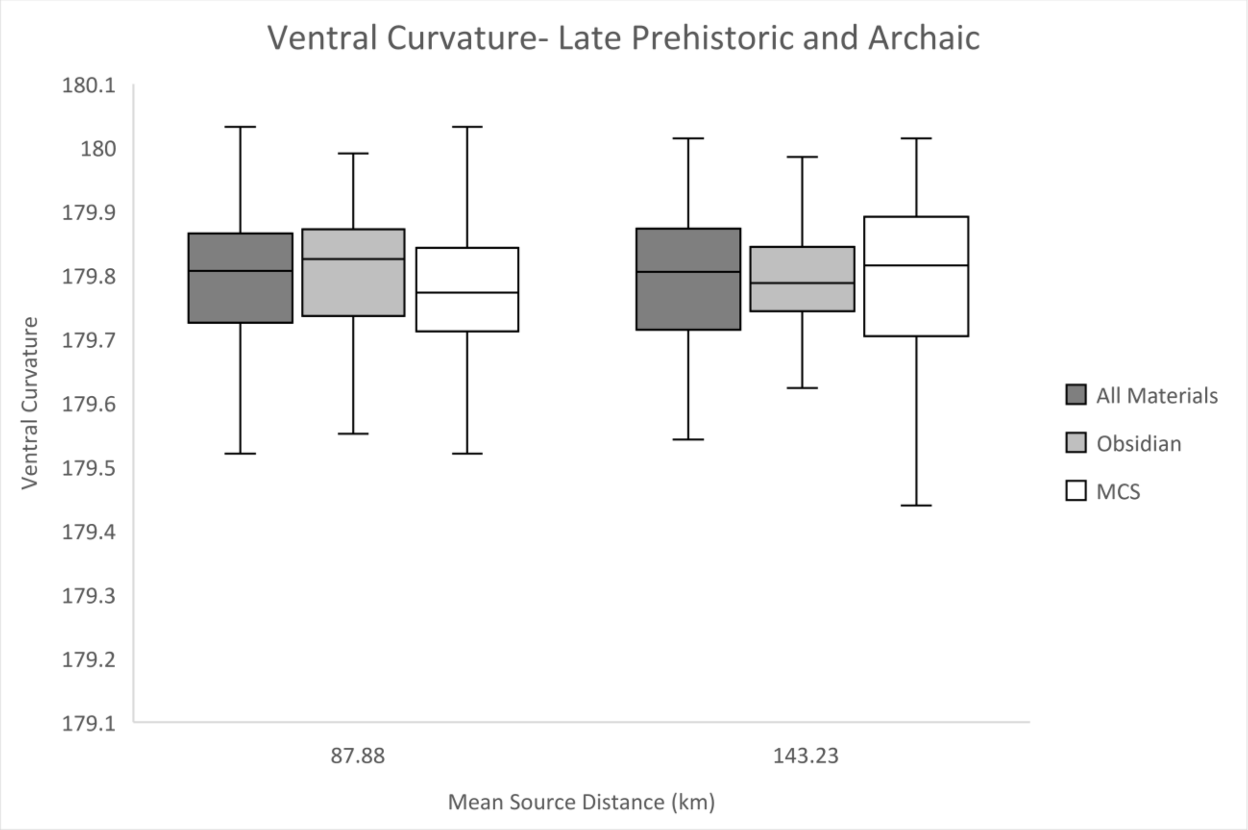

Figure 4.46 Ventral curvature- Late Prehistoric (left) and Archaic (right).

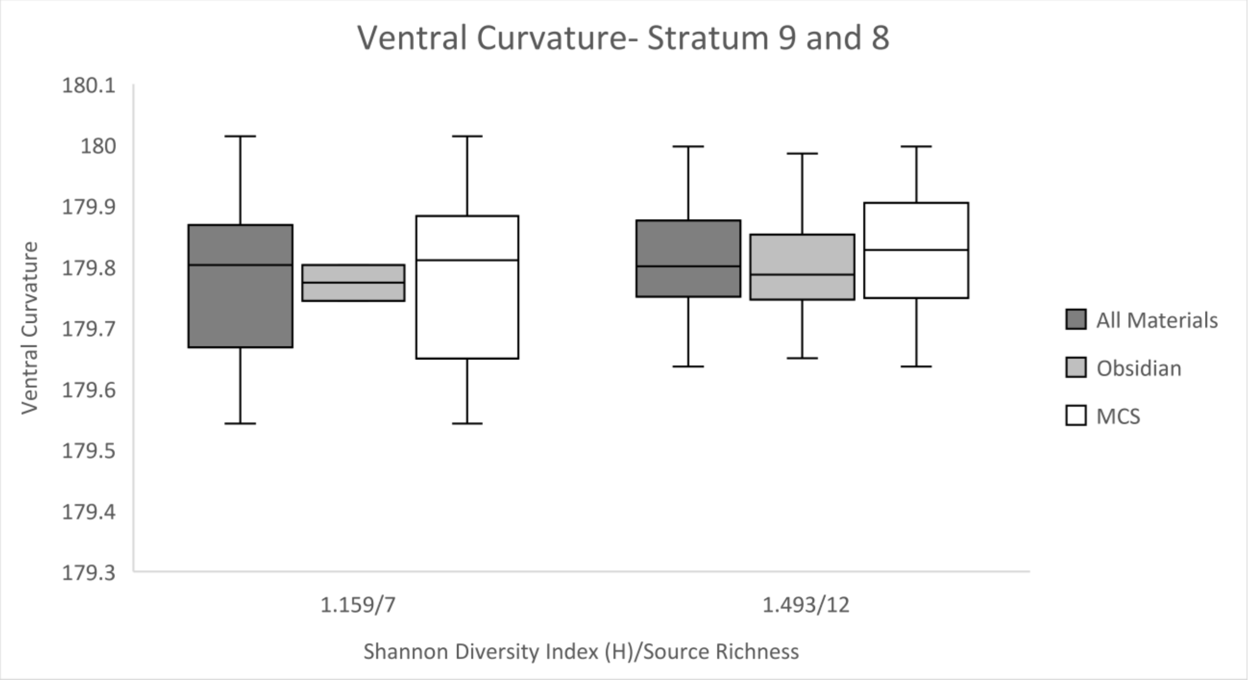

Figure 4.47 Ventral curvature- Stratum 9 (left) and 8 (right).