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ACROSS THE SNAKE RIVER PLAIN: TERMINAL PLEISTOCENE, EARLY HOLOCENE,

AND EARLY MIDDLE HOLOCENE LAND-USE IN SOUTHEAST IDAHO

by

Jennifer Finn

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

MASTER OF SCIENCE

in

Anthropology

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UTAH STATE UNIVERSITY
Logan, Utah

2024

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ABSTRACT

Across the Snake River Plain: Terminal Pleistocene, Early Holocene, and Early Middle Holocene Land-use in Southeast Idaho

by

Jennifer Finn, Master of Science

Utah State University 2024

Major Professor: Dr. Judson B. Finley

Department: Sociology, Social Work, and Anthropology

The range of mobility demonstrated to solve challenges with the distribution of resources is characteristic of hunter-gatherer societies. Prior research in southeast Idaho has investigated whether climatic variations may have influenced precontact mobility. Preliminary research on regional obsidian conveyance suggests that land use patterns were already changing during the early Holocene due to the onset of xeric conditions. However, there appears to be a substantial expansion in mobility at the early Holocene/middle Holocene transition, as indicated by the spatial distribution of Northern Side-notched points. Precontact human land use in southeast Idaho during the terminal Pleistocene/early Holocene, early Holocene, and early middle Holocene are explored using X-ray Fluorescence source analysis, diversity indices, and distance to source statistics on 376 diagnostic projectile points from federal collections and sites in the study area. The results of these analyses in conjunction with paleoenvironmental models were used to test the hypotheses that mobility in the study area was conditioned by environmentally mediated resource patch quality and abundance and that obsidian source data reflects differential land use practices associated with paleoenvironmental changes. Low mobility is expected during the terminal Pleistocene/early Holocene and early Holocene periods, while heightened mobility associated with peak paleoenvironmental aridity is expected during the early middle Holocene period. Obsidian source attributions, diversity scores, and distance to source statistics indicate that mobility was at its lowest during the terminal Pleistocene/early Holocene period, at its highest during the early Holocene period, and decreased at the onset of the early middle Holocene period. The results of this study do not support the hypothesis that mobility in the study area was conditioned by environmentally mediated resource patch quality and abundance.

(118 pages)

PUBLIC ABSTRACT

Across the Snake River Plain: Terminal Pleistocene, Early Holocene, and Early Middle Holocene Land-use in Southeast Idaho

Jennifer Finn

The range of mobility demonstrated to overcome challenges with resource distribution is a hallmark of hunter-gatherer societies. Previous studies in southeast Idaho have investigated the possibility that precontact human movement was impacted by climatic differences. According to preliminary studies on regional obsidian toolstone conveyance, land use patterns were already changing throughout the early Holocene due to increased aridity. However, the geographical distribution of Northern Side-notched projectile points suggests a significant expansion in mobility at the early Holocene/middle Holocene transition. This thesis tests the hypothesis that precontact early middle Holocene human mobility in the study area was conditioned by environmental factors during this period through the X-ray Fluorescence analysis of 376 volcanic glass projectile points dating to the terminal Pleistocene, early Holocene, and early middle Holocene periods. The results of this study indicate that human mobility was heightened during the early Holocene period rather than the early Middle Holocene period. This research contributes a deeper course-grained understanding of the land use patterns of precontact peoples in the study area.

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Chapter I Introduction

The range of mobility demonstrated to solve challenges with the timing and distribution of resources is one of the defining traits of foraging groups (Kelly 2013). Understanding Native American adaptation before contact depends critically on this relationship. For instance, nomadic foragers, like the ancestors of the Shoshone and Bannock, generated a distinctive, patterned material culture that reflects their movements (Wendrich and Bernard 2008). Therefore, it is not surprising that in many areas with a rich precontact archaeological record, such as the Great Basin and adjacent Snake River Plain, researchers continue to place a strong emphasis on investigating the factors that affect forager mobility (Cota 2022; Fowler 2014; Henrikson 2002, 2004, 2008; Holmer 1997; Long 2007; Plager 2001; Scheiber and Finley 2011; Smith 2010; Smith and Harvey 2018; Smith and Kielhofer 2011; Thompson 2004, Zumkeller 2020).

Prior research in southeastern Idaho has used proxy archaeological data to investigate if climatic variations may have impacted precontact forager land use (Henrikson 2002; Long 2007). Paleoenvironmental studies indicate that southeastern Idaho has experienced several climatic changes since the terminal Pleistocene (Bright and Davis 1982; Davis et al. 1986). Henrikson (2002) examined regional archaeological site distribution patterns to test whether these changes impacted the precontact seasonal round and suggested that climatic changes over the past 8,000 years were insufficient to prompt seasonal shifts. The only adjustment was the use of lava tube caves during the warmer, drier periods of the Holocene for the cold storage of bison meat (Byers et al. 2016;

Henrikson 2003). However, Henrikson (2002) noted that these caves also served as seasonal base camps during other periods.

In contrast to Henrikson's (2002) research, Holmer (1997) and Fowler (2014) argue that middle Holocene (ca. 7,600-3,000 cal. BP) xeric conditions are visible in the patterns of regional obsidian conveyance, which suggests that forager mobility contracted during this period. While Henrikson (2002), Holmer (1997), and Fowler (2014) primarily focused on the middle and late Holocene archaeological record, Long (2007) examined the distribution of terminal Pleistocene/early Holocene (TP/EH) sites across southern Idaho. Long posits that substantial land use changes began before the middle Holocene transition in response to the recession of Lake Terreton, a terminal Pleistocene lake, and the loss of wetland habitats during the transition from the early Holocene to the middle Holocene (Long 2007). Long (2007) suggested that foragers were more tethered to patches associated with the Big Lost River corridor and Pioneer Basin during the transition to the early Holocene, and over time became less tethered to these patch types.

Using a refined sourced obsidian artifact dataset as a case study, in this thesis, I test the hypothesis that forager mobility in southeastern Idaho was conditioned by environmentally mediated patch quality and abundance during the early Holocene and the early middle Holocene, as proposed by Long (2007). I examine the spatial distribution of TP/EH and early Holocene lanceolate and stemmed projectile points (ca. 12,000-7,600 cal. BP) in relation to the distribution of Northern Side-notched points (NSN), which are the first diagnostic projectiles to correlate with the early Holocene/middle Holocene transition (Holmer 2009). Using the available archaeological data in a fifteen-million-acre study area (Figure 1) developed by the Idaho National Laboratory (INL) Cultural

Resource Management Office (Henrikson et al. 2024), I compare and evaluate the obsidian source attributions assigned to TP/EH, early Holocene points, and NSN points to address if (1) there are statistically significant changes in source use during the early Holocene and middle Holocene transitions, and (2) the obsidian conveyance zones in the study area exhibit evidence of these changes.

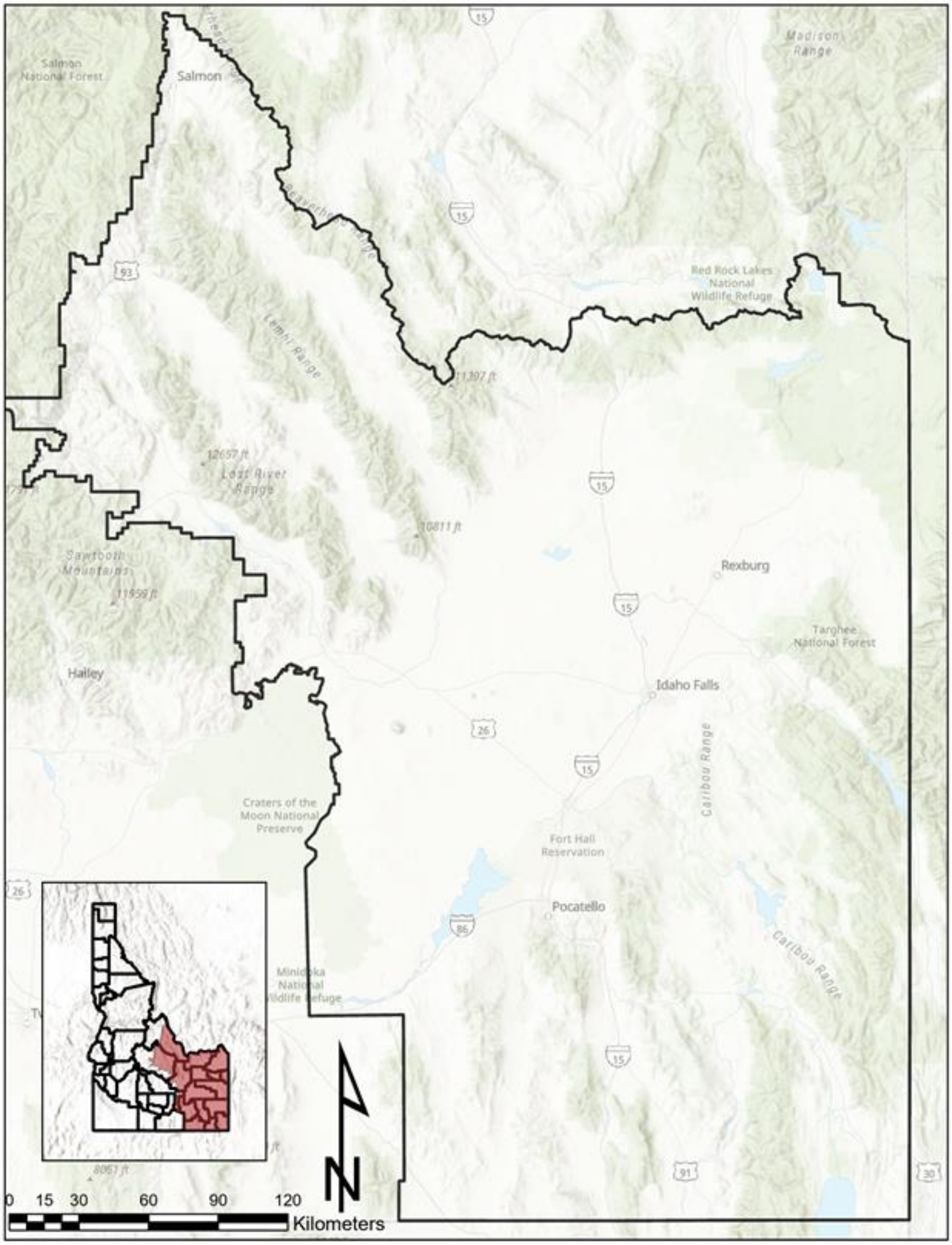

Figure 1. Study Area Boundary

By examining the ratios and diversity measures of local and non-local obsidian toolstone sources in archaeological assemblages, I argue that the Marginal Value Theorem (MVT) (Charnov 1976) is applicable in informing perspectives on past environmental quality and climatic change. The archaeological record reflects predictable behavioral responses to various environmental factors. Transit distances between resource patches and the duration of occupation in resource patches are approximations of patch and overall environmental productivity (James et al. 2022). Therefore, a higher relative abundance of local toolstone should correlate with long-term occupations of a productive patch (Kuhn 1995; Madsen 2007; Madsen et al. 2015). In contrast, as highly mobile groups are more likely to encounter a broader range of lithic sources during their subsistence activities, short-term occupations of marginal resource patches should be associated with a greater diversity of lithic source material that is less localized (Andrefsky 1998; Jones et al. 2012; Smith et al. 2013).

Given these assumptions, I predict the early Holocene point assemblage for the study area will reflect obsidian sources that are proximal to river corridors (Figure 2) and, to a lesser degree, Lake Terreton (Long 2007, Madsen 2007; Madsen et al. 2015). The spatial distribution of early Holocene points should also correlate with these areas (Long 2007). Obsidian sourcing for the early Holocene dataset should be less diverse if these patterns occur. In contrast, the middle Holocene NSN assemblage should reflect widespread obsidian sources, and the dataset's source attributions should be relatively diverse. The spatial distributions of NSN points and lithic source attributions should reflect land-use patterns that approximate those identified by regional ethnographies (Lowie 1909; Murphy and Murphy 1960; Steward 1938), as many previous researchers

(Henrikson 2002; Holmer 1994; Swanson 1972) have suggested a deep antiquity for regional lifeways in the study area that extends to 8,000 years ago (Henrikson 2002; Swanson 1972).

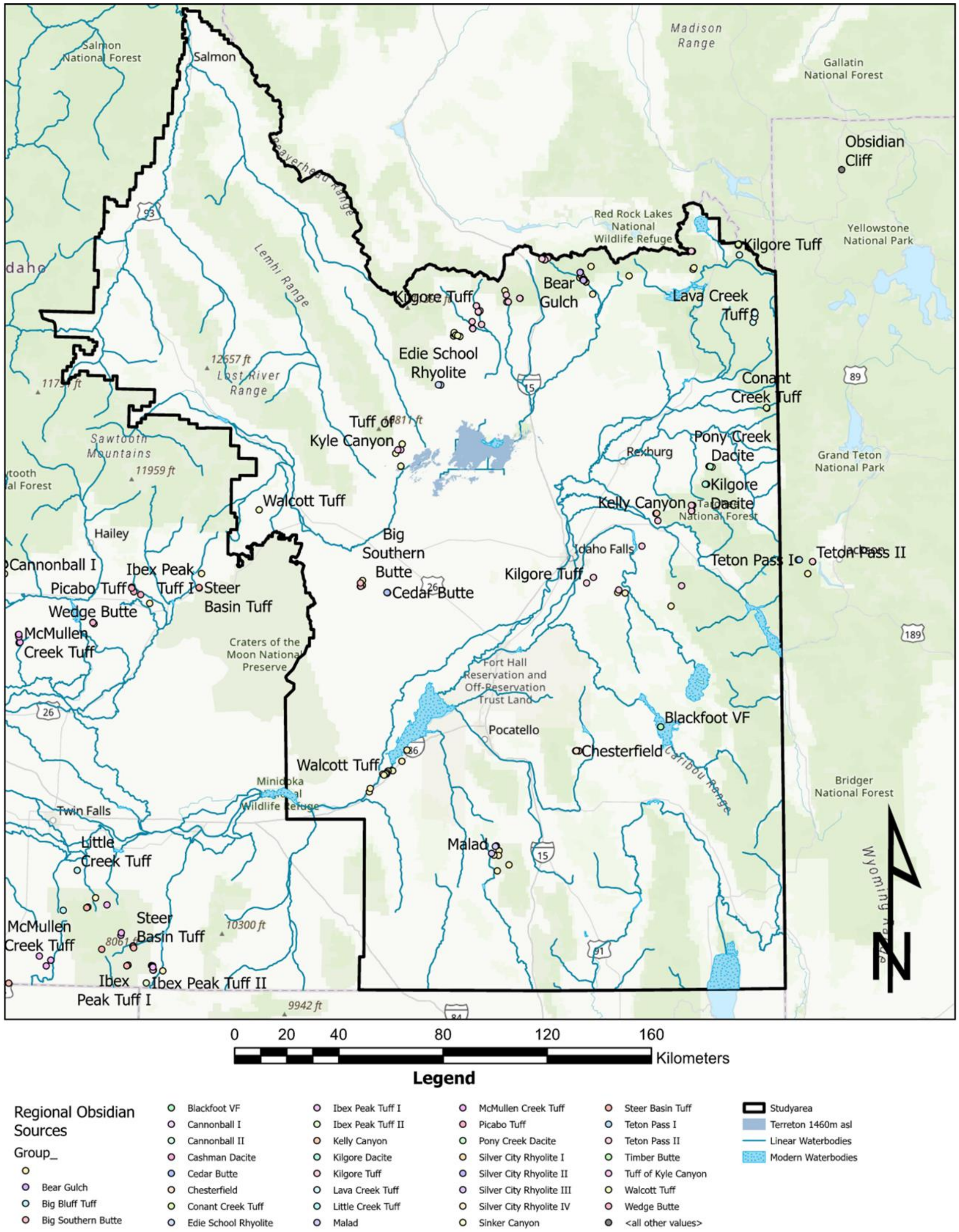

Figure 2. Regional water and obsidian resources.

The expectations outlined here are in opposition to the results of previous regional obsidian studies (Fowler 2014; Holmer 1997; Scheiber and Finley 2011), which observed peak mobility during the TP/EH transition, high mobility during the early Holocene and a significant decrease in mobility during the early Holocene/middle Holocene transition, where obsidian conveyance zones became more contracted (Fowler 2014; Holmer 1997) and less diverse (Scheiber and Finley 2011). This thesis tests Long's (2007) hypotheses about early Holocene patch choice and the subsequent expansion of mobility into lower-ranked patches during the transition from the early to the middle Holocene against these previous regional obsidian conveyance studies (Fowler 2014, Holmer 1997, Scheiber and Finley 2011). I accomplish this with an enhanced and refined obsidian source dataset generated by the X-ray fluorescence (XRF) analyses of 196 TP/EH and early Holocene points, 180 NSN points, and a suite of statistical measures paired with a regional paleoenvironmental record.

A chi-square test was used in this study to assess the hypotheses that (H_1) source use varied over time and (H_0) source usage was constant. Obsidian source use did in fact vary throughout time. Source diversity under both the Shannon Diversity index and Gini-Simpson Diversity index indicate that obsidian source use diversity was at its lowest during the TP/EH, while source diversity was at its highest during the early Holocene period. NSN source use was less diverse than in the early Holocene sample but more so than in the TP/EH sample. Distance-to-source statistics indicate that the early Holocene sample had the widest range on the landscape. The NSN sample had the second-highest range, while the TP/EH sample had the smallest overall range. The variance of distance-to-source measures was effectively the same for the TP/EH and NSN samples suggesting a period of lower mobility indicated by the obsidian sample. Taken together, the results of this study suggest that mobility was lowest during the TP/EH, highest during the early Holocene, and leveled out and decreased somewhat when NSNs emerged in the archaeological record during the early middle Holocene. The results of this study largely contradict my projected assumptions, and the MVT applied to the obsidian source in the study area does not fully explain differences in precontact mobility in the study area.

Chapters II and III of the following thesis briefly describe the environmental and paleoenvironmental background of the study area. Chapter IV describes the cultural background, while Chapter V examines the theoretical underpinnings of forager land use and mobility. Chapter VI describes the case study and outlines the predictions of the model, while chapter VII outlines the methods employed in the present study. Chapter VIII presents the results of these analyses. I follow these chapters with a discussion of the results in Chapter IX. Finally, I conclude with an overall synthesis considering the implications of the results on our understanding of precontact history in the study area and avenues for further investigation.

The results of this study have broader implications for understanding precontact land-use in the study area. While previous studies (Fowler 2014; Holmer 1997, Henrikson 2008; Long 2007; Plager 2001; Scheiber and Finley 2011) have made progress in characterizing precontact mobility in southeastern Idaho, the present study used a refined dataset that specifically focused on the TP/EH, early Holocene, and early middle Holocene periods to examine broad patterns of land use during the earliest periods of occupation in the study area. The results of this study contribute additional data and conclusions toward addressing the nature of mobility during these periods.

Chapter II Environmental Background

Study Area Boundary

The Idaho National Laboratory Cultural Resource Management Office (INL-CRMO) established the study area boundaries through the development of the Shoshone and Bannock Precontact Context, which is a document currently in development by the INL-CRMO and the Department of Energy in partnership with the Shoshone and Bannock Tribes, the Bureau of Land Management, the Bureau of Indian Affairs, and the Bureau of Reclamation (Henrikson et al. 2022; Henrikson et al. 2024). This thesis evolved in response to several research questions identified during the development of the context document (Henrikson 2022).

The study area was developed with reference to historical documentation, ethnographies, oral histories, tribal consultation, and archaeological reports (Henrikson et al. 2024). The ancestral and ethnographically documented Shoshone and Bannock had a wide territory encompassing much of the western United States (Figure 3). Euromerican settlers encountered Shoshone and Bannock people throughout what is today Oregon, Nevada, Idaho, Utah, Wyoming, and Montana (Boyle 2021). Incorporating all the traditional lands of the Shoshone and Bannock into the study area is not feasible. However, the study area boundaries by design capture important destinations and areas described in histories and ethnographies (Boyle 2021; Henrikson et al. 2024). As such, the study area boundary is sufficiently large enough to capture regional patterns of human behavior.

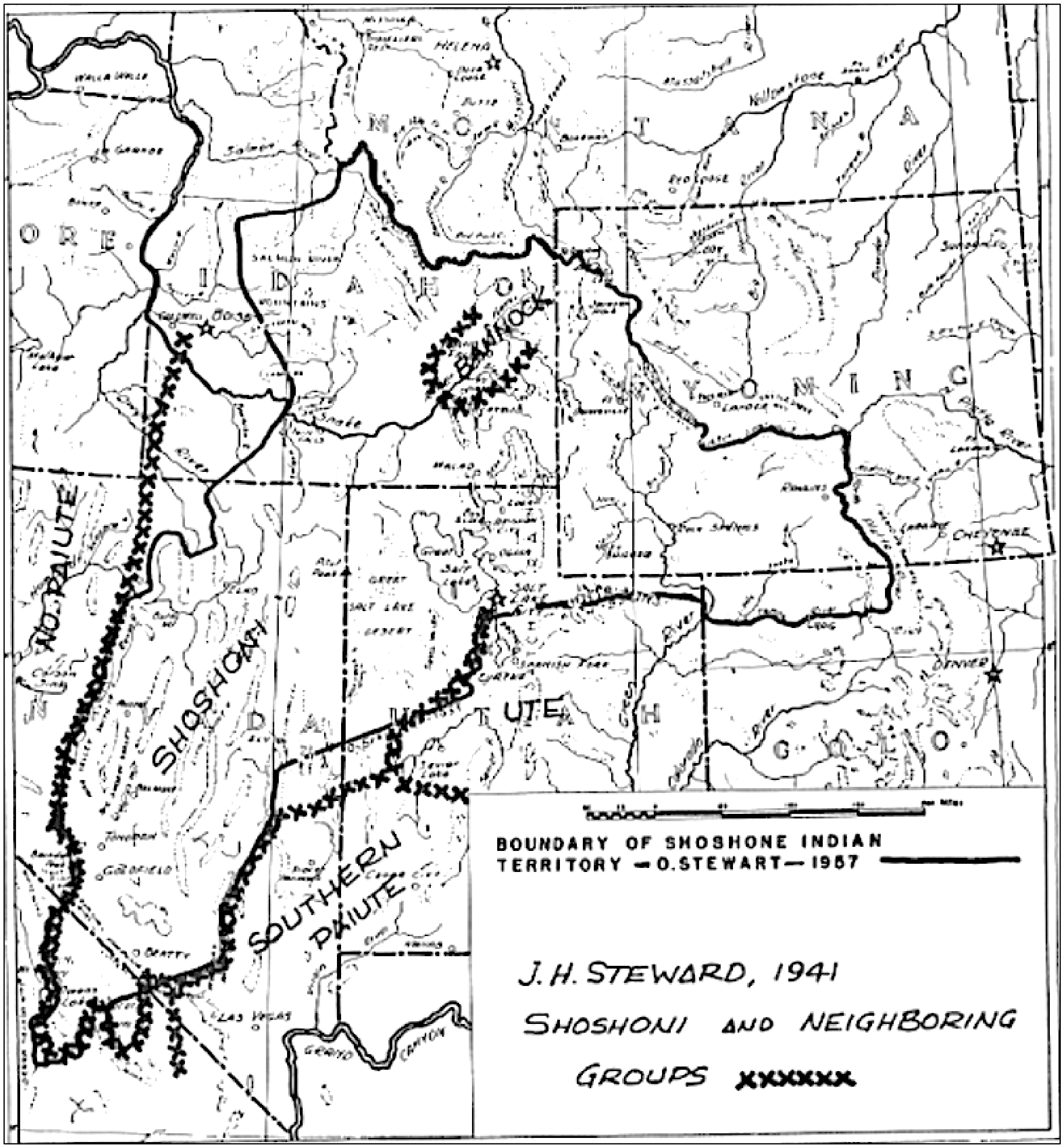

Figure 3. Shoshone and Bannock Territory from O.C Stewart (1970).

This research’s study area encompasses fifteen million acres (about 23,400 square miles) in eastern Idaho. It spans several physiographic provinces (Figure 4), including portions of the Columbia Plateau, the Basin and Range, and the Rocky Mountains

(Fenneman 1931). This chapter provides a brief environmental overview of the study area. Here, I describe each physiographic province's environmental setting.

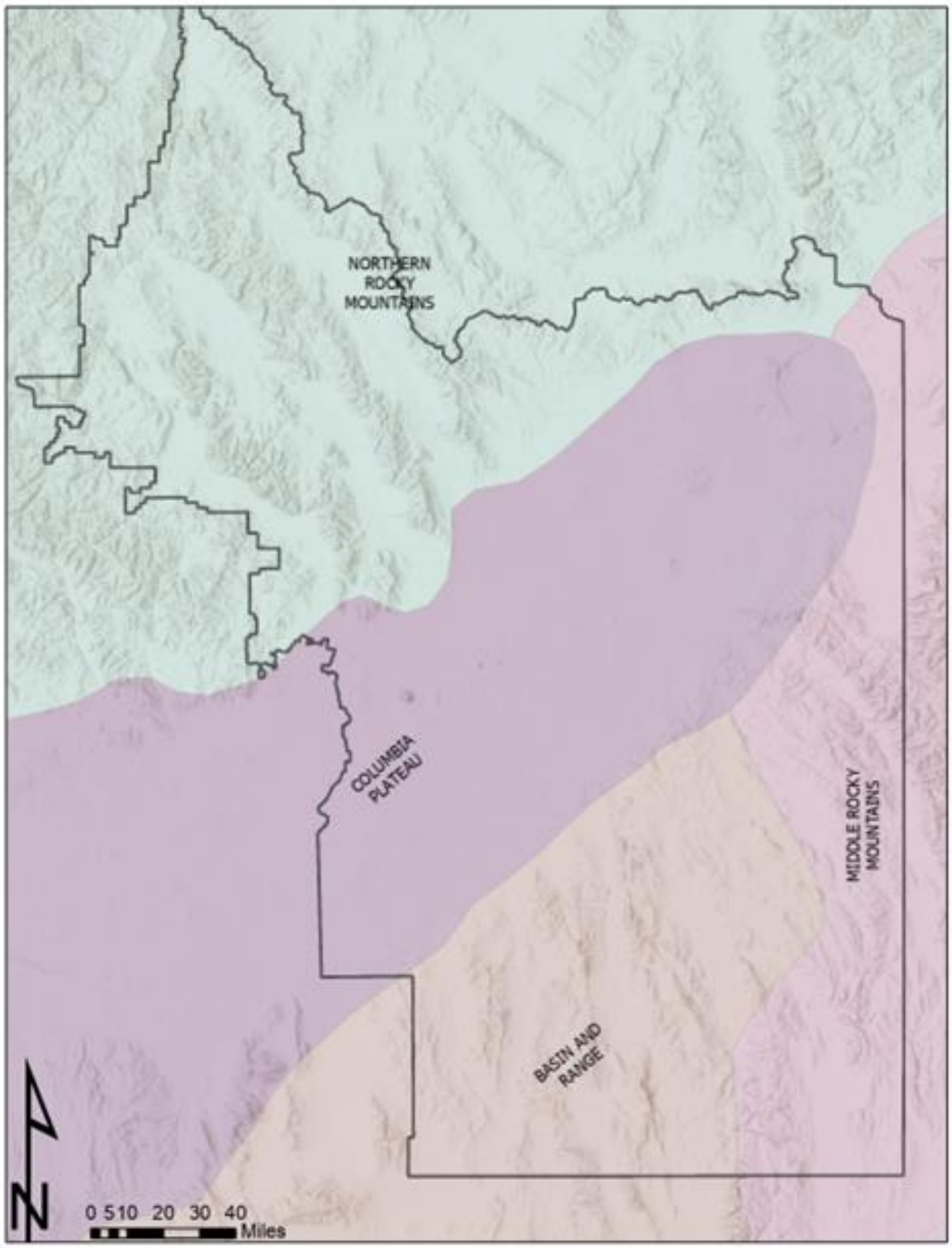

Figure 4. Physiographic Provinces within the study area boundaries.

Plateau Physiographic Province

Much of the study area encompasses the Eastern Snake River Plain (ESRP), which falls within the Columbia Plateau physiographic province (Fenneman 1931). Various geologic and hydraulic events developed the low-relief trough that forms the landscape of the ESRP. Basalt volcanic flows covered by aeolian sediment characterize the ESRP (Hughes et al. 1999). The basalt fields blanketing the region were created primarily by pahoehoe and a'a flows from fissure eruptions dating to the Quaternary period (Alt and Hyndman 1995; Kuntz et al. 1992). Most of the Holocene lava flows on the ESRP lack significant sediment accumulation and are visible testaments to recent volcanism. These flows include Hell's Half Acre, the Wapi Flow, and the Craters of the Moon National Preserve (Kuntz et al. 1992). Quaternary volcanism produced shield volcanoes (Cedar Butte and Middle Butte) and rhyolitic domes (Big Southern Butte and Middle Butte) (Hughes et al. 1999). The movement of the North American plate over a large magma chamber now in Yellowstone National Park created these prominent landforms (Alt and Hyndman 1995). The fissure eruptions formed topographic features unique to the ESRP, including basalt pressure ridges, knolls, embayments, lava tube caves, and kipukas.

The Snake River, the region's primary water source, crosses the plain in an arc stretching east to west from Wyoming into eastern Oregon before veering north to its confluence with the Columbia River in Washington. An additional major waterbody in the precontact period within the study area was Lake Terreton, an extensive lake system in the Pioneer Basin on the ESRP (Nace et al.1956). The Lake Terreton system, fed by streams and rivers whose headwaters originated in the surrounding mountain ranges, provided riparian and lacustrine habitats during the TP/EH (Stearns 1939). With an average annual rainfall of just 8–10 inches (Clark et al. 1998), numerous basins function as natural catchment locations for both snowmelt and spring rains, even though much of the ESRP lacks permanent water, as most water courses fail to reach the Snake River due to barriers caused by basalt lava flows and instead result in playas and shallow lakes (Malde 1991; Nace et al. 1975).

The ESRP consists of vegetation zones that vary based on elevation, with shadscale communities occurring at the lowest elevations and transitioning into sagebrush and grass communities interspersed with juniper woodlands at intermediate elevations (Bright and Davis 1982). The cold steppe of the ESRP became established during the Pleistocene, and preliminary studies suggest that the current precipitation and vegetation communities have remained relatively stable and consistent since around 7,000 years ago (Bright and Davis 1982). The ESRP is a high-elevation steppe characterized by aridisols and mollisols formed from aeolian and lacustrine deposits atop these lava flow expanses (USDA 2022). Natural processes deposited the alluvial sediments of the ESRP during the Pleistocene, consisting of sand, silt, and clays (Hughes et al. 1999).

Basin and Range Physiographic Province

The southern portion of the study area falls within the Basin and Range physiographic province (Fenneman 1931). The Basin and Range province differs floristically, hydraulically, and topographically from the neighboring Plateau province.

Notably, the Basin and Range section of the study area falls within the hydrographic Great Basin. The Great Basin is differentiated from surrounding provinces because its waterways have no outlet to the sea, as it comprises endorheic basins (Grayson 2011). The Basin and Range physiographic province is characterized by graben and horst topography, which resulted from the Earth's crustal extension and normal faulting since the late Tertiary Period. This geologic process produces the north-south oriented ranges (horst) and basins (graben) that are characteristic of the province (Grayson 2011). The north-south trending mountain ranges in the Basin and Range portion of the study area include the Bear River Range, the Portneuf Range, the Caribou Range, and the Bannock Range. Basin valleys between these mountains include the Malad, Pocatello, Cache, Portneuf, Curlew, and Arbon Valleys.

One of the region's main characteristics is its environmental variability linked to topographically defined elevation changes impacting the local hydrology and biotic species distribution (Grayson 2011). The upland forest belts of pine (*Pinus ponderosa* and *Pinus contorta*) with groves of aspen (*Populus tremuloides*) and mahogany (*Cerocarpus ledifolius*) grow because of the moisture captured by high-elevation escarpments (Grayson 2011). The shrub-steppe biotic community widespread throughout southeastern Idaho and northern Utah (Grayson 2011) comprises resilient low-growing plants that thrive in the Great Basin high desert. Intermediate elevations are dry and support species, including juniper, sagebrush, and grasses. The lowland vegetation comprises xeric-adapted species, including sagebrush, greasewood (*Sarcobatus vermiculatus*), and saltbush (*Artiplex* sp.).

Conditions are such in the lowlands that wetland systems form by stream runoff from higher elevations. These marshes support biotic communities of tule (*Scirpus* sp.), cattail (*Typha latifolia*), and other plant resources. During the terminal Pleistocene and early Holocene, many of these marshes connected to form larger pluvial lake systems such as Lake Lahontan and Lake Bonneville (Grayson 1993).

Rocky Mountain Physiographic Provinces

The far eastern section of the study area falls within the physiographic provinces of the northern and middle Rocky Mountains (Fenneman 1931). The Rocky Mountains are bordered on the east by the Great Plains, the Columbia Plateau to the west, and the Basin and Range along its southwestern margins. Originally, the Rockies formed as part of the Laramide orogeny (Kellog et al. 2004). The orogeny occurred because of the subduction of the Farallon Plate beneath the North American Plate (Bird 1988; Liu and Currie 2016) around 80-55 million years ago (English and Johnston 2004). The subduction of these plates caused block thrusts, which contributed to crustal deformation and mountain building. The Rocky Mountains additionally owe their high elevations to a later phase of epi-orogenic uplift (Abbott et al. 2022; Karlstrom et al. 2012). Pleistocene glaciation shaped the topography of the Rocky Mountains by creating moraines and cirques (Pierce 1979).

Major mountain ranges in the study area include the Bitterroot, Lemhi, Lost River, and Beaverhead. These mountains range in elevation from 2,000 m (7,000 ft) asl to 3,660 m (12,000 ft) asl and trend northwest/southeast. The mountains descend southeast beneath the Snake River Plain's more recent lava flows. The intermontane valleys, around 40 km (25 mi) long and 8–16 km (5-10 mi) wide, dissect the mountain ranges (Sadek-Kooros 1972:1). Among the key valleys are Birch Creek, Lemhi, and Pahsimeroi. Erosion and diastrophism created these valley basins between ranges (Scholten 1960). Quaternary block-faulting is the primary feature behind the presence of basins and uplands (Scholten 1960). However, due to repeated glaciations, their presence can also be explained by basin filling and stream aggradation (Williams 1961).

The biotic communities of the Rocky Mountains are similar to neighboring portions of the study area, with a few differences. Sagebrush and grasses blanket the valley and talus slopes, while willows and cottonwoods grow along the sides of streams and creeks. Much of the forest is lodgepole pine in the middle altitudes, with sporadic stands of Douglas fir (*Pseudotsuga taxifolia*) and Subalpine fir (*Abies lasiocarpa*) in the upper altitudes. There are sporadic occurrences of pine (*Pinus ponderosa*) and mountain mahogany (*Cercocarpus montonus*) at higher elevations within these mountain ranges.

Chapter III Paleoenvironmental Background

Regional climate has experienced several major shifts during the precontact period, with these climatic shifts demonstrating significant local variation. The nature of sedimentation and recent volcanism in the study area (Henrikson 2008) have constrained the dataset for paleoenvironmental conditions, and the focus of archaeological investigations in southeastern Idaho has not been conducive to collecting paleoclimatic data. However, preliminary studies have been conducted within the study area boundaries (Bright and Davis 1982; D. Butler 1984, 1986; Colman and Pierce 1986; Davis et al. 1986; Gianniny et al. 2002; Pierce and Scott 1982). Additionally, the broad application of regional studies (Fulkerson 2012; Kovanen and Easterbrook 2002; Whitlock 1992) and environmental studies conducted in areas adjacent to the study area (Cummings and Puseman 2005; Moser and Kimball 2009; Oviatt 1997) further support these local models.

When taken together, these studies illustrate the complex nature and effects of climate change in southeastern Idaho. While environmental conditions are not the only factor that affects human behavior, fluctuations in climatic conditions often elicit humans to alter their subsistence strategies and associated land use. Understanding the nature and chronology of climatic changes locally can provide perspectives on past lifeways and landscape-level patterning of the archaeological record.

While many of the modern flora and fauna species have existed in the region since the Pleistocene, eastern Idaho’s terminal Pleistocene and early Holocene environments differed from current conditions. Most notably, Pleistocene lakes were present in the landscape (Nace et al. 1956) where today they exist only as playas and ephemeral ponds or are drastically reduced in size. During the Pleistocene epoch, extinct megafauna such as those belonging to the genera *Mammuthus*, *Camelops*, *Equus*, *Bison*, and others roamed the landscape, with at least some coexisting with the region's early inhabitants (Grayson and Woolfenden 2016; Henrikson et al. 2017). Cold alpine glaciation in the mountains characterized the terminal Pleistocene environment of the study area (Colman and Pierce 1986; Pierce and Scott 1982), and the timber belts in the western US were lower (Minckley et al. 2004). Conditions were cooler and more arid for much of the terminal Pleistocene period (Thompson 1984), though a gradual warming trend and deglaciation accelerated around ca. 14,730-11,400 cal. BP (Kovanen and Easterbrook 2002).

Terminal Pleistocene and early Holocene climatic research in the study area has centered primarily on understanding the timing and nature of Lake Terreton's high stands (Amidon et al. 2016; Gianniny et al. 2002; Nace et al. 1975; Steele 2016). Lake Terreton is an internally drained basin, surrounded by the Lemhi and Lost River Mountains to the north and by the Snake River and steppe environment of the ESRP to the east and south. In the past, the basin was filled by glacial melt from the mountain ranges and was fed by the Big Lost River (Amidon 2016).

Research on Lake Terreton has been limited and, therefore, represents an area where further geologic, hydrographic, and palynological research is necessary. However, preliminary research has contributed to a course-grained characterization of this feature. Stearns et al. (1939) pioneered research on Lake Terreton. This study established the terminal Pleistocene age of the lake based on fossil evidence of Pleistocene megafauna and established a highstand for the lake at 1463 m (about 4799.87 ft) asl. Nace et al. (1975) concurred with this highstand and worked to further characterize Lake Terreton with core sampling and found more Pleistocene-aged faunal remains. Two additional high stands were proposed by Forman and Kaufman (1997), who placed one highstand 10 meters above where Nace et al. (1975) and Stearns (1939) had placed it. Gastropods were used to date this highstand at 22,000 cal. BP consistent with the timing of the Last Glacial Maximum (LGM).

More recent work has been built upon these previous studies. Gianniny (2002) produced optically stimulated luminescence (OSL) ages that suggest a high stand at 22,000 cal. BP and a second high stand around ca. 11,500 cal. BP. Amidon et al. (2016) generated additional OSL and radiocarbon ages for the high stands that concur with previous studies with a high stand at ca. 22,000 cal. BP at around 1463 m (about 4799.87 ft) asl. Amidon et al. (2016) suggest that the Big Lost River Flood produced the high stand. Glacial melt from the surrounding mountain ranges continued to feed Lake Terreton, creating additional high stands at ca. 15,000 cal. BP and ca. 11,000 cal. BP (Amidon et al. 2016). These high stands for Lake Terreton are consistent with the lake-level history of Lake Bonneville, which produced the Gilbert shoreline during the Younger Dryas ca. 11,500 cal. BP (Oviatt 1997). Bear Lake also had high river inputs between ca. 13,800 cal. BP and ca. 10,800 cal. BP and was maintained by deglacial conditions (Moser and Kimball 2009), though the effect on lake levels was moderate, perhaps resulting from increased evaporation followed by a drier interval between 10,800 and 9,200 cal. BP. Amidon suggests regressed lake levels between 15,000 cal. BP and

11,400 cal. BP roughly during the Younger Dryas for Lake Terreton.

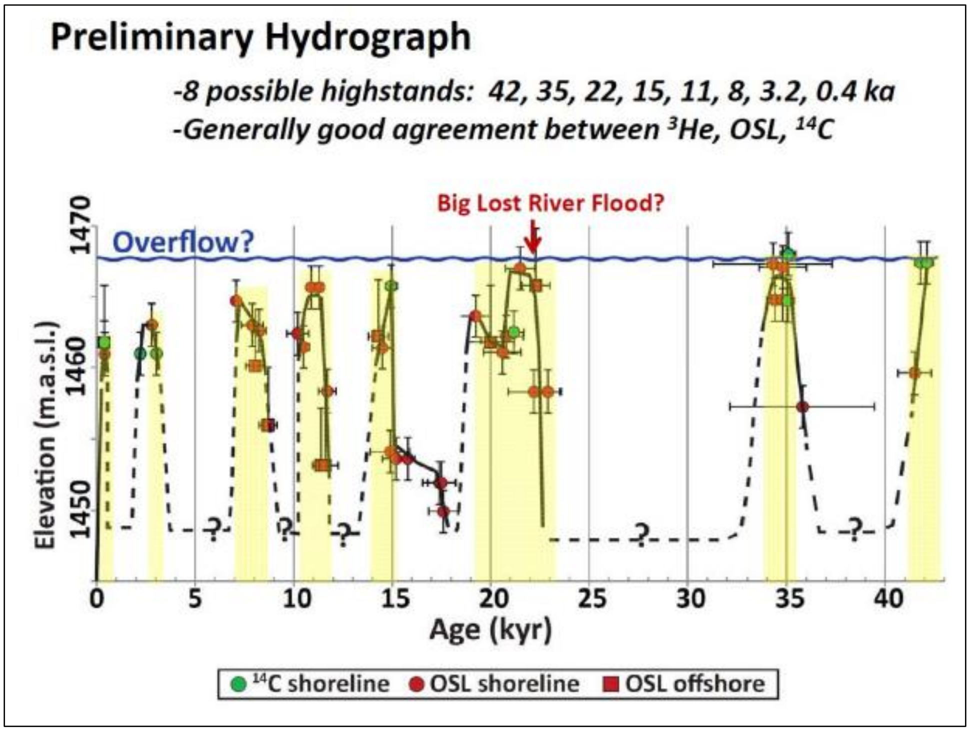

Figure 5. Preliminary hydrograph from Amidon (2016).

Palynological and geologic data provide further evidence for climatic changes during the terminal Pleistocene and early Holocene. Following the Bølling–Allerød interstadial, the onset of the Younger Dryas ca. 13,000–11,700 cal. BP marks the return of glaciation in North America (Meltzer and Holliday 2010), which interrupted the general warming and drying trend during deglaciation (Davis et al. 2009; Kovanen and Easterbrook 2002). However, the effects of the Younger Dryas in western North America were variable and may not have always had a cooling effect or increased precipitation (Fulkerson 2012; Meltzer and Holliday 2010; Whitlock 1992).

The vegetation history of the study area during the terminal Pleistocene and early Holocene periods varies widely, but generally, conditions were cooler than today. Rattlesnake Cave, for example, was characterized by a cold and dry sagebrush steppe environment (Davis 1981), and Swan Lake supported a cold spruce forest (Bright 1966). The climate history of Minnetonka Cave (11,200–9,000 cal. BP) during the early Holocene additionally indicated a cooler and wetter period (Lundeen et al. 2013). A warming trend began ca. 12,900 cal. BP at Swan Lake (Bright, 1966), whereas Grays Lake was cool until around ca. 11,500 cal. BP (Beiswenger 1991). Rattlesnake Cave, however, began to transition to warmer and drier conditions around 13,400 cal. BP (Davis 1981). Cleveland Lake in southern Idaho had lower lake levels between 10,240 and 7,480 cal. BP (Davis et al. 1986) coinciding with a shadscale maxima between 10,000–8000 years ago (Davis et al. 1986). The warming trend began after the Younger Dryas and prompted a gradual expansion of the sagebrush steppe and the movement of biotic communities to higher elevations in the west (Davis et al. 1986; Mehringer et al. 1984; Minckley et al. 2004).

The transition from cool to warm conditions occurred at various times, rates, and intensities in the Pacific Northwest and adjacent regions but centers around the period after the Younger Dryas (Fulkerson 2012). After the start of the early Holocene, pollen profiles document increased aridity and temperatures in southeastern Idaho and surrounding areas (Beiswenger 1991; Bright 1966; Cummings 2002; Davis 1981; Lundeen et al. 2013). The expansion of the xerophytic plant communities throughout the West attests to the transition to these conditions (Bright 1966; Bright and Davis 1982; Davis et al. 1986; Mehringer et al.1977; Mehringer et al.1984; Mehringer 1985, 1996), particularly the increase of sagebrush pollen and the decrease of conifer pollen (Mehringer et al. 1984).

Following the Younger-Dryas, annual precipitation began decreasing. Amplified solar radiation continued in western North America, which began around 12,000 years ago and lasted until 6,000 years ago (Whitlock 1992:11). This amplification of solar radiation resulted in a decrease in effective moisture and an increase in temperature peaking throughout the region approximately 9,600 cal. BP (Whitlock 1992; Minckley et al. 2004).

While there are conflicting records regarding the timing of maximum aridity, the early Holocene warming continued into the early middle Holocene. The Swan Lake palynological record places peak aridity at ca. 7,800 cal. BP (Bright 1966; Bright and Davis 1982). Gray's Lake experienced peak xeric conditions during the transition from the early Holocene to the middle Holocene, around ca. 9,500 cal. BP (Beiswenger 1991). Data from Middle Butte Cave on the Idaho National Lab suggests a thermal maximum around 7,000 years ago (Bright and Davis 1982), and the pollen records of Rattlesnake Cave indicate a thermal maximum ca. 8,400 cal. BP (Bright and Davis 1982, Davis et al. 1986). Climate data from Minnetonka Cave demonstrates a consistent warming trend after 7,200 cal. BP (Lundeen 2013) and the area around Cleveland Lake had greater aridity established by the time of Mazama tephra deposition (Davis et al. 1986), consistent with the Bonneville Basin environmental record, which exhibits the expansion of xeric-adapted species between ca. 11,000 cal. BP and the deposition of Mazama tephra (Spencer et al. 1984). Wigand (1997), however, exemplifies that rather than static middle Holocene aridity, inter-annual variability in pollen accumulation better describes the

Holocene, based on the palynological record of Scaredy Cat Cave within Craters of the Moon National Monument which shows the presence of both wet and dry adapted species.

It should be noted that the incongruity between Holocene vegetation histories for different sites in eastern Idaho may be explainable as variability in responses to changes in seasonal radiation maxima between early summer and late summer. Davis et al. (1986) suggests that seasonal radiation influences the timing of temperature maxima and that lower-elevation vegetation ecotones are more sensitive to early growing season temperature maxima. In contrast, vegetation ecotones at higher altitudes respond more to the length of the growing season (Davis et al. 1986). Therefore, lower-elevation vegetation is sensitive to drought conditions, whereas higher-elevation vegetation is sensitive to temperature. Incongruent vegetation histories may also be explained by sampling and dating errors in reconstructions.

In sum, while Lake Terreton experienced many fluctuations between the terminal Pleistocene and early Holocene, data suggest high stands around 22,000 cal. BP (Gianniny 2002), 15,000 cal. BP and 11,000 cal. BP (Amidon 2016). The lake history during the early Holocene transition to the middle Holocene is poorly understood in the study area, but wetlands in the Great Basin were desiccating or evaporating from ca. 9,500-7,800 cal. BP (Louderback and Rhode 2009; Oviatt et al. 2003; Thompson 1992; Wigand and Rhode 2002). Salt Lake levels were also at their premodern minimum during the early middle Holocene (Murchison 1989).

The palynological climate history of the region is variable. Still, it describes a general trend towards xeric conditions beginning during the transition from the

Pleistocene to the Holocene, which accelerated after the end of the Younger Dryas. Peak aridity centers between 9,500 and 7,000 years ago (Beiswenger 1991), which coincides with the transition from stemmed points toward NSNs (Holmer 2009). Ancestral populations in the study area and the broader Desert West shifted their subsistence pursuits to incorporate a broader array of resource patches, and they were no longer tethered to the wetlands and the basin valleys as they had been before the transition to a more arid environment (Rhode and Louderback 2015).

Chapter IV Cultural Background

Southeastern Idaho Cultural Chronology

The fifteen-million-acre study area on the ESRP has thousands of documented archaeological sites (Figure 6). These localities consist of isolated artifacts, surface scatters, and richly stratified locations demonstrating multiple occupations. The presence of Clovis, Folsom, and stemmed points evidence terminal Pleistocene and early Holocene occupation (B. Butler 1986), while NSNs are the first early middle Holocene occupation time marker. A series of other side and corner notched, stemmed, and lanceolate points suited for use with the dart and atlatl, and in the late period, bow and arrow technologies followed NSNs (Figure 7) (Holmer 2009).

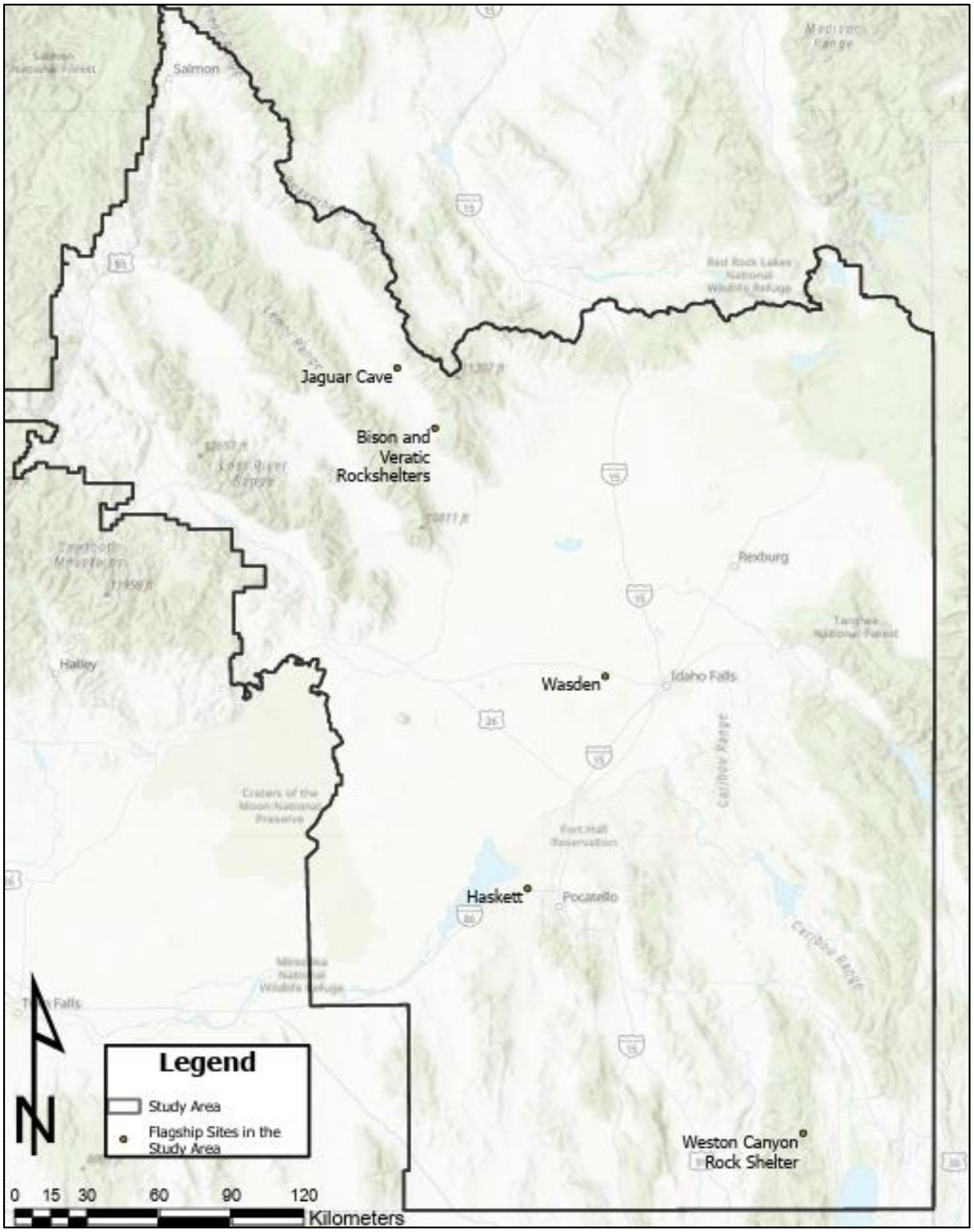

Figure 6. Flagship sites in the study area.

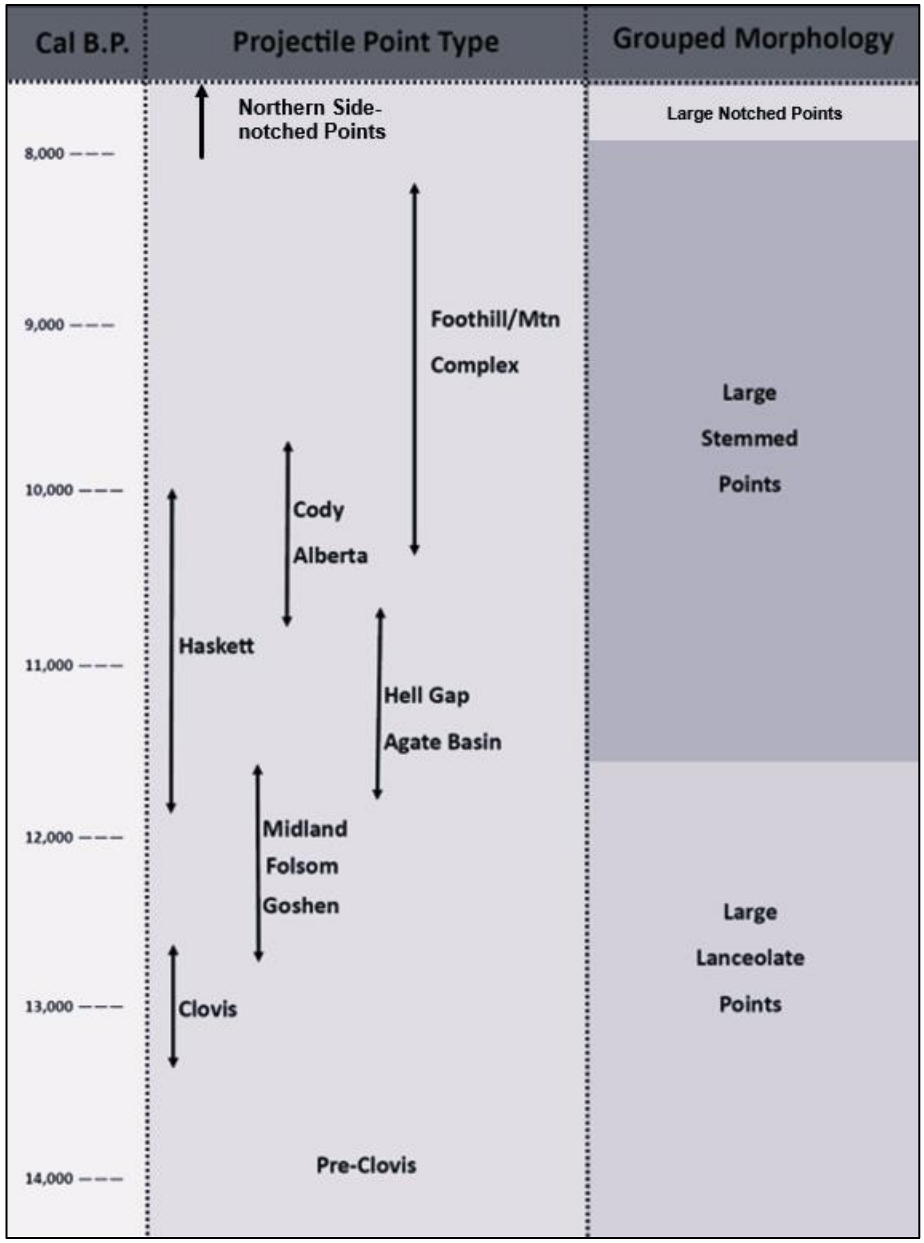

Figure 7. Diagnostic Projectile Point Chronology of Eastern Idaho.

The earliest occupations in Idaho extend as far back as 16,500 cal. BP with projectile points in stratified deposits from the Coopers Ferry site resembling Western Stemmed artifacts (Davis et al. 2019). While Clovis occupation of the area is not well documented, fluted points remain the earliest uncontested technological complexes in the region. Between 13,500–12,800 cal. BP, people using Clovis technologies lived in western North America (Hamilton and Buchannon 2007). They were highly mobile and adapted to the glacial environment. The Clovis point type is commonly associated with big game hunting and processing; however, in the northern Great Basin and eastern Idaho, there is no unequivocal association between extinct fauna and Clovis projectile points (Grayson and Meltzer 2002). While investigations have not recovered Clovis points from datable stratified contexts in the study area, studies have resulted in many examples from surface contexts, such as the notable Simon Cache (Butler 1963) and others (Titmus and Woods 1991). A perspective held by many archaeologists contends that the disappearance of Clovis in the precontact North American technological sequence resulted from a changing environment caused by the Younger Dryas, the extinction of megafauna, and less mobile adaptations (Haynes 2002).

The emergence of Folsom technology in southeastern Idaho coincides with evidence from the Northwestern High Plains (Frison 1991), and regional variation in fluted technologies and adaptations are characteristic of the post-Clovis period (Haynes 2002). Folsom points date to ca. 12,800–11,900 cal. BP on the ESRP (Holmer 2009) and coincide with the Younger Dryas. The frequency of Folsom and Midland finds in the study area is much higher than Clovis. The ESRP also represents the western extent of the Folsom tradition in western North America.

Investigations have documented points from the early Holocene period in datable contexts in the study area. Points ascribed to the early Holocene period include stemmed points such as Scottsbluff, Plainview, Angostura, Alberta, Agate Basin, Haskett, Eden, Hell Gap, Parman, and Foothill Mountain types (Holmer 2009). Except for the Parman type, these styles are more typical of the Central Rocky Mountains and Northwestern High Plains to the east of the ESRP (Kornfeld et al. 2010). Haskett points occur in stratified contexts in southeast Idaho, such as the type site (Butler 1965b), Bison and Veratic Rockshelters (Swanson 1972), Redfish Overhang (Sargeant 1973), and Wilson Butte Cave (Gruhn 1961). However, most Haskett points occur in surface contexts throughout the study area. The suggested age range for Haskett's in the study area is ca. 11,900- 10,200 cal BP (Butler 1965a, 1965b; Holmer 2009; Marler 2004; Yohe and Woods 2002) By 10,000 years ago, the extinction of North American megafauna (excluding bison), the retreat of the glaciers, and a warming climate resulted in diversification in other food resources for the region's early inhabitants, including smaller mammals, fish, and vegetal resources (Green et al. 1998).

The emergence of smaller and more varied projectile point types ca. 8,200 cal. BP in the archaeological record indicates the beginning of atlatl and dart technology in the West (Butler 1978; Henrikson and Finn 2023; Holmer 1972; Miller 1972; Swanson 1972). NSN points appear to have emerged around the height of the warming and drying trend in the region at about 8,200 cal. BP (Henrikson 2002; Henrikson and Finn 2023; Holmer 2009; Miller 1972; Swanson 1972). Compared to the early Holocene, the appearance, fluorescence, and spread of NSN points in the region indicates changes in land-use strategies (Butler 1978; Long 2007; Miller 1972; Swanson 1972). NSNs are routinely found in surface contexts and occur in large numbers at sites such as the Bison and Veratic Rockshelters (Swanson 1972) and Weston Canyon Rockshelter (Miller 1972).

Middle Holocene occupation in the study area continued with a proliferation of varied projectile point types following NSNs and Stemmed-indented base points. These include Elko series points, Humboldt series points, and McKean projectile points (Holmer 2009). The middle Holocene period is traditionally characterized by a climatic transition toward more warm and arid conditions (Beiswenger 1991; Bright 1966, Bright and Davis 1982) where subsistence (Butler 1968, 1986; Miller 1972) and land-use strategies diversified and changed as an adaptation to a more marginal environment (Bettinger 1999; B. Butler 1986). It should be noted, however, that current research indicates that middle Holocene and late Holocene environmental conditions in the western hemisphere demonstrate a range of fluctuations in temperature and effective moisture (e.g., Alley et al. 1997; Broughton et al. 2008; Fulkerson 2012; Grayson 2011; Mayewski et al. 2004; Shuman and Marsicek 2016).

The late precontact period in the study area (1,500 cal. BP- present) is represented by small projectile points. These projectile point types include Rosegate Corner-notched points, Desert Side-notched series points, and Cottonwood Triangular points (Holmer 2009). This period is also associated with the Intermountain Ware pottery tradition and is represented by potsherds in surface and buried contexts (Finley et.al 2017). The Lewis and Clark expedition, which produced the first written account of the area and its people, concluded the precontact period in eastern Idaho.

The Seasonal Round of the Shoshone and Bannock

Some researchers (Henrikson 2002, 2008; Holmer 1994; Swanson 1972) suggest a link between the archaeological record and the ethnographically recorded Shoshone and

Bannock, and that this continuity was likely established deep in antiquity. Boyle (2021), Finley et al. (2015) and Thomas (2019) established this antiquity with their work in the broader Numa culture area. Shoshone and Bannock bands obtained resources in seasonal rounds (Henrikson 2003, 2008; Holmer 1997). This seasonal round included extracting and using various resources acquired from multiple environments, including lava margins, riparian and lacustrine zones, plains, and uplands (Henrikson 2003; Ringe 1992). The seasonal availability and distribution of prey and plant resources prompted these seasonal movements during the precontact period (Steward 1938).

Like other tribes in the Plateau and Great Basin culture areas, the Shoshone band names reflect primary food sources. Designated groups in the study area (Figure 8) include the Tukudeka, which means “sheep-eaters,” who lived in the mountains. Additional Shoshone tribes include the Agaideka, who consume salmon; the Padehiya-deka, who eat elk; the Yahandika, who consume groundhogs; the Bangwedeka, who eat fish; the Kamuduka, who consume rabbits; the Tubaduka, who eat pine nuts, the Hukideka, who consume seeds, and the Kutsundeka, who eat buffalo (Liljeblad 1972; Lowie 1909: Murphy and Murphy 1960; Steward 1938). Band membership was fluid (Steward 1938).

The Tukudeka (sheep eaters) and Agaideka (salmon eaters) are commonly known as the Lemhi Shoshone. These bands lived along the Salmon, Middle Fork of the Salmon, and Lemhi Rivers, in the Birch Creek and Pahsimeroi Valleys, and the Lemhi, Bitterroot, Lost River, Beaverhead, White Knob, Pioneer, Boulder, and the Sawtooth Mountains and foothills (Liljeblad 1972; Ray et al. 1972; Steward 1938). The Tukudeka bands primarily occupied the uplands, hunting bighorn sheep (Liljeblad 1972). The Agaideka bands occupied the lower elevations and relied on resources along the river corridors, particularly salmon in the spring and fall. After spring fishing, the Agaideka traveled to Camas Prairie to harvest camas and interact with other bands (Murphy and Murphy 1960). As winter approached, the Tukudeka and Agaideka joined to participate in communal bison hunting (Lowie 1909).

Hukideka and Bangwedeka lived in the expansive sagebrush steppe of the ESRP as well as the lands around Snake River and its tributaries (Liljeblad 1972). In addition, southern and southeastern Idaho was home to the Kamuduka (rabbit-eaters), Tubaduka (pine nut-eaters), and Yahanduka (groundhog-eaters) bands, whose territories also extended into adjacent states (Steward 1938; Ray et al. 1938).

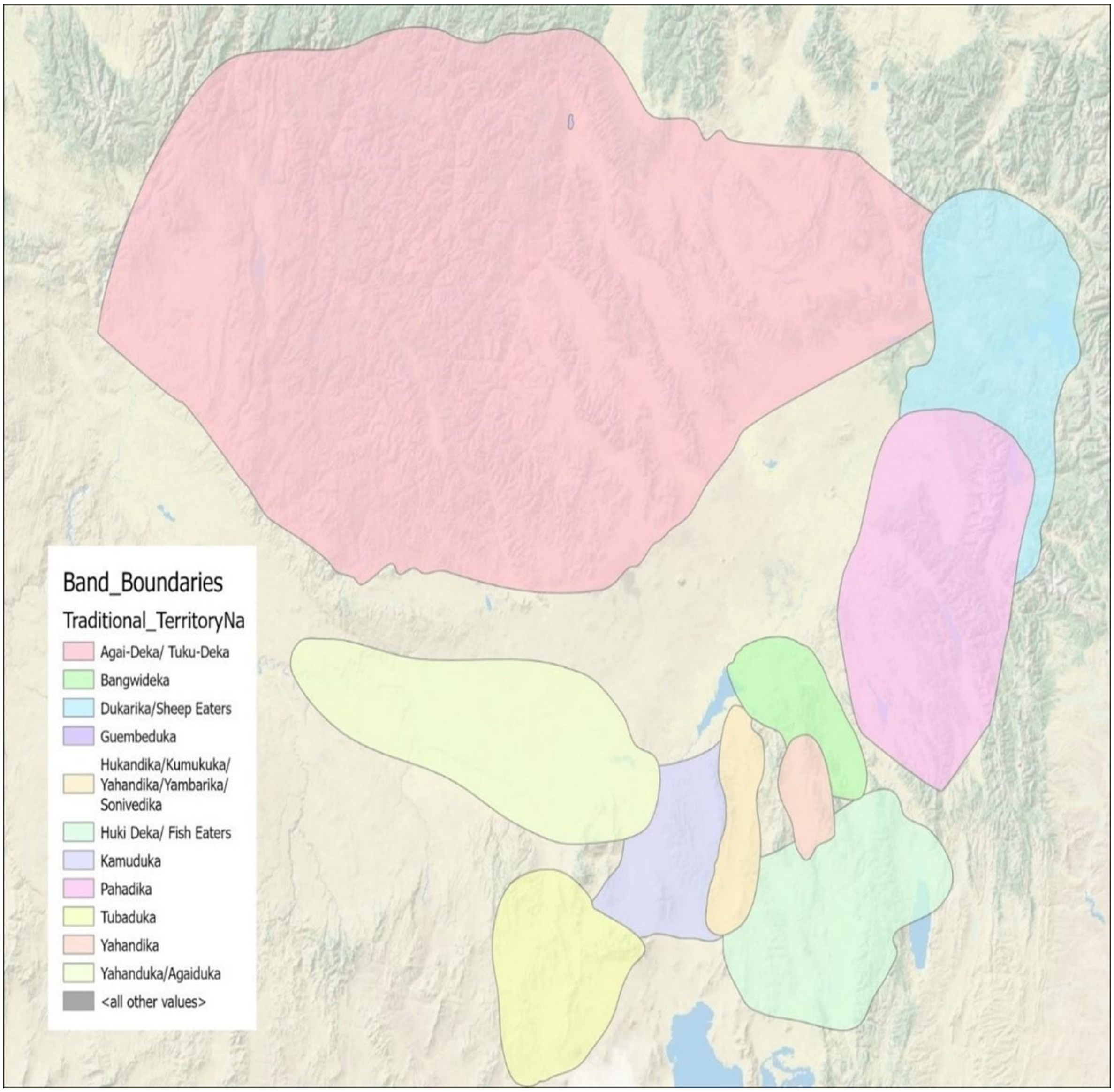

Figure 8. Band Territory map. Adapted from Murphy and Murphy (1960), Steward (1938), and Ray et al. (1938) by the INL-CRMO.

In eastern Idaho, the nomadism of the Bannock has made it difficult for ethnographers to establish a traditional territorial location (Ray et al. 1938:412), but they are placed within the landscape of the ESRP (Steward 1938; Murphy and Murphy 1960;

Ray et al. 1938; Hoebel 1939.) The general belief among ethnographers (Liljeblad 1972) is that the Bannock, who speak a Northern Paiute dialect, are recent immigrants to the area. However, Murphy and Murphy (1986) surmise that the Bannock, despite a linguistic distinction, maintain that they are a component of the Shoshone groups occupying southern Idaho. Ray et al. (1938) state that informants and historical records show that Shoshone and Northern Paiute bands in the northern Great Basin and Columbia Plateau areas saw themselves collectively as “the people” and often formed composite groups (Parry 2005; Ray et al. 1938), and Steward (1938) observed intermixing of Shoshonean and Bannock groups along the Snake River. The connections between the Shoshone and Bannock groups and the intermixing of the groups likely extend deeper into antiquity before the acquisition of the horse, and archaeological evidence points to a continuity between the lifeways associated with Bannock bands and artifact assemblages associated with those lifeways (Holmer 1994).

Traditionally, Euromericans considered the Bannocks to be bison hunters, moving across the SRP following the bison herds (Ray et al. 1938; Steward 1938). Although ethnographies suggest that bison hunting is primarily an adaptation brought to the area by horses, bison are the primary animals identified from ancient cold storage cave features, as well as numerous buried sites in the study area (Henrikson 2002, 2003, 2004). These assemblages thus attest to the antiquity of bison hunting and associated lifeways in the study area.

In the Fort Hall Bottoms, the Shoshone and Bannock people spent the winter collectively in sizable villages (Steward 1938:203). Small or extended family groups would depart from the winter camp as spring came and head to other places, such as the

Bear River or Yellowstone to the east, the salmon runs on the Snake River to the west, or the mountains and the Salmon River country. While some traveled northwest over the ESRP to harvest camas in the Camas Prairie, others ventured into the South Hills searching for pinyon nuts, berries, elk, and deer. Other parties commonly traveled east, across the continental divide, into western Montana and Wyoming in the early fall to participate in communal bison hunts. The scattered small and extended family groups would reconvene in winter villages, returning to the Fort Hall lowlands after the big hunts. After winter, when spring came, groups would again disperse into smaller units, albeit they would go to places different from where their specific group had gone the year before (Steward 1938).

Chapter V Theoretical Framework

Mobility influences many features of hunter-gatherer lifeways and is a distinctive characteristic of foraging cultures. I define mobility as the capacity and need to move from one place to another. It results from "the moment in time, the type of movement, and the motivation for mobility" (Wendrich and Bernard 2008:6). The accessibility and availability of resources structures foraging behavior and, thus, the mobility of cultures (Kelly 1983; 2013). The impact of mobility on the organization of hunter-gatherer lifeways is the impetus for research to understand its structure.

Middle Range Theory

Archaeologists have constructed various theoretical frameworks to examine variations in forager mobility. Mobility plays a role in the organization of foraging lifeways and, by extension, the patterning of material culture. This relationship has driven archaeologists toward the categorization of different mobility strategies (Kelly 1992). Early efforts separated societies by their degree of nomadism and sedentism. However, these early frameworks were lacking because they reduced complex systems into very few dimensions that could not accommodate individual behaviors and instead focused on the scale of whole group movements (Kelly 1992).

Binford (1980) moved beyond these simplistic schemes and differentiated mobility strategies by placing them somewhere along a continuum, with f*oragers* on one end and c*ollectors* on the other. These two poles on the continuum represent ideal categories of two distinct strategies with unique traits. Binford (1980) posited that hunter-gatherer systems fall along this continuum and demonstrate mixed characteristics of both ideals.

Primarily, the distinctive traits that separate the two are contrasted as indicative of residential vs. logistical strategies (Binford 1980). Foragers under this model employ a residentially mobile strategy, relocating their base camps to resource areas and foraging a limited distance from this base. In contrast, collectors practice a logistically mobile strategy where expediently organized groups dispatch from a residential base to different areas to extract specific resources, which they then bring back to their base camp (Binford 1980). Binford hypothesized that societies that occupy environments where seasonality was low and resources were homogeneously distributed in the environment (such as tropical ecotones) were more likely to be weighted toward the forager ideal, whereas societies that live in environments in which resources were heterogeneously distributed (such as patchy environments) within the landscape and where seasonality was higher would be more likely to demonstrate traits indicating a logistically oriented land-use strategy typical of the collector ideal (Binford 1980; Bettinger 1991). This model was influential in the development of archaeological mobility studies and provided the foundations for other foraging models (Thomas 1983), as well as models opposed to the continuum (Bettinger and Baumhoff 1982).

Binford’s (1980) forager-collector continuum was not intended to segregate societies by type. Binford’s model functions as an analytical tool to understand how different strategies might condition material patterns of past societies (Kelly 1992). Under the forager-collector continuum, archaeological sites are produced in predictable ways reflecting mobility and land-use strategies. Residentially mobile groups create base camps and extraction sites (locations), and logistically mobile groups produce these and other site types, including field camps, stations, and caches (Binford 1980). Within these different site types, site distributions and assemblages should reflect site function and, therefore, indicate the structure and land-use strategy of the society that produced the associated material culture (Binford 1980). Thomas (1983) expanded on the site type categories first described by Binford (1980) and translated them into a Desert West context in central Nevada; rather than being seen as diametrically opposed concepts, logistical and residential mobility may be used in different combinations in various contexts (Binford, 1980:19).

Thomas's (1983) discussion of settlement-subsistence systems variability within similar cultures at the band level, and how this variability is expressed archaeologically, highlighted the importance of understanding how spatial distributions of sites and assemblages can take on a distinct regional pattern. Occupation and task-specific sites become arranged across the landscape in annual cycles and pattern the archaeological record on a large scale (Thomas 1983:87-88). Long-term processes of hunter-gatherers positioning and repositioning within physical space create landscape-level site patterning (Kelly 1980; Thomas 1983:88). This positioning structures the cultural landscape and radiates out from residential base camps as hunter-gatherers engage in specific movements (Figure 9) like establishing extraction locations or field camps, for example (Binford 1982; Thomas 1983:88). When this annual pattern occurs over thousands of years, long-term mobility patterns are established, only changing in response to scarcity in local resource availability or for sociodemographic reasons (Thomas 1983: 90).

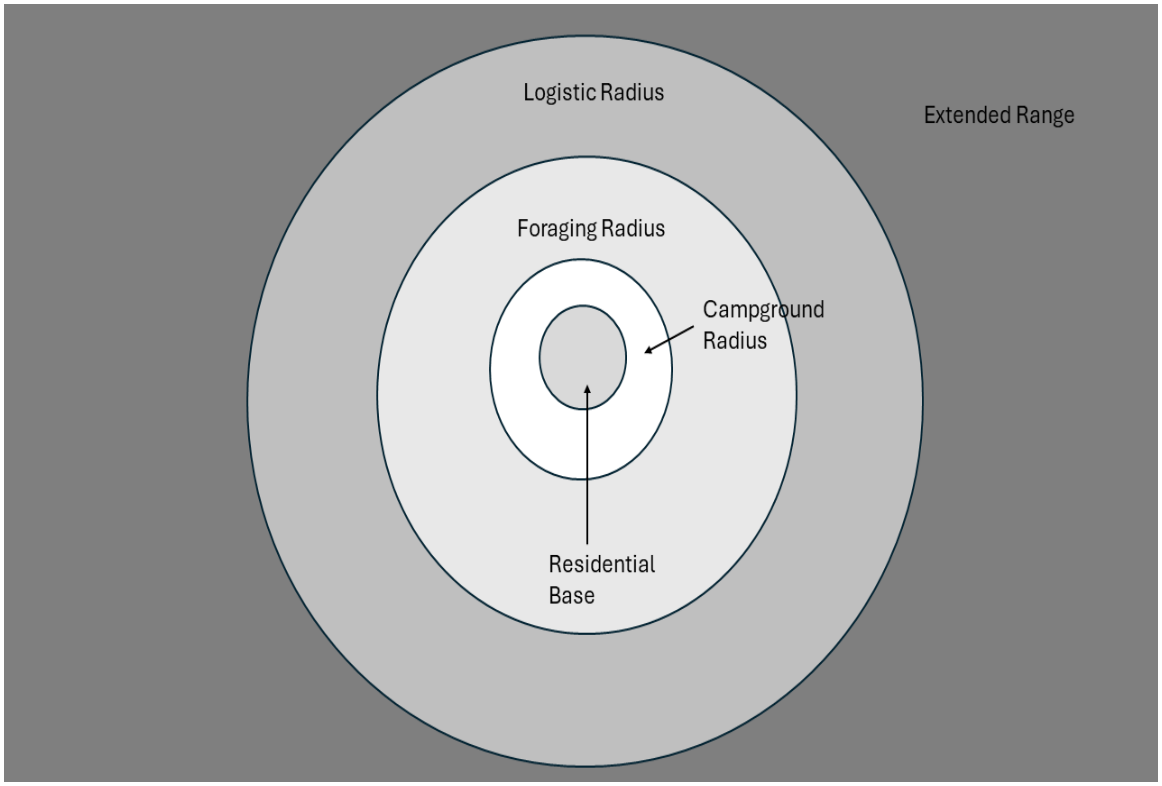

Figure 9. Logistic foraging strategy adapted from Thomas (1983).

Understanding the catalysts conditioning landscape patterning is essential to examine the long-term patterning of hunter-gatherer mobility in the study area. This study utilizes concepts under the Optimal Foraging Theory (OFT) framework and the MVT as an analytical device to examine mechanisms behind the incongruity in the long-range mobility patterns of eastern Idaho precontact hunter-gatherers between the early Holocene and middle Holocene as observed by Long (2007).

The Marginal Value Theorem and Mobility

Under the OFT framework, the MVT model predicts the optimal time a forager should stay in a resource patch to maximize net energy return rates on resources within a patch before deciding to move to a different patch. The landscape is characterized as patchy, and groups of resources as patches, when foragers encounter them heterogeneously dispersed throughout the landscape (Smith 1983). The energy a forager gains while in a patch and the average transit time to the subsequent patch within the foraging landscape define the patch return rate (Charnov 1976). Initial occupancy of a resource patch is conducive to low-cost resource acquisition because the resources in a patch are more abundant when first encountered. As resources in a patch become increasingly depleted, the acquisition costs (energy expenditure) increase, which decreases the return rate of the patch. As a result, there is an optimal time (when resource return rates are maximized) to move to another patch (Figure 10). The MVT model relies on the rationale that a patch's gain function decelerates because patches have limited resources that deplete while the forager harvests in the patch (Stephens and Krebs 1986).

The critical variable to be optimized under the MVT is the within-patch return rate (Smith 1983). According to the MVT, foragers should choose the time spent in a patch so that the marginal rate of gain upon leaving a patch is equal to the long-term average rate of energy in the forager's environment (Charnov 1976; Stephens and Krebs 1986). Hunter-gatherers should choose to migrate to a new patch when the return rate of the current patch drops to (or below) the average rate for the environment (Charnov 1976).

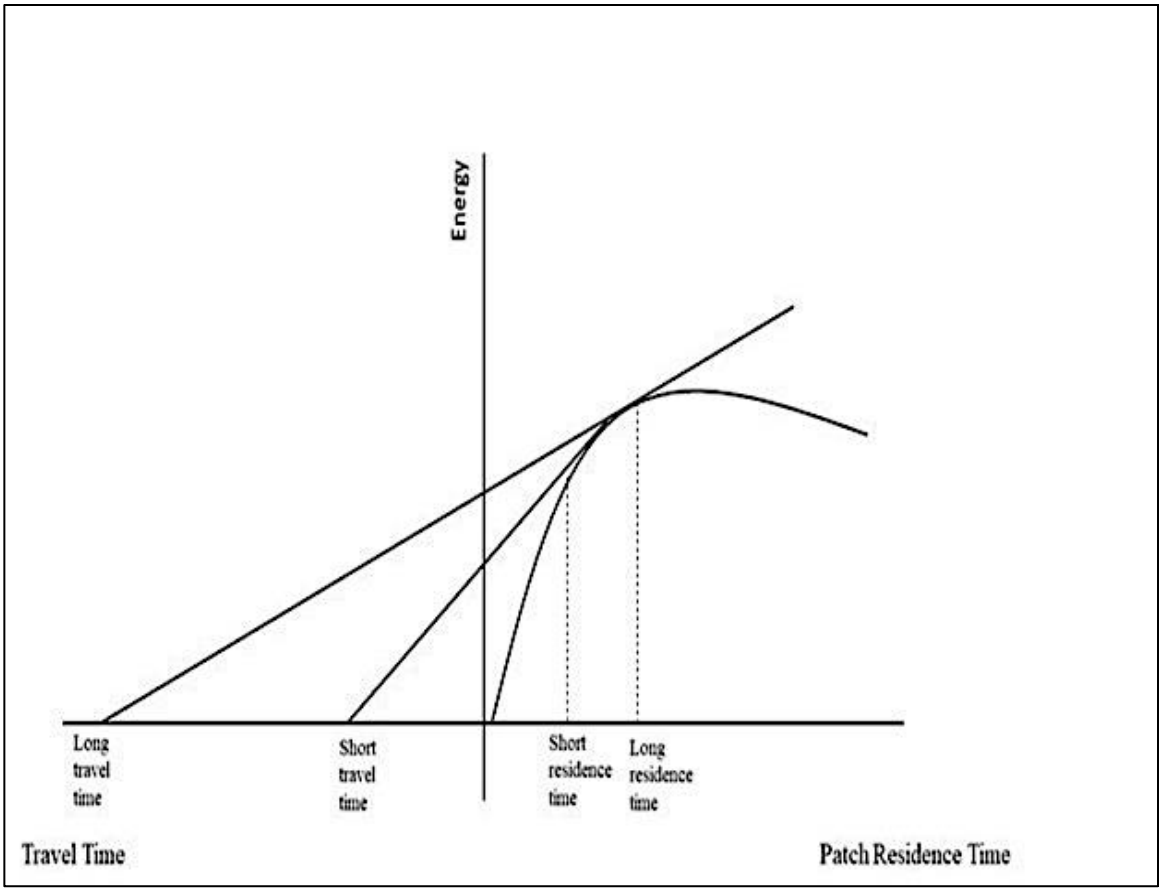

Figure 10. Marginal Value Theorem. The optimal patch residence time is found by plotting a line tangent to the gain function. The slope of this line is the average energy rate. Adapted from Stephens and Krebs (1986).

Extrinsic constraints, like the environment, influence the relationship between the decision to leave a patch and the net energy return rate of the patch. The MVT can, therefore, predict behavioral responses to environmental conditions (Bettinger 1991; Kaplan and Hill 1992):

1. When resource patches are densely distributed in the landscape and are highly productive, the environmental average is higher, and the

optimal time to leave a patch is lower. Foragers in these environments often exploit more heightened levels of mobility as they attempt to maximize foraging returns.

2. The environmental average is lower when resource patches are limited across the landscape but highly productive. This observation predicts that foragers will stay in more productive/higher-return patches longer as they more fully exploit within-patch resources.

3. When resource patches are widely distributed across the landscape and have lower returns (therefore quickly depleted), the average returns for the landscape will be lower, and, subsequently, the optimal within-patch residence time will be shorter, resulting in a faster pace of mobility. As a result, foragers must travel more frequently across considerable distances to acquire resources.

The MVT can be used as an indicator of previous environmental quality (Houston 2019), and changes in mobility due to climate change have been measured by analyzing trade-offs between the quality and travel distances to patches of various lithic materials (Garvey 2008). I propose that the MVT can measure past environmental quality and climate change by analyzing the proportions of local and non-local toolstone sources in assemblages. Different environmental conditions will generate predictable behavioral responses reflected in the archaeological record. Because the duration of occupation of resource patches and the transit distances between patches are approximate measurements of a patch and overall environmental productivity (James et al. 2022), and the acquisition of lithic resources is an integral component of subsistence activities (Binford 1980; Smith 2010), a higher relative abundance of local toolstone should be associated with long term occupations of a productive patch. Conversely, short-term occupations of resource patches should be related to a greater diversity of lithic source material that is less local, as groups using a higher mobility strategy encounter a greater variety of lithic sources in their subsistence pursuits (Andrefsky 1998).

Given the assumptions of the MVT and the associated expectations of land use in distinct types of patchy environments, I predict the following about mobility in the study area:

1. Terminal Pleistocene and early Holocene point assemblages will be tethered to obsidian sources proximal to river corridors and Lake Terreton (Long 2007). TP/EH and early Holocene foragers would have stayed longer in these more productive but spatially limited resource patches as they more fully extracted resources within these areas (Madsen 2007; Madsen et al. 2017).
2. In contrast, between 9,500 cal. BP and 7,000 cal. BP, vegetation communities in the study area reflect more xeric conditions and early middle Holocene NSN assemblages should reflect a reorganization of mobility and land use associated with a patchier and more marginal environment. Return rates in marginal patches had a lower threshold, and patches were likely distributed further apart, leading to an overall increase in forager mobility during this period.

Chapter VI Eastern Idaho Case Study

The fifteen-million-acre study area (Figure 1) is ideal for examining forager mobility because of the trans-Holocene archaeological record of hunter-gatherer lifeways and relatively comprehensive regional environmental records (Bright and Davis 1982; Davis et al. 1986). Using the study area's archaeological record, obsidian provenance data, and climate models, we can examine how environmental and climatic conditions may have influenced the patterning and productivity of regional resource patches, which in turn may have affected the pace of mobility.

The warming and drying trend peaked between ca. 9,500- 7,000 cal. BP (Beiswenger 1991; Bright 1966; Davis et al. 1986). The emergence and distribution of NSNs in the study area correlates with this environmental shift (Henrikson and Finn 2023; Holmer 2009; Miller 1972; Swanson 1972) and suggests changes in land use strategies for the region's foragers compared to the early Holocene (Long 2007). Previous investigations have suggested climate change during the early Holocene/middle Holocene transition as a mechanism underlying variation in obsidian source diversity (Fowler 2014; Holmer 1997). However, the influence of climate change on forager mobility for this period has remained an untested assumption.

Using the study area's archaeological record and provenance data from the early Holocene and early middle Holocene as a case study, I test the hypothesis that environmentally mediated patch quality and abundance conditioned the pace and extent of forager mobility. Long (2007) suggested that foragers were more tethered to patches associated with the Big Lost River corridor and Pioneer Basin during the transition to the early Holocene. These resource patches were highly productive but were not densely distributed over the broader landscape, resulting in a less mobile strategy for the region's foraging populations. Occupation duration in patches associated with these areas would have been longer because it took longer for return rates to fall below those of the overall environment. Conversely, as the study area environment became more xeric during the early Holocene and middle Holocene, resource patches became less productive and became more widely distributed in the broader landscape with greater distances between them, resulting in a more mobile foraging strategy with foragers expanding across the ESRP (Long 2007) to expand their use of ephemeral ponds, more widespread resource patches, and cold storage lava tube caves (Byers et al. 2016; Henrikson 2002). Given this hypothesis and the assumptions of the MVT, I predict changes in raw material procurement between the early Holocene and early middle Holocene in volcanic glass source diversity and average source distance. Specifically, I expect the following:

1. During the transition to the early Holocene, and for most of the early Holocene, source attributions and the spatial distributions of diagnostic points will reflect sources that indicate the significance of river corridors and, to a lesser extent, Lake Terreton as patches in forager land use for this period. These patches were highly productive but limited on the landscape. Hunter-gatherers in this environment would have occupied this patch type for longer periods to maximize energy returns. Therefore, obsidian sources used during this period will be more local to the artifact's discard,

with assemblages having lower diversity.

2. Early middle Holocene source attributions will reflect raw materials with a greater diversity of spread-out sources with greater distances between them than the early Holocene assemblages, indicating less productive resource patches widely distributed across the landscape. Because patches were more sporadically distributed through the landscape and were less productive, hunter-gatherer populations would have moved more often at greater distances to optimize returns.

Previous Regional Mobility Studies

Archaeological investigations frequently use obsidian sourcing as a proxy measurement of precontact forager mobility in regions where direct procurement is assumed due to the prevalence of local volcanic glass sources, such as the Snake River Plain, where volcanic activity has produced a landscape rich in obsidian (Holmer 1997). Obsidian sourcing is an appropriate measurement of mobility because raw material procurement is an embedded pursuit in broader subsistence activities (Binford 1980; McGuire 2002; Smith 2010). While limited in its explanatory power (Hughes 1998), obsidian sourcing remains the most direct method of detecting mobility in precontact societies (Black 2014; Fowler 2014). Researchers can measure artifact distance and direction from the source to delineate movement patterns in the archaeological record on multiple analytical scales (Cota 2022; Henrikson 2008; Holmer 1997; Plager 2001; Scheiber and Finley 2011; Zumkeller 2020).

Previous studies in southern and eastern Idaho have used obsidian sourcing to investigate the extent and pace of precontact forager mobility. These studies have generated conveyance zones and diversity measures (Fowler 2014; Holmer 1997; Scheiber and Finley 2011; Zumkeller 2020) and have examined Least Cost Path (LCP) modeling to consider travel corridors and the energetics of procurement (Cota 2022; Finley et al. 2015; Henrikson 2008). Additionally, investigations have observed distinct conveyance zones in Idaho (Fowler 2014; Holmer 1997; Plager 2001). Although the region's inhabitants conveyed some sources further (Fowler 2014; Henrikson 2008; Holmer 1997; Plager 2001), the region's precontact populations relied primarily on localized obsidian sources (Fowler 2014; Henrikson 2008; Holmer 1997).

Holmer (1997) investigated the characterization and use of obsidian sources in southeastern Idaho. This study, employing diversity measures and distance from the source, found that mobility was highest during the terminal Pleistocene and gradually became more constrained over the middle Holocene before expanding again in the late Holocene. This pattern was characterized by a dominance of local sources with greater transport distances during the terminal Pleistocene and lower transport distances beginning during the early Holocene and persisting through the early middle Holocene. This study also identified three conveyance zones. Holmer (1997) hypothesized that climate conditions or population pressure acted on forager mobility.

Fowler (2014) found that early Holocene conveyance zones were large, with greater source use diversity than middle Holocene conveyance zones and diversity measures. The middle Holocene indicated more local sources and contracted distances. Scheiber and Finley's (2011) study demonstrated similar patterns for Yellowstone, Wyoming Basin, the central Rocky Mountains, and eastern Idaho. They noted source diversity peaked during the early Holocene and began to decline around 7,000 years ago during the middle Holocene, suggesting reduced mobility.

While these conclusions are well founded, the MVT and patch choice model suggest that foragers experiencing a patchier marginal environment should respond by increasing their mobility to maximize returns on resource patches. In contrast, a foraging environment characterized by productive patches that are limited in their spatial distribution in the landscape such as Lake Terreton or the Big Lost River Trough should prompt foragers to exploit resources more fully within those patches, meaning longer stays and more tethering to specific resource areas (Madsen 2007; Madsen et al. 2015). Obsidian source diversity and distance to source measures should reflect these foraging decisions if the MVT and patch choice models are aligned with the archaeological record and local environmental models. This prediction conflicts with the findings of previous obsidian studies in the region (Fowler 2014; Holmer 1997; Scheiber and Finley 2011), which indicated that between the early Holocene and middle Holocene, there was a reduction in mobility as evidenced by obsidian conveyance distances and diversity.

This study expands on previous work initiated by Long (2007), who alternatively suggested increased mobility for the transitional period between the early Holocene and middle Holocene using geospatial data and diagnostic projectile points. Long surmised that terminal Pleistocene foragers in the region preferred riverine patches, with Lake Terreton as a secondary habitat. He suggested that early Holocene/middle Holocene hunter-gatherers continued to use riverine patches but, over time, became less tethered to them, began subsistence activities in lower-ranked resource patches, and expanded their land use across the plain. Using an enhanced and revised obsidian source dataset in tandem with regional paleoenvironmental records, this thesis evaluates the validity of Long's (2007) hypothesis in the study area compared to these earlier obsidian studies (Fowler 2014; Holmer 1997; Scheiber and Finley 2011) through the theoretical framework of the MVT. These previous studies have produced models of mobility that require more attention to allow definitive statements about land use during the transitions to the early Holocene and early middle Holocene for the study area and highlight the need for additional investigations.

Chapter VII Methodology

The objectives of this chapter are to provide a technical background for obsidian source analysis using X-ray fluorescence (XRF) spectrometry, the methods employed, the source material analyzed, and an overview of the statistical measures used in this study.

Obsidian Sourcing

Characterizing obsidian source material is a fundamental component of volcanic glass source studies. Sourcing studies follow the 'Provenance Postulate,' which, when applied to volcanic glass, is a concept that states that while obsidian is homogenous at the source, more significant geochemical variability exists between sources (Neff 2001; Weigand et al. 1977). Each volcanic episode results in obsidian with a chemical composition unique to that event (Shackley 2008; 2011). Obsidian is ideal for provenance studies, as it is geographically tied to volcanic flows and demonstrates near chemical uniformity at its source (Ferguson 2012). Obsidian is a rhyolitic rock characterized by disordered atomic structures and a high silicic composition (Shackley 2005). Obsidian forms from rapidly cooled lavas made up of lighter elements that are felsic. The trace elements within the silicic lavas proportionally vary between flows, making the characterization of obsidian outcrops and artifacts possible (Shackley 2011). This characterization is accomplished by statistically measuring the composition of obsidian and comparing their geochemical signatures (Shackley 1998, 2011; Weigand et al. 1977). Therefore, archaeologists can trace obsidian conveyed outside its original context through human behavioral processes to its origin and function as a proxy measurement of human mobility (Holmer 1997; Hughes and Smith 1993).

While researchers use many analytical techniques in obsidian sourcing, such as Neutron Activation Analysis (NAA) and Laser Ablation Inductively Coupled Mass Spectrometry (LA-ICP-MS), XRF instruments and techniques provide benefits that appeal to archaeologists because of their ease of application and non-destructive approach. Portable instruments, low cost, and rapid quantitative results on primary discriminatory elements are also benefits of XRF technology (Ferguson 2012).

X-Ray Fluorescence Spectrometry

Using consumptive (ground or pellet samples) or non-consumptive (whole rock samples) methods, XRF measures elements in part-per-million to detect major, minor, and trace elements to generate obsidian geochemical profiles (Shackley 2011). Establishing geochemical profiles is accomplished by irradiating a sample with an X-ray beam. This process stimulates and displaces the inner orbital shell electrons. Fluorescence (re-emitted radiation) results from valence electrons transitioning to low-energy orbits to replace expelled electrons and dissipate their surplus energy (Shackley 2011). The instrument detects the relative abundance of elemental intensities and concentrations in a sample (Shackley 2005). These data are then analyzed with statistical techniques, and the sample is compared to a database of known sources (Ferguson 2012; Shackley 2011). Sourcing archaeological obsidian specimens matches them to specific geologic sources.

Handheld XRF (pXRF) instruments have gained momentum in the discipline despite some misgivings regarding their reliability and accuracy (Shackley 2010). Several studies have compared the results of pXRF with those of stationary laboratory XRF instruments (Craig et al. 2007; Pessanha and Guilherme 2009; Shackley 2005; Williams-Thorpe 2008). Ferguson (2012) posits that contrary to researchers' perception of the portable instruments' inherent limitations; the problem lies with inexperienced analysts' use of the instruments and the need to understand physics and calibration techniques (Ferguson 2012:418). Therefore, adequately calibrated instruments and extensive and accurate source profiles to compare artifact samples are more critical in provenance investigations than the distinction between portable and non-portable instruments (Ferguson 2012).

XRF Methodology

Methods and analytical techniques developed by the INL-CRMO were used in the present study to source obsidian artifacts (Clements and Pink 2023a, 2023b; Clements et al. 2023a, 2023b). This section briefly summarizes these methods.

Specimens were examined using two Olympus Vanta portable XRF spectrometers. The instruments are calibrated to a factory setting using Compton normalization. The devices use three beams specifically designed for measuring various element groups. For each beam setting, samples were examined for 180 seconds and again for 60 seconds (Clements and Pink 2023a, 2023b; Clements et al. 2023a, 2023b). Using matrix-specific calibration curves derived from analysis of forty-three obsidian calibration standards available through the University of Missouri Research Reactor

(MURR) (Glascock 2021; Glascock and Ferguson 2012), the factory-calibrated output from each instrument was adjusted to concentrations in parts-per-million. Source determinations were assigned using statistical comparisons to data from a reference collection of geologic obsidian obtained by the INL-CRMO from natural deposits located across southern Idaho (Figure 11) (Clements and Pink 2023a, 2023b; Clements et al. 2023a, 2023b), and a series of multivariate statistical techniques typically used in archaeological provenance investigations generated these reference groups, including hierarchical cluster analysis, principal component analysis, and jack-knifed Mahalanobis distances (Clements and Pink 2023a, 2023b; Clements et al. 2023a, 2023b; Glascock 1992; Neff 2002).

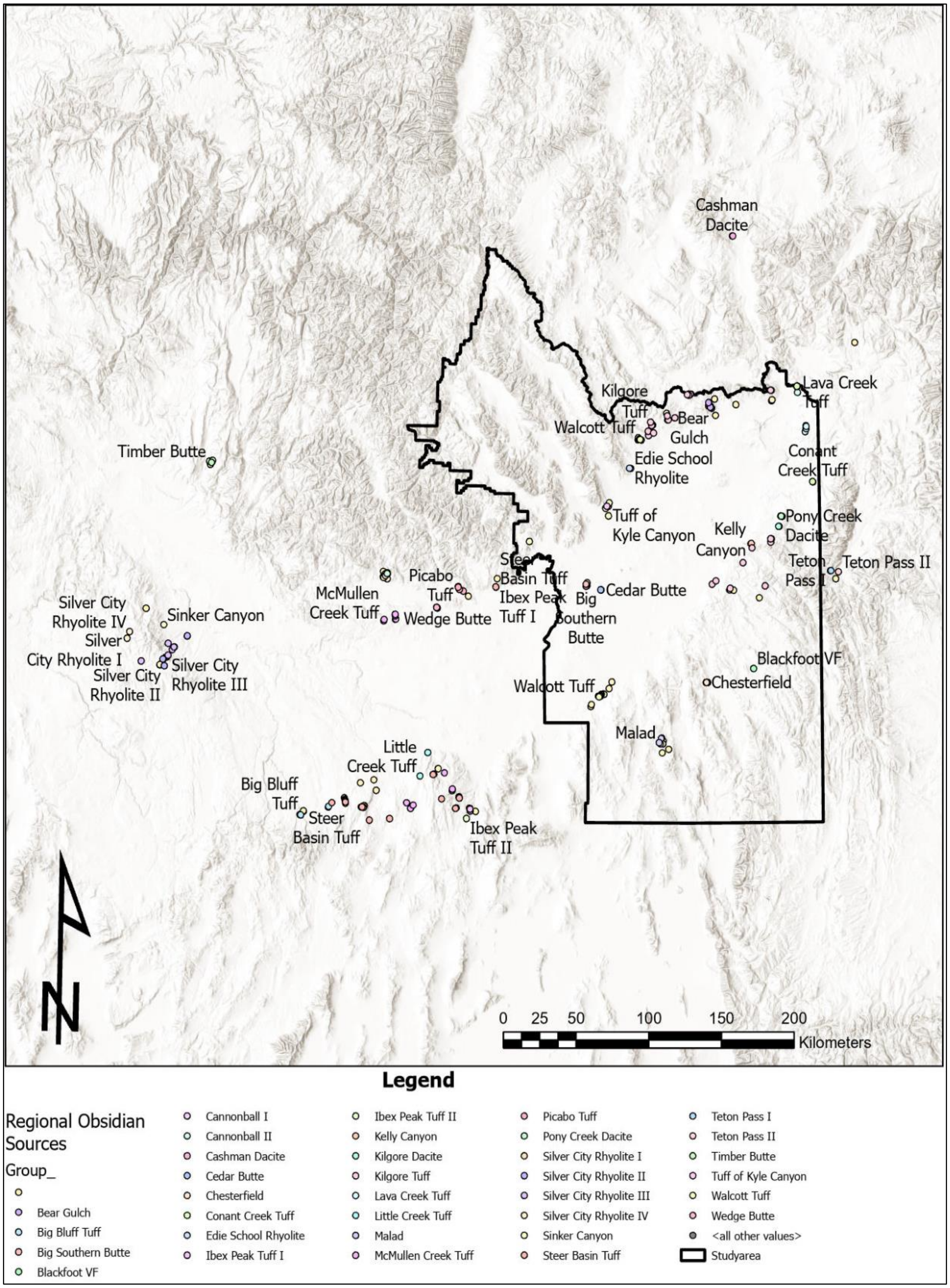

Figure 11. Regional Obsidian Sources.

Distance Measures

Distance-to-source computations were produced in GIS by calculating the distance between the source locations and the UTM coordinates of the artifacts/sites. It should be highlighted that many obsidian sources in the study area occur in multiple localities rather than distinct isolated outcrops. In these situations, the nearest known occurrence of the source material to the artifact discard was considered for distance to the source. Projectile points associated with unidentified obsidian sources were excluded from statistical analyses for distance measures because they could not be calculated. Mean, minimum, maximum, and standard deviation were calculated by period and by major source. Distance measures were tested for significant variance using a One-Way ANOVA test in Excel. Following this test, a Tukey HSD test was conducted using an online calculator (Vasavada 2016).

Measures of Diversity and Evenness

Diversity is a multidimensional property of systems and is a way to approach the quantification of diversity in a data set. Indices describe the general properties of datasets, allowing the comparison of attributes across datasets. Therefore, quantifying diversity is valuable for understanding a dataset’s structure. The number of artifact classes represented in a collection of artifacts, or the relative abundance of those classes, are usually used to quantify assemblage diversity (Rhode 1988). It has been hypothesized that variations in assemblage diversity reflect significant variation in past human behavior, such as in settlement patterning (Wood 1978).

Richness (S) (number of attributes present in a data set) is the simplest of the metrics used to quantify diversity, as well as the most common (Magurran 2004; Whittaker 1972). However, this metric is too simplistic to capture effects influencing the diversity of a dataset (Wilsey et al. 2005). Therefore, numerous indices attempt to combine measures of richness and abundance. The Shannon Diversity Index (H) and Simpson's Diversity Index (D) are two. These indices differ in their theoretical foundations and interpretation (Magurran 2004).

The Shannon-Wiener diversity index has roots in information sciences (Shannon 1948). The index is a measure of uncertainty, meaning the more diverse the sample, the lower the probability of correctly guessing the identity of an unknown individual (e.g., the source attribution of a projectile point type). In a highly diverse and evenly distributed assemblage, the obsidian source for an artifact could be any, making it hard to predict. If the data set is less diverse and dominated by one or so sources, it is easier to predict the correct obsidian source.

The Shannon Diversity index (H') is generated by calculating the proportion (p) of sources (i) relative to the total number of sources, giving us (pi). The pi is multiplied by the natural logarithm (ln) of this proportion ($ln pi$), giving $ln pi * pi$. The resulting product is summed across all products of the previous function, which provides the Shannon Diversity Index. The complete formula is expressed as:

$$H = -\Sigma pi * ln(pi).$$

This number is negative but can be made positive by multiplying by -1. A higher score indicates higher diversity.

Simpson's Diversity Index also considers richness and abundance. It examines the effect of dominance among attributes of a data set. As richness (the number of attributes in a dataset) increases and evenness (how similar the abundances of attributes are) increases, so does diversity. Using the original Simpson Diversity Index formula:

$$D = (\Sigma n_i (n_i - 1))/N(N-1)$$

The value of D ranges from 0 to 1, with 0 representing infinite diversity and 1 meaning no diversity (Simpson 1949). This is counterintuitive, and for this reason, Simpson's Diversity Index is usually expressed as its inverse (D/1) (known as Simpson's Reciprocal Index) or its complement (1-D), which is known as the Gini-Simpson index. These flip the interpretation so that 0 represents no diversity, and 1 represents high diversity. This is more intuitive (Magurran 2004) and represents the probability that two randomly selected individuals from a dataset will have two different attributes. Because using the complement or the inverse of the original formula flips the interpretation of the score, it is essential to indicate which is being used for an analysis. The Gini-Simpson index can be expressed as:

$$D = 1 - (\Sigma n_i (n_i - 1)/N(N-1)$$

where n*i* is the number of individuals in a category, and N is the total number of individuals.

The Shannon Diversity index is sensitive equally to rarity and abundance, richness (S) is sensitive to rarity, and the Gini-Simpson to abundance (Magurran 2004). Therefore, using more than one index is recommended because simultaneously considering multiple indices can elucidate the nature of the data and provide a more nuanced picture.

Evenness (equitability) measures the relative abundance of a category, the distribution of spread, and indicates if individuals are dominant in one or evenly distributed amongst many. In an archaeological obsidian context, evenness would refer to whether one source is more dominantly represented in an assemblage or dataset or if each source is equally represented. The equitability for a Shannon-Wiener Diversity index can be calculated as:

$$J=H/Hmax$$

where H represents diversity, and Hmax is the maximum possible diversity. Hmax is found by calculating the natural log of *S*. Values closer to one indicate high evenness.

Simpson's equitability is expressed as E=1/DS, where D is the diversity, and S is the richness (Smith and Wilson 1996; Zeleny 2023). Simpson's evenness is calculated by dividing Simpson's effective number of species (ENS) by the observed number of species. ENS is the number of equally abundant species a community would need for its

Simpson index to match the one computed. For Simpson's Diversity, the ENS is 1/D. Simpson's equitability is expressed as:

$$E = (1/D)/S$$

or simplified as 1/DS (Zeleny 2023).

Archaeologists frequently borrow analytical techniques from other disciplines; diversity indices have generally been borrowed from ecology, though many have questioned the relevance and accuracy of such applications (Dunnell 1989; Rhode 1988; Ringrose 1993). The issues in applying diversity measures primarily stem from the question (Betz 1987) of whether biotic diversity is analytically equivalent to archaeological diversity, and further, if archaeological diversity is reflective of heterogeneity in human behavior (e.g., interpretive biases introduced by preservation or sampling). This conflict manifests in discussions involving the sample-size effect (Rhode 1988). The sample-size effect is introduced into analyses because generally, the larger an archaeological assemblage, the more artifact classes it should have by default. Criticisms of this introduced bias highlight supposed irrelevant comparisons between assemblages because of this relationship (Grayson 1981; Jones et al. 1983).

Significant variations in sample size can result in significant discrepancies in computed diversity values. While some have attempted to mitigate this issue through methods like regression (Grayson 1984; Jones et al. 1983) or the sampling/simulation approach (Kintigh 1984), these solutions only highlight that different approaches produce different results (Rhode 1988). The fact remains that no mathematical index is absolute in capturing the reality of complex systems both biotically (Stirling and Wilsey 2001; Whittaker 1972), and archaeologically (Betz 1987; Rhode 1988); the datasets available to archaeology are generated by an inherently incomplete record that defies absolute quantification of diversity because a complete sampling universe that encompasses all hypothetical possible obsidian sources available cannot be known (Betz 1987). Diversity measures, despite their flaws, retain significance in that they allow a mode of exploratory comparison. Recognizing the sample-size effect, this thesis utilizes diversity indices in conjunction with other statistical measures like distance analyses and comparing variance in source use for significance to approach the issues of mobility from several angles.

Only to the extent that obsidian sourcing permits the study of human behavioral processes is it meaningful. The only way to properly study material culture is to consider its historical context within sociocultural systems; an obsidian system does not exist; rather, it is a component of sociocultural systems. XRF is used to reconstruct precontact mobility; it is a way to capture elements of a procurement range, or distances traveled to obtain resources. XRF allows for the empirical testing of the hypothesis that obsidian source use varies through time in the study area as a function of embedded procurement in hunter-gatherer systems influenced by climate-mediated resource patch abundance and quality. Source-specific projectile point occurrences are indicators of the range of precontact groups because obsidian sources are fixed points on the landscape. Diversity measures and distance-to-source statistics can be used as indirect indicators of past resource patch conditions. The MVT (Charnov 1976) suggests that when resource patches are more productive and limited on the landscape, hunter-gatherers will occupy these areas longer, resulting in more local obsidian sources and reduced travel distances to sources represented in artifact assemblages (Madsen 2007; Madsen et al. 2015). Conversely, if resource patches are unproductive and limited on the landscape, hunter-gatherer foraging radiuses should be larger, incorporating more obsidian sources from further away (Jones et al. 2012; Smith et al. 2013).

Long (2007) posits that during the early pre-contact period, groups were tethered to Lake Terreton and riverine resource patches in the study area, but as the climate became more arid, groups became less reliant on these resource patches and began to expand their land use to incorporate secondary and tertiary resource patches. If this is true, we can expect to see fewer and more local obsidian sources represented in the TP/EH and early Holocene samples and lower diversity in sources. On the other hand, we should expect to see middle Holocene (NSN) source use that is more diverse and less local. The following diversity and distance statistics are the basis for testing Long's hypothesis against other regional sourcing results (Holmer 1997; Fowler 2014, Scheiber and Finley 2011).

Chapter VIII Results

Here, I present the results of the XRF analyses of TP/EH, early Holocene, and NSN projectile points. First, I present summary statistics of the dataset generated by a cross-tabulation analysis. I then present the results of a Pearson Chi-square test to determine if the patterns in the dataset are random, followed by the results on diversity and evenness indices for each period. I then present the results of statistics on distance to source for each period, followed by an Anova Single Factor and Tukey HSD test. Finally, I synthesize the key findings of the results presented.

Sampling

Despite the possibility that only examining diagnostic projectile points could affect results and bias interpretations about mobility (Bamforth 2009), the nature of archaeological sites in the Intermountain West necessitates a sampling technique that ensures results are attributable to specific periods. Diagnostic projectile points from the early Holocene and middle Holocene periods sourced from the Federal Bureau of Land Management, Department of Energy, Bureau of Reclamation, Bureau of Indian Affairs, and US Forest Service collections and sites within the study area comprise the dataset. Points were assigned to these categories using measurements described in Holmer (2009). For distance-to-source measurements and statistics, projectile points with unknown provenience were omitted from the distance analyses but were included in diversity statistics. Distance-to-source measures were conservatively calculated for the closest obsidian outcrop to the artifact's discard in kilometers (km).

The Diagnostic Projectile Point Sample

The samples used in this study consist of 376 sourced obsidian projectile points from the study area. Diagnostic projectile points (Table 1) analyzed included 21 (6%) Folsom/Midland points, nine (2%) Hell Gap points, 124 Haskett/ Birch Creek (33%) points, 16 (4%) Cody complex points, 26 (7%) Angostura points, and 180 (48%) NSNs. Both Haskett/Birch Creek points and NSN points are overrepresented in the dataset, while Folsom/Midland, Hell Gap, Angostura, and Cody points are underrepresented in the dataset.

Table 1. Summary of Diagnostic Projectile Points Included in the Study.

Projectile Point Type	**Frequency**	**Percent**
Folsom/Midland	21	6
Hell Gap	9	2
Haskett/Birch Creek	124	33
Cody Complex	16	4
Angostura	26	7
Northern Side Notch	180	48
Total	376	100

The projectile point sample is broadly representative of archaeological sites in the study area. The Folsom/Midland points in the dataset are spread across 17 sites, with the highest concentrations from 10BT718, 10BT1449, and 10BV30, with two or three points collected from each of these sites. Most points from the Folsom/Midland dataset are isolated finds. The nine Hell Gap points in the dataset from the study area each come from different localities. Haskett/Birch Creek points largely come from numerous sites. However, 12 points are from 10BT1227, five are from 10CL03 and eight are from 10PR37. Angostura points are spread among nine sites; 14 of the points are concentrated in one site (10BT1573), and five are from site 10BV30. Points attributed to the Cody Complex come from several different sites, but two points come from 10CL3, and two points are from 10BM236. NSN points occur at several different localities, although many NSN points in the dataset come from a few sites: 10BT46 (n=23), 10CL03 (n=25), and 10FR04 (n=53). This distribution of projectile points is considered broadly representative of the study area and is a good proxy for obsidian source use and mobility during periods of interest.

XRF Results

There are 19 known obsidian sources observed within the data set, as well as a category for unknown sources (Table 2). During the TP/EH period (represented by Folsom/Midland and Hell Gap Points), Big Southern Butte is the most common source used (n=14; 47%) followed by Bear Gulch (n=7; 23%). The early Holocene period is represented by Haskett/Birch Creek, Angostura, and Cody Complex points. Among these, Bear Gulch was the most frequently used source (n=55; 33%) followed by Big Southern Butte (n=35; 21%), and Walcott Tuff (n=22; 13%). The NSN assemblage is dominated by the Malad source (n=64; 36%), Bear Gulch (n=40; 22%), and Walcott Tuff (n=36; 20%). Overall, across the periods, Bear Gulch was the most used source (n=102; 27%), followed by the Malad source (n=69; 18%), Walcott Tuff (n=63; 17%), and Big Southern Butte (n=62; 16%). Cashman Dacite (n=13; 3%), Kilgore Tuff (n=11; 3%), and Steer Basin Tuff (n=10; 3%) were uncommonly used across the periods and were mostly represented in the early Holocene and NSN samples. Edie School Rhyolite (n=1), Kelly Canyon Rhyolite (n=1), Pony Creek Dacite (n=1), Silver City IV (n=1), Modena (n=2), and Teton Pass II (n=2) were the rarest sources used. These data show strong preferences for particular sources across the study periods.

Table 2. Frequency of Obsidian Sources across the Three Time Periods.

Source	**Folsom, Midland, and Hell Gap**	**Haskett, Angostura, and Cody**	**NSN**	**Total**
Bear Gulch	7 (23%)	55 (33%)	40 (22%)	102
Big Southern Butte	14 (47%)	35 (21%)	13 (7%)	62
Cannonball I	1 (3%)	2 (1%)	1 (1%)	4
Cashman Dacite	1 (3%)	10 (6%)	2 (1%)	13
Dry Gulch Tuff	0	3 (2%)	0	3
Edie School Rhyolite	0	1 (1%)	0	1
Kelly Canyon Rhyolite	0	0	1 (1%)	1
Kilgore Tuff	0	5 (3%)	6 (3%)	11
Malad	2 (7%)	3 (2%)	64 (36%)	69
McMullen Creek Tuff	0	1 (1%)	3 (2%)	4
Modena	0	2 (1%)	0	2
Obsidian Cliff	0	8 (5%)	0	8
Pony Creek Dacite	0	1 (1%)	0	1
Silver City IV	0	1 (1%)	0	1
Steer Basin Tuff	0	5 (3%)	5 (3%)	10
Teton Pass I	0	1 (1%)	1 (1%)	2
Teton Pass II	0	0	5 (3%)	5
Timber Butte	0	7 (4%)	1 (1%)	8
Unknown	0	4 (2%)	2 (1%)	6
Walcott Tuff	5 (17%)	22 (13%)	36 (20%)	63
Total	**30 (100%)**	**166 (100%)**	**180 (100%)**	**376**

The chi-square statistic is an analytical tool to assess how modeled expectations fit real observations. This statistic is frequently used as a measure of association to test hypotheses. Given the sample size and number of variables in the relationship, the chi-square compares the size of disparities between observed and expected results. Degrees of freedom are used by this test to evaluate whether null hypotheses can be rejected given the number of variables and samples. The chi-square test is applicable in testing for independent relationships between variables. The likelihood that a discrepancy between actual and theoretical frequencies due to random chance is explained by the chi-square test for independence. In this test, the null hypothesis (H_0) is that there is no relationship, and the alternate hypothesis (H_1) is that there is a relationship. The chi-square test is limited in that it is not a measure of strength or direction, but it is useful in characterizing relationships between nominal variables.

The expected and observed frequencies generated for the chi-square test agreed in some ways but differed in others (Table 3). For example, Bear Gulch obsidian is observed in quantities close to what is expected in the model, although there is slightly more observed than expected for early Holocene points and slightly less observed than expected for NSN. Substantially more Big Southern Butte obsidian is observed than expected in TP/EH points and early Holocene points, but much less is observed than expected in NSNs. Malad and Walcott Tuff are also important drivers of the dataset structure. Expected frequencies of Malad obsidian are low for both the TP/EH and early Holocene periods, and the observed frequencies reflect similar results. However, the expected frequency of Malad use for NSN is substantially lower than the observed frequency. Walcott Tuff obsidian is expected to occur at a higher frequency in TP/EH and lower frequencies in early Holocene and NSN points than is observed. Rather, Walcott Tuff obsidian occurs less during the TP/EH period and more during the early Holocene and NSN periods than expected.

The hypotheses for the chi-square test performed in this analysis was that (H_1) source use varies between periods, or (H_0) source use does not vary between periods. The significance threshold (α) was set at 0.05. The results of the test were a p-value of 5.97668E-13, which is significantly less than 0.05, meaning that the null hypothesis (H_0) can be rejected. The test indicates that source use does vary between periods. The test, however, cannot describe or explain how and why source use differs between periods. To elaborate on the potential catalysts driving these differences, I consider diversity indices and later, distance to source measures.

Table 3. Observed and (Expected) Frequencies of Obsidian Sources for the Major Projectile Point Categories.

Source	Folsom/ Midland, Hell Gap	Haskett/Birch Creek, Cody Complex, Angostura	NSN
Bear Gulch	7 (8)	55 (45)	40 (49)
Big Southern Butte	14 (5)	35 (27)	13 (30)
Cannonball I	1 (0)	2 (2)	1 (2)
Cashman Dacite	1 (1)	10 (6)	2 (6)
Dry Gulch Tuff	0 (0)	3 (1)	0 (1)
Edie School Rhyolite	0 (0)	1 (0)	0 (0)
Kelly Canyon Rhyolite	0 (0)	0 (0)	1 (0)
Kilgore Tuff	0 (1)	5 (5)	6 (6)
Malad	2 (6)	3 (30)	64 (33)
McMullen Creek Tuff	0 (0)	1 (2)	3 (2)
Modena	0 (0)	2 (1)	0 (1)
Obsidian Cliff	0 (1)	8 (4)	0 (4)
Pony Creek Dacite	0 (0)	1 (0)	0 (0)
Silver City IV	0 (0)	1 (0)	0 (0)
Steer Basin Tuff	0 (1)	5 (4)	5 (5)
Teton Pass I	0 (0)	1 (1)	1 (1)
Teton Pass II	0 (0)	0 (2)	5 (2)
Timber Butte	0 (1)	7 (4)	1 (4)
Walcott	5 (5)	22 (28)	36 (30)
Unknown	0 (0)	4 (3)	2 (3)

Considering Source Diversity

The analysis of obsidian source diversity indicates that the indigenous peoples of the study area adjusted their land use and procurement of raw materials over time. Diversity indices exemplify the variety of sources acquired and may reflect embedded foraging decisions incorporating a variety of resource areas, while evenness measures evidence the preferential use of sources and areas. Under the Shannon Diversity index, the higher the value, the greater the diversity of sources in the dataset. Smaller numbers represent lower diversity, and when that number is zero, the dataset consists of a single source. Evenness under the Shannon Diversity index ranges from zero to one where one indicates total evenness, or total heterogeneity. A score closer to zero indicates more homogeneity across the dataset. In this sample (Table 4), source diversity was at its lowest during the TP/EH, while source diversity was at its highest during the early Holocene period. Middle Holocene source use was less diverse than the early Holocene but more so than in the TP/EH. There is little variation in evenness across the sample, although middle Holocene (NSN) source use was more concentrated by source than both the TP/EH and early Holocene periods. The TP/EH sample demonstrated the most evenness in source use.

Table 4. Shannon Diversity and Evenness Measures of Obsidian Source use.

Period	**Shannon Diversity Index (H')**	**Shannon Evenness (J)**
TP/EH	1.4	.78
Early Holocene	2.1	.73
NSN	1.8	.68

Under the Gini-Simpson Diversity index, values closer to one indicate greater diversity, whereas values closer to zero indicate less source diversity. Evenness values closer to one indicate more evenness, whereas values closer to zero indicate less evenness. The Gini-Simpson diversity index is sensitive to dominance of a single category, and therefore indicates when results are weighted by overrepresentation of one source type. For instance, the early Holocene source use is the most diverse, followed by NSN and finally the TP/EH. The NSN sample is the least even, followed by TP/EH and the early Holocene samples (Table 5). Both ways of calculating diversity and evenness show significant changes in that way obsidian sources were used across the time periods of interest in the study.

Table 5. Gini-Simpson Diversity and Evenness Measures of Obsidian Source use.

Period	**Gini-Simpson Diversity Index (D)**	**Simpson's Evenness (E)**
TP/EH	.71	.23
Early Holocene	.82	.31
NSN	.78	.09

Distance to Source

To further consider the relationship between changes in mobility across the three time periods, I consider variations in the distance to source as a proxy for the degree of mobility. Distance to source was analyzed by calculating the minimum, maximum, mean, and standard deviation for each period (Table 6), and then for each major source (where n > 3) by period. Outlier data were artifacts with an obsidian source that occurred fewer than three times in the overall dataset. These outliers were excluded from distance analyses because they likely represent unique instances of cultural contact between groups and were unlikely to pertain to the foraging activities of the precontact groups in the study area on account of the obsidian source occurring infrequently at a large distance from where the artifact was deposited in the archaeological record. For example, two Haskett points were attributed to the Modena (NV) obsidian source, which was 550km from the site the points were found.

The minimum and maximum values indicate the range of distances traveled between material procurement and artifact discard for each source by period. The mean indicates the average distance, while the standard deviation reflects the degree of variation in distance traveled between sources and sites during each period. Aggregated across the periods of interest, the early Holocene sample had the largest range, the largest mean, and the largest standard deviation. The NSN sample had the second highest range, mean, while the TP/EH sample had the smallest range and mean. The standard deviation for the TP/EH and NSN samples were effectively the same.

Table 6. Aggregated Distance to Source (km) Measures.

	Minimum (km)	**Maximum (km)**	**Mean (km)**	**Standard Deviation**
TP/EH	11	184	63	54
Early Holocene	2	550	108	91
Northern Side Notch	2	238	73	52

The highest mean distance for the TP/EH sample (Table 7) was the Bear Gulch obsidian source. On average, the distance between this source and artifact discard was 93km. The second highest mean was the Big Southern Butte obsidian source (36km), followed by Walcott Tuff (29km). The range of distance travelled for Bear Gulch was 61-128km, 11-175km for Big Southern Butte, and 17-38km for Walcott Tuff volcanic glass.

Table 7. Distance measures by major (N= >3) sources.

Source	Minimum (km)	Maximum (km)	Mean (km)	Standard Deviation
TP/EH				
Bear Gulch	61	128	93	22
Big Southern Butte	11	175	36	45
Walcott Tuff	17	38	29	11
Early Holocene				
Bear Gulch	61	214	112	36
Big Southern Butte	9	84	28	17
Cashman Dacite	147	238	204	32
Dry Gulch Tuff	121	188	149	35
Kilgore Tuff	2	90	64	36
Malad	51	174	116	61
Obsidian Cliff	160	232	189	24
Steer Basin Tuff	111	212	179	40
Timber Butte	277	277	277	0
Walcott Tuff	2	45	31	10
Northern Side Notch				
Bear Gulch	10	178	97	28
Big Southern Butte	11	107	53	28
Kilgore Tuff	2	63	35	27
Malad	50	137	63	29
McMullen Creek Tuff	179	234	204	28
Steer Basin Tuff	173	238	203	25
Teton Pass II	154	167	158	6
Walcott	2	97	24	22

The highest mean distance to source for the early Holocene period (Table 8) was with the Timber Butte obsidian source (277km), followed by Cashman Dacite (204km), Obsidian Cliff (189km), Steer Basin (179km), Dry Gulch Tuff (149km), Malad (116km), Bear Gulch (112km), Kilgore Tuff (64km), Walcott Tuff (31km), and Big Southern Butte (28km) obsidian sources. However, procurement ranges incorporating many of these higher distances were uncommonly used. Early Holocene groups most often used Bear Gulch (n=55), Big Southern Butte (n=35), Cashman Dacite (n=10), and Obsidian Cliff (n=8). The range of distance for Bear Gulch is 61-214km, Big Southern Butte 9–84km, Cashman Dacite 147–238km, and Obsidian Cliff 160–232km.

Table 8. Early Holocene Distance measures by major (N= >3) sources.

Source	Minimum (km)	Maximum (km)	Mean (km)	Standard Deviation
Bear Gulch	61	214	112	36
Big Southern Butte	9	84	28	17
Cashman Dacite	147	238	204	32
Dry Gulch Tuff	121	188	149	35
Kilgore Tuff	2	90	64	36
Malad	51	174	116	61
Obsidian Cliff	160	232	189	24
Steer Basin Tuff	111	212	179	40
Timber Butte	277	277	277	0
Walcott Tuff	2	45	31	10

The highest distance means for the NSN period (Table 9) is McMullen Creek Tuff (204km), followed by Steer Basin Tuff (203km), Teton Pass II (158km), Bear Gulch (97km), Malad (63km), Big Southern Butte (53km), Kilgore Tuff (35km), and Walcott (24km) obsidian sources. Again, it should be noted that for the NSN sample, Malad is overrepresented (n=64), followed by Bear Gulch (n=40) and Big Southern Butte (N=13). The distance range for Bear Gulch for this period is 10-178km, Big Southern Butte 11–107km, and Malad 50–137km.

Table 9. NSN distance measures by major (N= >3) sources.

Source	Minimum (km)	Maximum (km)	Mean (km)	Standard Deviation
Bear Gulch	10	178	97	28
Big Southern Butte	11	107	53	28
Kilgore Tuff	2	63	35	27
Malad	50	137	63	29
McMullen Creek Tuff	179	234	204	28
Steer Basin Tuff	173	238	203	25
Teton Pass II	154	167	158	6
Walcott	2	97	24	22

The One-way ANOVA (Table 10) indicates that there is a difference in the mean distance to source between groups because the p-value corresponding to the F-statistic is < 0.05. The test cannot differentiate which of these groups are statistically different from each other, just that one or more pairs of groups are significantly different. A post-hoc test such as a Tukey HSD test is necessary to elucidate which groups are different. There are three groups observed, meaning there are three treatments (k). The Tukey HSD test compares all the potential pairs to evaluate which differ significantly from one another. To conduct a Tukey HSD test, the critical value of the Q statistic is required. This statistic is based on the number of treatments ($k=3$) and the degrees of freedom (df) for the error term (MS within groups) ($df=373$) that was calculated with the One-way ANOVA test at 0.01 and 0.05 significance levels (α) in the Studentized Range Distribution. The results of the Tukey HSD test (Table 11) suggest a significant difference in distance to source between the TP/EH and early Holocene periods, and a significant difference between the early Holocene and NSN periods. The TP/EH and middle Holocene samples are clearly not different from each other having lower overall distance-to-source measures, and the early Holocene sample is significantly different than both the TP/EH and middle Holocene counterparts.

Table 10. Anova Single Factor Results

Source of Variance	SS	df	MS	P-Value	F Crit
Between Groups	97247.89073	2	48623.94536	4.20264E-06	3.02152
Within Groups	1326639.116	350	3790.397473		
Total	1423887.006	352			

Table 11. Tukey HSD results where A =TP/EH period, B = early Holocene period, and C = middle Holocene (NSN) period.

Treatments pair	Tukey HSD Q statistic	Tukey HSD p-value	Tukey HSD inference
A vs B	5.4755	0.001	** p<0.01
A vs C	2.3831	0.212	insignificant
B vs C	5.9588	0.001	** p<0.01

Chapter IX Discussion

I investigated Long's (2007) hypothesis that forager mobility in southeast Idaho was conditioned by patch quality and abundance during the early and middle Holocene, as mediated by environmental conditions. To test this idea, I compared the distribution and obsidian source provenance of Northern Side-notched points (NSN) with TP/EH and early Holocene lanceolate and stemmed projectile points (ca. 12,000-7,600 cal. BP). In order to determine whether (1) there were statistically significant changes in source use during the early Holocene and middle Holocene transitions, and (2) the obsidian conveyance zones in the study area exhibited evidence of these changes, I compared and evaluated the obsidian source attributions assigned to TP/EH, early Holocene points, and NSN points using the available archaeological data in a 15 million-acre study area (Figure 1) developed by the Idaho National Laboratory (INL) Cultural Resource Management Office (Henrikson et al. 2024).

According to Long (2007), during the transition to the early Holocene, foragers were more strongly tethered to patches in the Pioneer Basin and Big Lost River corridor. Because these resource patches were not widely dispersed over the surrounding terrain, despite their high productivity, the foraging populations in the area had to adopt a less mobile strategy. Under Long's (2007) model, occupation duration in patches associated with these areas would have been longer because it took longer for return rates to fall below those of the overall environment. On the other hand, resource patches became less productive and more widely distributed in the larger landscape with greater distances between them as the study area environment became more xeric during the early and middle Holocene (Long 2007), and occupation duration would have become shorter. This led to a more mobile foraging strategy with foragers expanding across the ESRP to increase their use of ephemeral ponds, more widespread resource patches, and cold storage lava tube caves (Byers et al. 2016; Henrikson 2002). The results of this study do not support Long’s (2007) hypothesis.

Considering Long’s (2007) hypothesis and the MVT's assumptions, I predicted variations in the average source distance and source diversity of volcanic glass between the early Holocene and early middle Holocene in terms of raw material procurement. I expected the following:

1. Source attributions and the spatial distributions of diagnostic points would reflect sources that emphasized the importance of river corridors and, to a lesser extent, Lake Terreton as patches in forager land use for this period during the transition from the TP/EH to the early Holocene. Although they were limited in extent, these patches would have been highly productive. To optimize energy returns, hunter-gatherers in this environment would have occupied this patch type for extended periods of time. Therefore, obsidian sources used during this period would be more local to the artifact’s discard, with assemblages having lower diversity.

2. Compared to the TP/EH and early Holocene assemblages, early middle Holocene (NSN) source attributions would show raw materials with a higher diversity of disparate sources and longer distances between them, indicating less productive resource patches widely dispersed over the terrain. Hunter-gatherer groups would have relocated more frequently and further apart to maximize returns since patches were less productive and more sporadically spread over the terrain.

The distribution of points in the study area is considered broadly representative of the study area and is a good proxy for obsidian source use and mobility during the periods of interest for the study. The results of the XRF analyses capture 19 known sources observed. During the TP/EH period, Big Southern Butte was the most common source, followed by Bear Gulch. During the early Holocene period, Bear Gulch was the most common source, followed by Big Southern Butte and Walcott Tuff. The NSN source use was dominated by the Malad source, followed by Bear Gulch and Walcott Tuff. Overall, across the periods, Bear Gulch was the most common source, followed by Malad, Walcott Tuff, and Big Southern Butte.

The expected and observed frequencies generated by the chi-square test both agreed and disagreed somewhat. For instance, Bear Gulch obsidian was found in quantities that were roughly in line with the model's predictions, but somewhat higher for early Holocene points and slightly less for NSN. In TP/EH and later early Holocene points, significantly more Big Southern Butte obsidian was observed than predicted, while significantly less was observed than predicted in NSNs. The dataset's structure was also heavily influenced by the Walcott Tuff and Malad sources. For the TP/EH and early Holocene samples, Malad obsidian was expected to occur at low frequencies, and these findings were consistent with the reported frequencies. Nonetheless, compared to the actual observed frequency, the predicted Malad obsidian source use in NSN was far lower. Walcott Tuff predicted frequencies were higher in TP/EH and lower in early Holocene and NSN than observed.

The present research employed the chi-square test to evaluate the hypotheses that (H_1) source usage differed between periods and (H_0) source use remained constant between periods. A significance threshold of 0.05 was established (α). The test's findings showed a p-value of 5.97668E-13, which was much less than the α of 0.05, which allowed for the rejection of the null hypothesis (H_0). The test results showed that there was variation in source use throughout time. Variation in source use was expected considering previous research and my hypotheses. While the use of certain sources (Bear Gulch, Walcott Tuff, Big Southern Butte, Malad) across all periods was consistent, the use of these sources and lesser sources fluctuated. I predicted that source use would expand or constrict by period. I expected the NSN source use to be the largest, followed by early Holocene and TP/EH. However, the results of XRF sourcing and the chi-square test instead indicate that early Holocene source use incorporated the most sources, while NSN source use incorporated fewer sources than the preceding period, but more than the TP/EH. TP/EH source use was the most limited. Regarding the early Holocene and NSN samples, the results were inconsistent with my expectations.

I then took diversity indices and distance-to-source measurements into consideration to expound on the possible drivers behind these differences. In this sample, source diversity under the Shannon Diversity index was at its lowest during the TP/EH, while source diversity was at its highest during the early Holocene period. Middle Holocene source use was less diverse than the early Holocene but more so than in the TP/EH. There was little variation in evenness across the sample, although middle Holocene (NSN) source use was more concentrated by source than both the TP/EH and early Holocene periods. The TP/EH sample demonstrated the most evenness in source use. Under the Gini-Simpson diversity index, the early Holocene source use was the most diverse, followed by NSN and finally the TP/EH. The NSN sample was the least even, followed by TP/EH and the early Holocene samples. Both types of diversity indices and evenness measures showed significant changes in how obsidian sources were used across the time periods. I expected that the NSN sample would be the most diverse, followed by the early Holocene sample and the TP/EH sample. Results for the NSN and early Holocene period were incongruent with my expectations.

Distance to source was analyzed by calculating the minimum, maximum, mean, and standard deviation for each period, and then for each major source (where $n > 3$) by period. Aggregated across the periods of interest, the early Holocene sample had the largest range, the largest mean, and the largest standard deviation. The NSN sample had the second highest range and mean, while the TP/EH sample had the smallest range and mean. The standard deviation for the TP/EH and NSN samples were effectively the same.

When the distance to source was explored across the periods and segregated by source, the highest mean distance for the TP/EH sample was the Bear Gulch obsidian source. The second highest mean was the Big Southern Butte obsidian source, followed by Walcott Tuff. The highest distance to source mean for the early Holocene period was with the Timber Butte obsidian source, followed by Cashman Dacite, Obsidian Cliff, Steer Basin, Dry Gulch Tuff, Malad, Bear Gulch, Kilgore Tuff, Walcott Tuff, and Big Southern Butte obsidian sources. The highest distance means for the NSN period was McMullen Creek Tuff, followed by Steer Basin Tuff, Teton Pass II, Bear Gulch, Malad, Big Southern Butte, Kilgore Tuff, and Walcott obsidian sources.

The One-way ANOVA indicated a difference in the mean distance to source between groups because the p-value corresponding to the F-statistic was < 0.05, but the test cannot differentiate which of these groups were statistically different from one another, just that one or more pairs of groups were significantly different. A post-hoc Tukey HSD test was conducted to elucidate which periods were significantly different. The results of the Tukey HSD test suggested a significant difference in distance to source between the TP/EH and early Holocene periods, and a significant difference between the early Holocene and NSN periods.

The results of the distance to source statistics, Anova single factor and Tukey HSD tests were incongruent with my expectations. I expected the NSN sample to have expanded distance to source measures compared to the early Holocene sample. Instead, the early Holocene sample had the highest distance to source measures. The Tukey HSD found significant variation in distance measures between the TP/EH and early Holocene, and the early Holocene and NSN periods. I expected a significant difference between the TP/EH and NSN samples, which the test did not indicate.

In many archaeological contexts, the presence of non-local sourced artifacts leads to two disparate conclusions: (1) that stone was acquired directly in embedded subsistence pursuits, reflecting the territorial range of hunter-gathering cultures, or (2), stone was acquired indirectly through social processes, reflecting social connections across the landscape (Kelly 1992; Newlander and Zacharias 2024; Smith and Harvey 2018). Additionally, Smith and Harvey (2018) suggest that rather than reflecting short-term human activities (e.g., foraging forays or annual seasonal rounds) data could instead reflect a palimpsest of thousands of years.

To rectify the linkage problem of direct or indirect acquisition, the distribution of both physical and social resources must be accounted for, and only by the process of elimination facilitated by a deeper understanding of the distribution of these resources can we infer the mode of acquisition and make claims about precontact mobility (Newlander and Zacharias 2024). In the context of this study, ethnographic accounts (Liljebald 1972; Ray et al. 1938; Steward 1938) document the patterning of settlement and territories over the broader landscape of the study area, and the obsidian sources reflected in the sample occur in or near ethnographically documented subsistence procurement areas. Some artifact source attributions reflect non-local sources; however, these outliers were excluded from distance-to-source measures, and overall, the obsidian sourcing data and geographic patterning are considered reflective of direct procurement. Additionally, this study did not attempt to address short-term episodes of human activity (Smith and Harvey 2018), rather, the emphasis of this study was on periods of human activity spanning thousands of years.

The results of the XRF analyses, the chi-square test, diversity indices, distance to source statistics, Anova single factor test, and Tukey HSD test indicate the mobility was at its lowest during the TP/EH, highest during the early Holocene period, and reduced somewhat when NSN emerged in the archaeological record. I predicted that the NSN period would demonstrate heightened mobility compared to the early Holocene and TP/EH periods. While NSN mobility was higher than the TP/EH period, the most significant change in mobility was between the TP/EH and early Holocene period, with early Holocene heightened mobility beginning to decline during the NSN period. While changes in mobility between the TP/EH and early Holocene may coincide with environmental changes associated with the Younger Dryas, presently, climate models for the study area lack the fine-grained detail necessary to definitively correlate environmental change with the archaeological record. Additionally, I predicted that the

NSN mobility would correlate with and indicate changes in mobility due to peak xeric conditions, however, the significant change in mobility preceded peak aridity in the region (Beiswenger 1991) and suggests either that the Younger Dryas, the following warming trend after the Younger Dryas, or some catalyst unrelated to environmental change prompted a significant shift in mobility. Peak Holocene aridity began further west and moved eastward (Whitlock et al. 1995) and the ESRP is a transitional zone with poor data quality, however, the results of this study where mobility was heightened during the transition from the TP/EH to the early Holocene may track peak northern hemisphere summer solar insolation around 9,600 cal. BP (Whitlock et al. 1995).

The results of the present study are largely inconsistent with my modeled expectations, and the MVT applied to obsidian sourcing in the study area is not applicable to explain changes in precontact mobility in the study area. Long’s (2007) hypothesis is not supported by the obsidian source analysis presented in this study.

Chapter X Conclusion

This thesis assessed the validity of Long's (2007) patch-choice hypothesis in the study area in comparison to previous obsidian studies (Fowler 2014; Holmer 1997; Scheiber and Finley 2011) using an improved and revised obsidian source dataset in conjunction with regional paleoenvironmental records and the theoretical framework of the MVT. To make firm conclusions on land use in the research area during the transitions to the early Holocene and early middle Holocene, these earlier models of mobility raised several issues that needed to be further addressed. For example, while previous studies (Fowler 2014; Holmer 1997, Henrikson 2008; Long 2007; Plager 2001; Scheiber and Finley 2011) made progress in characterizing precontact mobility in southeastern Idaho, the present study used a refined dataset that specifically focused on the TP/EH, early Holocene, and the early middle Holocene to examine broad patterns of land use during the earliest periods of occupation in the study area. The results of this study contribute additional data and conclusions toward addressing the nature of mobility during these periods that corroborate Scheiber and Finley's (2011) findings which observed peak mobility throughout the ESRP and central Rocky Mountains during the early Holocene, followed by a decline in mobility around 7,000 years ago. Fowler (2014) did not model TP/EH mobility due to constraints in his data set. Still, his findings for the early Holocene and early Middle Holocene were consistent with Scheiber and Finley (2011) with early Holocene conveyance zones expanded, and early middle Holocene conveyance constricting. The results of the present study, which observed low residential mobility for the TP/EH period, conflict with findings of Holmer (1997), which observed heightened levels of mobility for the TP/EH period.

Presently, climate models for the study area lack the fine-grained detail necessary to interpret the effects of environmentally mediated patch quality and abundance on human mobility for the periods of interest and could not test the validity of Long's (2007) patch-choice model. The greatest shift in mobility occurred between the TP/EH and early Holocene periods, with early Holocene heightened mobility starting to decrease during the NSN period. While shifts in mobility between the TP/EH and early Holocene may be correlated with Younger Dryas environmental changes, climate models for the study region currently lack the fine-grained resolution required to conclusively link this environmental change to the archaeological record. Furthermore, I hypothesized that early-middle Holocene mobility would correlate with and show changes in mobility as a result of peak xeric conditions; however, the notable shift in mobility occurred prior to peak aridity in the area (Beiswenger 1991), which implies that a significant shift in mobility was either triggered by the warming trend that followed the Younger Dryas or a catalyst unrelated to environmental change. The MVT applied to obsidian sourcing in the research region does not fully explain variations in precontact mobility in the study area, and the current study's results are generally at odds with my predicted assumptions.

Further research on the mobility of precontact groups in the study area may further explore the reduced mobility of TP/EH adaptations in the study area. The results of this study are inconsistent with seminal Folsom, Midland, and Hell Gap research which finds TP/EH mobility to be heightened (Hofman 2002; Hofman and Todd; Kelly and Todd 1988), however the results of this study may support the findings of Andrews et al. (2008) and Buchanan et al. (2019) which also observed TP/EH Folsom mobility patterns to be constrained.

Andrews et al. (2008) employed a macro-regional scale study that utilized whole site samples. Their findings indicate that the Folsom archaeological record is comprised primarily of small sites and isolates sparsely distributed in the landscape punctuated by larger reoccupied site locations. Frequently, Folsom systems have been typified as highly mobile, but this study instead suggests that in certain contexts, reduced residential mobility is most characteristic of the Folsom tradition. Moreover, Folsom mobility, which is typically painted as centered around highly mobile prey, may have been conditioned in part by more predictable resources such as water and toolstone (Andrews et al. 2008). Reoccupied sites examined by Andrews et al. (2008) occurred in areas where stable resources and ideal landscape features are present. This was especially consistent in intermountain and foothill areas where resource availability is generally more diverse.

Buchanan et al. 2019 additionally observed relative reduced residential mobility in Folsom land use; their study demonstrated increasingly redundant toolstone source use compared to Clovis, an observation they attributed to the year-round residency of the Plains. They hypothesize that Folsom land-use represents a foraging culture that was becoming increasingly settled in their landscape, resulting in a process of landscape learning (Buchanan et al. 2019).

The results of this present study indicate reduced residential mobility in the Folsom/Midland tool traditions in the study area using both obsidian source diversity and distance-to-source measures. The results observed here may contribute to a growing body of work that challenges the typical characterization of Folsom land-use as highly mobile and provides a foundation for future research to investigate.

Additionally, future research may investigate the heightened levels of mobility for the early Holocene period. The results of the present study indicate that there was a significant difference in source use and the procurement ranges for tool traditions included in this category, particularly in the Haskett sample. Further research may also incorporate the rest of the middle and late Holocene periods which the present study did not incorporate. Future research may also choose to refine the study area's climate models, which this study found to be incomplete.

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