CLIMATIC AND CULTURAL CHANGE IN THE NORTHERN GREAT BASIN: A GEOSPATIAL ANALYSIS OF NORTHERN SIDE-NOTCHED PROJECTILE POINTS FROM THE BURNS BUREAU OF LAND MANAGEMENT DISTRICT

by

JORDAN E. PRATT

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Dr. Patrick O'Grady

Climate change dramatically transforms the ecological zones that humans call home. Historically the northern Great Basin region of eastern Oregon provides an ideal case in which to study human adaptation to climate change because in this region, the Pleistocene-Holocene transition that brought the first people into the region, was followed by multiple smaller shifts in climate that influenced people's ecological adaptations to the region.

The early Middle Holocene of around 8,000 – 4,000 calendar years ago (cal. B.P.) provided one of these warming periods, in which the regional environment became much drier and more arid. One of the few types of material culture that have reliably been dated to the early Middle Holocene in the northern Great Basin are Northern Side-notched points, a type of atlatl dart point dated to circa 7,000-4,000 cal. BP. In this paper, Northern Side-notched points collected by the Bureau of Land Management Burns BLM District and UO Museum of Natural and Cultural History's Archaeological Field School are analyzed to establish a rigorously objective classification for such projectile points found in eastern Oregon. BLM site reports are

analyzed to determine significant site characteristics that are then compared to Northern Side-notched site characteristics as previously determined by John Fagan in 1974. Finally, ArcGIS is used to geospatially analyze the distribution of the projectile points throughout the Burn's BLM District compared to known obsidian sources. By analyzing the distribution of projectile points and movement of materials across the landscape, as well as site attributes, insights can be made into prehistoric mobility and settlement patterns.

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INTRODUCTION

Human resilience in responding to fluctuating environments makes an understanding of the rate and degree of change (if any) in these environments essential to unlocking the secrets of the human past in the Great Basin.
Peter J. Mehringer (1986: 37)

If our goal is to use artifactual time-markers to identify archaeological sites as middle Holocene in age, only Northern Side-Notched points will do the trick.
Donald K. Grayson (2011: 312)

The lifeways of prehistoric humans are closely tied to the environments they called home. Thus, understanding how prehistoric human populations interacted with their environments and adapted to ecological change is an integral aspect of archaeology, especially in the Great Basin region of the western United States. Historically there have been many alternating periods of global cooling followed by warming, including the Pleistocene-Holocene transition, during which humans were forced to adapt to a loss of water and biotic diversity brought by climatic warming. In the northern Great Basin region of southeastern Oregon the middle Holocene or Altithermal period that began about 7,800 years before present (BP) was marked by severe warming and increased aridity throughout the region (Antevs 1948), thus is an ideal case for studying human environment interactions.

In the Great Basin around 7, 500 year BP there was a "dramatic shift" in the morphology of stone projectile points towards smaller points that were notched on "sides, corners, or bases" and were used on spears and on darts cast by atlatls (Aikens, et al. 2011: 45; Grayson 2011: 450). In the northern Great Basin, Northern Side-notched points were the first to exhibit this change in basal morphology. Because these stone tools are easily and reliably identified in the archaeological record, they provide temporal and spatial information that can be correlated not only to the environmental shifts, but also to changes in human mobility and settlement patterns. By investigating the geographical distribution of diagnostic tools such as these one can glean a deeper knowledge about how humans lived during prehistoric warming periods.

This paper focuses on the typological analysis and spatial distribution of over 200 large side-notched projectile points collected by the Bureau of Land Management's (BLM) Burns BLM District archaeologists over the past 23 years. The purpose of this paper is to: 1) refine the classification of large side-notched projectile points (distinguishing Northern Side-notched and Elko Side-notched) in the Burns BLM District and northern Great Basin at large, 2) examine the spatial distribution of Northern Side-notched sites and isolated points (isolates) across the Burns BLM District using the ESRI ArcGIS computer program suite[1], 3) determine if the artifact distributions match the Northern Side-notched site patterns tentatively established in 1974 by John Fagan, 4) further explore human mobility and settlement patterns in the northern Great Basin, 5) consider the implications of human adaptation to climate change for human ecology.

1 ArcGIS (which includes multiple programs including ArcMap) is a type of "Geographic Information System" or GIS program. These programs are "computer systems whose main purpose is to store, manipulate, analyze and present information about geographic space" (Wheatley 2002).

BACKGROUND

Great Basin Environment

The Great Basin is a large region of the western United States that includes large parts of Nevada and Utah, as well as portions of Oregon, California, Idaho and Wyoming. One can define the region in a number of ways: as a hydrographic province, a physiographic province, a floristic region and as an ethnographic unit (Grayson 2011). Here the discussion will be focused upon the hydrographic and physiographic definitions of the region, as those most closely align with the environmental prehistory of the region.

Geography and Geology

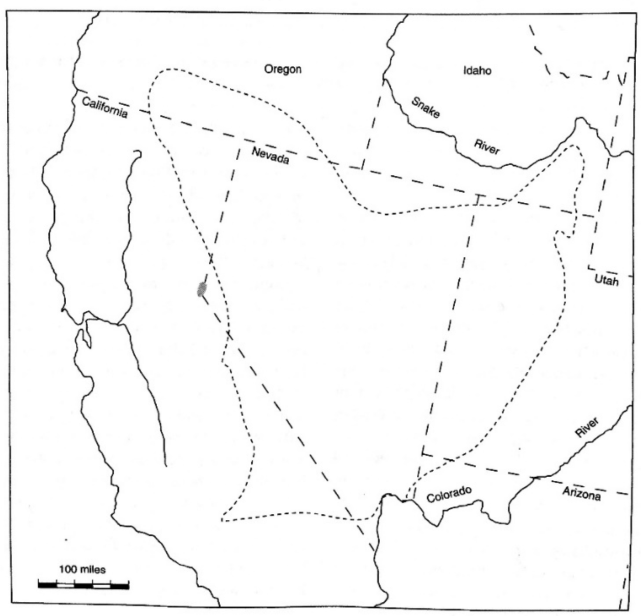

Figure 1. The physiographic Great Basin

(Grayson 2011: 15; with permission).

The physiographic Great Basin is classified as the Basin and Range province. Basin and Range topography, which can be found in other regions of the world, is created through extension of the earth's crust. In the northern Great Basin, crustal extension, starting at least 11 million years ago, created a series of parallel north-south trending normal fault blocks; in between the faults, the basins dropped, leaving the mountain ranges in high relief[2] (Miller 2014: 314). Considered a "high desert[3],"the region is home to over thirty mountain ranges, with some summits reaching over 14,000 feet (White Mountain Peak in California) (Grayson 2011). In Oregon the arid basin floors are around 3,500 – 4,500 feet in elevation, with the mountaintops extending a further 5,000 feet (Aikens, et al. 2011; Madsen 2007).

Initially the Great Basin was described in 1845 by John C. Frémont, the original surveyor from the U.S. Bureau of Topographical Engineers, as a great basin "containing many lakes, with their own system of rivers and creeks, […] and which have no connexion (sic) with the ocean, or the great rivers which flow into it" (Grayson 2011: 8). This definition is still largely used to designate the hydrographic Great Basin, which is composed of a series of internally draining systems, or basins, where water has no outlet to the ocean or any large rivers that flow into it. Instead the water flows into low-lying lakes and playas on the basin floors.

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[2] In geology the uplifted ranges are referred to as horst and the basins as graben.
[3] "High Deserts" are deserts that are located at least 2,000 feet above sea level, although on average the Great Basin's valley floors are located at least 4,000 feet (Grayson 2011).

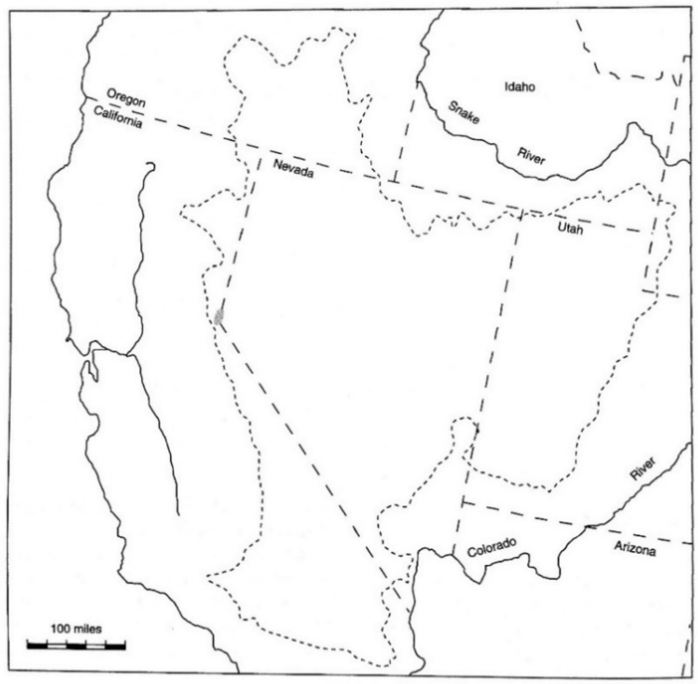

Figure 2. The hydrographic Great Basin

(Grayson 2011: 12; with permission).

In total, there are over 187 distinct internal drainage systems in the Great Basin and over eighty percent of these basins still contain lakes or playas (Aikens, et al. 2011; Madsen 2007: 5). The hydrographic province is bounded to the east and west by the Colorado Plateau and the Sierra Nevada and Cascade ranges respectively; and to the north and south by the Columbia and Colorado River drainages and nearly matches the physiographic boundary (Grayson 2011).

Great Basin lake levels were closely tied to the global climate. During wet periods the basins fill with lakes and marshes that can spread over huge expanses. In fact, during the late Pleistocene, pluvial Lake Bonneville (in Utah) extended more than 51,000 square kilometers or 19,800 square miles at its maximum and covered seven sub-basins in Utah and portions of Nevada and Idaho (Grayson 2011; Madsen 2007). In

Oregon, lakes extended between about 200 to 900 square miles; notable lakes include the Catlow (347 $miles^2$), Warner (483 $miles^2$), Fort Rock (751 $miles^2$) and Malheur (919 $miles^2$) (Grayson 2011). Both the Catlow and Malheur lakes grew so large that they "overflowed into an adjacent basin at maximum levels" (Grayson 2011: 96). The lakes and marshes produce many resources exploited by prehistoric peoples, therefore some researchers have argued that "the extent of Great Basin lakes and marshes was most important to the numbers and distribution of people," (Mehringer 1986: 31). Prehistoric lifeways and pluvial lake environments were closely entwined, and it is the "unpredictability" of these lake-marsh environments and resources that perhaps played the largest role in human organization throughout the Great Basin (Graf, et al. 2007: xvi).

The Great Basin is a huge physical expanse and the region includes many different ecological zones. Therefore, it is "difficult to generalize about the prehistoric Great Basin environments and the adaptive strategies required to live in them," because individual areas have varied ecological communities, elevations, patterns of precipitations, temperature, and seasonality (Madsen 2007: 4). Further, the disparity in water distribution throughout the Great Basin results in habitats that are "very sensitive to even short term climatic changes" (Madsen 2007: 7). While the Great Basin was generally much drier in the middle Holocene, this drying was not uniform and various parts of the Great Basin were affected in different ways by rapid environmental changes. Thus, it is important for researchers to study more localized environments in order to prevent generalizations about environmental changes and their impacts on prehistoric peoples throughout the region (Grayson 2011; Jones 2012; Mehringer 1986).

The Burns BLM District and its context in the northern Great Basin

The term “northern Great Basin,” is used to designate the portion of the Great Basin located in southeastern Oregon. More specifically, this paper focuses on the section of the northern Great Basin in which the Burns Bureau of Land Management (BLM) District is located. The Burns BLM District encompasses most of Harney County, as well as small portions of Lake, Grant and Malheur counties and includes the Harney, Alvord and Catlow basins. The Malheur Lake-Mud Lake-Harney Lake chain, located in the Harney Basin, provides the best extant example of a large scale pluvial lake chain (Madsen 2007: 5). In fact, the “topography of Harney Basin is one of the major factors influencing local climate” and historically the lakes have fluctuated in size, with Malheur Lake ranging from 1.6 by 14.5km to 32.2 by 24.1km long (or 1x9 to 20x15 miles) depending upon precipitation levels (Wigand 1987: 432).

Harney County, including the Burns BLM District, is unique because its boundaries cross into multiple physiographic provinces, composed of Oregon’s High Lava Plains, Blue Mountains, Owyhee Uplands and Basin and Range (Baldwin 1981; Miller 2014). In general the study region is dominated by volcanism and its resulting depositional landscapes. The Blue Mountains province is made up primarily of accreted terrane overlain with lava flows. The High Lava Plains and Owyhee Uplands are both made almost completely of basaltic lava and rhyolitic ash flows. The main difference between the High Lava Plains and the Owyhee Uplands is the age of the volcanic eruptions (the Owyhee Uplands rhyolitic eruptions occurred between 16-14 million years ago, about 4 million years before those of the High Lava Plains [Miller 2014: 219]). The Owyhee Uplands, which are home to the Stinkingwater Mountains, drain from the Owyhee River into the Snake River (Miller 2014). One result of the volcanism are the many obsidian flows that dot the landscape, there are 29 obsidian sources in the Burns BLM District alone, and many more sources can be found in the surrounding region.

Paleoenvironment

Environment and climate are not static through time. Isotopic analysis of ice cores from Greenland has provided the "best" information regarding global fluctuations in climate over the last 60,000 years, resulting in a chronology of environmental shifts that can be directly compared to changes in human material culture (Bousman, et al. 2012: 3; Lowe, et al. 2008; Rasmussen, et al. 2007). It is important to note that the analysis provided by ice cores is very broad and therefore "some terrestrial events *especially* Holocene events do not register on this isotopic record" (Bousman, et al. 2012: 5; Steffensen, et al. 2008). Instead, scientists use empirical proxy data[4] to investigate and recreate these prehistoric environments, resulting in what are referred to as paleoenvironmental reconstructions. These analyses are used to understand localized examples of past environmental conditions, including patterns of precipitation and drought, the resulting changes in plant and animal life and their impacts on human life.

In the Great Basin, the local environmental patterns are based primarily upon Ernst Antevs' (1948) Neothermal Climate sequence. Antevs analyzed annual sedimentary deposits (or varves) from Abert and Summer lake[5], in order to create an

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[4] Geologic examples include volcanic and tectonic activity, sedimentology, wind and sand dune deposition, & lake extents (Antevs 1948; Mehringer 1986; Wigand 1987). Biologic examples include plant macrofossils, fossil pollens, dendroclimatology and the analysis of animal faunal remains (Grayson 1979; Mehringer 1986; Wigand 1987).

[5] Located in south-central Oregon.

environmental sequence for the "postglacial" Great Basin of the last 9,000 years (Antevs 1948). Antevs' sequence includes three periods: the "Anathermal" (9,000-7,000 BP), a period relatively warm compared to the glacial era, but moister than present[6] conditions; the "Altithermal" (7,000-4,500 BP), a "high heat" period that was much warmer than present; and the "Medithermal" (4,500 BP – present), a relatively warm period in which pluvial lakes reappear (Antevs 1948: 10-12).

This paper focuses on the Altithermal period, otherwise referred to as the Middle Holocene, and its associated environmental and archaeological trends. While Antevs' scheme is still generally accepted and used throughout the Great Basin literature to describe changes in climate, some researchers expand or contract the dates depending upon localized information, and Antevs himself later adjusted the dates of each period (Grayson 2011). In the northern Great Basin, subsequent paleoenvironmental reconstructions have corroborated Antevs' sequence and provided more nuanced analyses (Grayson 1979; Mehringer 1985 in Grayson 2011; Wigand 1987).

Closed lake beds are an ideal location to study micro-climates because they are "excellent gauges of the climatically controlled balance between inflow and evaporation" meaning that they provide a direct reflection of fluctuating climates (Mehringer 1986: 35). For example, geologic cores from Diamond Pond show that the Harney Basin underwent multiple major shifts in climate that lasted a couple of centuries with very quick transitions, of "less than twenty-five to forty years"

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[6] Indicating the time of Antevs' writing. Present climate change and climate is not included as a point of reference for paleoclimates in this paper.

between them (Wigand 1987: 455). Similarly, archaeofaunal remains from the Fort Rock Basin[7] indicate a loss of biotic diversity, especially that of large grazing ungulates post 7,000 BP (Grayson 1979). Grayson posits that the change in faunal communities is a result of major shifts in flora from, “a higher percentage of herbaceous vegetation [pre 7,000 BP] to… a higher percentage of shrubs” (Grayson 1979: 450). This transition from mesic (wet adapted) to xeric (dry adapted) plants occurs at the Middle Holocene Altithermal boundary.

In general there are few cultural markers that reliably date to the Middle Holocene dry period, which led initial researchers in the region to hypothesize total abandonment of the region during this period (Antevs 1948; Baumhoff and Heizer 1965). The total abandonment hypotheses are generally no longer accepted, evidence now points instead to “relatively low human population densities […] likely caused by increased aridity” with Northern Side-notched points being the only artifact that is reliably dated to this period (Grayson 2011: 312). It is important to note that there are other projectile points which date to the mid-Holocene in the northern Great Basin, including Elko series points (e.g. Elko Corner-notched and Elko Eared projectile points). These points are found in substantial numbers throughout the Burns BLM District, with 1,735 Elko series points collected by district archaeologists (Thomas 2015: personal comm. 6/1). However, these points do not consistently date to the dry portion of the Middle Holocene. Thus, by exclusively

[7] The Fort Rock Basin is located in Lake County, which neighbors Harney County to the west. While not technically localized to the study area analyzed in this paper, it is close enough for paleoenvironmental data to be utilized.

studying Northern Side-notches, the scope of the paper focuses only on those artifacts which correspond with the dry portion of the Middle Holocene.

Great Basin Ethnographic & Archaeological History

The northern Great Basin is home to the Northern Paiute (Grayson 2011). The *Wada'tika* or "Wada-Eater" band, now called the Burns Paiute, occupied Harney Basin at the time of contact (Whiting 1950). The Wada'tika were named after wada, a dietary staple found on receding lake shorelines in the early fall. The tiny black seeds were either a preferred food item for local consumption or a prized trade item in larger exchange systems (Whiting 1951). Historical accounts by Peter Skene Ogden (of the Hudson Bay Company) in the late 1820's and ethnographic accounts by Beatrice Blyth Whiting in the 1950's have helped to establish a seasonal round and settlement pattern for the *Wada'tika* band (Elliot 1910; Whiting 1950). From Ogden's journals we know that the large numbers of people lived around the Malheur and Harney Lakes during this period. In his journal he reports, "We cannot go 10 yds. without finding them […] No Indian nation so numerous as these in all North America" (Ogden, November 3, 1926, in Elliot 1910:208).

The home territory of the *Wada'tika* "extended to Silvies and Drewsey in the north, west to Wagontire, and included Beaty's Butte, Catlow Valley, and Alvord Lake as its southernmost extent (Blyth 1938). From Whiting's (née Blyth) ethnographic account we know that the *Wada'tika* camped for large portions of the year (including winter and late summer when they harvested wada) around the Harney and Malheur lakes (Whiting 1950). During other parts of the year they foraged in other regions exploiting resources as they came into season. Notable areas include the Stinkingwater

Mountains, where important roots including camas, biscuit root, and bitterroot were collected during the spring (Whiting 1950); the Drewsey River where salmon was caught in spring and Cow Creek to the east of Harney where crickets were gathered during the summer (Whiting 1950). Whiting notes that families “often wandered up towards Seneca and John Day and hunted deer […] some families went up to Canyon City,” but in September they always came “south to the vicinity of Malheur Lake and Saddle Butte” in order to harvest the *wada* (Whiting 1950: 18) . From this ethnographic information two things are clear: historically people moved great distances in order to exploit seasonal resources, and the Harney and Malheur lakes were the focal point of *Wada’tika* settlement and subsistence, the location to which peoples always returned. It is important to note this information is based on post-contact accounts and thus it provides an intriguing glimpse into the *historic* lifeways of the people inhabiting the region and information about where resources were found. The degree to which this seasonal round matched prehistoric lifeways has not been extensively analyzed except in Patrick O’Grady’s 2006 dissertation. As established earlier in this paper, the environment in the Harney Basin was altered by climatic events and the degree to which resources, especially edible plants, were distributed through the Harney Basin during such changes is not well understood. For this reason, it is hard to project which areas and resources would have been utilized during prehistoric warming periods.

Archaeological Research

The northern Great Basin has been the subject of archaeological research since the 1930's, when Luther Cressman began his research in the Fort Rock Basin. Cressman was the initial excavator on a number of sites, including Paisley Caves, which following the recent work by Jenkins (2012) is now integral to our understanding of the northern Great Basin, North American prehistory, and the peopling of the Americas (Cressman 1942; Grayson 2011; Jenkins, et al. 2012). 1n 1942 Cressman controversially claimed that people had occupied southern Oregon for "more than 10,000 years" (Cressman 1942: 93; Grayson 2011). While this claim was initially rejected, research throughout the ensuing decades has reaffirmed the antiquity of human occupations in the region (Aikens, et al. 2011; Grayson 2011; Jenkins, et al. 2004). However, most of this research has centered on the Fort Rock, and Christmas Valley Basins, with research occurring over a shorter duration within the Harney Basin.

Diagnostic projectile points of chipped stone are often the only artifacts that are consistently preserved in the archaeological record and are thus used to create temporal chronologies to correlate data between sites and localities. However, these chronologies are often "nothing more than morphological types that are found consistently to be associated with a particular span of time in a given area" (Thomas 1981: 14). This can be very problematic because why and how new elements and types are established[8] and reinforced (thereby becoming visible in the archaeological record) is often ignored (Dunnell 1978). There are two projectile point types that are consistently dated (through

8 In this case Dunnell is referring to the Evolutionary Archaeology theoretical framework and the evolutionary processes/natural selection should be considered when analyzing the creation of material artifacts.

association with radiocarbon dated deposits) to the beginning of the Middle Holocene dry period, the Northern Side-notched point in the northern Great Basin and the Pinto point in the southern and eastern Great Basin (Grayson 2011). The purpose of this paper is to study the geospatial distribution of Northern Side-notched points in a portion of the northern Great Basin (e.g. Burns BLM District). While important, this paper does not extensively address the morphological attributes of Northern Side-notches, why or how the point was adopted or the evolutionary implications of the points themselves.

Fagan and Altithermal Spring Sites

The first (and last) extensive consideration of Northern Side-notched points in the northern Great Basin was completed in 1974 by John Fagan in his doctoral dissertation, which examined Altithermal spring sites throughout the northern Great Basin. Fagan found Northern Side-notched points in a distinct sequence of buried deposits, which he consistently dated to 7,000-5,000 BP (Fagan 1974). Perhaps more interestingly, he found that "eight of the ten sites occupied during the Altithermal were situated around high altitude springs, between 5,000 – 6,000 feet above sea level" (Fagan 1974: 97). These finds led Fagan to conclude that the northern Great Basin was not abandoned during the Altithermal, rather humans were forced to move to higher elevations in order to exploit the limited resources concentrated around springs (Fagan 1974). The sites Fagan excavated recovered few "milling" stones, used to process plant remains (Fagan 1974). For Fagan, this indicated these sites were used for hunting and were briefly occupied (Fagan 1974: 103). While the lack of ground stone and use of Northern Side-notches is not uniform across the Great Basin during this time, the sites Fagan analyzed correspond to other Great Basin Middle Holocene sites in multiple ways, namely, “they are near dependable supplies of water” and are “centered on the wetlands that happened to remain” (Grayson 2011). Fagan’s assertions are central to a key component of this paper, which is to geospatially map and analyze the site attributes of all of the Northern Side-notched points collected by the Burns BLM District to test the conclusions he made about Altithermal spring sites and the distribution of Northern Side-notched projectile points in the Harney Basin and larger Burns BLM District.

METHODS

In order to accomplish this investigation, three distinct components of analysis were completed. First, projectile points were measured on a series of standard attributes in order to create an empirical set of salient characteristics that could be compared to other projectile points. In total, 358 projectile points were analyzed. Of these, 259 were initially designated as Northern Side-notched points and 99 were designated as Elko Side-notched points by the Burns BLM District. Second, Burns BLM District site reports with references to Northern Side-notched points were analyzed and defining site attributes, such as elevation, water sources and cultural materials, were recorded. Third, the sites and isolates were mapped in order to explore their geospatial distribution. The data was then compared to known seasonal rounds and mobility patterns (O'Grady 2006; Smith 2007; Whiting 1950). Together, this study provides a means for archaeologists to understand settlement and mobility during the middle Holocene, while simultaneously refining the typological definition of the Northern Side-notched points in this specific geographic region.

Northern Side-notched Projectile Points

Northern Side-notched projectile points, date to 7,300-4,500 BP and were used to tip “atlatl darts, which were then propelled with an atlatl or “spear thrower” (Grayson 2011: 309). In general these dart points are large, weighing more than 1.5 grams (Aikens, et al. 2011; Thomas 1981). Northern Side-notched projectile points are found throughout the Great Basin as well as parts of central Utah and the Columbia River Plateau, however they are most commonly found in the northern Great Basin (Grayson

2011). The term “Northern Side-notched” was first proposed by Ruth Gruhn in 1961, who in her analysis of the Wilson Butte Cave in South-central Idaho states:

> A distinctive form of large side-notched point thus appears both east and west of the High Plains at about the same time, 7,000-5,000 B.C. This approximate contemporaneity and the close similarity of these artifacts over a wide geographical range suggests some rapid cultural movement may have been involved. […] In the western United States the distribution of these large side-notched points is northern, and I propose the term Northern Side-notched for these points […] to distinguish them from the small side-notched points characteristic of the late prehistoric period in the West (130).

Northern side-notches are identifiable by their distinct shape and notching, but are distinguished by their large size. They are bifacial, meaning they have been worked on both sides, and usually triangular or lanceolate in shape (Justice 2001). They are distinguished by their U-shaped notches, which are found on both sides of the point (e.g. the left and right). While these notches are generally horizontally placed parallel to the base, they can also be placed with a slight upward angle (Justice 2001). The final distinguishing characteristic of Northern Side-notches is the basal shape.

Figure 3. Image of “Classic” Northern Side-notched Points

(From left, artifact #: 2039-3855-4-C-5-1 and 2039-3855-4-21-1).

They typically have concave bases, although this trait also shows a substantial amount of variation with some points exhibiting flat bases (Thomas 1981).

Typological Analysis

Before the geospatial and site analysis could be initiated, I had to ensure that the points collected and tagged by the Burns BLM District Bureau of Land Management, were in fact Northern Side-notches as I understand them to be. There are many typologies that have been utilized to define projectile points in the Great Basin over time, including Luther Cressman's "Basis of Classification" or "Principles of Classification," Robert F. Heizer's "Berkeley Typology," Flennikan & Wilke's "Typology, Technology, and Chronology of Great Basin Dart Points" and Thomas' "Monitor Valley Key," as well as others (Thomas 1981). Because of the stylistic basal variation present in the Northern Side-notched points, various regional researchers have referred to these points by different names, including: Bitterroot Side-notched (Aikens 1970; Swanson 1964), Cold Springs Type (Butler 1961; Shiner 1961), and Madeline Dunes Side-notched (Riddell 1960), or simply as Large Side-notched (Thomas 1981). Researcher have also split the overarching typology into multiple point types, thereby including Elko Side-notched for flat based specimens (Aikens 1970; Justice 2001; Thomas 1981). These divisions are problematic for several reasons. For one, there is little evidence that these basal differences represent *functional* advantage, meaning that the basal shape doesn't provide any sort of Darwinian fitness for the populations (Bettinger and Eerkens 1997), instead the variation in basal shape represents various *styles* (e.g. forms without detectable selective value [Dunnell 1978]), while basal width determines how a point is hafted to a dart or arrow and thereby provides a functional advantage (Bettinger and Eerkens 1997; Eerkens and Lipo 2005). Further, there is no consensus as to which "type" has what basal shape, while most researchers consider Northern Side-notches to have bases that are "markedly convex," there are many examples in published reports of Northern Side-notches with flat bases (Thomas 1981: 30). Additionally, when points can be re-worked or re-sharpened, an "economical measure," that extends a tool's use life (Flenniken and Raymond 1986: 608). Often rejuvenated tools become smaller, because the length, width and weight are "systematically reduced through time" (Thomas 1981: 15). This results in Northern Side-notches that are not the perfectly proportioned triangular shape that is considered by many the "classic" Northern Side-notched morphology.

Thomas' Monitor Valley Key does not include Northern Side-notches or Elko Side-notched. Instead it only discusses "Large Side-notched points" which are large shouldered side-notched points, weighing more than 1.5 grams with a proximal shoulder angle greater than 150˚(Thomas 1981). It is important to note that this typology is based on only fifteen points, and therefore is very limited in scope due to the relatively late period of human use at Gatecliff Shelter. The Burns BLM District created a typological reference guide in 2012 (Thomas and Morlan 2012). The guide is used in this paper only as a point of reference for how archaeologists within the district utilize other typologies to classify points. Unlike Thomas, who staunchly lumps all large side-notches together, the BLM's guide splits the large side-notches into two distinct typologies including Northern Side-notched and Elko Side-notched (Thomas and Morlan 2012). Their typology states that Northern Side-notched points have a “basal concavity, squared ears, and ear tips” and a neck width larger than 6.5mm. (Thomas and Morlan 2012).

The purpose of my typological analysis is twofold. First, to compare a much larger sample of Northern Side-notched points in order to create a more comprehensive, empirically based, key (e.g. Thomas 1981) for points being collected in the northern Great Basin, specifically in the Burns BLM District. Second, to compare points classified by others as Northern Side-notched and Elko Side-notched points to determine whether there are two morphologically distinct point types. In order to do this, several characteristics were recorded, including: 1) the weight of the artifact; 2) the material used to make the artifact; 3) the angle of the notches (e.g. straight – indicating side notched, slightly upturned, or upturned – indicating notches that were angled from below similar to a corner notch); and 4) the shape of its base (e.g. concave or flat). Then, using a Vernier sliding dial caliper, I measured six additional characteristics, including:

> *Maximum Length (L):* Length indicates the maximum distance between the tip of the projectile point and the most inferior portion of the base. This was measured and recorded as “Length.” If part of the base or tip and blade of the point was broken a note was made indicating that only a partial measurement was taken.
>
> *Thickness (T):* The maximum thickness of the projectile point’s profile (e.g. dorsal to ventral surface).
>
> *Neck Width (NW):* The distance between the two notches was measured to determine the neck width. This measurement was only taken if both notches were visible and indicates the smallest distance between the two notches.
>
> *Blade Width (Bl.W)*: Indicates the maximum width of the projectile point. Measurements indicate the maximum distance between the two barbs or the maximum distance between the widest portion of the blade. If both barbs were not present a note was made indicating that only a partial measurement was taken.

Base Width (BW): The maximum width of the projectile point's base. Measures the maximum distance between the two sides of the stem (e.g. the portion of the base located below the notches). If the any portion of the base was broken a note was made indicating that only a partial measurement was taken.

Basal Height (BH): After Largaespada 2006, the height of the base was measured between the inferior of the base and the corner of the proximal shoulder. This measurement was only taken on a subsample (n=10) of both the Northern and Elko Side-notched points (as well as a sample of Elko Corner-notched points) in order to be used for comparisons.

For a visual representation of the measurements taken, refer to Appendix A. Additionally, all of these measurements were recorded and can be seen in Appendix B (Northern Side-notches), and Appendix C (Elko Side-notches).

After measurements were recorded, those artifacts most closely fitting the description of Elko Side-notched points were compared against a control sample of Northern Side-notched points, with the results of obsidian hydration analysis utilized for temporal associations. A simple statistical analysis was used to determine if there was enough temporal variation to differentiate between Northern and Elko Side-notched points. Furthermore, the basal height of these subsamples were compared to determine if there was a unique morphological attribute associated with Elko Side-notched points. This analysis does not represent the main purpose of this paper, rather it is used as a way to control the data that is analyzed later. Therefore this portion of the results is only briefly addressed in the results section.

Site Analysis

The main purpose of this paper is to determine whether the findings presented in Fagan's dissertation are accurate and then to use geospatial maps to further discuss the distribution of Northern Side-notched sites across the landscape.

Fagan hypothesized that during the Altithermal people moved from low altitude lake side caves to higher altitude spring sites where food and water could be more readily obtained (Fagan 1974). Fagan identified several material culture patterns associated with the spring sites he analyzed. First, he found that the heavier and larger projectile points (including Northern Side-notched) were found in the oldest deposits and were most often found in high altitude sites (5,000+ feet above sea level) associated with permanent water (e.g. springs). Second, he found that ground stone and other milling stones used to process plant remains, were most often found in the low elevation sites, and that when found at higher elevation sites they were "always in the most recent deposits" (Fagan 1974: 103).

In order to determine whether these patterns are accurate, I analyzed the BLM site and isolate reports associated with every Northern Side-notched projectile point I identified[9]. Geographic, geologic, hydrologic and material culture attributes were recorded in order to determine if there were defining site attributes that could be associated with Northern Side-notched projectile points.

For every site, I recorded the physiographic province, basin, sub-basin, elevation, primary depositional environment, secondary depositional environment, as well as "other landforms" (which encompassed any physical details recorded under the "Other Environmental Features/Observations (Relevant to Site Location/Formation)" section of the BLM Site report). I then recorded information regarding the availability of water at the sites, including the name, type (e.g. stream/river, spring/seep etc.), status

[9] I did not have site or isolate reports for every artifact correctly identified as a Northern Side-notch. Also note that the BLM utilizes "site" to designate any archaeological feature where multiple artifacts or culturally modified materials are present. Conversely, "isolate" is used to designate individual artifacts recovered and not associated with other artifacts.

(e.g. perennial vs. intermittent/ephemeral) and the distance from the site (in meters) of every water source associated with each site. Finally, I recorded information about the material culture found at each site. This included what the site reports referred to as "Site Type" (which describes the artifacts/culturally modified aspects of the site). Examples include: "Lithic Scatter," "Ground stone Tool," "Hearth," "Rock Alignment" etc.). I also made note if the sites were excavated or simply represented surface deposits. Unfortunately, isolate reports are not as detailed as site reports, therefore I recorded as much information as I could. When there was no information on the site/isolate report or the report was missing, I recorded "unk" or unknown, indicating that there was no data available.

Once all of these details were recorded, the sites were separated into categories based on elevation. Fagan considered "High Elevation" sites to be those located above 5,000 feet. However, initial results from my analysis showed that only about 10 sites were located between 4,800 and 5,000 feet above sea level. These sites displayed other characteristics similar to high elevation sites as defined by Fagan (e.g. they were near springs or other water sources and lacked ground stone tools). Thus, because 200 feet is essentially negligible (it is less than 4/100$^{\text{ths}}$ of a mile), I expanded my definition of "High Elevation" sites to include these localities. Thus, the definition of "High Elevation" sites used in this paper does not match Fagan's. Instead it includes all sites and isolates found above 4,800 feet above sea level, while "Low Elevation," is used to designate all sites located below 4,800 feet above sea level. High elevation sites in this study extended to a maximum of 8,960 feet above sea level.

GIS Analysis

The distribution of sites and artifacts was then analyzed using a GIS program (ArcGIS) and combined with the obsidian sourcing information in order to consider the mobility and settlement patterns present in Burns BLM District.

"Geographic Information System" or GIS programs are "computer systems whose main purpose is to store, manipulate, analyze and present information about geographic space" (Wheatley 2002:9). There are two main types of GIS: vector and raster data sets. Vector data sets are those in which "data is represented in terms of geometric objects" (Wheatley 2002: 32). In essence vector-based data sets, such as the one utilized in this paper, are points, lines or geometric shapes that can easily be mapped using an (X, Y) system of coordinates. Conversely raster data sets are those in which information is stored "as a rectangular matrix of cells, each of which contains a measurement that relates to one geographic location" (Wheatley 2002:32), meaning that pixels are used to store geographically important attributes.

I used Environmental Systems Research Institute (ESRI) ArcMap 10.2 program[10] to geospatially analyze the Northern Side-notched projectile point sites and isolates. The Burns BLM District graciously provided me with the eastings and northings of every projectile point and their associated sites. I mapped these points to create a vector based map. It is important to note that my maps represent the eastings and northings of each site and isolate recorded by the BLM, they do *not* represent every projectile point's recorded GPS position. This was a conscious decision made to create the most streamlined and understandable maps possible. Sites with multiple artifacts

[10] ArcMap is component of the ESRI's ArcGIS for Desktop program suite.

were recorded using only the site's (X, Y) coordinates. The BLM utilizes the North American Datum of 1927 (e.g. NAD27) coordinate, therefore this projection is used on my maps.

The "World Topographic Map," a basemap provided by ESRI was utilized in my maps.11 This basemap was chosen because it not only visually represents elevation, but also incorporates important environmental attributes (e.g. rivers, lakes). I created two maps depicting the distribution of Northern Side-Notched points across the landscape. The first is a simple distribution of the sites and isolates. The second map depicts the Northern Side-notched sites by size. Sites were divided into categories based on the number of Northern Side-notched points recovered, and this information is then visually represented on the map. It is important to note that most of the sites included other typologically distinct projectile points and artifacts and varied in spatial size. My maps and analysis do not include this information, therefore the "size" of a site is not actually representative of the true spatial size or total number of artifacts recovered from a site. Rather, my map distinguishes sites based only on the number of Northern Side-notched artifacts collected.

Obsidian Hydration and XRF Obsidian Sourcing

Obsidian, a type of volcanic glass, is a unique material because each obsidian source flow has a "distinctive geochemical signature" composed of rare elements that can be quantified and compared (Aikens et al. 2011). There are over 140 distinct

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11 A basemap is essentially a background layer of reference information utilized as a backdrop to display the data being shown in a map. Some are available for free via the ESRI (Environmental Systems Research Institute) website. These basemaps are "built with content contributed by organizations around the world through the *Community Maps Program*" and the lower right hand portion of each map has the appropriate citation (ESRI, Web).

obsidian flows in Oregon, and 29 of these are located within the Burns BLM District (with many more located just outside of the district's boundaries). X-Ray Fluorescence (XRF) techniques[12] can be utilized to measure the geochemical compounds in order to determine which volcanic flow a piece of obsidian (or a tool made out of obsidian) came from. Most projectile points collected in the district are made out of obsidian and it is now common to "source" or identify the provenance from which these raw materials originally from.

Obsidian hydration is a relative dating technique. After a piece of obsidian is broken, the exposed surface starts to adsorb "molecular water from the environment […] building a uniform band of hydration that gradually increases in thickness over time" (O'Grady 2006:512). This "hydration rim" can be used to determine a relative date for when the obsidian was broken or flaked during the tool making process. There are many different factors that affect the hydration rate including temperature, depositional context, and the geochemistry of the obsidian itself (Friedmann 1960) . Once all of the factors affecting the hydration rate are understood an age estimate can be generated based on the hydration rim's thickness and the obsidian's rate of adsorption (although this was not performed for this study).

Through the generous support of the Oregon Archaeological Society's Roy F. Jones Memorial Scholarship, I was able to have X-Ray Fluorescence (XRF) sourcing performed by Craig Skinner of the Northwest Obsidian Research Studies Laboratory and obsidian hydration analysis performed by Jennifer "Pips" Thatcher of Willamette

[12] X-Ray Fluorescence (XRF) studies are performed using a spectrometer which determines the trace elements found in an artifact, which can then be compared to known geochemical signatures from various obsidian sources.

Analytics. Obsidian hydration and XRF tests were performed on 10 Elko Side-notched points and 10 Northern Side-notched points.

The hydration data was then analyzed to determine if there was a statistical difference in obsidian hydration rims (and therefore ages) between Northern Side-notched and Elko Side-notched points. The XRF data was combined with Northern Side-notched XRF data from an additional 20 artifacts (also performed by Skinner) shared by the BLM and MNCH Archaeological Field School. Only sourcing information from artifacts identified and analyzed during this study was included, resulting in a sample of 30 sourced artifacts from archaeological 16 sites. A map was generated comparing known obsidian sources with the Northern Side-notched sites and isolates identified by the Burns BLM District. The map was created by merging my sites and isolates map with a map of known obsidian sources from southeast Oregon that was created by the Northwest Research Obsidian Studies Laboratory. Sources identified by XRF sourcing were then highlighted on the map. A second map was created by Thatcher (of Willamette Analytics) showing a sample of sites that were sourced and their corresponding obsidian sources. This map includes both Northern Side-notched and Elko Side-notched sites (19 sites are shown) and only includes those sites that correspond with artifacts that I sent in for sourcing. Thus, I adapted this map, highlighting *only* the sources from which the Northern Side-notched points were identified (n=9) and drawing lines between the sites and their corresponding sources. These maps were then incorporated with the rest of the geospatial data to address patterns of mobility and settlement across the Burns BLM district.

RESULTS

My analysis of 358 projectile points resulted in the classification of 238 Northern Side-notched points and 13 Elko Side-notched points. 36 points were Side-notched but otherwise indistinguishable. 50 diagnostic projectile points were misclassified as either Northern Side-notched (n=8) or Elko Side-notched (n=49). Additionally, 19 points were broken or otherwise unclassifiable. Finally, 2 artifacts were not projectile points. The most commonly used material was obsidian, 96% of identified Northern Side-notches were made of obsidian, while only 2% of Northern Side-notches respectively were made out of cryptocrystalline silicates (CCS) (ex: chert) or fine grain volcanics (FGV) (ex: basalt).

Table 1. Assemblage Characteristics - Projectile Point Classification

	BLM/MNCH "Northern Side-notched" Sample	BLM/MNCH "Elko Side-notched" Sample	Total
Northern Side-notched	214	24	238
Elko Side-notched	1	12	13
Side-notched	29	7	36
Desert Side-notched	3	3	6
Corner-notched[1]	4	35	39
Gatecliff Series	--	4	4
Malheur Stemmed	1	--	1
Un-classified Projectile Points	7	12	19
Drill	--	1	1
Unfinished tool	--	1	1
Total	**259**	**99**	**358**

[1]In this case Corner-notched indicates Elko Corner-notched, Elko Eared, Rose Spring and non diagnostic corner-notched projectile points.

Morphological Characteristics of Northern Side-notched

There was a large amount of morphological variation in the shape of the Northern Side-notches in this assemblage. The shortest projectile point in this assemblage was only 1.92cm long (Catalog #: 10-501), indicating that some of these points were extensively rejuvenated. There are three general shapes consistently represented in the assemblage: the "classical" points with triangular shaped blades; points with very long and slender blades; and points so heavily reworked that their blades are relatively short and narrower compared to their bases. Additionally there are a number of points with highly serrated edges (see Figure 4).

The majority of the projectile points were broken in some way. Only 16 of the Northern Side-notched points were complete, accounting for 6.7% of the sample (making the recorded weights essentially useless). 79% of the projectile points displayed incomplete lengths. Researchers, such as Thomas (1981), have noted a projectile point's length is generally "unstable" overtime, primarily because tips are prone to breaking and are reduced when a projectile point is re-sharpened or because of copying errors (Eerkens and Lipo 2005; Thomas 1981: 15). Conversely, Thomas (1981) notes that "basal attributes clearly provide the most stable variables for monitoring temporal change in projectile points," (Thomas 1981:15). Other researchers have also noted that basal width variation is generally very low, in part because basal widths provide an evolutionary function (e.g. the width determines how a point is hafted and ultimately its function [Eerkens and Lipo 2005]). The basal attributes in this assemblage were generally stable, especially neck widths. In fact, 94.5% of neck widths were complete while only 47.1% of basal width measurements were complete (due to the fact that tangs were often broken). The second most stable characteristic of the assemblage studied here are the maximum blade widths, of which 71.4% were unbroken.

The histograms and box plots (see Figure 5 and 6) indicate that neck width, thickness, base width and blade width display the smallest amount of standard deviation; all of these characteristics portray a normal distribution. The consistency and stability of these attributes throughout the assemblage indicates that these characteristics are significant and should be used to key Northern Side-notched projectile points in the Burns BLM District, and, I argue, the northern Great Basin at large. Based on the information collected it is reasonable to state that Northern Side-notched projectile points are those points which display a neck width greater than 0.7cm (mean = 1.2cm), a base width greater than 1.3cm (mean = 2.14cm) and a blade width greater than 1.2cm (mean = 2.01cm). Only 67% of the Northern Side-notched bases were concave (23% flat, 10% unknown or without a base), indicating that basal shape alone is not enough to distinguish Northern Side-notch from other side-notched points.

Figure 4. Examples of the morphological variation of Northern Side-notched projectile points

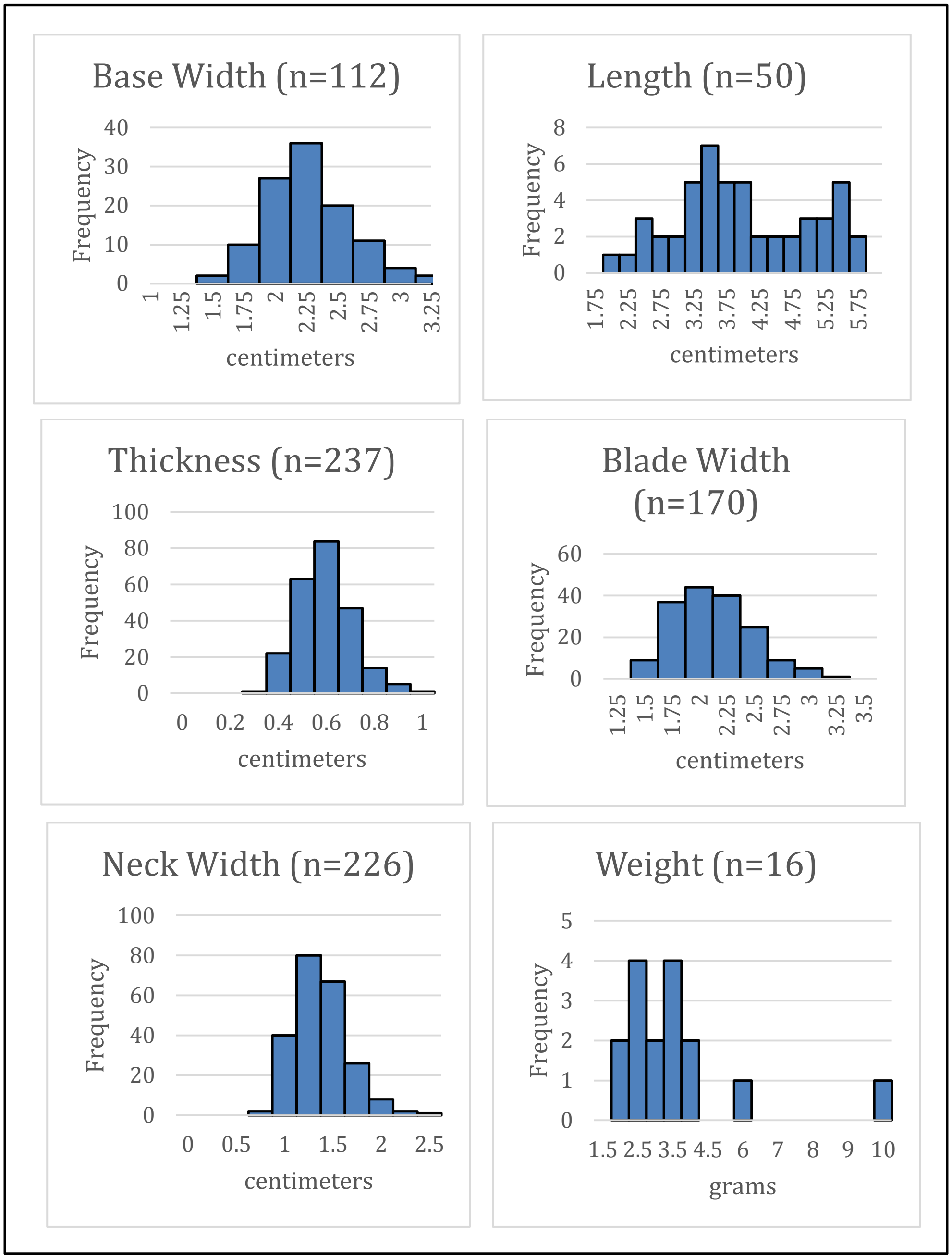

Figure 5. Histograms of Northern Side-notched morphological characteristics

These histograms represent the morphological characteristics identified in the study. Only complete elements were included in the histograms. Note – the axis labels indicate the smallest number in a given bar's range (not the median number).

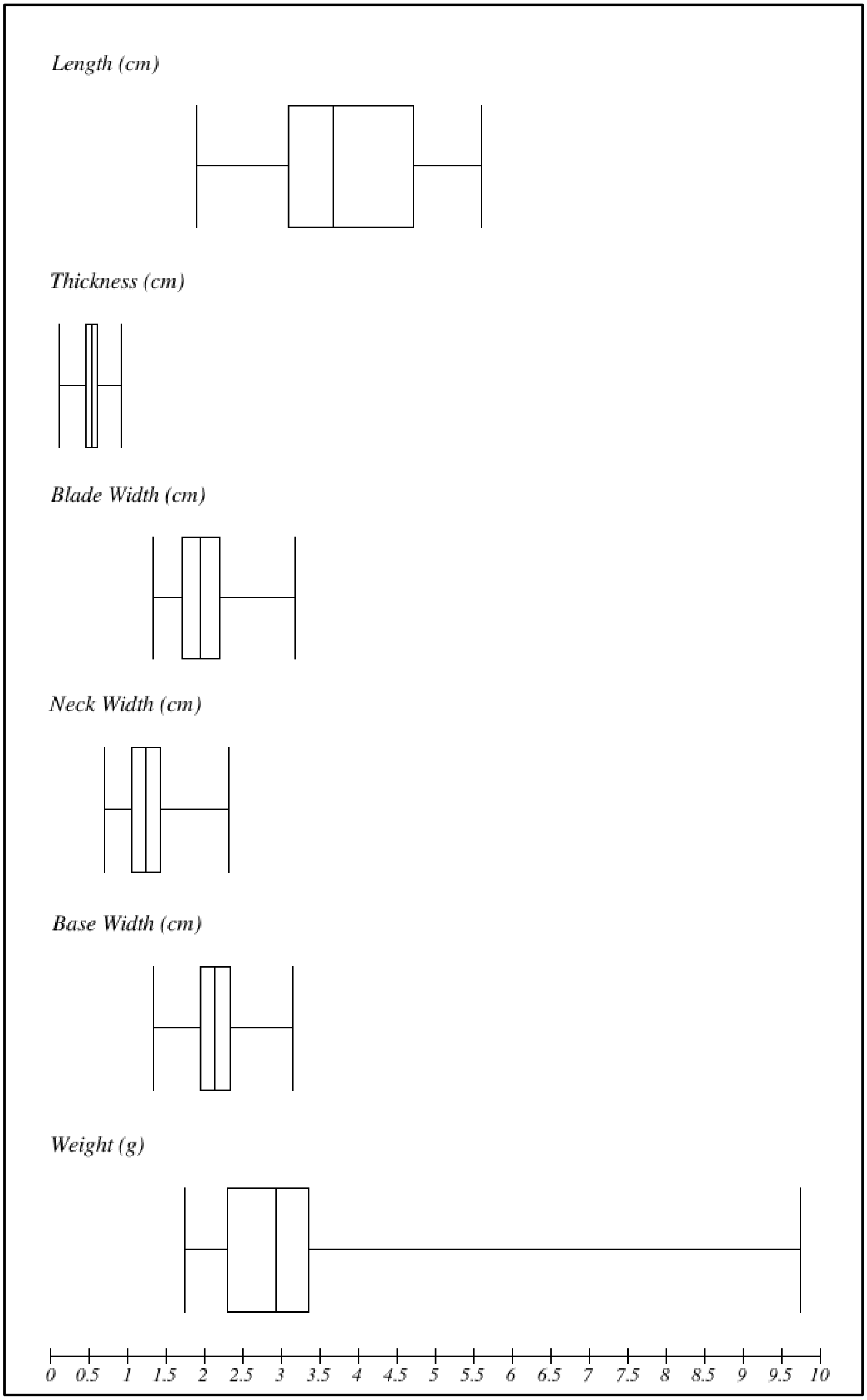

Figure 6. Box plots of Northern Side-notched morphological characteristics

Like the histograms in Figure 5, these box plots represent the morphological characteristics and only complete elements used to generate the diagrams.

Northern Side-notched vs. Elko Side-notched

There are three features of Elko Side-notched points that distinguish them from other large side-notched points (Largaespada 2006; Thomas and Morlan 2012). First, they are considered temporally distinct; second they have flat bases; and finally they display a basal height of less than 6mm. I tested all three of these traits to determine whether they are consistent. Of the 13 identified Elko Side-notched points, 11 display flat or relatively flat bases (accounting for 85%). Despite the small sample size, this matches well with the guidelines established by Largaespada (2006) and maintained by Thomas and Morlan (2012). Flat bases are present on 23% of the Northern Side-notched points from the Burns BLM District, therefore this attribute is not exclusive to Elko Side-notched projectile points. These points should not be classified based on basal shape alone.

To test Largaespada's basal height characteristic, I measured the basal height of ten Northern Side-notched and 10 Elko Side notched projectile points[13]. Basal height is the construct of side-notching, by which the proximal edge of the notch defines the metric index (Largaespada 2006). However, some corner-notched projectile points have tangs, or ear tips, which can be measured in the same way as the basal height. Therefore, I measured an additional 10 Elko Corner-notched projectile points for comparative purposes (see Table 2). When possible the basal height was measured on both of a projectile point's ears and recorded in millimeters.

[13] The points measured were the same points sent in for obsidian hydration and XRF analysis, they are not all complete (some have broken tangs etc.).

Table 2. Basal Height measurements of NSN, ESN, and ECN projectile points

Catalog Number	Basal Height Tang 1 (mm)	Basal Height Tang 2 (mm)	Difference (mm)
Northern Side-notched (NSN)			
02-448	6	6.2	0.2
07-407	6.2	--	--
08-137	5.2	5.9	0.7
08-251	9.2	--	--
08-769	12	8.5	3.5
09-058	7.5	7.2	0.3
09-199	8	6.9	1.1
10-044	9.9	--	--
12-275	10	7	3.1
13-219	7.7	7.7	0
Elko Side-notched (ESN)			
01-213	5.5	---	---
02-618	6	---	---
03-652	5.7	---	---
08-134	4.3	---	---
08-410	5	3.7	1.3
08-914	6.1	---	---
09-197	5.5	0.6	4.9
10-052	5	---	---
10-230	4	4.8	0.8
14-125	3.5	3.3	0.2
Elko Corner-notched[1] (ECN)			
1264-3075-150-4	2.5	2.1	0.4
1264-3075-150-19	0.1	0.1	0
1264-3075-150-10	1.2	2.3	1.1
1264-3075-1-D-4-1	0.1	---	---
1264-3075-2-B-1-1	1.4	1.6	0.2
1264-3075-3-B-2-1	4.5	3.6	0.9
1264-3075-150-28	1.6	2.4	0.8
1264-3075-2-B-4-1	0.8	2	1.2
1264-3075-2-B-6-2	1.9	---	---
1264-3075-2-B-2-2	0.6	0.8	0.2

[1]All Elko Corner-notched points are from the Broken Arrow Site (O'Grady 2006) and are curated at the UO Museum of Natural and Cultural History.

For the most part the Elko Side-notch basal heights matched Largaespada's definition, with two exceptions where they were equal to or greater than 6mm, putting them in the Northern Side-notched range. However, from my measurements (Table 2) it is clear that basal height is not a very precise measurement. Some projectile points display a difference in basal height (between the two ears on the same point) of 4.9mm. Additionally, some of the Elko Corner-notched projectile points have basal heights similar to those recorded for Elko Side-notched points. This indicates that basal height is not exclusively diagnostic of side-notched points, and that the measurement is not suitable as the sole distinguishing characteristic between Northern Side-notched and Elko Side-notched.

Of the 20 artifacts on which obsidian hydration analysis was performed, 8 Elko Side-notches and 9 Northern Side-notches presented hydration rims and are presented as micron values in Table 3. A statistical F-test performed in Excel indicated that the variances of the two groups were significantly similar ($F=1.89$, $p=0.21$). Therefore a two-sample statistical t-test was also performed that assumed equal variance. While the Elko Side-notched mean was smaller (Mean=6.01, Standard Deviation =0.79, Variance = 0.63, n=8) than that of the Northern Side-notched (Mean = 6.29, Standard Deviation = 1.09, Variance = 1.19, n=9), the two tailed p-value for both points is greater than 0.05 ($p=0.56$). This indicates that there is no statistical difference between hydration rims for either point type, and thus no obvious temporal difference.

The diagnostic characteristics that distinguish Elko Side-notched points from other side-notched types and place them firmly in a replicable typological classification of their own is still unresolved, if even approachable. The morphological attributes previously used to define these points lack consistency, and attempts to clarify or confirm these attributes did not hold, even in the small sample size analyzed here. Researchers, such as David Hurst-Thomas in his Monitor Valley Key (1981), similarly avoid the classification of Elko Side-notches because they are typologically indistinguishable from other morphological types. It should be noted that many of the misclassified Elko Side-notched points analyzed in this study had been previously identified as Northern Side-notched points, and then subsequently re-assigned as Elko Side-notched. Ultimately, Elko Side-notched points showed no unique morphological or temporal characteristics compared to Northern Side-notched. Therefore, Elko Side-notched points are questionable as a typological classification in the northern Great Basin.

Table 3 – Obsidian Hydration Rims: Northern & Elko Side-notched

Catalog #	Obsidian Hydration Rim (μ)	Standard Deviation	
Elko Side-notched			
01-213	4.4	0.1	Minimum: 4.4μ
02-618	Not Available	Not Available	
03-652	5.7	0.1	Maximum: 7.0μ
08-134	6.2	0.1	
08-410	7.0	0.1	Mean: 6.025μ
08-914	Not Measured	Not Measured	
09-197	5.9	0.1	
10-052	6.0	0.1	
10-230	6.1	0.1	
14-125	6.9	0.1	
Northern Side-notched			
02-448	6.3	0.1	
07-407	4.6	0.1	Minimum: 4.6μ
08-137	6.4	0.1	
08-251	5.4	0.1	Maximum: 8.1μ
08-769	6.1	0.1	
09-058	5.4	0.1	Mean: 6.29μ
09-199	8.1	0.1	
10-044	7.6	0.1	
12-275	Not Available	Not Available	
13-219	6.7	0.1	

Site Distribution and Characteristics

Site records for 213 of the 237 Northern Side-notched points were provided by the Burns BLM District. These represent 91 sites (accounting for 173 of the artifacts) and 40 isolates[14]. Only two sites, Rimrock Draw Rockshelter and Lake on the Trail, were excavated, thus, the rest of these points were surface-collected. All site reports were analyzed based on the three major characteristics of high altitude spring sites as described by Fagan (1974) (e.g. elevation, association with perennial water and association with ground stone tools [see Appendix D]). In this study high elevation sites are those located above 4,800 feet above sea level.

Fagan stated that most of the Northern Side-notched points he collected were from buried deposits at spring sites located 5,000 feet or more above sea level (1974: 102). However, my analysis considers high elevation sites to be those located 4,800+ feet above sea level *not* 5,000+ feet. Regardless, this elevation pattern does not hold for the sites collected by the Burns BLM (see Table 4). Eighty-three of the 91 sites and 29 of the 40 isolates had recorded elevations. Of these, 51.6% of sites are located at high elevation compared to 39.6% of sites located at low elevation sites (8.8% of sites had no recorded elevation). However, each of the high elevation site accounted for only one or two Northern Side-notched artifacts respectively. If one considers the frequency of Northern Side-notched artifacts (instead of sites), it becomes clear that a majority (52.6%) of the Northern Side-notched artifacts recovered come from low elevation sites.

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[14] The BLM classifies any diagnostic artifact found by itself as an isolate. 2+ diagnostic artifacts in association with other cultural materials constitute a site.

Table 4. Distribution of Northern Side-notched by elevation

	Number of Sites	%	Number of Isolates	%	Total NSN Artifacts	%
High Elevation[1]	47	51.6	16	40	82	38.5
Low Elevation[2]	36	39.6	13	32.5	112	52.6
Unknown	8	8.8	11	27.5	19	8.9
Total	91		40		213	100

[1]High Elevation >= 4,800 feet

[2]Low Elevation < 4,800 feet

A simple majority of the Northern Side-notched sites identified in this study were located at high elevations, *but*, a simple majority of the artifacts were located at low elevations, a somewhat incongruous pattern. However, this division is based in part on the sampling distribution. Rimrock Draw Rockshelter and Lake on the Trail, the two excavated sites, are located at low elevation and together account for 22% (n=25) of the total artifacts collected from low elevations. This indicates two things: first, the BLM data assemblage may be biased by these two sites and the lack of high elevation excavations[15]; second, the abundance of artifacts found at low elevations (despite a relatively lower number of sites) may mean site elevation indicates different patterns of site utilization. In order to monitor the differences between high and low elevation sites,

15 Note, I did not include Fagan's excavations in this part of the analysis because I did not re-analyze the projectile points he collected. In total, Fagan collected 57 Northern Side-notched points. 51 of these artifacts came from high elevation sites, with only eight or 15.7% of them found in buried deposits (the rest were found on the surface). Of the six artifacts he found at low elevation, three or 50% were found in buried deposits.

division of sites by elevation was maintained and then further subdivided by Fagan's other defining site characteristics (e.g. by water source and cultural materials).

Middle Holocene sites across the Great Basin share one defining characteristic: they are found near reliable sources of water. The nine high elevation sites analyzed by Fagan are all found near perennial spring sources and the three low elevation sites analyzed by Fagan (1974) were associated with marshes/lakes. After analyzing site reports, I determined that 44 of the 47 high elevation sites are associated with water of some type (see Table 5). Of these, 74.5% were located within 200m or less than ~1/8th of a mile from a water source, 19.1% were located between 200-800 meters or around 1/8 – 1/2 of a mile away, and 4.3% had no water attributes recorded (2.1% reportedly had water, however, the source type and distance to source was not recorded). Similarly, 32 of the 36 low elevation sites were associated with water sources. Of these, 55.6% were located within 200m from a water source, 27.8% were located between 200-800m away, 5.6% were located over 1km away, and 11.1% did not have water present. It is apparent that, as Fagan predicted, a larger percentage of high elevation sites were located directly adjoining water sources.

Refined analysis of water attributes was computed *only* for those sites that had water within 200 meters. A range of source types were recorded by the BLM, the most common being "Spring/Seep", "River/Stream" and "Lake/Pond," or some combination of the aforementioned (see Figures 7 & 8). Some modern water sources (e.g. created by man) are only recorded in the appendices because they lack significance for this study.

Table 5. Distance from sites to water sources

Distance to Water Source	High Elevation Sites	Low Elevation Sites
< 200m (1/8 mile)	35	20
201-800m (1/8 – 1/2 mile)	9	10
> 800m (1/2 mile)	---	2
Distance Unknown	1	---
No Water	2	4
Total	47	36

Some sites had multiple water sources and sometimes these water sources fell into multiple distance categories. When this occurred the smallest distance was used to define the category (ex: one site had two sources. One was 0m from the site and one was 9,800m from the site. This site was thus categorized under the <200m designation).

The dominant water source is River/Stream at both high and low elevation sites. They supply 89% of high elevation sites and 50% of low elevation sites[16]. The second most dominant water source at low elevation sites is Lake/Pond, with 40% of sites located near one, compared to 3% of high elevation sites. The second most dominant water source at high elevation sites is Spring/Seep, with 25% of sites located near these water features, compared to 10% of low elevation sites. While the abundance of River/Stream based sites was somewhat surprising in relation to Fagan's assertions, the emphasis on spring sites at high elevations and lake sites at low elevations not only supports Fagan's analysis, but is also a logical consequence of the local topography. In the northern Great Basin and Harney Basin, lakes and marshes dominate the low elevation basin bottoms, fed by streams originate in the highlands.

[16] These percentages include sites that have multiple water types and therefore are also included in the other source percent totals (e.g. 14% of the 89% of River/Stream sites also have Spring/Seeps present). See Figures 7 & 8 for more detailed analysis of source types.

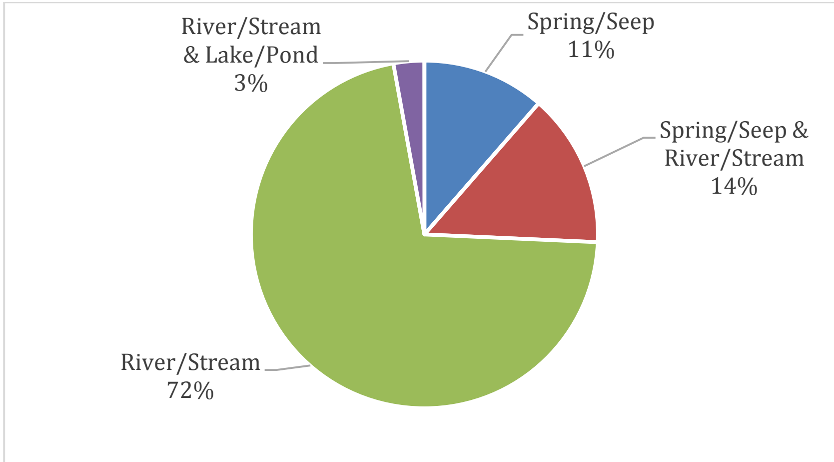

Figure 7. Types of water sources: high elevation sites

This chart represents the 35 high elevation sites with water within 200 meters of the site. Sites with more than one type of water source (e.g. River/Stream & Lake/Pond), are distinguished from those with only one type of water source. However, if more than one water source of the same type (e.g. two River/Streams) were attributed to one site, the site was simply placed in the River/Stream category.

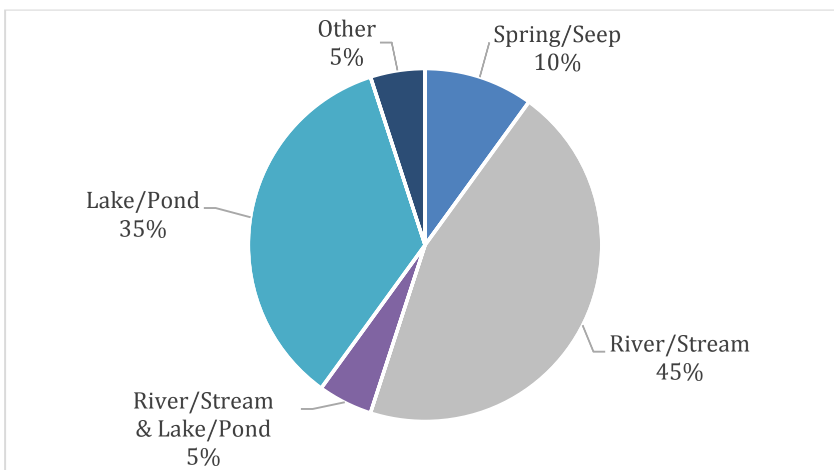

Figure 8. Types of water sources: low elevation sites

This chart represents the 20 low elevation sites with water located within 200 meters of the site. Sites with more than one type of water source (e.g. River/Stream & Lake/Pond), are distinguished from those with only one type of water source. However, if more than one water source of the same type (e.g. two River/Streams) were attributed to one site, the site was simply placed in the River/Stream category.

The simple presence of a water source does not imply that water was present year round. Therefore, high and low elevation sites were divided again, based on the status of their water sources, meaning sources were designated as either perennial or intermittent/ephemeral (see Figure 9 & 10)

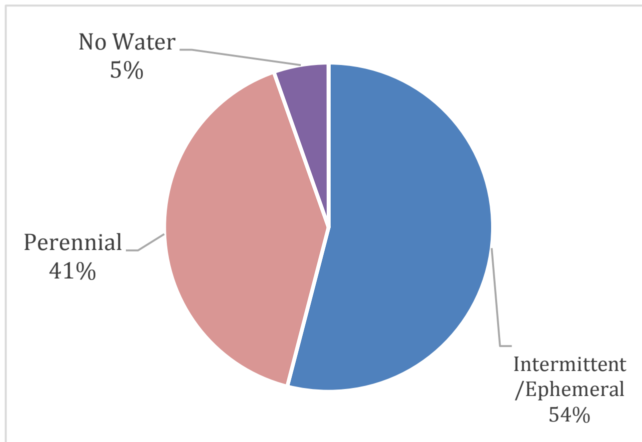

Figure 9.Water status: high elevation sites

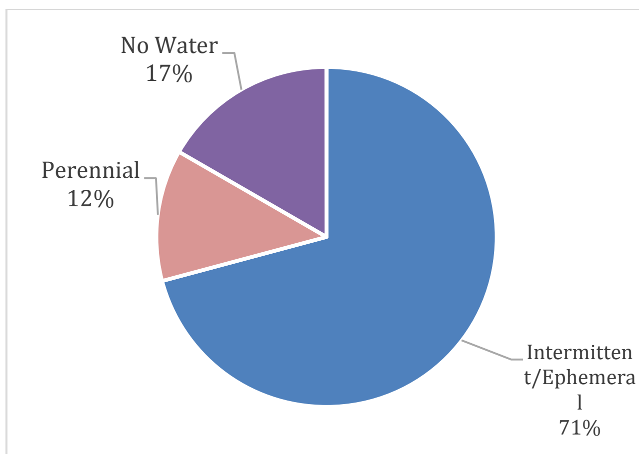

Figure 10. Water status: low elevation sites

Both of these figures represent the percentage of sites with each water status types. Some sites had more than one water source, if one or more of these sources was perennial the site was categorized as such.

Perennial water sources are found at a much higher rate at high elevation sites, including spring sites. It is also important to note that a large percentage of the low elevation sites were located near lakes or playas. Historically, and prehistorically, lake levels fluctuated a great deal (Grayson 2011; Wigand 1987) and many are currently dry, thus are considered by the BLM to be intermittent and ephemeral. At this point we can't determine which sites had access to water during the Altithermal. It is reasonable to assume that perennial springs and streams may have been more consistent through time and more likely to be productive during dry periods, therefore, the attraction to the highlands during the Altithermal makes sense. High elevation sites are found closer on average to water sources compared to low elevation sites.

Fagan hypothesized that perennial water sources made high elevation spring sites more favorable for food procurement, especially game, during the Altithermal period. The relative lack of ground stone found in the Altithermal deposits where Northern Side-notched points were recovered led Fagan to conclude that "higher altitude spring sites served as hunting camps" (Fagan 1974:103). In order to test this assertion site reports were examined to determine the suite of cultural materials present at each site. Sites included: lithic scatters, diagnostic formed tools, ground stone tools, obsidian, basalt & CCS quarries, rock alignments, rock cairns, hearths and house pits.

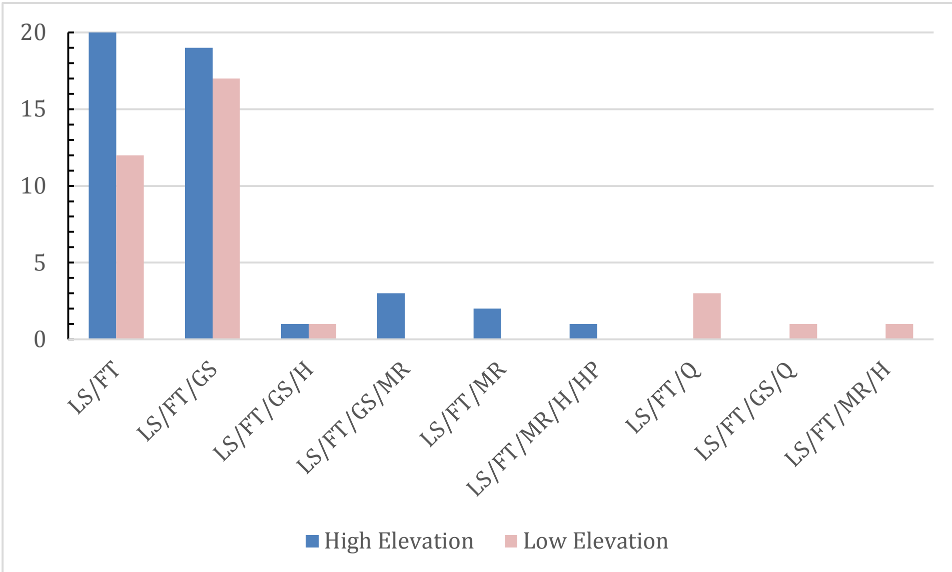

Figure 11. Distribution of cultural materials by site elevation

LS = Lithic Scatter; FT = Flaked Stone Tools; GS = Ground Stone Tools; Q = Quarry;
H = Hearth; MR = Modified Rock (e.g. Rock Alignments and Rock Cairns);
HP = House Pit

There are two forms of cultural materials present at every evaluated site; diagnostic flaked stone tools, e.g. Northern Side-notches[17] and lithic scatters. This implies that tool creation, reduction or rejuvenation was occurring at each site. There were 4 tool stone quarries present in the assemblage of sites, all associated with low elevation sites. While modified rock (e.g. rock alignments and rock cairns) were present at both high and low elevation sites, they are commonly found at high elevation sites (4 alignments and one cairn were found at high elevation; one alignment was found at low elevation). Hearths were found at both high (n=2) and low elevations (n=1) sites. Surprisingly, the only house pit recorded was from a high elevation site. The cultural materials present in the BLM site assemblage do not correlate well with sites described

[17] Most sites included many morphological stone tools from different periods, including both large dart and small arrow points.

by Fagan, especially the distribution of ground stone or “milling” tools, which are most often associated with the grinding of plant remains. Fagan states that “Higher altitude sites, which tend to be early, are characterized by a scarcity of milling stones while lower altitude sites, which tend to be late, are characterized by an abundance of milling stones” (Fagan 1974:103). This is not true for the Burns BLM Northern Side-notch sites. Ground stone tools were present at 48 of the 83 BLM sites (57.8%); 53.2% of high elevation sites (n=47) and 63.9% of low elevation sites (n=36) yielded ground stone tools (see Figure 12).While there is a higher percentage of low elevation sites with ground stone tools, the total number of sites with ground stone tools is larger for high elevation sites (n=25) compared to low elevation sites (n=23) containing Northern Side-notched points (see Figure 12).

Fagan notes that when ground stone was found at high elevation sites, it was always with later cultural deposits and not Altithermal deposits (Fagan 1974). He concludes that the relative lack of milling stones at high elevation sites, even during late periods, indicates that these high elevation sites were “predominately hunting camps” throughout the entire Holocene (Fagan 1974:105). Because all of the high elevation sites discussed in this paper are surface deposits, it is currently impossible to date ground stone tools to determine whether the ground stone tools are exclusively characteristic of the later Holocene, although it is possible. Even if the ground stone was from the post-Altithermal, the large number of sites with ground stone tools appears incongruent with Fagan’s conclusions. They indicate that the high elevation sites were

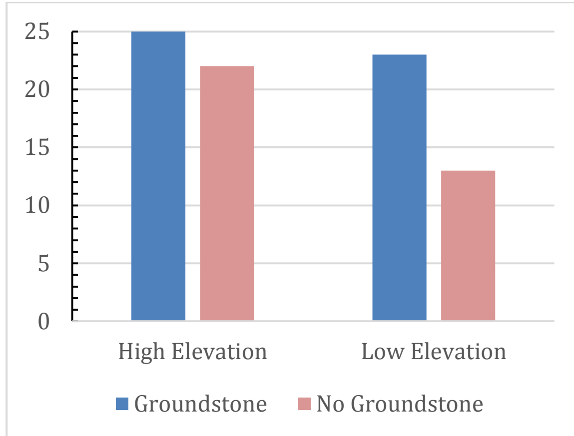

Figure 12. Presence of ground stone artifacts by site elevation

not simply used as hunting camps during the Holocene, rather they were utilized for a variety of functions, including the processing of plant remains. It is clear that the site attributes as identified by Fagan in 1974, do not adequately address the nuanced characteristics represented by the Burns BLM District sites.

Geospatial Characteristics

Multiple maps were generated to analyze the distribution of Northern Side-notched sites and isolates across the Burns BLM District. In order to make the maps more accessible, inset maps of specific areas were generated as well.

Site and Isolate Distribution

The general distribution map (Figure 13) shows that Northern Side-notched sites and isolates are found throughout the entire Burns BLM District, with three specific areas of higher site and isolate concentrations (Figures 14, 15 & 16). Starting in the upper left going clockwise, the first cluster of sites of sites (Group 1) is located in the Silver Creek Subbasin (see Figure 14). This region is home to the Silver Creek

Drainage, which is one of the main tributaries that drains into the now dry Harney Lake. This region is full of playas, including Capehart, Silver Lake and Hay Lake among others. Today water sources include the Chickahominy and Moon Reservoirs, as well as Stinking, Derrick and China Lakes. The region is also home to a multitude of known obsidian sources. The second cluster of sites (Group 2) are located in the Stinkingwater Mountains (see Figure 15). This region is known ethnographically as a prized root harvesting area and is home to at least 17 plant varieties that were utilized by the *Wada'tika* peoples (O'Grady 2006). The highest percentage of sites is located in the Five Creeks region (Group 3) of the Donner und Blitzen Subbasin (see Figure 16). This is a high elevation region packed with springs, streams and rivers that drain into the Donner und Blitzen River and Kiger Creek, eventually flowing from Steens Mountains into the south end of Malheur Lake (Oetting 1992).The Donner und Blitzen River alone supplies "approximately 45% of the annual flow into Malheur Lake" and is fed by Mud, Indian Little Blitzen and Fish Creeks (& their tributaries) (Council June 2003: 25; Oetting 1992). Of all the regions identified, the Five Creeks area most closely aligns with the spring sites described by Fagan, and in fact includes some of sites he studied.

It is interesting to note that there are almost no Northern Side-notched sites or isolates located along the Harney, Mud or Malheur Lake margins or the Blitzen River Marsh which is part of the Malheur National Wildlife Refuge[18]. In part the lack of sites is because this area is not under the jurisdiction of the Burns BLM District; instead, it is managed by the US Fish and Wildlife Service.

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[18] However, two of the three of the low elevation sites excavated by Fagan were located near the Blitzen Marsh (these sites account for 5 Northern Side-notched points).

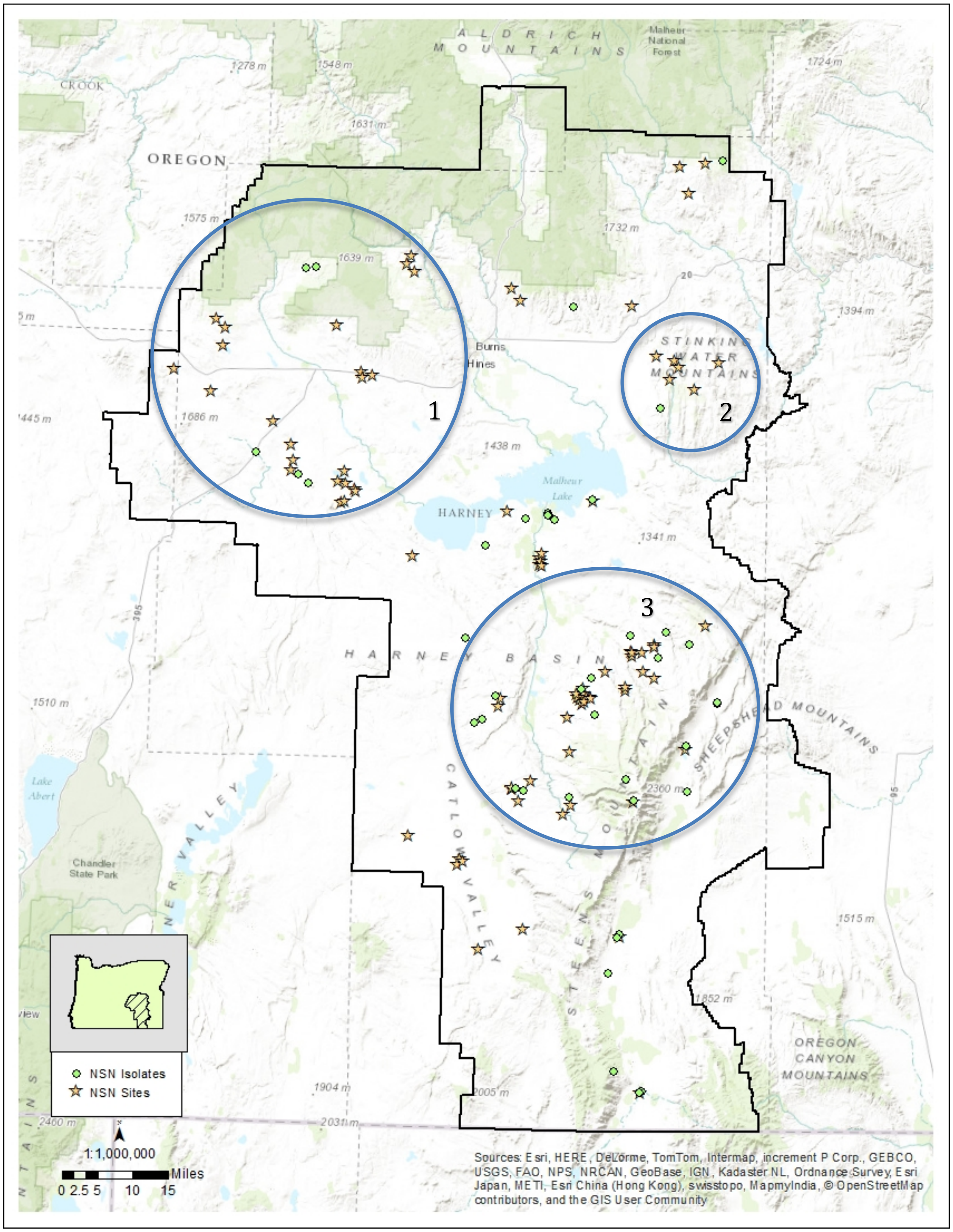


Figure 13. Map of Northern Side-notched site and isolate distribution in the Burns BLM District

This map represents all 91 sites & 41 isolates. The circles represent areas with concentrations of sites & isolates. They're referred to in the following text as Silver Creek (1), Stinkingwater (2), and Five Creeks (3) and enlarged in Figures 14, 15 & 16.

Other researchers have also noted the lack of Northern Side-notches recovered adjacent to Malheur Lake. In the late 1980's Malheur Lake flooded, exposing many archaeological sites, and, unfortunately, resulting in much looting. However, a large scale archaeological survey was conducted for the Malheur National Wildlife Refuge during this period (Oetting 1992). The results of this survey included recording 73 new archaeological sites, and the collection of 2,131 artifacts including 695 projectile points (Oetting 1992).The entire survey recovered only 23 Northern Side-notched points, constituting less than 4% of the collection (Oetting 1992: 121). This, coupled with the relative lack of sites identified in this study, seems to indicate that for whatever reason the shorelines of Malheur Lake were not extensively utilized during the Early Middle Holocene, a departure from the Late Holocene archaeological sites and ethnographic/historic records.

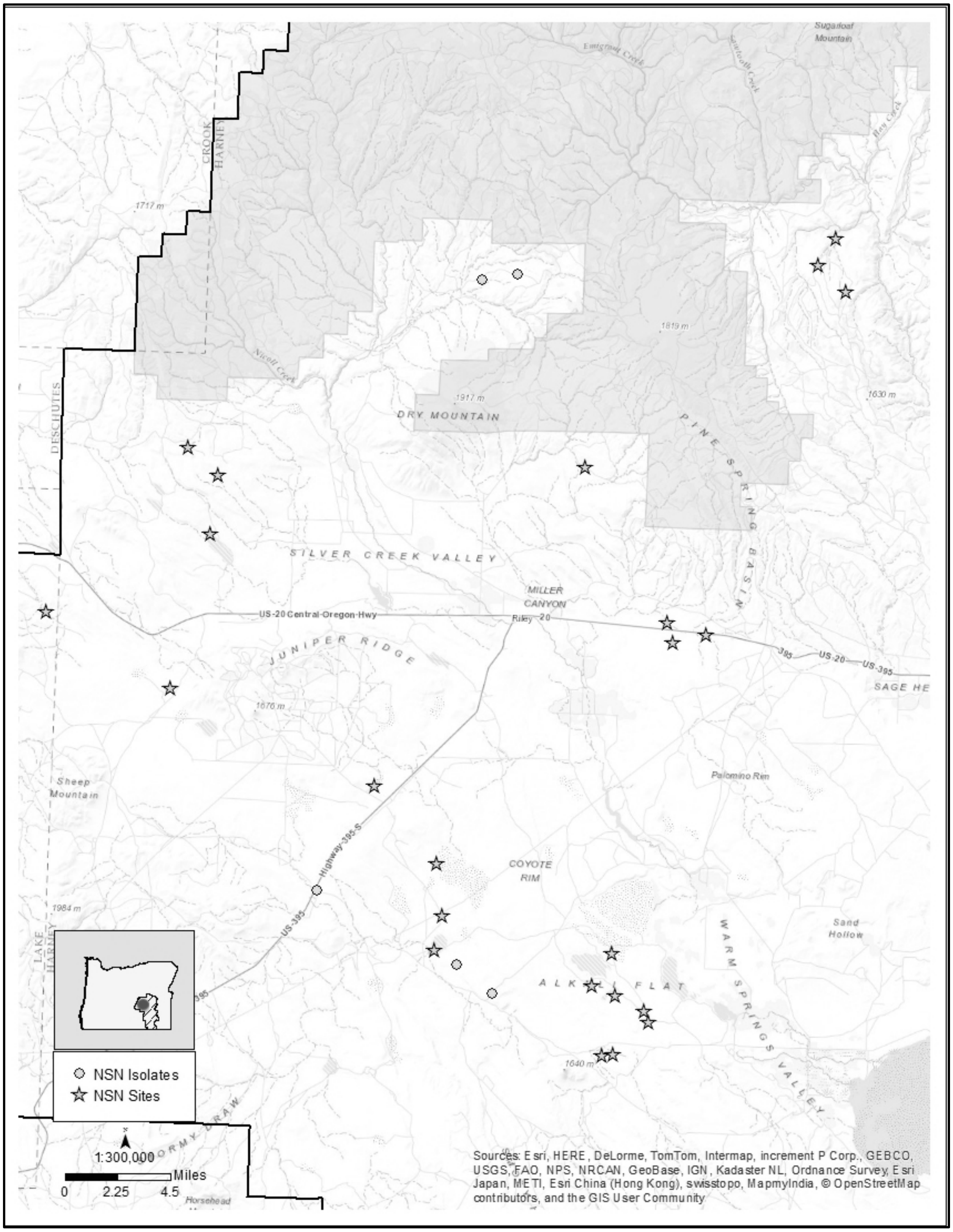


Figure 14. Map of Silver Creek subbasin and watershed with NSN sites & isolates

A majority of these sites are located on playa lakes, which would have been marshes prehistorically, and are often near obsidian sources. The sites with the largest numbers of Northern Side-notched artifacts per site are located in this region.

Figure 15. Map of Stinkingwater Mountain region and NSN sites & isolates

These sites are ethnographically associated with the harvest of roots and many of them are located near springs and rivers and streams such as Stinkingwater Creek, Pine Creek, Little Stinkingwater Creek, and Crane Creek. No more than five Northern Side-notched points were recovered from any site.

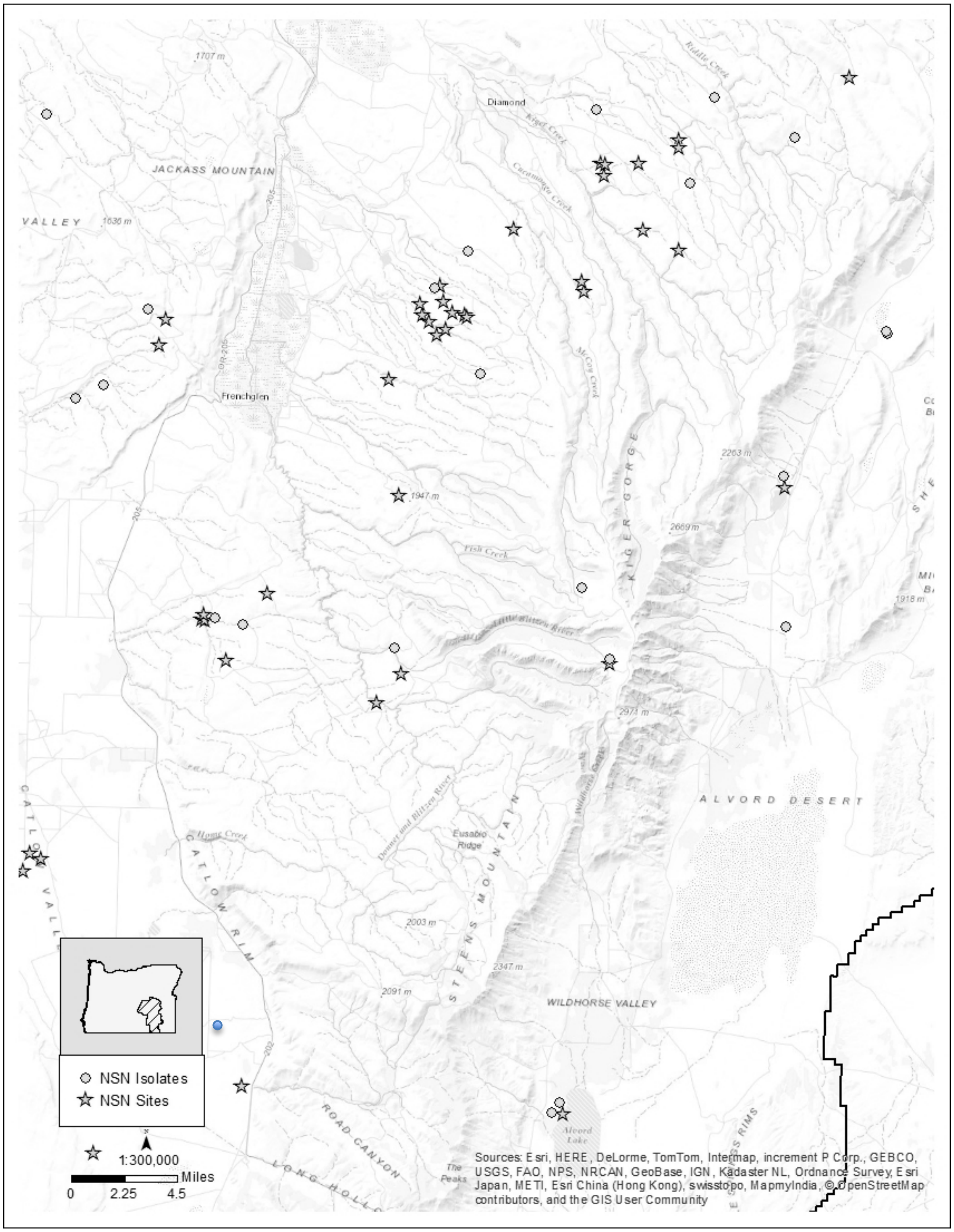


Figure 16. Map of Donner und Blitzen subbasin and watershed with NSN sites & isolates

This map depicts the Five River Region. Almost all of the sites are located near water sources that drain either into Donner und Blitzen or Kiger Creek and subsequently into Malheur Lake. The majority of these sites are located at high elevation and no more than five Northern Side-notched artifacts were recovered from any site.

Figure 17 is the same general map as Figure 13, however the sites are represented not only by distribution but also by the number of Northern Side-notched points recovered at any given site. I refer to this as the site's yield.

In general most sites included only one to five Northern Side-notches, especially those sites located at higher elevations. This seems to indicate that the sites were not occupied for long periods of time during the Altithermal. Only four sites included more than five Northern Side-notched points and all of these sites are located at lower elevations. Three out of the four sites are located in the Silver Creek Subbasin located to the northwest of Harney Lake and one is located in the Catlow Valley. One reason for the abundance of artifacts at these locations is the type of site represented. BLM site number 0502064070si is located in the Catlow Valley near Guano Slough and is a lithic scatter with over 500 flakes per square meter and from which over 100 diagnostic stone tools, 9 of which are Northern Side-notched have been recovered. Rimrock Draw Rockshelter (35HA 3855) and Lake on the Trail (35HA 3864), both located in the Silver Creek Subbasin, respectively account for 16 and 9 Northern Side-notched points. Rimrock Draw Rockshelter and Lake on the Trail are the only two sites in this analysis which have been excavated and both include intact stratigraphic deposits with diagnostic points. All three of these sites have also produced both stemmed points and fluted point technologies (including fluted bifaces and overshot flakes).

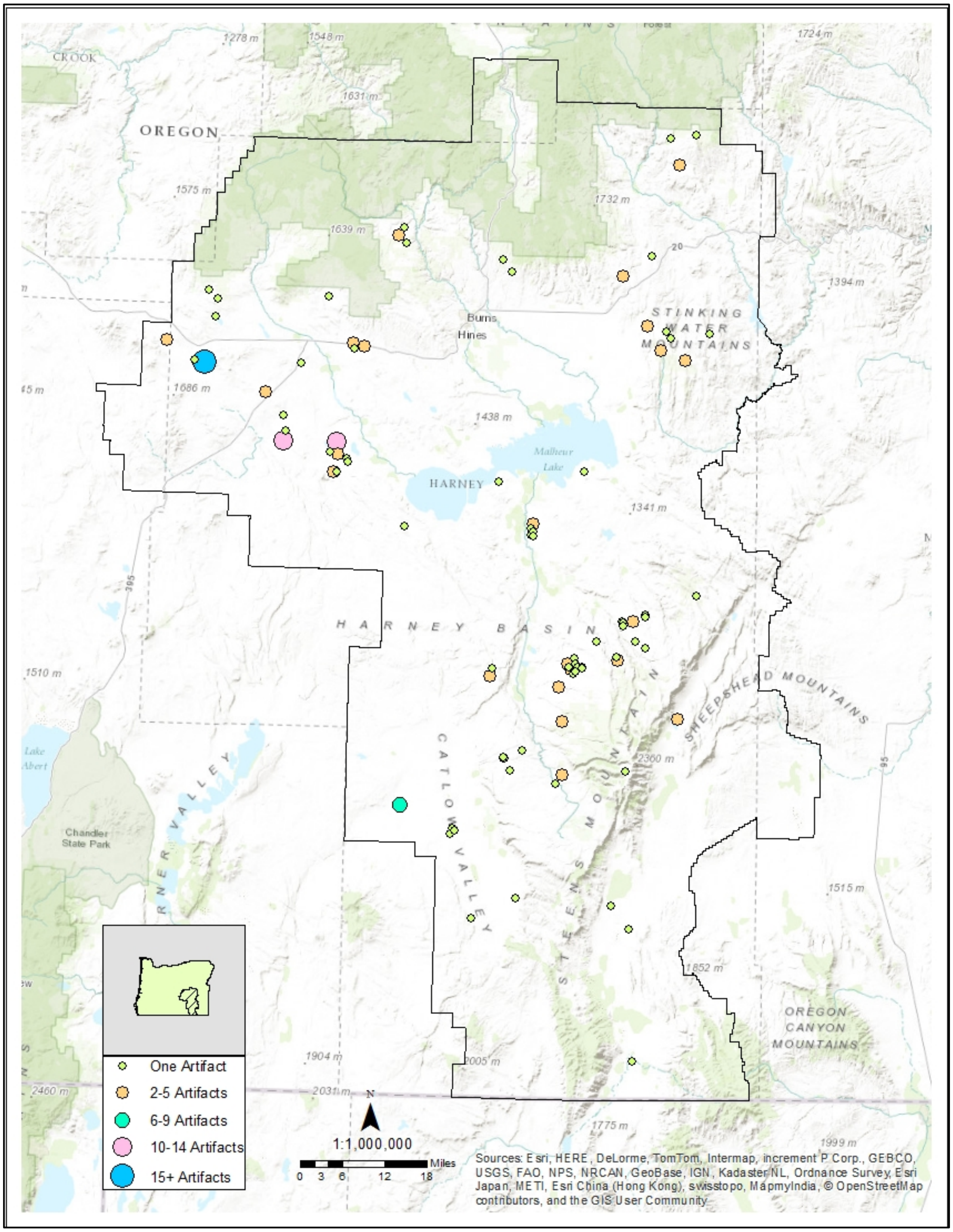


Figure 17. Map of Northern Side-notched sites by yield

“Sites by yield” does not refer to the total number of artifacts recovered from the site. Instead it only visually represents the number of Northern Side-notched artifacts found at a site. No isolates are represented on this map.

Site 35HA 2819, a large lithic scatter, located at the south end of a small southern subbasin of Silver Lake, includes more than 200 diagnostic artifacts including 13 Northern Side-notches (which only represent around 6.5% of the diagnostic artifacts at the site). While this site has not produced any evidence of fluting technologies, stemmed points have been recovered. Overall, all four sites with large numbers of Northern Side-notched points also include diagnostic tools that are generally dated to 7,000 years BP or older. This indicates that sites where numerous Northern Side-notched points were recovered are also some of the oldest sites in the region and have been used repeatedly throughout the entire Holocene.

Four sites were randomly selected from the Donner und Blitzen Subbasin in order to compare low elevation sites with large numbers of Northern Side-notched points to high elevation sites where fewer NSN's were recovered. These include: BLM sites 0502063692SI (3 Northern Side-notched recovered out of 24 projectile points), 0502063448SI (3 NSN out of 21 projectile points), 0502063683SI (4 NSN out of 41 projectile points) and 0502063450SI (1 NSN out of 7 projectile points, 12+ pieces of ground stone). Because these sites include fewer diagnostic tools, Northern Side-notched points account for a larger percentage of each site's diagnostic points. A stemmed point was recovered from only one of these sites (BLM site 0502063448SI). In general these sites seem to represent brief occupations over a relatively shorter period of time, especially compared to the lower elevation sites which all have artifacts associated with both earlier and later periods, such as smaller arrow points (ex: Rose Spring, Eastgate and Desert Side-notched points).

The number of sites and isolates represented in these maps indicate that the region was not abandoned during the Middle Holocene dry period, as some researchers have previously hypothesized (Antevs 1948). Instead, it is clear that Northern Side-notched points are found across the entire Burns BLM District, with sites and artifacts located in higher concentrations in some regions. The movement of resources and Northern Side-notched between these regions is the focus of the next portion of this paper.

Obsidian Sourcing

Known obsidian sources were compared to the distribution of Northern Side-notched sites and isolates, and are visually represented in Figure 19. This map also highlights obsidian sources which were identified through XRF obsidian sourcing.

Thirty artifacts drawn from 16 archaeological sites were geochemically sourced, utilizing XRF. This resulted in the identification of 16 distinct obsidian sources (see Figure 18 & Table 6). The majority of the sourced artifacts were drawn from archaeological sites located within the Silver Creek Subbasin. Of the 16 archaeological sites from which artifacts for sourcing were drawn, 10 (62.5%) are located in the Silver Creek Subbasin. These 10 sites account for 23 of the 30 sourced artifacts (76.7%). Similarly, a clear majority of the geochemically identified sources (9 of 16 or 56.25%) are located within the Silver Creek Subbasin or are directly adjacent to it[19]; and, 21 of the 30 (70%) geochemically sourced artifacts were attributed to these 9 obsidian sources. This is unsurprising considering a majority of the sourced artifacts come from

[19] This includes the Glass Buttes, Squaw Mountain, Bald Butte, Buck Springs, Chickahominy, Wagontire, Tank Creek, Big Stick and Double O obsidian sources.

this region. However, it is important to note that a number of artifacts collected in the Silver Creek Subbasin (n=4) were identified to sources located outside of the subbasin. Additionally, two artifacts collected outside of the Silver Creek Subbasin were attributed to obsidian flows from the subbasin. Therefore, while the majority of the obsidian artifacts were found near their original source, it is clear that the transmission of obsidian to more distant places as well as the importation of obsidian from long distances did occur (see Figure 20). For example, Rainbow Mines is located over 175 kilometers to the southwest from BLM site 0502051068 (which is located along the Silver Creek Drainage and Harney Lake). This implies that the prevalence of local tool stone in this sample does not preclude the extensive movement of peoples across the landscape. Ultimately XRF obsidian sourcing of more Northern Side-notched points from the Harney Basin is necessary for a more nuanced understanding of which raw materials are being utilized.

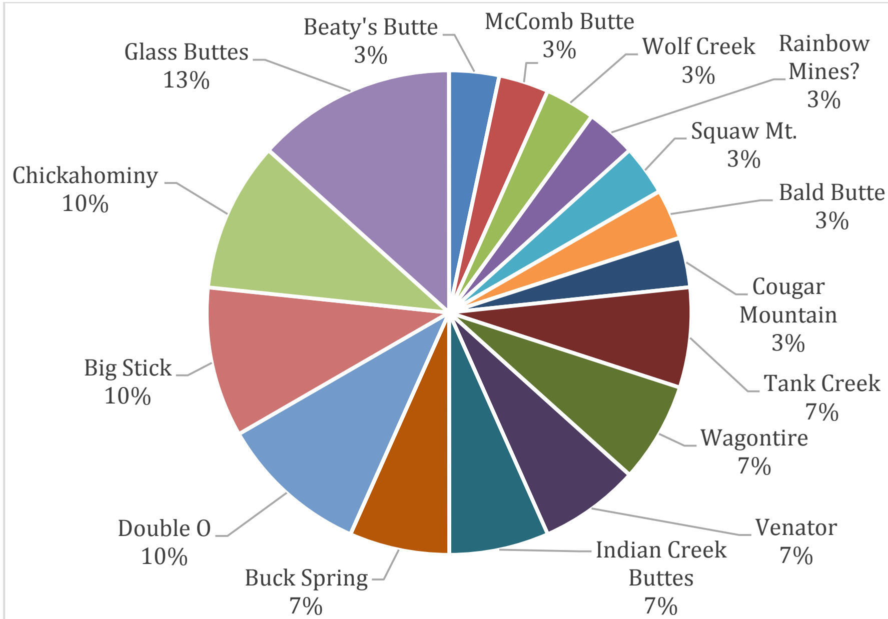


Figure 18. XRF geochemically identified obsidian sources

This diagram shows the percentage of artifacts XRF Sourced to a specific obsidian flow. Note that this is based only on 30 tested artifacts. Sources (ex. Glass Buttes) which have multiple distinct flows were not differentiated and are instead represented using the overarching source category.

Table 6: XRF geochemically sourced NSN artifacts and obsidian sources

Catalog #	**Site #**	**Subbasin**[1]	**Geochemical Source**
00-451	BBF-LDT-S8-A15	Guano	McComb Butte
04-307	0502062584SI,	Silver Creek	Double O
06-159	0502062584SI	Silver Creek	Wagontire
02-255	0502062623SI	Malheur Lake	Double O
01-224	0981IF	Malheur Lake	Wolf Creek
03-708	2336SI	Silver Creek	Big Stick
01-208	2570SI	Malheur Lake	Venator
01-255	2570SI	Malheur Lake	Venator
06-159	0502062584SI	Silver Creek	Wagontire
07-103	0502062584SI	Silver Creek	Indian Creek Buttes
01-416	35-HA-2983	Unk	Tank Creek
2010-surf-15	35-HA-3855	Silver Creek	Squaw Mt.
2012-surf-47	35-HA-3855	Silver Creek	Chickahominy
4-C-5-1	35-HA-3855	Silver Creek	Buck Spring
7-B-26-1	35-HA-3855	Silver Creek	Glass Buttes 1
7-C-21-1	35-HA-3855	Silver Creek	Chickahominy
15-D-4-1	35-HA-3855	Silver Creek	Glass Buttes 3
26-A-6-1	35-HA-3855	Silver Creek	Cougar Mountain
29-C-14-1	35-HA-3855	Silver Creek	Buck Spring
23-A-8-1	35-HA-3855	Silver Creek	Glass Buttes 2
02-448	0502062724si	Silver Creek	Big Stick
07-407	0502063342si	Silver Creek	Glass Buttes 7
08-137	0502051068si	Silver Creek	Rainbow Mines?
08-251	0502062584si	Silver Creek	Double O
08-769	0502050328si	Silver Creek	Big Stick
09-058	0502050923si	Silver Creek	Tank Creek
09-199	0502050920si	Silver Creek	Bald Butte
10-044	0502063667si	Malheur Lake	Indian Creek Buttes
12-275	05020550920si	Silver Creek	Beaty's Butte
13-219	0502063941si	Silver Creek	Chickahominy

[1]Indicates which watershed the corresponding site is from

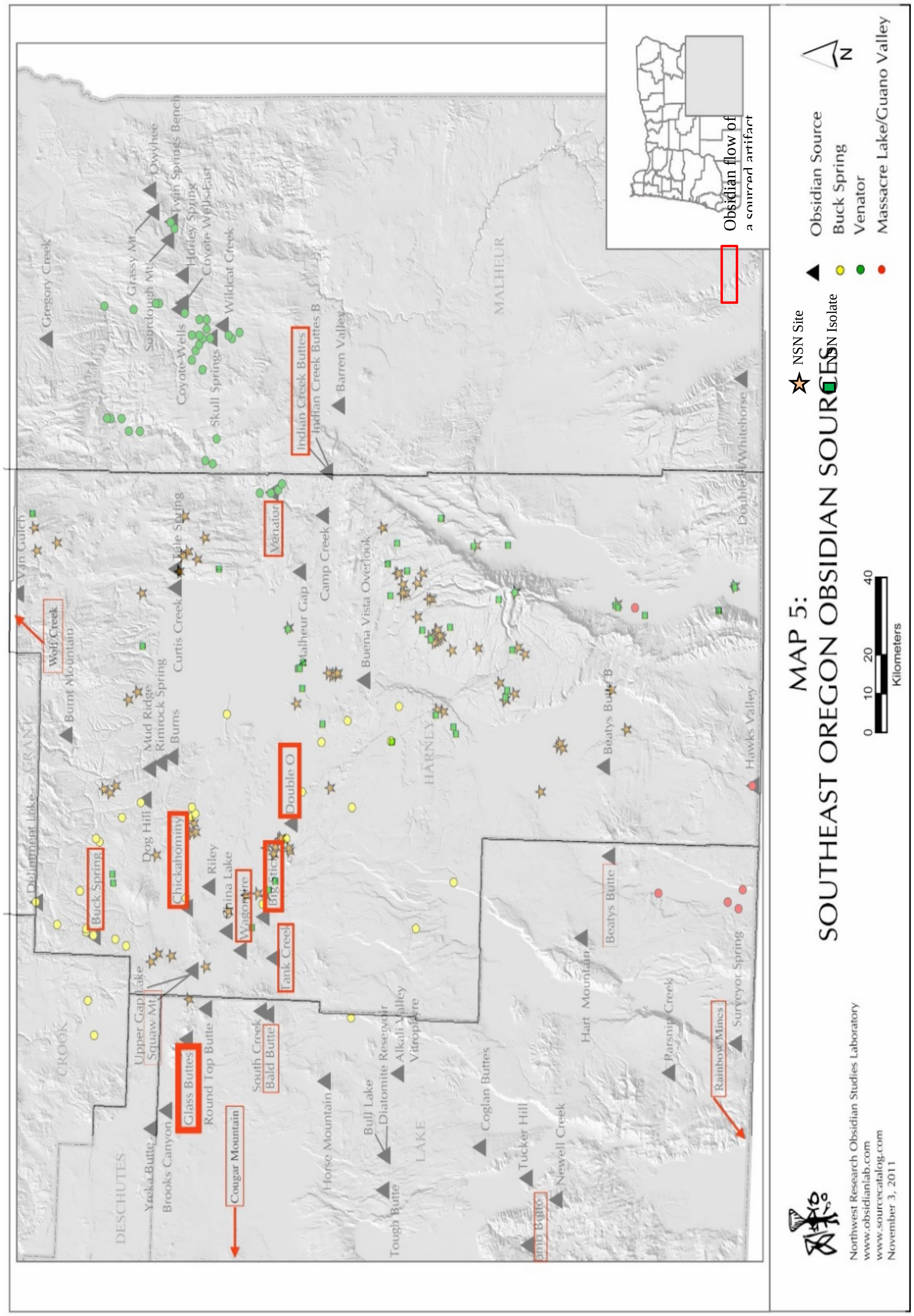


Figure 19. Map of all known obsidian sources and sources for Northern Side-notched sites & isolates

The black triangles represent known obsidian sources. Rectangles around obsidian source names represent the sources from which NSN artifacts were identified.

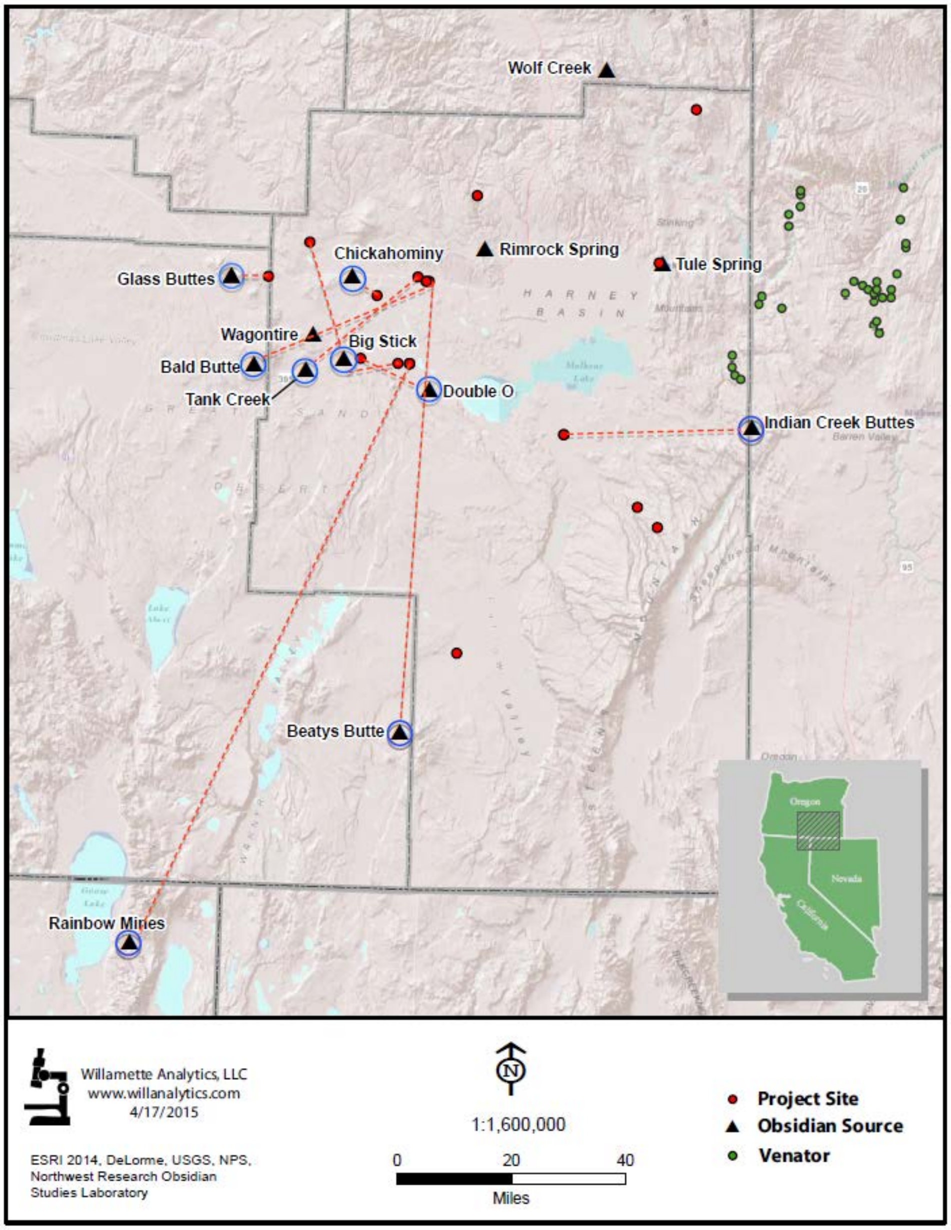


Figure 20. Map of nine Northern Side-notched sites and their corresponding obsidian sources

This map shows the distance between the sites from which 9 of the 30 geochemically sourced NSN artifacts were collected and the obsidian sources from which they were geochemically identified.

The geochemical sources identified in this study reaffirm that the three areas Group 1 (Silver Creek Subbasin), Group 2 (Stinkingwater Mountains), and Group 3 (Five Creeks) previously identified in Figures 13-16, were favored by Northern Side-notched users. The connections between these regions and the geochemically identified obsidian sources, indicate potential mobility patterns (see Figure 21). The Stinkingwater Mountains (Group 2) are firmly established as root gathering areas that, historically, are heavily utilized in the early spring (Whiting 1950). From this region we know that bands split in multiple directions with some individuals heading north towards John Day and some heading back towards the lakes via the southeast (O'Grady 2006: 495; Whiting 1950). Similarly we know that people who traveled north came back to the lake region in the fall, often travelling through the Silver Creek Subbasin (Group 1 [Whiting 1950]). It seems clear that the pattern of seasonal movement between highland and lowland resource gathering areas is represented to an extent in the distribution of Northern Side-notched sites and isolates. Not only are there a cluster of sites and isolates in the Stinkingwater root gathering area, there are also isolates, sites and identified obsidian sources extending both north (toward Wolf Creek obsidian source) and southeast (towards Venator and Indian Creek Buttes obsidian sources) from the Stinkingwaters. Similarly a number of sites are located along the Silver Creek drainage, near various playas and obsidian sources. These sites would have been located on or near playa lakes and marsh zones in the past. The distribution of these sites seems to indicate that prehistoric peoples were following whatever water sources remained during the middle Holocene, back towards the Harney and Malheur Lakes.

The third and final area with a heavy concentration of sites is the Five Creeks region (group 3), where there is some uncertainty about whether these sites represent briefly occupied localities, base camps, or winter camps. Ethnographically we know that winter camps are located near Malheur Lake, in sheltered places, where people were protected from the elements (O'Grady 2006; Whiting 1950). No sites identified in this paper quite fit this description. The multitude of sites located in the Five Creeks region are the closest geographically, however these sites represent much smaller sites than those in the Silver Creek drainage. Instead they seem to be sites that were utilized for both hunting and plant gathering/processing forays. Similarly, the sites located along the Silver Creek drainage, also do not adequately represent winter camps. However, without reliable excavations to investigate 7,000-4,000 BP or Northern Side-notch bearing deposits in the Five Creeks region it becomes hard to determine the purpose of these sites. Regardless of site function, it is clear that resources weren’t exclusively found at high elevation spring sites, instead they were distributed across basins and closely associated with river and stream drainages.

There is one mobility pattern that remains to be discussed, the connection of the Catlow Basin with the Harney Basin. Geochemical sourcing from this study shows that materials found in Harney Basin were coming from as far away as northeast California (Rainbow Mines) and from west of Harney County at McComb Butte and Cougar Mountain, both of which are located in Lake County. Previous technological research in the region has indicated that prehistoric hunter-gatherer bands prior to 7,500 RCY B.P., were far ranging and utilized obsidian from a wide range of geographic locations (Smith 2007). For example, the Parman Localities found at Five Mile Flat in northwestern

Nevada include obsidian from far to the northeast in southeastern Oregon (e.g. Indian Creek Buttes & Venator), as well as Beaty's Butte, and sources such as Buck Mountain located in northeastern California (Smith 2007: 148). Based on Smith's evidence for comparable long distance mobility patterns and the distribution of Northern Side-notched sites and obsidian sources, I have generated a hypothetical round. Obsidian sources conceivably connect the Five Creeks region to Beaty's Butte via the Skull Creek Dunes and Guano Slough sites, continuing southwest to Rainbow Mines and then north via McComb Butte and Cougar Mountain. The path from Rainbow Mines/McComb Butte/Cougar Mountain is a northerly one that can lead to Glass Buttes and then connect with the Silver Creek drainage area (see Figure 21). This round is meant not as a literal interpretation of where or how prehistoric peoples would have moved, but rather as a large conveyance zone that connects the obsidian sources in the southwest, with those in the northwest and finally the northeast (although there could be any manner of routes connecting these three larger obsidian source areas).

Ultimately much more XRF obsidian sourcing needs to be undertaken on Northern Side-notched points in order to verify this hypothetical mobility pattern and to determine the extent to which obsidian sources located in the northwest of Harney County (e.g. in the Silver Creek Subbasin) were being utilized. This information may indicate to what extent hunter-gatherer movements were confined to the Harney Basin versus the larger region.

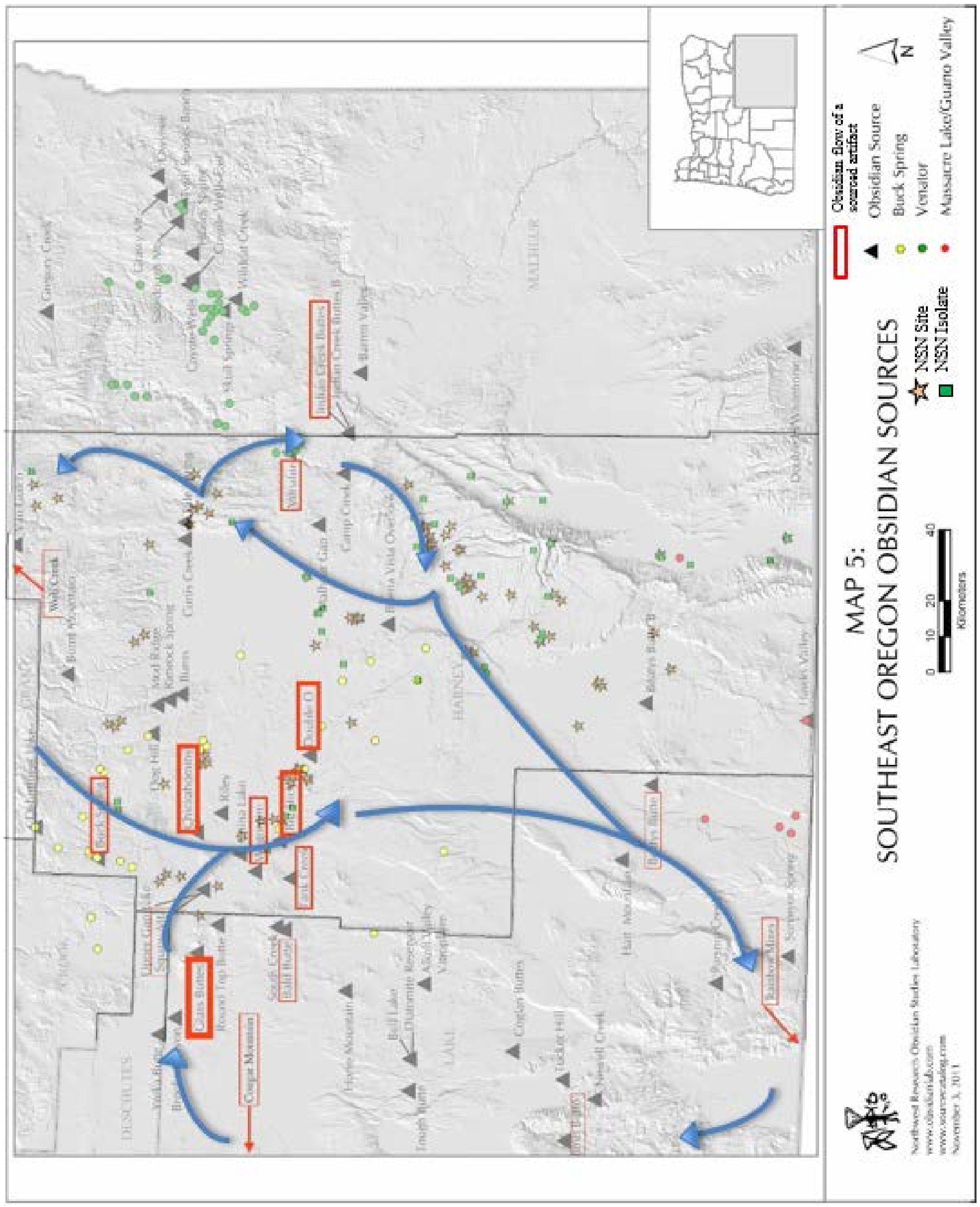


Figure 21. Relationship between NSN sites/isolates and obsidian sources, with patterns of movement

This map is an adaptation of Figure 10.4 in O'Grady 2006: 482. These cyclical mobility patterns are not meant to be exact paths followed by prehistoric peoples, rather they show general relationships between the landscape, NSN Sites & Isolates and geochemically identified obsidian sources.

SUMMARY AND CONCLUSIONS

Generally, we know that the northern Great Basin and Harney Basin in particular, were much hotter and drier during the Middle Holocene (Antevs 1948; Grayson 2011; Mehringer 1986; Wigand 1987). However the extent to which each season, year, or decade was influenced by the Altithermal is not well understood across the Harney Basin. Grayson, in reference to pollen cores from Fish and Wildhorse lakes in the Steens Mountains analyzed by Peter Mehringer, states "That Middle Holocene climates were varied in both time and space should not be surprising given the evidence for it" citing the "sawtooth nature" of the pollen ratios as evidence that the warm dry climate wasn't totally consistent throughout the Middle Holocene (Grayson 2011: 249). Most of the Northern Side-notched sites are associated with water sources. The association of sites with water sources, logically leads to the inference that these water sources were providing or attracting food resources of some kind or that the water itself was simply being utilized as a resource.

While the majority of water sources associated with sites studied here are not springs nor are they associated exclusively with perennial water, as Fagan hypothesized, there is still a distinct variance between the water sources found at high and low elevations. Ultimately, many sites are associated with rivers and streams (and their tributaries), that flow into the lakes and not the lakes themselves. Only two sites studied in this paper are located near the shoreline of Malheur or Harney Lake. The lack of sites in this area is supported by previous research, which shows very few Northern Side-notches are found near Malheur Lake or the surrounding Malheur National Wildlife Refuge (Oetting 1992). This is a huge departure from late Holocene archaeological sites and ethnographic/historic records, which indicate that very large populations were occupying the regions adjacent to the lakes (Whiting 1950). The distribution of sites away from lakes, and in association with other water sources such as rivers and streams, shows that for whatever reason the lake shores are not a focal point during the drier portion of the middle Holocene. While there are not many Northern Side-notched found directly in association with the Malheur Lake, they are frequently found at low elevation sites located near rivers and smaller playa lakes. This seems to indicate that some low elevation marsh areas remained during certain intervals throughout the middle Holocene, however they were either not found adjacent to Malheur Lake, or, for some reason, marshes near the lake margins were abandoned for other pluvial marsh areas. Overall, it seems a more nuanced climatic scheme and distribution of water and food resources is present in the northern Great Basin during this period, and that more extensive paleoenvironmental reconstructions need to occur in order to understand the nature of the environment and resources during this period.

The relative number of Northern Side-notched projectile points is low when one considers the total number of artifacts collected by the Burns BLM District (which numbers in the thousands[20]). While this theoretically indicates that population densities were low, it is quite obvious that the Harney Basin was not abandoned during the drier portion of the middle Holocene. Instead, multiple eco-zones were repeatedly exploited including traditional root crop gathering areas, low elevation marsh and playa sites and high elevation river and spring sites. Overall, the distribution of sites across the landscape, the types of artifacts present at each site and the utilization of both local and

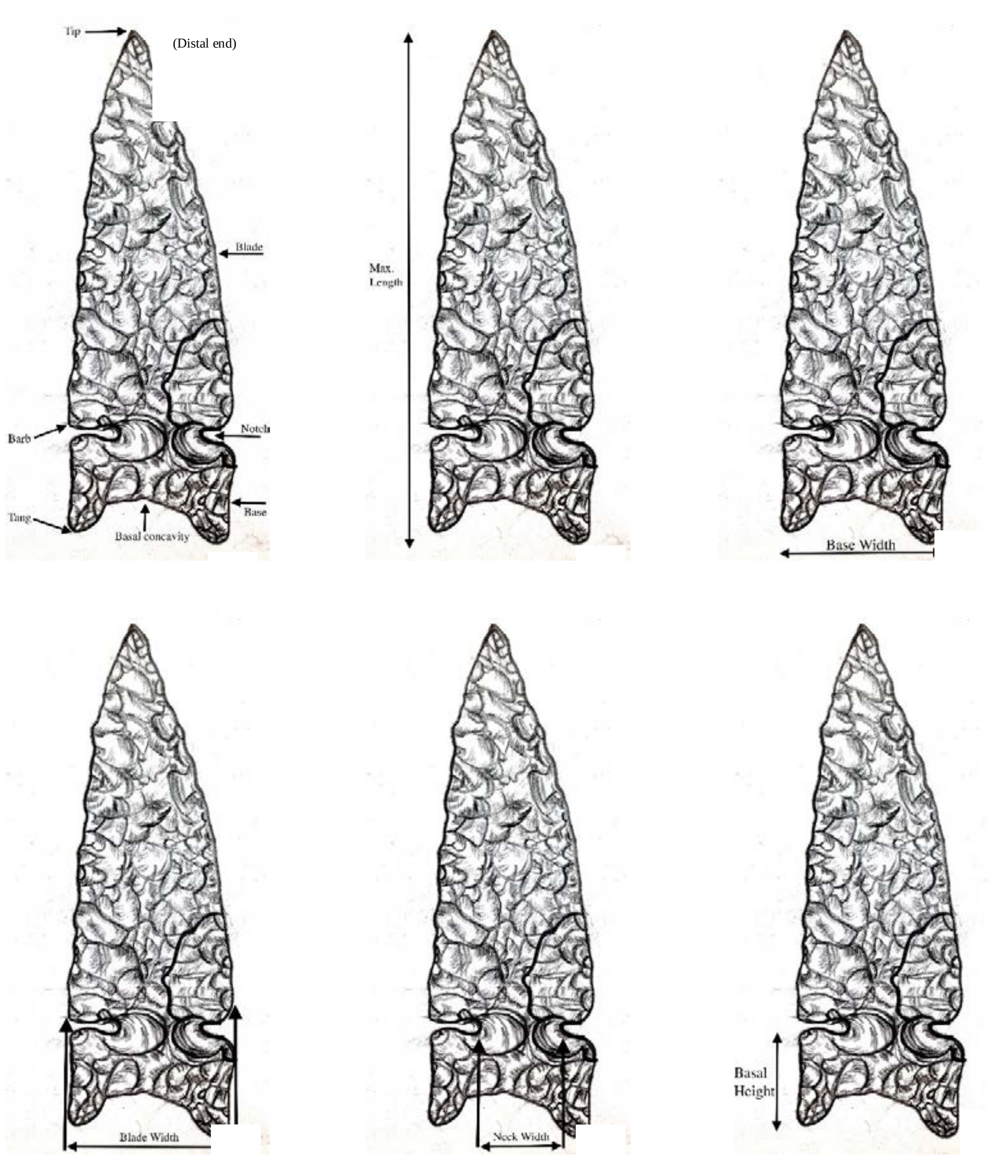
[20] Ex: the Burns BLM has collected 1,735 Elko series points (Thomas, personal comm. 6/1/15).

non-local tool stone quarries indicates that prehistoric peoples were not simply exploiting one resource type nor were they living in any one area. The sites with the highest frequency of Northern Side-notched points are also associated with stemmed points, fluted point technologies and arrow points from the late Holocene. This indicates that sites were repeatedly used throughout the entire Holocene and not abandoned during the Middle Holocene dry period.

The analysis of Northern Side-notched points, and their distribution across the landscape has provided information integral to the continued understanding of the Middle Holocene warming period in the northern Great Basin. It is clear that the site attributes established by Fagan in 1974 are not wholly consistent with the sites found in the Burns BLM District. Instead, a large number of sites and artifacts are found at both low and high elevations. The frequency of artifacts found at low elevations compared to the majority of high elevations sites implies that sites have different functions, or inhabitance periods. The prevalence of ground stone tools indicates that high elevation sites were not used exclusively for hunting as Fagan hypothesized. However, the relatively small size of these sites indicates they were inhabited for shorter periods and possibly used during foraging excavations. Ultimately, more subsurface excavations at both high and low elevation localities will be necessary to establish site functions and further explore the Middle Holocene period. Despite this, it is clear that the northern Great Basin, especially Harney Basin, was fairly widely inhabited during the Middle Holocene, implying that prehistoric humans were actively moving across the landscape, exploiting multiple resource types and surviving despite climatic fluctuations.

APPENDIX A

Morphological characteristics measured



APPENDIX B

Measurements of Northern Side-notched Projectile Points.

Note: 1) Only those projectile points measured and identified as Northern Side-notched points are included here (other projectile point measurements available on request). 2) All measurements are recorded in centimeters. 3) Weight is recorded in grams.

Catalog #	Site #	Material	Weight	Length	Thickness	Blade Width	Neck Width	Base Width	Base Type	Notch Type
00-451	0502062508si	OBS	3.56	3.63	0.52	1.65	0.92	1.97*	concave	straight
00-713	0502062679si	OBS	2.69	3.3	0.52	1.52	1.43	1.82	concave	straight
00-722	0502062679si	OBS	0.93	1.57*	0.46	n/a	0.98	1.96*	concave	straight
01-189	0502062633si	OBS	5.18	4.48*	0.58	1.83*	1.22	1.89*	flat	both
01-208	0502062570si	OBS	3.19	3.29*	0.5	2.2*	1.22	1.99*	unk	straight
01-215	0502062645si	OBS	2.71	1.99*	0.63	1.98*	1.36	1.66*	concave	straight
01-255	0502062570si	OBS	0.87	1.37*	0.35	n/a	0.97	2.15	concave	straight
01-431	0502062584si	OBS	1.95	2.66*	0.5	n/a	1.15	2.19*	concave	straight
01-577	0502063126si	OBS	3.81	3.35*	0.6	1.86	1.37	2.2	concave	straight
01-579	0502063156si	OBS	7.95	7.28*	0.61	2.14	1.13	1.65*	concave	straight
02-173	0502062736si	OBS	0.76	1.07*	0.33	n/a	1.53	2.04	concave	straight
02-255	0502062623si	OBS	2.29	3.11*	0.49	1.62	0.86	2.09	concave	straight
02-340	0502062777si	OBS	1.11	1.86*	0.28	1.78*	0.98	1.96*	flat	straight
02-351	0502062779si	OBS	2.45	2.14	0.58	1.86*	n/a	1.99*	concave	straight
02-355	0502062740si	OBS	2.03	3.04*	0.52	1.49	0.71	1.31*	unk	straight
02-448	0502062724si	OBS	11.26	4*	0.75	3.25	2.31	2.89	flat	straight
02-509	0502062756si	OBS	1.28	1.3*	0.51	n/a	1.16	2.36	flat	straight

Catalog #	Site #	Material	Weight	Length	Thickness	Blade Width	Neck Width	Base Width	Base Type	Notch Type
02-511	0502062756si	OBS	2.33	1.75*	0.59	n/a	1.35	2.82	concave	straight
02-523	0502062756si	OBS	1.22	1.55*	0.46	n/a	0.98	2.23*	concave	straight
02-524	0502062756si	OBS	0.94	1.3*	0.43	n/a	0.96	1.79*	concave	straight
02-623	0502062811si	OBS	1.84	3.26	0.4	1.67	0.94	2.04	concave	straight
02-671	0502062926si	OBS	1.15	1.54*	0.42	n/a	n/a	1.14*	concave	straight
02-720	0502062584si	OBS	1.93	3.3	0.43	1.79	0.92	1.57*	concave	straight
03-393	0502062845si	OBS	1.92	2.68*	0.45	1.85	1.08	1.78*	concave	straight
03-511	0502062866si	OBS	3.52	1.99*	0.64	2.98	1.54	2*	concave	straight
03-653	0502062859si	OBS	0.85	1.44*	0.35	n/a	1.01	1.84*	concave	straight
03-655	0502062859si	OBS	3.33	3.3*	0.58	2.37	1.39	1.96*	concave	straight
03-708	0502052336si	OBS	6.18	3.48*	0.61	3.1*	1.2	2.51	concave	straight
03-855	0502063004si	OBS	3.19	2.84*	0.58	2.24	1.29	1.6*	concave	straight
04-079	0502062961si	OBS	3.25	3.91	0.55	1.92	1.24	1.79	concave	both
04-088	0502062961si	OBS	3.17	3.29	0.47	1.95	1.25	2.11	concave	straight
04-089	0502062961si	OBS	1.7	1.63*	0.54	n/a	1.11	2.19	concave	straight
04-097	0502062962si	OBS	6.38	3.74*	0.8	2.21	1.35	1.51*	concave	straight
04-122	0502062967si	OBS	1.18	1.44*	0.39	n/a	0.89	2.3	concave	straight
04-307	0502062584si	OBS	3.11	2.63*	0.58	2.26	1.06	2.22	flat	straight
04-450	0502062805si	OBS	2.32	2.95	0.52	1.59*	1.3	1.81*	concave	straight
05-057	0502063066si	CCS	3.19	3.23	0.63	1.4	1.2	2.09	concave	straight
05-061	0502063088si	OBS	4.39	3.47*	0.56	2.01	1.4	1.94*	concave	straight
05-565	0502063069si	OBS	0.94	1.27*	0.44	n/a	1.28	2.42*	concave	straight
05-566	0502063069si	OBS	2.51	2.71*	0.53	1.84	1.25	1.94	concave	straight
06-076	0502063156si	OBS	5.95	3.72*	0.55	2.65	1.56	2.45*	concave	straight
06-365	0502062899si	OBS	2.23	3.03	0.45	1.95	1.08	1.88*	concave	straight
07-043	0502063308si	OBS	4.7	5.04	0.5	1.88	1.31	1.76*	concave	straight

Catalog #	Site #	Material	Weight	Length	Thickness	Blade Width	Neck Width	Base Width	Base Type	Notch Type
07-103	0502062584si	OBS	3.08	2.59	0.63	n/a	1.19	2.44*	concave	straight
07-176	0502063342si	OBS	5.5	4.74	0.53	2.26	1.57	2.52*	unk	straight
07-269	0502063352si	OBS	2.32	2.48*	0.49	1.76*	1.07	2.06	concave	straight
07-278	0502063352si	OBS	1.47	2.4	0.43	1.59*	0.97	1.8*	concave	straight
07-293	0502063358si	OBS	3.99	2.55*	0.72	2.75	1.45	2.43*	concave	straight
07-316	0502063348si	OBS	1.83	1.65*	0.56	n/a	1.34	2.94	concave	straight
07-323	0502063367si	OBS	3.56	2.79*	0.62	n/a	1.3	2.21*	concave	straight
07-338	0502063369si	OBS	2.84	2.3*	0.62	2.29	1.08	2.08*	flat	straight
07-353	0502063370si	OBS	1.92	1.78*	0.47	1.8*	1.5	2.18	flat	straight
07-357	0502063370si	OBS	1.72	1.76*	0.54	n/a	1.51	2.49	concave	straight
07-405	0502063342si	OBS	5.41	2.61*	0.83	2.46	1.76	2.44*	unk	straight
07-406	0502063342si	CCS	3.17	2.55*	0.62	2.01	1.32	n/a	flat	straight
07-407	0502063342si	OBS	5.36	3.13*	0.67	n/a	1.85	2.48	concave	straight
08-052	0502051068si	OBS	4.6	2.32	0.82	2.54	1.47	2.11*	concave	straight
08-063	0502051068si	OBS	1.63	1.56*	0.51	n/a	1.24	2.51	concave	straight
08-064	0502051068si	OBS	2.64	1.86*	0.54	2.09	1.39	2.08*	flat	straight
08-070	0502051068si	OBS	4.66	3.99*	0.64	2.05	0.94	1.65*	unk	straight
08-085	0502051068si	OBS	4.51	2.42*	0.83	2.27	1.67	1.84*	concave	straight
08-108	0502051068si	OBS	2.42	3.58	0.52	2.49*	1.07	2.15*	unk	straight
08-137	0502051068si	OBS	3.48	2.53*	0.55	2.23	1.35	2.21*	flat	straight
08-153	0502062584si	OBS	4.18	3.3*	0.61	2.43	1.48	2.07*	concave	straight
08-251	0502062584si	OBS	5.72	3.76*	0.64	2.26	1.07	1.55*	concave	straight
08-299	0502051070si	OBS	2.69	3.26*	0.53	1.68*	1.17	1.91*	concave	straight
08-305	0502051068si	OBS	3.53	3.4*	0.52	1.9	1.5	2.03	concave	straight
08-342	0502051068si	OBS	1.69	2.34*	0.38	1.92	1.69	2.17*	concave	straight
08-363	0502051068si	OBS	3.26	3.01*	0.6	1.78	1.37	1.86*	concave	straight

Catalog #	Site #	Material	Weight	Length	Thickness	Blade Width	Neck Width	Base Width	Base Type	Notch Type
08-412	0502051068si	OBS	3.49	3.22*	0.5	1.93	1.43	1.91	flat	straight
08-450	0502051068si	OBS	2.75	3.14	0.47	1.95*	1.33	1.03*	flat	straight
08-522	0502063437si	OBS	4.19	3.33	0.62	2.19*	1.35	2.29	flat	straight
08-542	0502063448si	OBS	4.73	2.76*	0.57	2.55	1.7	2.12	concave	straight
08-553	0502063448si	FGV	2.87	2.18*	0.64	2.13	1.2	1.81*	concave	straight
08-555	0502063448si	OBS	1.43	2.13*	0.4	1.93	n/a	n/a	concave	straight
08-562	0502063449si	OBS	3.55	3.45*	0.54	2.09	1.56	2.42	concave	straight
08-563	0502063450si	FGV	4.7	3.04*	0.75	2.43	1.49	2.32	concave	straight
08-769	0502050328si	OBS	6.11	4.13*	0.74	2.15	1.63	2.37	concave	straight
08-835	0502050920si	OBS	1.91	2.06*	0.42	1.77	0.99	1.58	flat	both
09-035	0502050923si	OBS	8.22	4.5*	0.92	2.03	1.05	n/a	n/a	straight
09-040	0502050923si	OBS	4.36	3.2*	0.69	2.48	1.45	2.3	concave	both
09-044	0502050923si	OBS	4.83	4.85	0.66	2.29	0.98	1.96*	flat	both
09-058	0502050923si	OBS	3.92	4.9	0.53	1.68	0.96	1.8	concave	straight
09-154	0502062584si	OBS	4.05	3.96*	0.55	2.03	n/a	1.23*	unk	straight
09-155	0502062584si	OBS	2.6	2.91*	0.44	2.07	1.12	1.73*	unk	straight
09-175	0502062584si	OBS	4.79	3.72*	0.66	2.12	1.19	1.84	flat	straight
09-199	0502050920si	OBS	5.11	5.73	0.65	1.73	0.92	1.79	concave	straight
09-206	0502062501si	OBS	0.82	1.07*	0.38	n/a	1.15	2.13*	unk	straight
09-214	0502062501si	OBS	1.66	2.27*	0.38	2	n/a	1.25*	concave	straight
09-320	0502060461si	OBS	1.96	2.4*	0.4	1.77*	1.26	1.99	concave	straight
09-377	0502063629si	OBS	1.25	1.5*	0.49	1.67	1.13	1.79	concave	straight
09-467	0502063615si	OBS	0.79	1.4*	0.4	n/a	1.01	1.32	concave	straight
09-502	0502063540si	OBS	1.08	1.33*	0.42	n/a	1.11	2.12	concave	straight
09-660	0502063595si	OBS	4.12	4.49*	0.64	1.61	1.12	1.39*	concave	upturned
10-026	0502063655si	OBS	3.73	3.64*	0.49	2.08	1.2	1.77*	unk	straight

Catalog #	Site #	Material	Weight	Length	Thickness	Blade Width	Neck Width	Base Width	Base Type	Notch Type
10-042	0502063367si	OBS	2.52	2.11*	0.63	n/a	1.5	2.45	flat	straight
10-044	0502063667si	OBS	5.35	3.8	0.7	2.48	1.36	1.84*	concave	straight
10-085	0502063657si	OBS	2.98	2.4*	0.55	2.39*	1.35	2.01*	concave	both
10-100	0502063663si	OBS	1.22	1.3*	0.46	n/a	1.49	2.59	concave	straight
10-105	0502063666si	OBS	3.07	3.4*	0.53	1.67	1.07	1.72	flat	straight
10-117	0502063670si	OBS	4.01	2.81*	0.65	2.42*	1.29	1.79*	unk	straight
10-120	0502063670si	OBS	2.71	2.2*	0.54	2.56*	1.26	1.9	concave	straight
10-152	0502063707si	OBS	2.39	2.91	0.47	1.92	1.14	1.88	flat	straight
10-176	0502063683si	OBS	2.21	2.48*	0.44	1.59*	1.02	2.58	concave	straight
10-178	0502063683si	OBS	2.77	2.66*	0.48	2.02	0.95	1.96*	concave	sl. upt.
10-181	0502063683si	OBS	1.83	1.65*	0.51	n/a	1.51	2.32	concave	straight
10-195	0502063683si	OBS	0.82	1.63*	0.37	n/a	1.02	1.77	concave	straight
10-211	0502063689si	OBS	1.3	1.74*	0.4	1.6*	1.21	1.97	concave	straight
10-233	0502063692si	OBS	1.7	1.87*	0.42	2.07*	1.58	2.4*	concave	straight
10-268	0502063701si	OBS	0.58	1.66*	0.34	n/a	n/a	1.27*	concave	straight
10-490	0502050923si	OBS	3.89	3.93*	0.58	2.35	1.29	1.6*	unk	straight
10-501	0502063693si	OBS	1.09	1.92*	0.45	1.35	0.97	1.68	concave	straight
11-034	0502063766si	OBS	2.09	2.41*	0.43	1.92	1.25	2.07	concave	sl. upt.
11-067	0502063775si	OBS	n/a	2.89*	0.59	2.35	1.36	2.11	concave	straight
11-075	0502063777si	OBS	4.04	3.02*	0.72	1.95	1.99	2.06	concave	upturned
11-087	0502063752si	OBS	1.92	1.99*	0.42	1.75	1.45	2.01	concave	straight
11-111	0502063749si	OBS	2.24	3.97	0.52	1.42	1.17	1.79	concave	straight
11-215	0502063755si	OBS	2.08	2.41*	0.47	1.62	1.42	1.8*	concave	straight
11-289	0502063846si	FGV	3.18	2.58*	0.65	1.77	1.03	1.4*	concave	straight
11-314	0502062707si	OBS	2.31	2.51	0.43	1.84	1.43	2.12	concave	straight
12-119	0502050334si	OBS	5.46	5.26	n/a	2.08	1.01	1.53*	concave	upturned

Catalog #	Site #	Material	Weight	Length	Thickness	Blade Width	Neck Width	Base Width	Base Type	Notch Type
12-159	0502050334si	OBS	3.24	3.41	0.53	1.92*	1.52	1.88*	concave	straight
12-162	0502050334si	OBS	2.31	2.58*	0.48	1.44*	1.22	1.95	concave	sl. upt.
12-166	0502050334si	OBS	2.31	2.22*	0.48	2.13*	1.2	2.12	concave	upturned
12-179	0502062584si	OBS	1.75	1.49*	0.47	n/a	1.29	2.36	concave	straight
12-248	0502050334si	OBS	3.84	3.72*	0.59	1.65*	1.36	1.98	flat	straight
12-257	0502050327si	OBS	2.92	2.66*	0.58	1.72	1.25	1.73	flat	straight
12-275	0502050920si	OBS	4.28	3.22*	0.61	2.06	1.44	2.14	concave	straight
12-294	0502051070si	OBS	2.34	2.05*	0.59	n/a	1.12	2.2	concave	straight
12-302	0502051070si	OBS	3.96	3.92*	0.55	1.72	1.05	1.72*	concave	straight
12-313	0502051070si	OBS	2.12	2.34*	0.46	2.03	0.98	2.08	flat	upturned
12-320	0502051070si	OBS	1.99	2.4*	0.54	1.53	1.14	1.67	sl. conc.	straight
12-378	0502051068si	OBS	2.64	2.48*	0.64	n/a	n/a	1.62*	flat	straight
13-214	0502064034si	OBS	3.77	4.05*	0.65	1.59	1.43	1.83	concave	straight
14-140	0502064070si	OBS	2.03	3.14	0.47	1.76	0.89	2.26	concave	straight
14-156	0502064070si	OBS	2.41	2.82*	0.45	1.67	0.9	2.61	concave	straight
14-156	0502064070si	OBS	2.42	3.12*	0.51	1.54	0.82	1.82	concave	straight
14-157	0502064070si	OBS	3.66	3.61*	0.6	1.6	0.93	1.38*	unk	straight
14-171	0502064070si	OBS	1.6	2.38*	0.39	1.95	0.92	1.3*	unk	straight
14-184	0502064070si	OBS	4.22	2.96*	0.6	2.34	1.42	1.88	concave	straight
14-192	0502064070si	OBS	2.34	1.85*	0.47	2.34	1.77	2.1	flat	straight
14-227	0502064072si	OBS	2.88	2.62*	0.59	1.99	1.58	1.9*	concave	upturned
14-275	0502064072si	OBS	3.58	2.76*	0.48	2.63	1.43	2.55	concave	straight
92-076	0502061179si	OBS	0.71	1.44*	0.32	n/a	0.95	2.68	concave	straight
92-107	0502061179si	OBS	1.48	1.37*	0.44	n/a	1.22	2.3	concave	straight
95-038	0502062016si	OBS	2.22	3.21*	0.47	1.51	0.81	1.36*	unk	straight
95-141	0502060338si	OBS	2.07	4.26	0.47	1.47	0.73	1.45*	concave	straight

Catalog #	Site #	Material	Weight	Length	Thickness	Blade Width	Neck Width	Base Width	Base Type	Notch Type
95-142	0502060338si	OBS	2.84	3.75	0.59	1.72	1.29	1.96*	concave	straight
98-094	0502062500si	OBS	2.4	2.4*	0.53	1.78*	1.25	2.02	concave	straight
98-110	0502062470si	OBS	2.63	3.11	0.56	1.9	1.6	2.02	flat	straight
5-A-15-1[z]	35HA3855	OBS	3.97	3.26*	0.58	2.24	1.29	1.8*	flat	straight
5-C-30-1[z]	35HA3855	OBS	3.56	3.56	0.47	2.36	1.19	2.32	flat	sl. upt.
29-C-14-1[z]	35HA3855	OBS	1.55	1.31*	0.45	n/a	1.6	2.58	flat	straight
26-A-6-1[y]	35HA3855	OBS	4.7	5.08*	0.59	1.72	0.98	n/a	n/a	straight
6-A-7-1[x]	35HA3855	OBS	4.73	5.26	0.65	1.98	1.24	1.65*	flat	upturned
6-A-7-1[x]	35HA3855	OBS	4.73	5.26	0.64	1.98	1.28	1.66*	flat	straight
5-C-30-1[z]	35HA3855	OBS	3.55	3.58	0.47	2.37	1.19	2.32*	flat	straight
5-A-15-1[z]	35HA3855	OBS	3.97	3.26*	0.57	2.28	1.27	1.77*	flat	straight
4-C-5-1[z]	35HA3855	OBS	6.79	5.56	0.5	2.86	1.73	3.03	concave	straight
4-D-21-1[z]	35HA3855	OBS	6	5.39	0.59	2.49	2.01	2.71	concave	straight
7-C-21-1[z]	35HA3855	OBS	3.28	4.13	0.55	2.01	1.22	2.15	concave	straight
2012-surf-47[z]	35HA3855	OBS	3.02	3.08*	0.63	1.58	0.89	1.86	flat	straight
2010-surf-15[z]	35HA3855	OBS	4.45	3.18*	0.6	2.17	1.48	2.05	concave	straight
7-B-26-1[z]	35HA3855	OBS	6.19	4.21*	0.65	2.73*	1.69	2.65*	unk	straight
15-D-4-1[z]	35HA3855	OBS	4.76	4.58*	0.63	2.25	1.72	2.37*	flat	straight
23-A-8-1[x]	35HA3855	OBS	5.84	4.21*	0.68	2.06	1.64	2.25*	concave	straight
00-786	--	OBS	3.86	3.71*	0.61	1.98*	1.08	2.25*	concave	straight
02-219	--	OBS	3.21	1.65*	0.55	2.05	0.93	1.93	flat	straight
08-594	0502050867si	OBS	1.37	1.28*	0.43	n/a	1.44	2.26	concave	straight
10-421	--	OBS	2.52	2.13*	0.59	2.27	1.09	1.45*	concave	straight
13-219	502063941si	OBS	5.71	3.87*	0.69	1.89	1.28	1.92	concave	straight
14-232	0502064079si	OBS	1.29	1.26*	0.46	n/a	n/a	2.48	concave	straight
11-066	050206774si	OBS	3.22	2.78*	0.5	2.05	1.6	2.21	flat	straight

Catalog #	Site #	Material	Weight	Length	Thickness	Blade Width	Neck Width	Base Width	Base Type	Notch Type
02-603	0502051125if	OBS	0.75	3.06*	0.36	n/a	n/a	0.46	concave	straight
01-224	0502050981if	OBS	2.07	3.27*	0.43	1.65*	1.03	1.32	unk	straight
01-317	0502050972if	OBS	4.05	4.4	0.63	1.69	1.3	2.15	concave	both
01-568	0502051064if	OBS	1.74	2.32	0.6	1.72	1.31	2.29	concave	straight
02-375	0502051071if	OBS	5.82	4.87	0.6	2.76	1.42	1.63*	concave	straight
02-645	0502051200if	OBS	2.12	2.65*	0.45	2.08*	0.83	1.6*	concave	both
02-655	0502051211if	OBS	2.93	4.74	0.45	2.04	0.87	1.64*	concave	straight
03-546	0502051175if	OBS	2.54	2.41*	0.57	1.87	1.39	1.77*	concave	straight
03-771	0502051435if	OBS	0.65	0.92*	0.49	n/a	1.27	1.75*	concave	straight
03-775	0502051439if	OBS	2.82	2.82*	0.55	1.53	1.36	2.24	concave	straight
03-780	0502051444if	OBS	0.83	1.27*	0.46	n/a	1.47	2.14	concave	straight
04-049	0502051253if	OBS	2.93	3.05*	0.51	1.73	1.37	1.68	concave	straight
06-040	0502051530if	OBS	2.31	3.03*	0.44	1.8	0.92	1.65*	concave	straight
06-446	0502051529if	OBS	2.21	3.75	0.47	2.02	0.83	1.59*	concave	sl. upt.
07-444	0502051728if	OBS	7.19	5.62*	0.72	2.19*	1.22	1.68*	concave	sl. upt.
08-519	0502051812if	OBS	5.16	4.86*	0.66	1.92	1.81	1.05*	unk	straight
08-824	0502051849if	OBS	2.83	3.63*	0.54	2.45*	1.1	2.04*	concave	slightly
09-110	0502051894if	CCS	4.69	3.49*	0.71	1.83	1.11	1.96	concave	straight
09-285	0502051916if	OBS	2.77	2.59*	0.6	1.87*	1.39	1.7*	concave	straight
09-288	0502051923if	OBS	2.22	3.09*	0.47	1.67	1.23	1.51*	concave	straight
09-412	0502051930if	OBS	4.41	2.58*	0.52	2.92	1.79	3.13	flat	straight
09-417	0502051957if	OBS	4.67	3.19*	0.66	1.99	1.2	1.78*	concave	straight
10-539	0502052122if	OBS	4.21	3.49*	0.61	2.13*	1.3	1.78*	concave	straight
11-040	0502052053if	OBS	4.08	3.19*	0.6	1.93*	n/a	n/a	concave	straight
11-298	0502052076if	OBS	1.3	2.02*	0.42	1.48	0.97	1.68	concave	straight
11-406	0502052120if	OBS	2.09	2.24*	0.55	1.79	1.06	1.65	flat	sl. upt.

Catalog #	Site #	Material	Weight	Length	Thickness	Blade Width	Neck Width	Base Width	Base Type	Notch Type
12-575	0502052217if	CCS	13.44	5.81*	0.9	2.65	1.99	2.84	concave	straight
12-583	0502052192if	OBS	2.74	2.83*	0.49	2.09	1.34	1.82	concave	upturned
14-023	0502052300if	OBS	0.8	1.69*	0.34	n/a	0.93	1.75*	concave	straight
92-201	0502050863if	OBS	5.48	2.41*	0.68	2.95	1.91	2.81*	concave	straight
98-093	002050784if	OBS	4.59	3.74*	0.63	2.2	1.19	1.67*	unk	straight
01-570	0502051066if	OBS	1.07	1.4*	0.4	n/a	1.17	2.73	concave	straight
01-584	0502051012if	OBS	9.76	5.17	0.75	2.54	1.56	2.52	concave	straight
02-728	0502051639if	OBS	4.63	5.15	0.52	1.83	1.17	1.94	concave	straight
03-766	0502061430if	OBS	1.01	1.29*	0.4	n/a	1.04	2.34	concave	straight
03-799	0502051331if	CCS	3.59	2.91*	0.62	1.67	1.15	1.72*	concave	straight
03-803	0502051799if	OBS	3.78	4.06	0.55	2	0.98	1.5*	concave	straight
04-299	if-4A	OBS	4.42	2.49*	0.74	2.6	1.48	2.07	concave	straight
07-469	0502051756if	OBS	2.66	2.82*	0.54	1.77	1.2	1.65*	concave	straight
08-830	0502051851if	OBS	4	1.75*	0.8	n/a	2.03	3.33*	concave	straight
09-030	0502051901if	OBS	11.04	6.77*	0.83	2.13	1.74	1.42*	flat	straight
14-060[e]	0502064064si	OBS	1.04	1.4*	0.4	n/a	1.27	2.07*	concave	straight
09-048[e]	--	FGV	5.47	5.38	0.63	2.04	1.26	1.81*	flat	straight
09-190[e]	3497si	OBS	2.87	3.19*	0.53	1.64	0.93	1.66	flat	straight
01-586[e]	2602si	OBS	4.64	3.05*	0.73	n/a	1.23	2.05	sl. conc.	sl. upt.
13-107[e]	050205225if	OBS	1.76	2.08*	0.6	1.51*	n/a	1.54*	sl. conc.	straight
13-180[e]	0502051070si	OBS	1.35	1.77*	0.42	1.62	1.07	1.61	flat	straight
13-209[e]	0502064033si	OBS	5.63	3.36*	0.77	2.16	1.11	1.43	concave	sl. upt.
08-022[e]	3421si	OBS	2.87	3.36	0.55	2.06*	1.06	1.52*	unk	straight
08-099[e]	051068si	OBS	1.12	1.38*	0.38	n/a	0.95	1.83*	sl. conc.	both
10-482[e]	0502060018TK	OBS	2.43	3.03*	0.51	1.62*	n/a	1.59*	unk	straight
10-499[e]	0502052023if	OBS	4.45	3.77	0.52	2	1.03	1.37*	flat	straight

Catalog #	Site #	Material	Weight	Length	Thickness	Blade Width	Neck Width	Base Width	Base Type	Notch Type
02-626[e]	2829si	OBS	5.05	3.81*	0.6	2.52	1.19	1.66*	flat	straight
02-673[e]	2926si	OBS	2.82	3.07*	0.49	1.81	1.25	1.76	flat	straight
12-319[e]	0502051070si	OBS	4.01	2.81*	0.66	2.23	n/a	1.38*	flat	straight
12-322[e]	0502051070si	OBS	2.93	2.61*	0.57	1.9*	0.99	1.49*	flat	straight
01-206[e]	950if	OBS	2.71	2.38*	0.61	1.75	1.11	1.93	flat	straight
01-416[e]	2427si	OBS	2.32	1.93*	0.52	n/a	1.54	2.33*	flat	straight
01-452[e]	2599si	OBS	3.49	3.67*	0.54	2.07*	1.09	1.45*	flat	straight
01-582[e]	2605si	OBS	3.47	2.69*	0.54	2.22	0.92	2.02*	flat	straight
06-159[e]	2584si	OBS	4.08	3.69*	0.57	2.08	1.24	2.24	flat	straight
07-024[e]	3311si	OBS	6.31	5.01*	0.63	2.06*	1.39	2.05	flat	straight
07-036[e]	3309si	OBS	4.57	3.15*	0.57	2.03	1.53	2.24*	unk	straight
07-096[e]	3318si	OBS	4.76	3.79*	0.68	2.08*	1.18	1.81*	flat	upturned
07-456[e]	1677if	OBS	8.49	5.37*	0.79	2.35	1.68	2.42	flat	straight

* Element is broken or fragmented and the measurement is not complete

["slt. upt."] Slightly upturned

[e] Previously designated as Elko Side-notched

[CCS] Cryptocrystalline Silicate

[Unk.] Unknown

[z] Include accession number 2039-3855

[x] Include accession number 2110-3855

[if] BLM Isolate

["sl. conc."] Slightly concave

[both] One straight and one upturned notch

[OBS] Obsidian

[FGV] Fine Grained Volcanic

[n/a] Non applicable; impossible to take measurement

[y] Include accession number 2209-3855

[si] BLM Site

APPENDIX C

Measurements of Elko Side-notched Projectile Points.

Note: 1) Only those projectile points measured and identified as Elko Side-notched points are included here (other projectile point measurements available on request). 2) All measurements are recorded in centimeters. 3) Weight is recorded in grams.

Catalog #	Site #	Material	Weight	Length	Thickness	Blade Width	Neck Width	Base Width	Base Type	Notch Type
14-125	0502064070si	OBS	2.23	3.64	0.46	1.72	1.06	1.68	flat	straight
09-383	3582si	OBS	4.04	3.56*	0.65	1.87	1.42	1.49*	flat	straight
08-134	051068si	OBS	3.21	3.17*	0.62	1.72	1.12	1.51*	flat	straight
08-410	051068si	OBS	1.88	2.38*	0.57	1.74*	1.17	2.03*	sl. conc.	sl. upt.
08-914	0502063095si	OBS	3.16	3.52*	0.59	1.68	1.08	1.56*	concave	straight
10-052	3667si	OBS	1.44	2.26	0.5	0.47*	n/a	1.44*	sl. conc.	straight
10-172	0502063683si	OBS	2.92	2.14*	0.57	2.07	1.27	2.11*	flat	sl. Upt.
10-230	0502063692si	OBS	3.77	3.79	0.6	2.04	1.25	1.94	flat	straight
02-618	2899si	OBS	1.43	1.89*	0.43	1.51*	n/a	1.03*	flat	straight
01-213	2645si	OBS	2.03	2.41*	0.51	1.44	1.07	1.56*	n/a	straight
03-652	2859si	OBS	3.12	3.22*	0.64	1.89	1.06	1.81*	flat	both
09-197	050920si	OBS	4.08	3.86*	0.54	1.78	1.16	1.78*	flat	straight
04-255[n]	2972si	OBS	2.15	3.03	0.42	1.8	1	1.82*	flat	straight

* Element is broken or fragmented and the measurement is not complete

"slt. upt." Slightly upturned

[n] previously designated as Northern Side-notched

[si] BLM Site

[n/a] Non applicable; impossible to take measurement

"sl. conc." Slightly concave

[both] One straight and one upturned notch

[OBS] Obsidian

[if] BLM Isolate

APPENDIX D

Northern Side-notched Site Attributes

Only sites with Burns BLM District site reports are displayed in this appendix.

Site #	# NSN	Subbasin	Elevation (ft.)	H2O Name	H2O Source	H2O Status	H2O Distance (m)	Cultural Materials	Excavated
0502062570SI	2	ML	5160	Little Crane Cr.	R/S	P	0	LS; FT; GS; PG	no
0502062645SI	1	ML	5580	UnN, UnN	S/S; R/S	P; I/E	0; 0	LS; FT	no
0502062736SI	1	AL	5400	UnN, Camp Cr., UnN	S/S; R/S; R/S	I/E; P; I/E	0; 3200; 0	LS; FT	no
0502062777si	1	ML	5480	yes	unk	unk	unk	LS; FT	no
0502062779si	1	ML	5660	Stinkingwater Cr. & UnN	R/S; R/S	P; I/E	850; 200	FT; LS	no
0502062845SI	1	ML	5035	UnN & Little Stinkingwater	R/S; R/S	I/E; P;	25; 5	LS; GS; FT	no
0502063004si	1	DUB	8960	UnN & UnN	S/S; S/S	P; P	108; 95	LS; FT	no
0502062961SI	3	DUB	5561	UnN; UnN	R/S; S/S	I/E; P	0; 0	FT; GS; LS	no
0502062962SI	1	DUB	5421	UnN	R/S	I/E	370	GS; LS; FT	no

Site #	# NSN	Subbasin	Elevation (ft.)	H2O Name	H2O Source	H2O Status	H2O Distance (m)	Cultural Materials	Excavated
0502062805si	1	DUB	5560	UnN	R/S	I/E	10	FT; GS; LS; RA	no
0502063069si	2	ML	5580	unk	S/S	I/E	221	FT; LS	no
0502062899SI	1	DUB	5800	Yank Cr.	R/S	P	0	LS; FT	no
0502063352SI	2	DUB	5150	Bridge Cr.; UnN ; UnN	R/S R/S; R/S	P; I/E; I/E	100; 500; 30	GS; LS; FT	no
0502063348SI	1	DUB	5400	Krumbo Cr.	R/S	P	90	GS; LS; FT	no
0502063367SI	2	DUB	5200	Dry Krumbo Cr.	R/S	I/E	100	GS; LS; FT	no
0502063369SI	1	DUB	5051	Dry Krumbo Cr.	R/S	I/E	90	GS; LS; FT	no
0502063370SI	2	DUB	5051	Dry Krumbo Cr.	R/S	I/E	220	LS	no
0502063448SI	3	DUB	5394	unk	R/S	I/E	120	RC; GS; LS;	no
0502063450SI	1	DUB	5313	UnN	R/S	I/E	0	GS; LS; FT	no
0502062501SI	2	--	6085	Frazier Sp.	S/S	P	0	LS; FT	no
0502060461SI	1	DUB	5450	UnN ; UnN	R/S; L/P	I/E; P	300; 300	LS; FT; RA	no

Site #	# NSN	Subbasin	Elevation (ft.)	H2O Name	H2O Source	H2O Status	H2O Distance (m)	Cultural Materials	Excavated
0502063629SI	1	G	5350	UnN; UnN	L/P; R/S	P; I/E	135; 10	LS; FT	no
0502063615SI	1	DUB	5238	UnN; Little Kiger Cr.	R/S; R/S	I/E; I/E	100; 1300	GS; LS; FT	no
0502063595SI	1	G	5480	UnN	R/S	I/E	403	LS; FT;	no
0502063707si	1	HM	5277	Smyth Cr.; Smyth Cr. Trb.	R/S; R/S	P; I/E	649; 439	FT; LS	no
0502063683si	4	DUB	5293	UnN	R/S	I/E	167	FT; LS	no
0502063689SI	1	HM	5024	Little Kiger Cr.	R/S	I/E	124	GS; LS; FT	no
0502063692SI	3	DUB	5019	Little Kiger Cr.	R/S	I/E	576	FT; LS	no
0502063701SI	1	G	5328	UnN	R/S	I/E	32	LS; FT	no
0502063693si	1	DUB	5036	Kiger Cr.	R/S	I/E	150	H; LS; GS; FT	no
0502063766Si	1	DUB	5317	UnN	R/S	I/E	150	LS; FT	no
0502063775Si	1	DUB	5394	UnN	R/S	I/E	100	LS; FT	no
0502063777Si	1	DUB	5674	UnN	R/S	I/E	40	LS; FT; GS	no

Site #	# NSN	Subbasin	Elevation (ft.)	H2O Name	H2O Source	H2O Status	H2O Distance (m)	Cultural Materials	Excavated
0502063752SI	1	DUB	5554	UnN ; Dry Krumbo Cr.	R/S; R/S	I/E; I/E	74; 1000	LS; FT; GS	no
0502063749Si	1	DUB	5494	Dry Krumbo Cr.; Krumbo Cr.	R/S; R/S	I/E; P	50; 420	FT; LS; GS	no
0502063755Si	1	DUB	5600	UnN	R/S	I/E	10	LS; GS; FT	no
0502063846si	1	DUB	5150	DUB; UnN	R/S; R	P; I/E	110; 60	LS; FT; GS	no
0502062707SI	1	HM	5200	UnN	R/S	I/E	120	FT; LS; GS	no
0502061179SI	2	--	5250	unk	unk	unk	unk	LS; FT; GS	no
0502062016SI	1	--	5000	n/a	n/a	n/a	n/a	HP; RA; FT; LS; GS; H	no
0502062679SI	2	ML	4873	UnN; UnN	S/S & R/S	I/E	1200 & 0	RC, FT, LS	no
0502062633SI	1	ML	4900	Upper Ryegrass Sp.	S/S	P	200	LS; FT; GS	no
0502062740si	1	ML	4800	UnN; UnN	S/S; R/S	P; I/E	0; 30	FT; LS	no
0502062724si	1	SC	4820	Horsehead	S/S	I/E	0	LS; GS; FT	no
0502062756si	4	UM	4870	UnN	R/S	I/E	0	FT; LS; RA; GS	no

Site #	# NSN	Subbasin	Elevation (ft.)	H2O Name	H2O Source	H2O Status	H2O Distance (m)	Cultural Materials	Excavated
0502063066SI	1	ML	4994	UnN	R/S	I/E	213	FT; LS	no
0502063437SI	1	UM	4860	Bluebucket Cr.	R/S	P	300	FT; Basalt Q; LS	no
0502062508SI	1	G	4650	UnN		I/E	3200	LS; FT; GS; H	no
0502062584SI	9	ML	4225	Lake on the Trail Playa	L/P	I/E	0	LS; Q; GS; FT; LS	yes
0502063126si	1	G	4550	Catlow L	L/P	I/E	10	FT; LS	no
0502063156si	2	SC	4430	Squaw L	L/P	I/E	0	LS; FT; GS	no
0502062623SI	1	ML	4210	UnN	other	I/E	0	LS	no
0502062811si	1	AL	4030	AL	L/P	I/E	200	LS; FT; GS	no
0502062926si	1	AL	4165	Cottonwood Cr.	R/S	I/E	560	LS; GS; FT	no
0502062866SI	1	ML	4585	Slickear Cr.	R/S	P	0	FT; LS; GS	no
0502062859SI	2	MO	4620	Tule Sp.; Mahon Cr. Trb.; Tule Sp.	R/S; R/S; S/S	P; I/E; P	300; 200; 500	FT; GS; LS; CCS Q; Q	no

Site #	# NSN	Subbasin	Elevation (ft.)	H2O Name	H2O Source	H2O Status	H2O Distance (m)	Cultural Materials	Excavated
0502052336SI	1	--	4225	Capehart L	L/P	I/E	1	LS; FT	no
0502062967SI	1	ML	4400	UnN	R/S	I/E	1	LS;	no
0502063088SI	1	ML	4320	UnN	R/S	I/E	300	LS	no
0502063308SI	1	SC	4550	Sheep L	L/P	P	500	LS; GS; FT	no
0502063342SI	4	BVS	4500	UnN	R/S	I/E	5	LS; FT	no
0502063358SI	1	SC	4110	Badger Sp.	S/S	P	300	FT; LS	no
0502051068SI	13	ML	4123	unk	unk	unk	unk	RA; LS; FT; GS; H	no
0502051070SI	5	ML	4130	unk	unk	unk	unk	LS; FT; GS	no
0502050328SI	1	--	4140	Seiloff Sp.	S/S	P	10	LS; FT; GS	no
0502050920SI	3	SC	4480	UnN	R/S	I/E	1	LS; FT	no
0502050923SI	5	SC	4400	Rock Quarry Canyon	R/S	I/E	1	LS; FT; Q	no
0502063540SI	1	SC	4448	UnN	R/S	I/E	0	GS; LS; FT	no

Site #	# NSN	Subbasin	Elevation (ft.)	H2O Name	H2O Source	H2O Status	H2O Distance (m)	Cultural Materials	Excavated
0502063655SI	1	G	4512	Catlow L	L/P	I/E	0	GS; LS; FT	no
0502063667SI	1	ML	4136	DUB	R/S	P	615	LS; FT	no
0502063657SI	1	DUB	4146	Busse Canal	R/S	P	300	GS; LS; FT	no
0502063663SI	1	DUB	4138	Busse Canal	D/C P	P	460	GS; LS; FT	no
0502063666SI	1	DUB	4136	DUB	R/S	P	1.8km	GS; LS; FT	no
0502063670SI	2	DUB	4127	n/a	n/a	n/a	n/a	LS; FT	no
0502050334si	5	ML	4140	n/a	n/a	n/a	n/a	LS; FT; GS	no
0502050327si	1	ML	4140	Thorn Sp.	S/S	P	100	LS; FT	no
0502064034si	1	SC	4140	UnN; UnN; Angie Potholes	L/P; L/P; S/S	I/E; I/E; P	100; 150; 3300	LS; FT	no
0502064070si	7	G	4575	GS; GS R	R/S; R	I/E; P	0; 9800	LS; Q; FT; GS	no
0502064072si	2	G	4600	GS	R/S	I/E	0	LS; GS; FT	No

Site #	# NSN	Subbasin	Elevation (ft.)	H2O Name	H2O Source	H2O Status	H2O Distance (m)	Cultural Materials	Excavated
0502060338SI	2	AL	4220	Mann L	L/P	P	305	LS; FT; GS	no
0502062500SI	1	ML	4135	ML	L/P	P	360	LS; FT; GS	no
0502062470SI	1	ML	4115	Mud L/ML	L/P	P	800	LS; FT; GS	no
35HA3855	16	SC	<4,800	Hay L; UnN	L/P; R/S	P; I/E	unk	LS; FT; GS; H	yes

ML= Malheur Lake; UM = Upper Malheur Lake; G = Guano; SC = Silver Creek; AL = Alvord Lake; DUB = Donner und Blitzen; BVS = Beaver-Southfork; MO = Middle Owyhee; HM = Harney-Malheur Lake

Cr. = Creek; L. = Lake; Sp. = Spring; UnN = Unnamed water source; GS = Guano Slough; Trb. = Tributary

R/S = River/Stream; S/S = Spring/Seep; L/P = Lake/Pond

P = Perennial; I/E = Intermittent/Ephemeral

LS = Lithic Scatter; FT = Flaked Stone Tools; GS = Ground Stone Tools; Q = Quarry; H = Hearth; RA = Rock Alignments; RC = Rock Cairns; PG = Pictograph; HP = House Pit

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