# THE INFLUENCE OF ECOLOGICAL VARIABLES ON ARCHAEOLOGICAL SITE DENSITY IN THE OWYHEE REGION, SOUTHWEST IDAHO

by

Jennifer Cuthbertson

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Jennifer Cuthbertson

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The following individuals read and discussed the thesis submitted by student Jennifer Cuthbertson, and they evaluated the student's presentation and response to questions during the final oral examination. They found that the student passed the final oral examination.

| | |
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| Pei-Lin Yu, Ph.D. | Chair, Supervisory Committee |
| Mark Plew, Ph.D. | Co-Chair, Supervisory Committee |
| Mikael Fauvelle, Ph.D. | Member, Supervisory Committee |
| F. Kirk Halford, MA | Member, Supervisory Committee |

The final reading approval of the thesis was granted by Pei-Lin Yu, Ph.D., Chair of the Supervisory Committee. The thesis was approved by the Graduate College.

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# ABSTRACT

Vegetational resources are reported to have had multiple uses in indigenous groups who were present in the Great Basin area throughout the Archaic periods. Resource acquisition and position of resources is documented to have had impacts on settlement patterns, but the impact of the range of vegetational resources, specifically, is lacking thorough study in the northern Great Basin area. Due to fluctuating climates, modern development, and other factors both anthropogenic and otherwise, Archaic vegetation ranges may not be wholly visible in the same locations today; however, the environments surrounding sites may be determined by observing a variety of ecological variables, including soil type, hydrology, slope, and elevation.

Using Owyhee County, Idaho for an example, this study seeks to evaluate if known locations of archaeological sites have any visible correlation to four variables reported to have critical importance to the ecology and ranges of vegetation communities: soil type, groundwater accessibility, slope, and elevation. I analyze how ecological variables heavily associated with vegetation types can be mapped against known archaeological resource location ‘hotspots’, and use them to create a well-informed analysis of the vegetations correlated with these variables and estimate a general assessment of the resources most likely to have been available in these locations. Observing how these variables are associated with vegetation that correlates to documented ethnographic usages, this thesis advances possible factors that influence the selection of residential, temporary camp, and resource-specific processing site locations, and provides strong evidence for the need to consider environmental factors when conducting archaeological surveys.

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# CHAPTER 1: INTRODUCTION

Macrobotanicals are ethnographically and archaeologically known to have been a reliable and important resource to humans in semi-arid environments similar to the modern Owyhee County area in southwestern Idaho (Dering 1999). Assuming that foragers of the approximately 7000 – 250 YBP period of the Great Basin known as the ‘Archaic Period’ (Plew 2016) operated with a knowledge of the locations of such resources, it is highly likely that camp settlement patterns would be affected by different vegetation ranges. Indeed, the distribution of resources has been demonstrated to have an impact on forager camp locations and affect residential strategies and mobility (Binford 1980; Plew 1985; Eastman 2011; Plew 2016; Hall et al. 2015). While multiple variables have been used to predict likelihood of archaeological site locations, the correlation between resource location and site location has not been extensively studied in southwestern Idaho, especially in the case of floristic resources. This project attempts to use ecological variables associated with floristic resources to model site distribution and observe if these variables have any visible impact on site distribution.

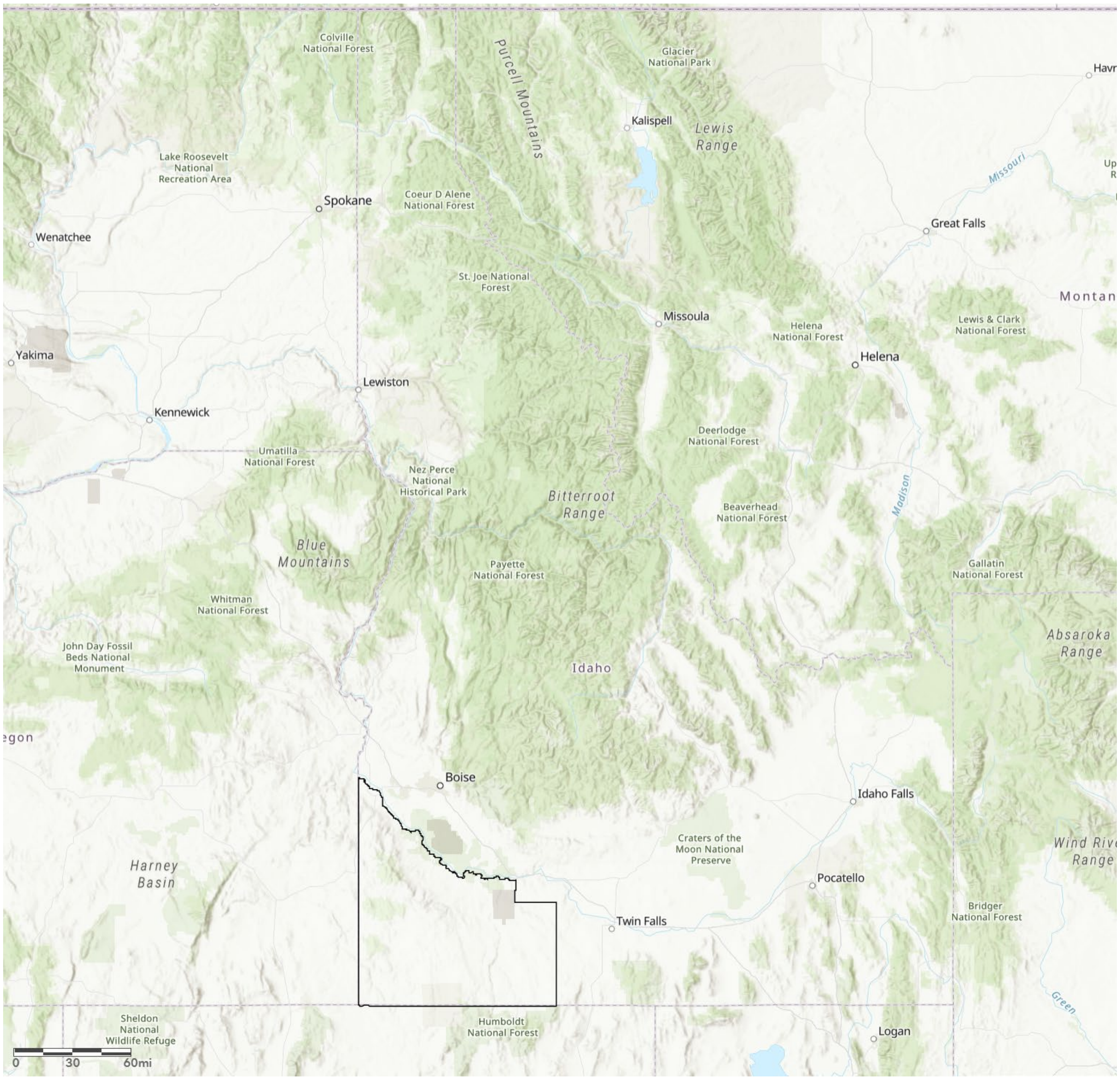
Though there are likely variable changes in environmental factors from the Archaic periods to modern day, general distribution patterns can be studied by looking at the ecological variables in which plant species proliferate. For instance, plant species can be correlated to preferred soil types as shown in such studies as the Web Soil Survey, provided by the United States Department of Agriculture. By modeling the relationships between the density of prehistoric archaeological sites and soil typology, a general, well-informed expectation for the floristic landscape around these sites can be inferred. While ancient climates and landscapes differ from current ones, soil type and the structure of related paleosols has been demonstrated to have a stability that can be studied to infer paleoclimatic and paleoenvironmental variables (Tabor and Myers 2015).

The correlation between soil typology and prehistoric site density has been demonstrated before, such as in the study of archaeological sensitivity models performed by the Bureau of Land Management (Ingbar and Wriston 2017); they learned that multiple variables in today's environment have demonstratable correlations to the likelihood of finding archaeological sites. However, most studies done in the study area combine soil analysis with a large host of other factors, looking more for overall sensitivity than possible explanatory reasoning behind *why* these variables may correlate to higher site densities or site sensitivities (Hall et al. 2015; Ingbar and Wriston 2017). That is not to say that these studies do not include such discussions; rather, that they are rarely the focus. Similarly, their correlation with the landscape variables are in need of a deeper exploration. By modeling human distribution through the distribution of material remains, and comparing the density of the spread of these archaeological sites against soil typology, and then further exploring the environment around sites by including other ecological factors directly tied to vegetation (groundwater drainage distance, elevation, and slope) (USDA 2021), this project analyzes not only what the vegetational environment around sites in the Owyhee County might look like, but why these sites may have been selected over other locations with similar access but primarily to other resource types – such as quarries, fisheries, and fauna.

Certain species of vegetation influence prey behavior, but other key resources provided necessary sources of food and raw material for constructive purposes. Theoretically, human-behavioral ecology suggests that resource patches and prey should be exploited with an energy cost/return frame of mind; assuming that foragers had knowledge of their landscape, these choices should be visible in the selection of camp location (Steward 2006; Smith and Winterhalder 1985) and the distribution of archaeological materials. By modeling the relationship between site density patterns and current ecological variables, which are associated with vegetation, patterns emerge that may suggest a bias in location selection by Archaic foragers. Considering another variable of what might have made specific locations attractive to Archaic foragers could assist archaeologists in probability modeling, research design, and could assist in the field when surveying for cultural materials. This is of particular use to federal agencies who are stewards of archaeological resources and who inventory large areas of land; identifying important resources and areas on the landscape that may be of note can help in making educated decisions regarding both possible resource locations and possible site usage for scientific study. The objective of this thesis is to draw attention to those variables, to suggest a greater attention paid to them, and to push for a greater awareness of environmental variables in archaeological modelling, surveying, reporting, and the subsequent studies of both the sites and the materials recovered.

## The Study Area

The ‘study area’ includes all lands located within the borders of the Owyhee County of Idaho (Figure 1). This area includes 19,940 square kilometers, including portions of the northern Great Basin area, and the Western Snake River Plain (Ingbar and Wriston 2017).



**Picture 1. Outline of Study Area, Owyhee County, Idaho. Graphics Presented in ArcGIS®. ArcGIS® is the Intellectual Property of Esri and is Used Herein Under License. Copyright © Esri, www.esri.com.**

## Current Conditions

Southwestern Idaho is a riparian and plains environment characterized primarily as a sagebrush steppe with the Owyhee Mountains in the northwestern portion, and is host to a diverse range of vegetation, soil types, weather patterns, and climates (Daubenmire 1969). On average throughout southwestern Idaho, summers are characterized by high aridity and high temperatures, while winters tend more towards increased moisture and dropping temperatures. Rainfall varies, reaching between approximately four to eighteen inches per year (NRCS 2021). Fluctuating temperatures and anthropogenic disturbances have changed the face of Southwestern Idaho between the Archaic periods to modern day; these are visible in botanically-identifiable changes in the range of vegetative species, groundwater ages determined through stable isotopic analyses, and perhaps in the identifiable behavior patterns of humans recovered in the archaeological record (Schlegel et al. 2009).

Modern data on the climate of Southwestern Idaho is available through several federal monitoring sites. Recent studies have also been performed on the area's various riparian, river, and plains, and sagebrush steppe ecosystems (Swanson and Muto 1975; Burman, Wright and Jensen 1975; Sohrabi, Ryu, Abatzoglou and Tracy 2013). Current extreme droughts and water levels are of particular interest in recent studies in Southern Idaho (Sohrabi, Ryu, Abatzoglou and Tracy 2013). Other areas of note are biodiversity of vegetation patches, the rate of invasion by non-native species, and how climate change over the past century has affected both the growth of vegetation, and the populations of animals that live in the area (Bradley 2009).

Southwestern Idaho hosts a great amount of biodiversity today. Aquatic species such as freshwater mollusks (*Mollusca sp.*), Pacific salmon and trout (*Oncorhynchus*), and sculpin (*Cottus sp.*) are found throughout (Owyhee Watershed Council 2004). Several species of ungulate inhabit the region, including sheep (*Ovis*), pronghorn (*Antilocapra americana*), and deer species (*Cervidae*). Bird species are also diverse, including populations of raptors, grouse, and ducks (Owyhee Watershed Council 2004). Riparian areas alone are host to approximately thirty different species of amphibians and reptiles (Owyhee Watershed Council 2004), and are critical to the amount of biodiversity in the area, with important habitat and resources that make up parts of the diet for a high amount of varying fauna. They also provide important access to water and water-containing vegetation for the fauna in the area, especially since a high percentage of rivers and streams throughout the Owyhee area are intermittent water sources (Moseley 1999).

The flora throughout Southwestern Idaho is diverse, and can be broken up into separate ecoregions. While the greater portion of Southwestern Idaho can be classified as a sagebrush steppe, the full system includes a series of plains, bottomlands, semiarid foothills, alpine biomes, agricultural landscapes, and desert environments (McGrath et al. 2002). The most floristic community is the steppe, which includes species such as sagebrush (*Artemisia tridentata*), needle grasses (*Nassella pulchra*), and rabbit brush (*Chrysothamnus*) (McGrath et al. 2002). Other common species of vegetation include common Juniper (*Juniperus occidentalis*), various species of willow (*Salix sp.*), and bulrush (*Typha sp.*) (McGrath et al. 2002).

## Archaic Conditions and Paleoenvironment

The paleoclimate and Archaic cultural structure of Southwestern Idaho have been studied through both ethnographic documentation and several ecological estimation techniques, including coring, tree-ring evaluation, pollen data, and carbon testing (Miller and Wigand 1994). Environmentally speaking, the Archaic periods in southwestern Idaho went through several shifts regarding temperature and overall climate, impacting the vegetation of the landscape. Water availability and drought were likely high drivers of the environmental state of the land. Fire also has been estimated to have had high impacts, driven both by climate change and potentially anthropogenic manipulation of the Archaic landscape (Miller and Wigand 1994; Nelson and Pierce 2010; Arkush and Arkush 2021).

Data throughout the Archaic periods suggest that large portions of the Owyhee County area were sagebrush-dominated with periods of fluctuation dependent on climate change. Throughout the pre-Contact timetable, it is likely that one of the greatest recent shifts within the greater northern Great Basin area – encompassing the study zone – occurred approximately 11 KYA – 12.5 KYA, with deglaciation processes greatly impacting water sources, landscape formations, and overall ranges of plant communities (Miller and Wigand 1994). Since then, repeated cycles of heating and cooling of the climate have further changed vegetation ranges, with these changes progressing and regressing with the aridity levels of the environment (Miller and Wigand 1994; Nelson and Pierce 2010).

Studies done in areas throughout the ecologically-similar zones of the greater Great Basin area suggest revolving periods of aridity and higher temperatures from 12 KYA, with an enduring period of aridity and heat at approximately 9-5 KYA being termed Holocene Climatic Optimum; this period is associated with a shift to desert scrub and smaller sagebrush varietals, as well as decreases in the ranges of larger vegetation such as common Juniper (Miller and Wigand 1994; Nelson and Pierce 2010). Studies on pollen have suggested a rapid increase in moisture in some sections of the study area, while temperatures remained relatively warm; this may have led to increases in the ranges of plants such as Juniper and Wyoming Big Sagebrush, as well as other vegetation that demanded higher levels of moisture (Miller and Wigand 1994). Interestingly, studies in the greater Great Basin area suggest that these increases in moisture may have also led to increases in fire-prone areas, with higher levels of available fire fuel (Nelson and Pierce 2010). Mesic conditions appear to have dominated several ecological zones within the study area until approximately 1.9 KYA; grasses that flourished with higher moisture levels and higher overall water tables appear to have been relatively widespread in the area between 4 KYA – 2 KYA (Miller and Wigand 1994). Throughout these periods, perennial and intermittent water sources provided moisture to vegetation that required it, while grass and forb levels fluctuated. Sagebrush still largely dominated the landscape, but the size and species of the sagebrush shifted with available water (Miller and Wigand 1994).

Following this mesic period came another period of high aridity and increasing temperatures with the end of the neoglacial, with an overall decline of water levels throughout the Great Basin. Aridity appears to have followed a massive increase between approximately 1.9 KYA and 1 KYA, with the centuries following showing fluctuating levels of drought that had multiple peaks (Miller and Wigand 1994). This period, ranging throughout what is termed the Late Archaic, was classified by continued sagebrush ranges and desert grass expansion up until the end of the Late Archaic at approximately 250 YBP (Miller and Wigand 1994; Plew 2016).

## Previous Research

Compilations have been assembled on the archaeology, ethnographic setting, and overall state of anthropology in Southwestern Idaho and its surrounding areas, which has made approaching this subject more streamlined. Butler's *Guide to Understanding Idaho Archaeology* (1968, 1978), Plew's *An Introduction to the Archaeology of Southern Idaho* (1986), and Meatte's *Prehistory of the Western Snake River Basin* (1990), have all offered a comprehensive overview of Western Snake River Plain archaeology and prehistory and shaped the background knowledge required for this project. At the time of writing, the most comprehensive of the Snake River Plain syntheses is Plew's most recent edition of *The Archaeology of the Snake River Plain* (2016).

While studies have been done on the use of vegetation in the greater Great Basin area, currently, the Owyhee area is lacking besides in archaeological reports that document the items themselves. These reports often include cultural resource management work, including inventory reporting and documentation of historical properties, much of which has extensively covered some portions of the area and made the documentation and reporting of archaeological materials possible. Cultural resource management efforts in the area have also been collected for the purpose of reporting, with the Bureau of Land Management's 2021 Inventory Report containing approximately 7,499 documented sites (Gruhn 1961; Bettinger 1993; Plager, Plew and Willson 2006; Plew 2016; BLM 2021). In the Northern Great Basin, however, multiple studies have explored the ways that Archaic foragers used plant resources and moved through the landscape as related to resources and resource acquisition (Couture, Ricks and Housley 1986; Fowler 1986; Fowler 1990; Connolly, Fowler and Cannon 1998; McGuire and Hildebrandt 2005; Connolly et al. 2016; Arkush and Arkush 2021).

Regarding Archaic foragers in the Southwestern Idaho area themselves, the diet-breadth and mobility of Archaic foragers in Owyhee County does appear to shift over the course of the Archaic periods. Mobility patterns over the Archaic periods are highly variable, with foragers often displaying high rates of mobility suggested by both archaeological and ethnographic evidence (Lowie 1909; Lowie 1924; Harris 1940; Steward 1941; Eastman 2011) that shifted patterns based on resource acquisition and seasonality

(Plew 1985; Plew 2016). However, some sites suggest later decreases in mobility, with higher rates of sedentism and residences displayed by storage practices and the remains of semi-permanent housing structures and bases (Eastman 2011). This was not the only mobility strategy in the Late Archaic; some sites still display evidence of higher residential mobility patterns and sparse populations, with variability shifting by years, groups, purposes of resource acquisition, and seasonality that impacted the likelihood of resource acquisition (Lowie 1924; Plew 1985; Eastman 2011).

Diet-breadth in Archaic foraging communities experienced shifts over the three periods, but displayed common staples and little marked resource intensification throughout the Archaic. Early and continuing staples include medium- and large-bodied ungulates, including deer, elk, sheep, and bison (Fowler 1986; Plew 2009). Rabbits, birds, small mammals, and fish also appear to have been included in the diet-breadth, with increasing frequency in the Middle Archaic. The Late Archaic is characterized by an increasing ubiquity in the taking of small mammals, and a high abundance relative to ubiquity of salmon and cervid remains (Fowler 1986; Plew 2009). Knowing the general diet-breadth throughout the Archaic helps to form the general background for why certain edible resources may have been of use.

The inclusion of plants in the Archaic diet-breadth is less known, perhaps largely due to a low frequency of vegetation remains found within a cultural context. Of most perishable remains found in archaeological sites throughout Southwestern Idaho, a large portion were primarily used for construction (Plew 2007). However, ethnographies and some archaeological data suggest some common food plants throughout the Archaic periods, including the fluctuating usage of hackberry (*Celtis occidentalis*), the berries of

Juniper, camas (*Camassia*), bulrush (*Typha latifolia*), and cattail (*Typha domingensis*) (Fowler 1986). A further discussion of the importance of some vegetation is discussed furthermore in the Discussion section of this project.

### Ethnographic and Ethnobotanical Work in the Study Area

Several ethnographies exist on the peoples living in the study area, including the White Knife Shoshone, the Northern Paiute, and the Shoshone-Bannock tribes (Lowie 1909; Lowie 1924; Harris 1940; Steward 1941; Steward 1943; Liljeblad 1957; Murphy and Murphy 2019). Although ethnobotanical observations are routinely made in ethnographic works, few studies in Southwestern Idaho have been conducted with ethnobotany as the focus (Fowler 1986). However, references on the vegetation use by some tribes in immediate surrounding areas have been compiled, giving a glimpse into how the vegetation throughout the Owyhee area may have been used by forager groups. Of importance are those that reference forager knowledge of the landscape (Stoffle et al. 1990*;* Turner 2014). Other works employ archaeobotany to fortify these observations, including foraging methods, foraging behaviors, and the chronology of the uses of different vegetational resources (Fowler 1990; Connolly, Fowler and Cannon 1998; Connolly et al. 2016; Arkush and Arkush 2021)

These compilations provide a foundation for our understanding of plant uses in Southwestern Idaho and the greater Great Basin area, including dietary, medicinal, hunting, and construction uses. If the hypothesis that forager camp location is related to plant resource location is accurate, the forager groups had prior knowledge of the landscape, its resources, and their uses. The above reports all suggest that foragers were highly knowledgeable of their landscape, knew which plants could be used, and knew something of the landscape groundcover in the areas they settled. It should be noted that Stewart (1951) suggested shifts in vegetation groundcover due to changes in habitat burning, however, and that forager control of some other vegetational species is suggested (Arkush and Arkush 2021). Admittedly, there is likely some ranging of vegetation due to anthropogenic influence that is invisible in ecological factors; however, this does not negate the value of studying non-human-involved vegetation ranges.

## Cultural Past of Southwestern Idaho

This thesis focuses on the Archaic period of human population in Owyhee County, Southwestern Idaho. Amongst current Idaho archaeologists, there are generally three accepted time periods of the Archaic: the Early Archaic (7000 – 5000 YBP), the Middle Archaic (5000 – 1000 YBP), and the Late Archaic (1000 YBP until European contact, considered hereafter as approximately 250 YBP), as described by Plew (2016). Other chronologies exist and have been discussed (Butler 1968; Butler 1978). However, for the purpose of this project, the chronological terminology described above by Plew (2016) will be used.

Studies throughout the Owyhee area, as well as the general northern Great Basin area, have had some focus on vegetation recovered from sites or vegetation of use to indigenous groups in the area; however, these studies in the area are minimal (Fowler 1990; Metcalfe and Barlow 1992; Connolly, Fowler, and Cannon 1998; Connolly 2013; Johnson 2020). Plew (2007) has suggested that some of the cause for a lack of reference to vegetation recovered from sites and further studied is due to a lack of systematic searching for such remains.

## Archaeological Modeling

Recent advancements in programs such as ESRI's ArcGIS® have made map-based analyses easier and more approachable (Davies, Romanowska, Harris and Crabtree 2019). Geographic Information Systems ('GIS') provides a host of tools that can be used to interpret site density through the modeling of 'hotspot' locations and interactions of features. The program has been used by archaeologists globally to map points and look for patterns in site data (Mehrer and Wescott 2005; Tennant 2007; Davis 2007; Ingbar and Wriston 2017). ArcGIS® modeling has been used in the Owyhee County area before by the Bureau of Land Management, to create a model that can help predict possible site locations. Multiple environmental factors were used to determine how sensitive areas were for archaeological remains; the higher the sensitivity, the more likelihood for archaeological sites (Ingbar and Wriston 2017). Such approaches have also been used to build similar predictive models, as well as to model relationships between variables and work with existing study results to adapt to new and changing datasets (Hall et al. 2015). The model mentioned here, the 'Owyhee Land Exchange' model, combined ecological variables in the Owyhee county area to create a sensitivity model useful in determining likelihood for areas with resources potentially eligible for the National Register of Historic Places (Hall et al. 2015).

Modeling variable relationships using ArcGIS® has shown the existence of patterns in archaeological site locations; 'hotspots' of archaeological resources have been identified, and, in similar studies, have suggested that these clusters of resources and camp locations have some correlation to ecological variables (Hall et al. 2015; Ingbar and Wriston 2017). Pulling from these studies, and observing the information presented throughout this chapter, this thesis hypothesizes that forager camp locations were not random, but were instead most likely selected on the basis of multiple factors beneficial to the group – and that a driving factor was potentially the proximity to usable resources, with this study focused on floristic resources. If true, this selection preference will be visible in the locations of clusters of sites modeled in ArcGIS®.

Though floristic groundcover cannot presently be accurately modeled due to a lack of fine-scale paleoenvironmental data, the past groundcover can be predicted by looking for a relationship between site density and soil typology, noted by the USDA as a variable that can be used to estimate environmental contexts including botanicals. The environment around sites can be further typed by modeling the general trend of the relationships between site densities and ecological variables most closely correlated to plant type: proximity to groundwater sources, elevation, and slope (McGrath et al. 2002). Despite changes in paleoclimate, these variables tend to remain somewhat stable over time (McGrath et al. 2002). If general trends are identified, an important question is whether the places where these variables intersect show any correlation between the densities of archaeological site locations and any specific plant types. If so, it is expected that the relationship can be analyzed from the standpoint of the theoretical framework of Human Behavioral Ecology.

# CHAPTER 2: THEORETICAL BACKGROUND AND HYPOTHESIS

Human Behavioral Ecology (HBE) explains human behavior through continual adaptation and use of the environment, and suggests that individuals will rely on information regarding their environment to make the choices that best suit their own fitness (Bettinger 1977). To explain human choice in an environment, HBE uses a variety of models, which typically explain some form of choice measured by a costs and benefits analysis (Steward 2006). These models are intended to be frameworks for the creation of hypotheses, which can then be tested in the field or against data and used to further and provide some explanatory framework for observations and questions (Smith and Winterhalder 1985).

Other theoretical frameworks were considered for this project, primarily including the concept of cultural ecology – a method of studying human adaptations as related to their environments, with emphasis given to cultural adaptation (Smith and Winterhalder 1985; Steward 2006). It was determined through the later ethnobotanical analysis that an explanatory framework looking at cultural adaptations could be useful for possible other, future studies, as some differences in plant use and landscape use are documented throughout different groups in the area (Fowler 1989). However, for the purpose of this project, it was determined that an HBE model-based framework was best to explain active choice on an open landscape and when looking more at general usage of plants and overall choices made in regards to camp selection processes and potential plant usage.

HBE models operate as mathematical principles above all else. One, Optimal Foraging Theory (OFT), is a framework that assumes economic rationality of human decision-making. Given all the knowledge of their environment, OFT suggests that individuals will seek to maximize returns and minimize costs in foraging behaviors. The specific models within the branches of OFT can be used for their predictive factors to create a framework in which an hypothesis may be generated. If the model used predicts that one foraging choice is more 'beneficial' than the other, then this might be used to form a testable hypothesis. According to OFT, an individual should always choose to maximize their own potential return given all factors remain equal besides the net return rate of the items being foraged. If a resource of net return lower than other resources is being exploited, it may suggest some other change in the factors. Groups or individuals would travel longer distances to exploit high-value resources due to their higher rate of return, as suggested by Metcalfe and Barlow (1992). An exploitation of a lower-return resource may suggest that the distance and access to this resource were low and easy enough to warrant its exploitation over a different source.

The model of Central Place Foraging is meant to be used as a framework in which hypotheses about settlement patterns in relation to the environment might be constructed, given variabilities in resource values as suggested by OFT (Smith and Winterhalder 1985). Unlike cultural ecology, it is not concerned primarily with adaptations related to the environment; however, it does concern these adaptations. It is concerned with optimality and choice. Specifically, as with other HBE models, it suggests that humans should adapt to their environment, and should use the knowledge available to them to make the choices that would benefit them the most. That is, when returning to a 'base camp', including longterm encampments and winter encampments, foragers are likely to travel larger distances to exploit the resources that are most profitable. However, they are less likely to travel large distances to exploit resources of lower profitability (Metcalfe and Barlow 1992).

This is useful in understanding the importance of ecological variables due to the varying values of ‘importance’ given to resources located throughout the Owyhee area. If a resource is ‘lower-ranked’, Metcalfe and Barlow (1992) suggest that a central place camp is more likely to be located near these patches, as the caloric expense of exploiting such patches would not warrant the trip otherwise. They further suggest that camps within 25 kilometers of an exploitable resource are also more likely to have higher quantities of archaeobotanical material, due to field processing costs and the costs of returning to camps in a terrain with varying elevations such as some sections of Owyhee County.

Prehistoric studies utilizing Optimal-Foraging Theory and Patch-Choice Modeling have also suggested dietary and resource shifts and stabilities in Southern Idaho. Following the exploitation of both stable patches and resource patches that shifted over time, choices are visible through the modeling of forager gathering and processing activities. Studies, such as Yeates’ (2019) project in observing five occupations at Birch Creek Rockshelters, have used OFT and other bodies of HBE theory to suggest shifting prey values and the importance of carrying capacity for Archaic foragers; this particular study also discusses visible correlations between forager resource processing intensity, carrying capacity as related to processing and foraging distance, and environmental conditions in Idaho (Yeates 2019). Other studies in similar arid and semi-arid environments (O’Connell and Hawkes 1981; Pate 1986; Soldati et al. 2017) have determined the importance and impact of resource acquisition on group settlement and foraging strategy, suggesting the critical nature of plant resource acquisition particularly in times when temperatures rise and drought increases.

These previous studies have suggested several key points: that forager camp location may be tied to ecological variables, and that forager behavior may be altered by resources available in the landscape. Similarly, resource acquisition may be a driving force in the choices behind Archaic settlement patterns. However, the extent to which botanical resources impact forager decisions regarding settlement and temporary camp locations is not well studied in the Southwestern Idaho area. Other Great Basin ethnographic records and ethnobotanical studies in other semi-arid environments suggest that botanical resources are critical in changing environmental landscapes, or when the predictability of resource availability is low (O'Connell and Hawkes 1981; Pate 1986; Turner 2014; Soldati et al. 2017). This may be related to a lack of vegetation data available for the area. Vegetation data provided for the Owyhee County area are far from fine-grained, and only reflect current conditions. There is currently a lack of paleoecological studies in the area regarding how – or, if – vegetation has any impact on Archaic forager settlement and temporary camp locations. This is due largely to an overall lack of a single, comprehensive dataset that can be used for these observations.

Where vegetational data is not available, ecological variables that do not experience rapid shifts in their compositions can be used as proxies to discuss suitable habitat for various flora, including habitats that would have likely been suitable for correlated flora throughout the Archaic period. At the very least, this approach can open up the long-overdue discussion on the impacts of vegetation on forager choice in the Archaic Northern Great Basin environment. If site densities and spreads are influenced by these variables, one reason may be related to the ways in which these variables uniquely interact to determine the plant resources available on a landscape. In theory, pulling from the works above, the combination of these studies would suggest that forager camps during Archaic periods of increased temperatures have a higher likelihood of being located near plant resources than too far removed from patches of plant resources.

This project hypothesizes that this strategy will be visible when ecological variables are modeled in their relation to densities of site locations; if settlement patterns are at all influenced by usable flora, then, there should be some visible form of preference when patches of density are mapped in relation to soil types. If a preference exists, trends of relationships between these site 'hotspots' and soil, hydrology, slope, and elevation – all related to habitat selection in plants – can be modeled, and used to narrow the likelihood of sites to be located in a given environment. If the hypothesis that usable flora influence site location has merit, plants found in the zones with the greatest number of archaeological sites should have demonstrated ethnographic uses.

# CHAPTER 3: METHODS AND MATERIALS

To determine ecological variables that influence floristic environments, expected variables were studied by plotting the locations of archaeological sites and archaeological inventory reports on a map of the Owyhee area, then overlaying these points on top of boundaries that are correlated to elevation, slope percentage, and soil type. Visual analysis was conducted for the frequencies of sites within these barriers and zones, and an average analysis of density using Esri's ArcGIS®'s average Kernel Density analysis tool. Data in this report was collected from the United States Geological Survey (hereafter referred to as 'USGS'), the United States Census Bureau, the Bureau of Land Management (hereafter referred to as 'BLM'), and the United States Department of Agriculture (hereafter referred to as 'USDA'). Information on exact locations of cultural resources were collected from the BLM State Office's 2021 GIS datasets, as were the locations of past archaeological surveys throughout the Owyhee County. Variables collected from these sites were weighted through analysis in ESRI's ArcGIS® Pro program, to test their relationship on densities of site location.

All density analyses were done using ArcGIS® Pro and IBM's Statistics Package for the Social Sciences (SPSS). ArcGIS® Pro uses feature points and multiple layers of data to analyze geospatial phenomena. To properly analyze the raw data collected from the BLM, the feature classes of cultural resources and cultural inventory survey work were converted into separate point classes. These two variables were known as

‘Resources’ – identified archaeological sites with cultural materials – and ‘Investigations’ – ranges of archaeological surveys in the Owyhee County area.

The two point classes were weighted to determine density of sites, using a Kernel Density analysis and a visual analysis of site scatter. Kernel analyses take selected points and weigh them, according to patterns identified in the algorithm. If an analysis finds a pattern in the data, it gives it a higher score, which is represented by a visual ‘map’ of variabilities in density. The Kernel analysis in this thesis used the color purple as an identifier, with pale purple suggesting no pattern, and dark purple suggesting a statistically-significant pattern – these were chosen for their visibility on the landscape, and correlate to ranks determined by a number between 0 and 10, separated in set increments. For the Resources point set, pattern correlation rankings ranged from less than or equal to 0.000001 to approximately 4.18. Significance of soil areas were selected to be correlated between 3.757511 and 4.175011 as these numbers indicated a higher than average value for point density. The Kernel Density Analysis was performed using an Equal Interval due to the non-normal distribution of the data.

Points were selected for their relevance to the research question. Only points within the specified study area were kept. Likewise, only points which specified their cultural materials as prehistoric were included in the analysis; post-Contact sites were excluded from the analysis. This was done through ArcGIS®’s ‘attribute table’ tab, which allows a user to sort variables by attribute and keep or remove any points within the feature that are unneeded. No analyses were done using post-Contact-only site data.

Other variable sets within the analysis were obtained from outside the BLM, primarily through the USDA. The USDA soil survey was used for this analysis, and the soil survey identifier used was ID675. ID675 divides Owyhee County into classifiable ecoregions, each with its own unique marker known as a 'MUSYM' code, otherwise referred to as a 'Map Unit Symbol' code. Each MUSYM code can be used to identify the associated attributes of a bordered spatial area, which can then be used with the USDA's guide to identify important factors of each ecoregion. The soil report includes slope, soil type, soil density, associated vegetation, and elevation of the range (USDA). These factors were used to tie soil types to their associated plant communities, which were then researched for known and documented ethnographic uses.

Ethnographies were obtained from multiple sources (Lowie 1909; Lowie 1924; Harris 1940; Steward 1941; Steward 1943; Liljeblad 1957; Fowler 1990; Connolly, Fowler and Cannon 1998; Connolly et al. 2016; Plew 2016; Murphy and Murphy 2019). Information on the Northern Paiute was obtained both in physical format through Boise State University's Albertson's Library, as well as eHRAF online. Information about general plant usage in the northern Great Basin was obtained in physical copy through Boise State University's Albertson's Library, through eHRAF, and through the Albertson's Library's digital database.

## Variables Included in the Analysis

Multiple key variables were included in the analysis. Environmental dataset variables included in this project were:

### Elevation

Elevation is defined as the point's place in *x* amount of meters above sea level. Elevation values were obtained using the Digital Elevation Model, or DEM, available from the USGS online database.

### Slope

Slope is the degree or percentage at which a landform creates an incline. The slope model used in this project was calculated in using ArcGIS® Pro's Slope tool and a raster from the National Elevation Dataset. Within symbology, the slope model was set to Standard Deviation for visibility of data. Slope values for soil typologies were obtained from the USDA's ID675 Soil Survey. All slopes were calculated in percentages.

### Soil typology

Soil typologies were defined through the ID675 resource from the National Soil Survey. Soil types were determined through the indications of the MUSYM numbers associated with each given area, then compared against the USDA's soil report on individual soil complexes within the Owyhee County (USDA and NRCS).

### Archaeological Resources

Archaeological resources are defined as any point on the map at which cultural materials were discovered. Cultural materials included in this project are regarded as 'prehistoric'; all materials listed as 'historic' were controlled for. The database of archaeological resources in the Owyhee County was received from the Bureau of Land Management as a set of features. These features were then converted to points, using ArcGIS® Pro's 'Feature to Point' tool, for better visualization and for this analysis as plotted in relation to the above variables.

### Inventory

Inventory data includes the spread of area on which archaeological inventory expeditions ('surveys') were carried out; the data obtained from this layer included the full spatial extent of each inventory. Inventory data was included as a control variable, to check for sampling bias. Inventory data was also received from the Bureau of Land Management as a set of features, and converted to individual points using ArcGIS® Pro's 'Feature to Point' tool.

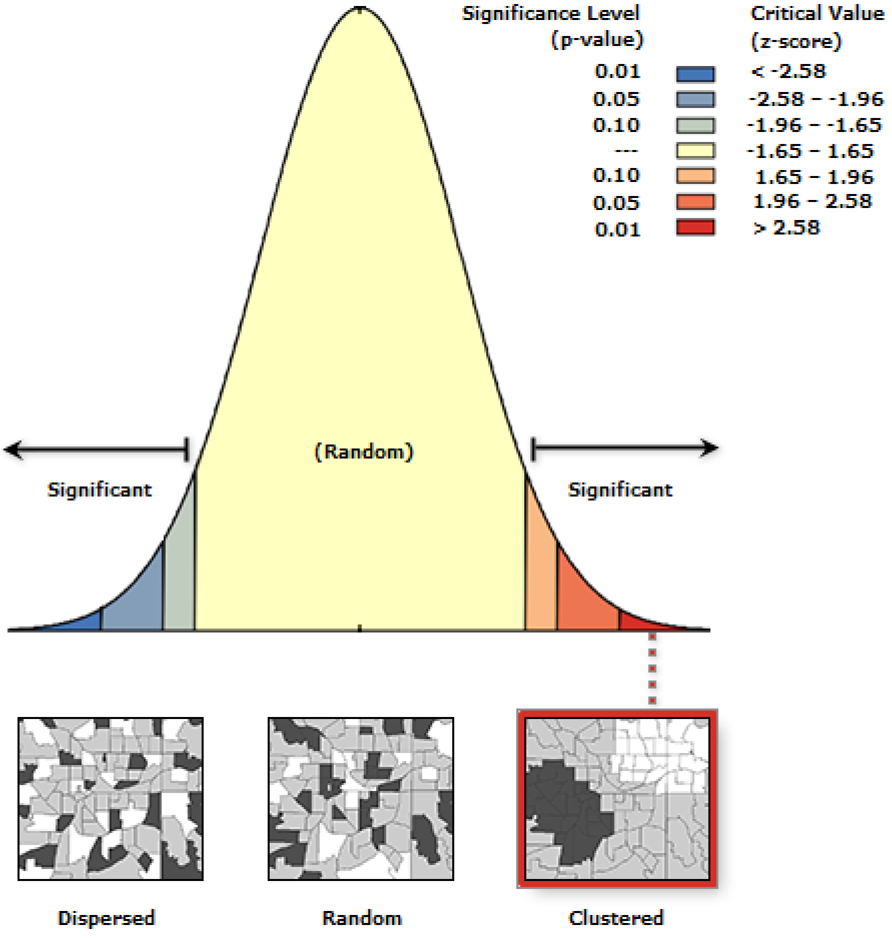
### Distance to Nearest Water Source

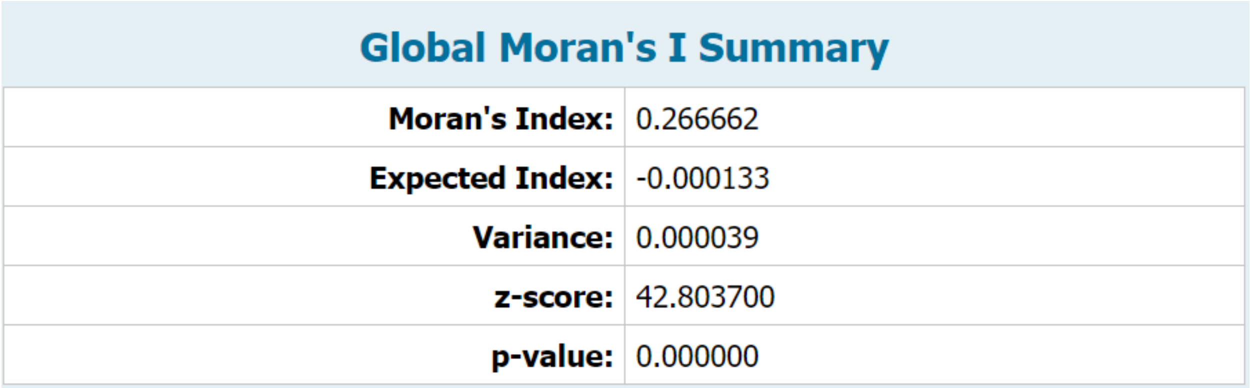
Water sources were defined through the USGS National Hydrology Dataset, including all flowing water sources that are either intermittent, ephemeral, or perennial in the Owyhee county area. The distance from archaeological resources to their nearest water source determined through ArcGIS® Pro's 'Near' feature, which draws a 'shortest' distance between two feature points. Three proximities were defined: 500 meters, 250 meters, and 100 meters. Only 'natural' water sources were included; human-made water sources in the USGS National Hydrology Dataset, including pipelines, conduits, canals, connections, and artificial paths were all removed from the dataset so as to filter drainages that result of recent anthropogenic actions or disturbances.

# CHAPTER 4: RESULTS

The results of this project were handled in four parts. An analysis of site density patterns compared to the ID675 soil report suggests that two soils in Owyhee County are highly correlated with archaeological sites: MUSYM 206, and MUSYM 162, consistent with an earlier report on the impact of ecological variables on the sensitivity of an area for cultural materials (Ingbar & Wriston 2017). Following this, the associations between these two soil types and groundcover types are discussed; five other soil types with visible correlation to site density are included as well (MUSYM 6, MUSYM 35, MUSYM 45, MUSYM 81, MUSYM 101, and MUSYM 124), with Kernel density numbers of statistical significance occurring within at least 25% of the soil type's barriers. Association with water sources is discussed next; a distance analysis suggested a high correlation between distance to drainages and site likelihood. Finally, the slope and elevation appear to correlate with site density, with site clusters located around low-medium slope.

An initial report on the correlation of site clusters to ecological variables was also run, to determine the possibility that the scatter of sites on the landscape followed a random pattern and lacked true clustering. Using a Global Moran's I spatial autocorrelation analysis available in ArcGIS® Pro's Spatial Analyst Toolbox, a z-score of 42.8037 and a p-value of 0.0000 suggested that cluster location had a <1% chance at being completely random within the special scale (Figure 2). It must be mentioned that a possible cause for the appearance of data is not completely uncoupled from sampling bias; the data presented represents only what has currently been discovered. These results may change in subsequent studies; however, this analysis presents what was currently available as of the 2021 inventory report (BLM 2021).





**Global Moran's I Summary**

| | |
|---|---|
| **Moran's Index:** | 0.266662 |
| **Expected Index:** | -0.000133 |
| **Variance:** | 0.000039 |
| **z-score:** | 42.803700 |
| **p-value:** | 0.000000 |

**Figure 1. Global Moran's I Spatial Analysis of Material Distribution**

## Soil Type Association

Soils MUSYM 162 and MUSYM 206 displayed an unusually high number of archaeological sites when compared to the rest of the Owyhee County area. Points and the original resource map were individually evaluated to ascertain likelihood that soil correlations were due to spilling of kernel densities across lines, and adjusted accordingly. Site densities ranged from an absolute minimum of 0.0 to an absolute maximum of 4.18; site density mean was 0.20, with a standard deviation of 0.36. Density points of 3.50 and above were solely found in MUSYM 162 and MUSYM 206, with the highest point of site density (4.04) in the center of MUSYM 206 (Figures 2, 3a, and 3b).

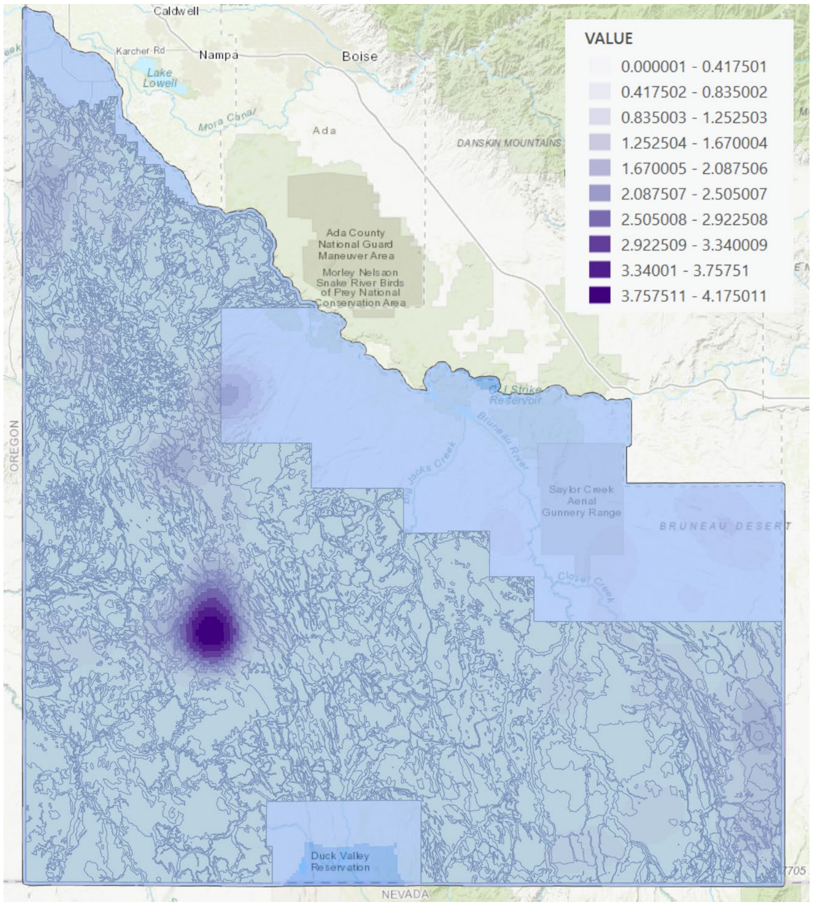
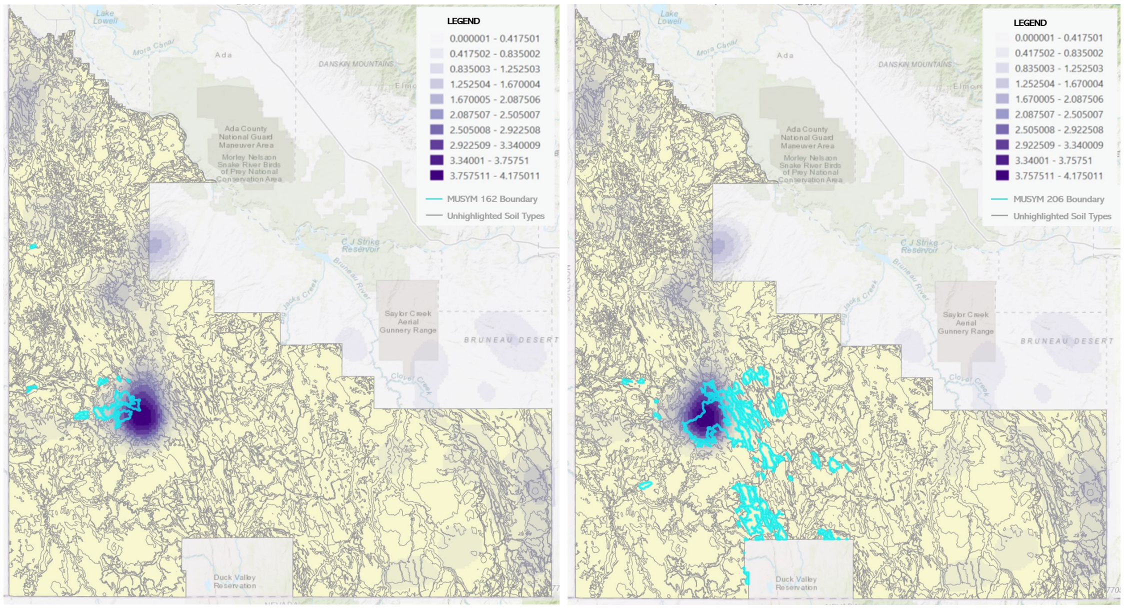


**Figure 2.** **Kernel Analysis of Density of Prehistoric Cultural Resources**



**Figures 3a and 3b. MUSYM 162 and MUSYM 206, Respectively, on the Kernel Analysis of Cultural Resources**

There is, of course, the possibility of sampling bias due to inventory locations; a higher frequency of resources may be discovered due to a higher frequency of archaeological survey work done in the area. To control for this, the analysis was compared to inventory extent data within the Owyhee County area. The highest data clusters for survey work were farther northwest and east than the highest data clusters for resources; though loosely correlated, the highest frequency of inventory data was associated with MUSYM 89 (Figure 3). An ArcGIS® map was created with an overlay of cultural resources (purple) and inventory (pink) to better visualize the relationship between the two (Figure 4). While there is overlap – including with MUSYM 162 and 206 – the areas of significance are not strongly spatially-correlated and the locations of inventory reports do not solely explain the areas of significance.

It should also be noted that, as seen in Figures 3a and 3b, there are some areas on the map with the soil types associated with cultural materials that do not appear to have high frequencies of deposits. However, looking at the extent of the surveys themselves, the areas without high frequencies of deposits can be seen to have minimal inventory reports performed, leading to a potential for sampling bias. This does not imply that there *will* be cultural materials in these locations; however, they cannot be confirmed either to contain or not contain the materials, due to this lack of sampling. If inventory reports are performed in these locations in the future, the data in this report can be updated to reflect them.

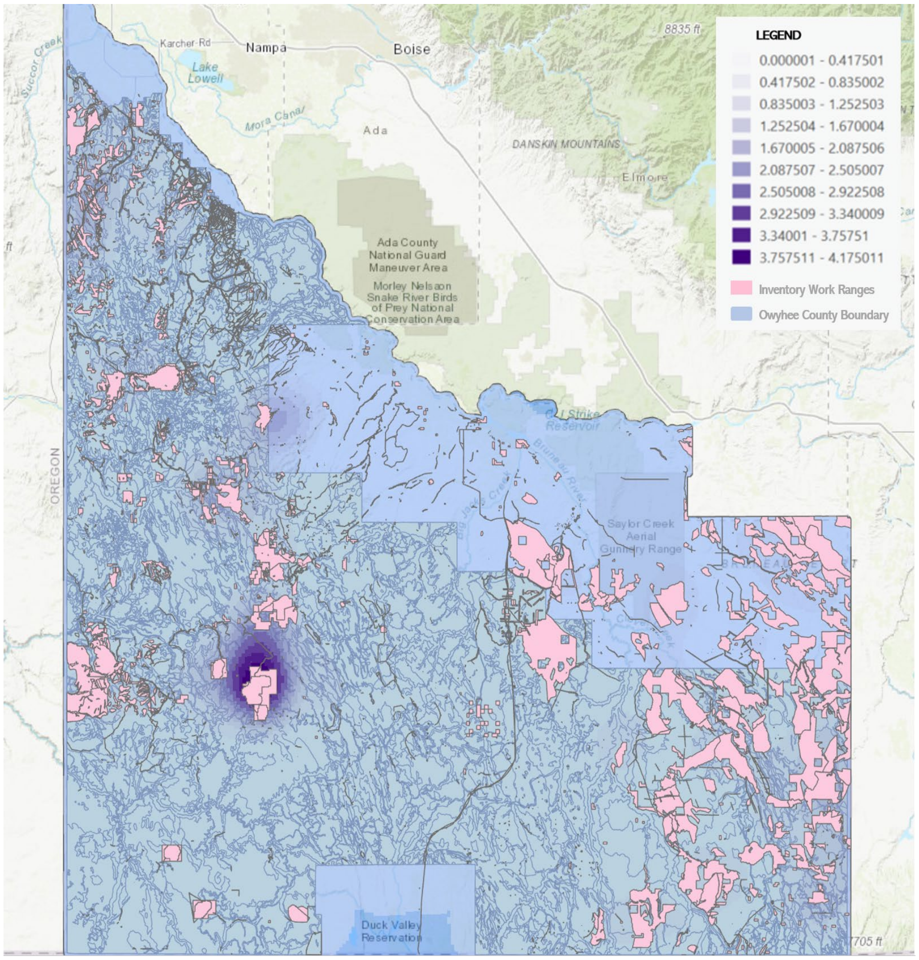


**Figure 4.** **Comparison of BLM Archaeological surveys (Pink) vs BLM-discovered cultural materials (Purple)**

## Soil Cluster Vegetation Association

The soil types associated most heavily with archaeological site locations were determined to be MUSYM 206 and MUSYM 162. Following this, six other soil types were associated with clusters of archaeological sites: MUSYM 6, MUSYM 35, MUSYM 45, MUSYM 81, MUSYM 101, and MUSYM 124. Each of these soils is associated with a ‘complex’ type, including slope averages, soil-type averages, and endemic vegetation highly correlated with the soil. Soil types in the seven identified ‘hot spots’ of archaeological activity include clay, claypan, stony soil, loams, and loam ranges. Slopes mostly range between 1 – 15%, with the exception of MUSYM 124 (Table 1).

**Table 1. Soil Types, Classifications, and Associated Endemic Vegetation Covers**

| MUSYM Indicator | Complex and Slopes | Soil Type(s) | Associated Endemic Vegetation |
|---|---|---|---|
| MUSYM 206 | Wickahoney-Wagonbox-Rubbleland complex, 1 to 8% slopes | Clayey soil | Idaho fescue, alkali sagebrush, low sagebrush, bluebunch wheatgrass, needlegrass sp., perennial grasses, perennial forbs, phlox, bottlebrush squirrel tail (Hall et al. 2015; USDA 2021) |
| MUSYM 162 | Squawcreek-Avtable-Wagonbox complex, 1 to 15% slopes | Claypan/stony soil | Idaho fescue, low sagebrush, big sagebrush, antelope bitterbrush, bluebunch wheatgrass, common western juniper, phlox, perennial grasses, perennial forbs (Hall et al. 2015; USDA 2021) |
| MUSYM 6 | Arbidge-Heckison Association, 2 to 15% slopes | Loam | Wyoming big sagebrush, Thurber needlegrass, bluebunch wheatgrass, western wheatgrass, foxtail wheatgrass, perennial forbs, perennial grasses, bottlebrush squirrel tail, phlox (Hall et |

| | | | |
|---|---|---|---|
| | | | al. 2015; USDA 2021) |
| MUSYM 35 | Catchell-Longcreek complex, 3 to 25% slopes | Loam | Low sagebrush, bluebunch wheatgrass, Idaho fescue, basin big sagebrush, bluegrass, basin wildrye (Hall et al. 2015; USDA 2021) |
| MUSYM 45 | Deunah-Yatahoney-Lostvalley Complex, 1 to 10% slopes | Clayey soil | Alkali sagebrush, Idaho fescue, low sagebrush, Basin big sagebrush, phlox, needlegrass sp., longleaf hawksbeard, perennial forbs (Hall et al. 2015; USDA 2021) |
| MUSYM 81 | Heckison-Bigflat silt loams, 1 to 10% slopes | Loam | Wyoming big sagebrush, bluebunch wheatgrass, bottlebrush squirrel tail, western wheatgrass, phlox, foxtail wheatgrass, perennial forbs (Hall et al. 2015; USDA 2021) |
| MUSYM 101 | Merlin-Lostvalley-Chayson complex, 1 to 12% slopes | Claypan/loam range | Low sagebrush, fuzzy sagebrush, Idaho fescue, Basin big sagebrush, bluebunch wheatgrass, phlox, perennial forbs, perennial grasses (Hall et al. 2015; USDA 2021) |

| | | | |
|---|---|---|---|
| MUSYM 124 | Parkay-Wickahoney Association, 2 to 30% slopes | Claypan/loam range, stony soil | Mountain big sagebrush, Idaho fescue, low sagebrush, snowbank aspen, silver sagebrush, bluegrass, sedge, phlox, needlegrass sp., mountain snowberry, antelope bitterbrush, longleaf hawksbeard, mountain brome, perennial grasses, perennial forbs (Hall et al. 2015; USDA 2021) |

For a full list of plants well-documented to have usage by peoples in the study area, see Appendix A. Within the significant soil types, the highest frequency of vegetation cover belonged to sagebrush (*Artemisia* sp.), with 25% of associated vegetation being some form of sagebrush. The second highest vegetation type was the category of perennial forbs, approximately 10% of the overall total. This was subsequently followed by phlox (*Phlox*) at approximately 9%, and a tie between Idaho Fescue (*Festuca idahoensis*), Bluebunch Wheatgrass (*Pseudoroegneria spicata*), and the category of perennial grasses, each being approximately 7% of the associated groundcover types (Figure 5). The USDA report on vegetation associations does not indicate the presence – or lack thereof – of geophytes, with is an unfortunate omission that should be corrected in the future when more information is available on the subject.

These plants being available in areas with multiple clusters of sites is not surprising, given their potential for use by foragers and the diverse amount of usage associated with them, as well as the fact that many of the plants in the list are those which have unexpected or somewhat ‘limited’ usage (USDA 2021) and would likely be more plants where individuals and forager groups would probably not go too far out of their way to harvest them to maximize their own returns. This would suggest a likelihood for camps to be located in their vicinities, so that the plants could be more useful as quick forage. This changes by more specific locations within the soil types, narrowed further by the following variables. However, this will be discussed further throughout the Discussion section.

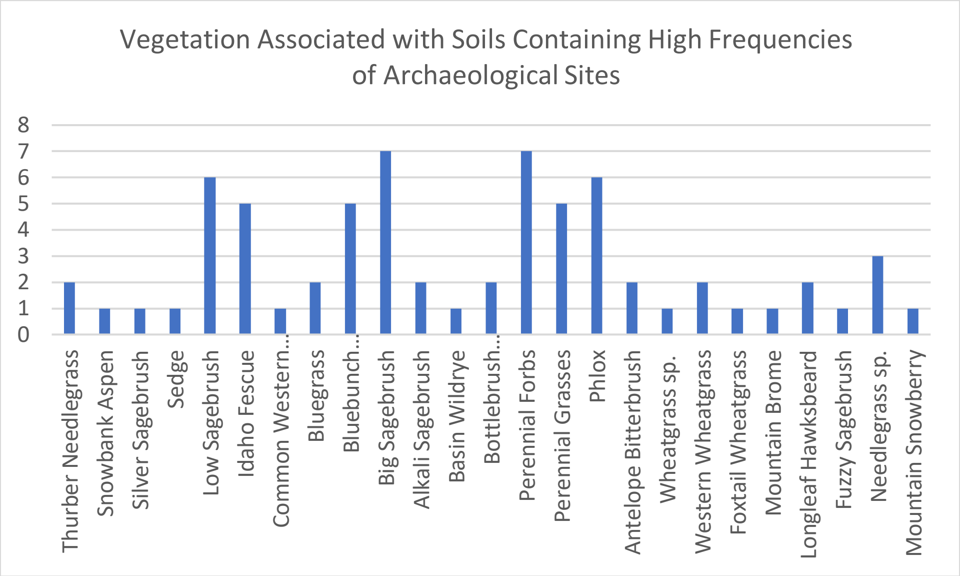


**Figure 5.** **Frequency of Vegetation Associated with Identified Important Soil Types**

## Drainage Association

The evaluation of the nearest point of flowing water to archaeological resources suggested a correlation between flowing water and site location. In total, 6,704 resource points were plotted against their proximity to flowing water. Of these: 6,537 (~98%) were within 500 meters of the nearest natural drainage; 5,744 (~86%) were within 250 meters of the nearest natural drainage; and 3,980 (~60%) were within 100 meters of the nearest natural drainage. A model of the relationship between cultural material count and proximity to water (Figure 6) was plotted, including the Mean (~110.89), the Median (~73.69), and the normal distribution of the dataset, suggesting an impact of hydrology to site location.

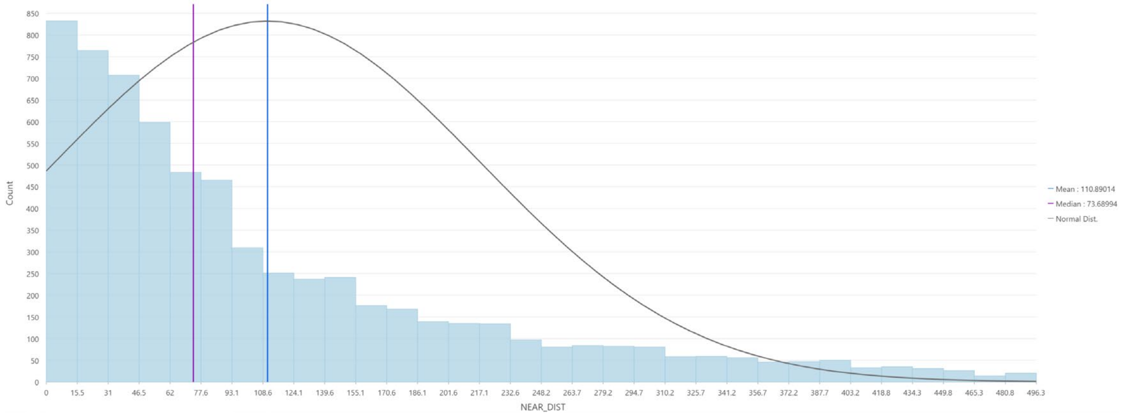


**Figure 6. Cultural Resource Count vs Proximity to all Hydrological Features (NEAR_DIST)**

Furthermore, it should be noted that clusters of sites within Owyhee County have an overall proximity to intermittent hydrological features. This is not a rule, but is an overwhelming majority, especially near the locations of highest densities. The exception of this is located within Soil Types 162 and Soil Type 124, through which Pole Creek and Big Springs Creek run, respectively. Both of these creeks are perennial water sources. Camas Creek – another perennial water source – also runs through Soil Type 206 at the northernmost point, and interacts with a cluster of cultural sites that are located within 100 meters of its buffer. Each of these water sources may have offered indigenous foragers important resources depending on the time of year that trips were made through the area; in regards to vegetation, they also impact the resources that would have been available when people moved through the landscape at specific points in the year.

## Elevation and Slope Association

The evaluation of both ArcGIS® raster data (Figure 7) and the soil complexes (Table 1) suggest a correlation of sites located below or equal to a 14.04 percent slope. Visual analysis of individual points also suggests this, with clusters of individual points visually associated with lower-slope areas along rivers. Often, site points are associated with river valleys; points line the low-slope corridors between high-slope walls, but drop off steeply when slope values range above 9 degrees. As mentioned with soil typologies, there is a slight change with MUSYM 124, where slopes range from 2-30 percent; however, even within this complex, site clusters are associated with the lower end of the slope range within the soil zone.

Regarding elevation, the general elevation range of site clusters within the Owyhee County is located in a range between 5200 – 5500 ASL, with some reaching up to 5900 ASL. This is the range of the largest cluster; other, smaller clusters stay most commonly within the range of 4000 – 6000 ASL, with some minimal outliers dipping near 3000 ASL and rising to 6739 ASL. On average, for the largest clusters and the Soil Types identified, elevations stay around 5000 – 6000 ASL.

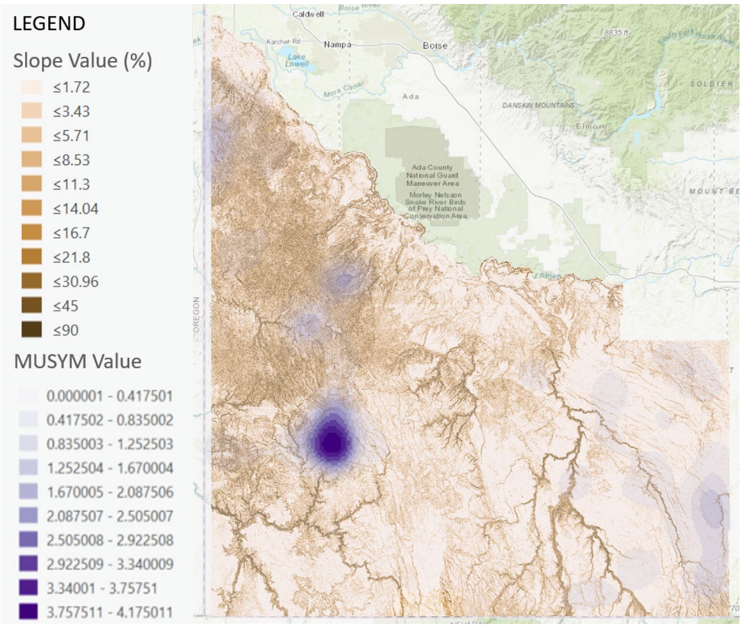


**Figure 7.** Kernel Density of Archaeological Resources Plotted Over a Standard Deviation of an Elevation Raster Sourced from the National Elevation Data Program

# CHAPTER 5: DISCUSSION AND CONCLUSION

Looking over the literature of the previous two decades has demonstrated the capabilities of using mapping software to visualize and organize archaeological data on a broad scale (Mehrer and Wescott 2005; Hall et al. 2015). If we refer to Human Behavioral Ecology and the suggestion that Archaic foragers were attentive to their landscape and making decisions based upon the identifiable properties and resource distributions on it, it stands to reason that known patterns of ecological factors in the landscape would likely influence settlement and mobility patterns. If archaeologists can estimate the ecological variables that may have been favored by foragers, plotting these in a GIS should have some visible correlation to the distribution of cultural materials on the landscape.

The analyses performed for this thesis suggests that there are correlations between the positions of certain ecological features and archaeological site density. Visually and statistically, there are correlations between site density and all four variables tested: soil type, drainage association, elevation, and slope. Each of these variables speaks to the environment of the sites, as well as the resources that would have been available during settlement in these areas. However, the initial variable used to determine site ecology and likelihood for environmental bias was soil typology. There is, indeed, a visible preference in the clustering of sites within two specific soil zones (MUSYM 162 and MUSYM 206), with some small clusters in other sites with, for the most part, similar plant ecologies.

Combining the soil data with ethnographic reports on plant usage in the area, and further defining site ecology with the trends modeled between the site densities and the other three variables, we may begin to see some of the reasons why areas with such environmental conditions may have been particularly attractive to foragers during the Archaic period. We know that choices in the landscape were often made with preference given to areas rich in resources, and that choices made on the landscape can be reflective of what would be available at the time of settlement (Soldati et al. 2017). Similarly, studying the landscape may provide answers regarding why certain choices were made, and what would have been available to foragers in the area who chose to settle at particular camp locations.

Again, while the environment has shifted since the paleoclimatic conditions of these foragers, the soil types studied in this report are somewhat stable over long periods of time. The higher stability of these variables helps with a greater predictive capacity than current environmental settings and visible vegetation ranges alone. Observing them both in this study and in the field can allow researchers to make well-informed assumptions about what the environment surrounding the sites in this study may have looked like during the periods of occupation, even if current climatic conditions have likely shifted some of the plant communities currently occupying the areas.

Spread across the different soil-types associated with higher-than-average site density, the United States Department of Agriculture lists eight main vegetation cover types: Sagebrush (*artemisia* sp.), bluebunch wheatgrass (*Pseudoroegneria spicata*), Bluegrass (*Poa* sp.), Thurber Needlegrass (*Achnatherum thurberianum*), sedges (*Carex* sp.), Juniper (*Juniperus occidentalis*), Idaho fescue (*Festuca idahoensis*), Basin Wildrye

(*Leymus cinereus*), bottlebrush squirrel tail (*Elymus elymoides*), perennial forbs, phlox (*Phlox*), perennial grasses, antelope bitterbrush (*Purshia tridentata*), longleaf hawksbeard (*Crepis acuminata*), foxtail wheatgrass (*Pseudelymus Saxicola*), western wheatgrass (*Pascopyrum smithii*), fuzzy sagebrush (*Artemisia papposa*), mountain brome (*Bromus carinatus*), mountain snowberry (*Symphoricarpos oreophilus*), and Snowbank Aspen (*Populus* sp.). Each has some observed ethnographic usage, either in the study area itself or amongst groups in other geographical locations (USDA 2020).

Sagebrush is known to have multiple uses in the Owyhee County area. It had a wide range of medical uses, and the gum of the plant could be chewed as a candy. Its seeds were used as food. The wood of sagebrush bushes has been used to make drills, hearths, and fire tinder (Moerman 1998). Its bark was also known to be frayed and woven to make cloth, cordage, sandals, and moccasin padding (Moerman 1998). Overall, sagebrush has had multiple uses; however, the plant’s place on this list is over little surprise, as the Owyhee area ecoregion is regarded as a sagebrush steppe (Moerman 1998; USDA 2020).

The vegetation type with the second most known ethnographic uses on the list is Juniper (*Juniperus occidentalis*). The plant had multiple known medicinal uses. As a food source, juniper had two primary uses: berries could be mashed and eaten, or stored as a winter supply food. Plant material could be used in the construction of housing. Materials could also be woven, and used as fiber for clothing, rope, and sandals (Moerman 1998; USDA 2020).

Bluebunch wheatgrass, foxtail wheatgrass, western wheatgrass, and Thurber needlegrass are usable for their seeds, which could be harvested and used as a possible food source amongst foragers in the study area (Turner, Bouchard, and Kennedy 1980). Beyond this, they are also desirable forage materials for large-bodied ungulates present in the Archaic diet-breadth. While bluebunch wheatgrass is preferred more by deer, Thurber needlegrass is desirable forage for elk in all seasons but spring, where it becomes preferred forage (USDA 2020). Western wheatgrass is desirable feed throughout the spring, summer, fall, and winter, though protein levels of the forage are highest in the spring months before the plant begins to cure out (USDA 2020). The presence of such vegetation may suggest locations that were preferable for animals that may have been of hunting interest to groups in the area. Large-bodied prey animals – including deer and elk – would have been of importance to Archaic foragers due to their continued demonstrated inclusion in the diet-breath during this period (Plew 2016; USDA 2020).

Sedges and Snowbank aspen both have documented ethnographic usages, though to a lesser extent than those listed above; not unsurprising, in the context of the Barlowe and Metcalfe argument regarding lower-ranked resources (1992). Sedges have some properties as forage, with some species in the area providing harvestable roots, bulbs, or seeds depending on the sedge type. They are also known to have been used to be woven into cooking tools (Moerman 1998). Snowbank Aspen has some medical properties, while its logs were used as building material for housing structures (Moerman 1998).

Mountain Brome has a primarily food-based documentation, throughout the Great Basin and surrounding areas. The seeds of this plant had documented usage as a forage material that could be used in breads and cakes. It also was used as a material for a type of porridge. Finally, its seeds saw use as a staple, and were documented to have been parched and then ground into a flour (Powers 1874). Conversely, bottlebrush squirrel tail was used as a food, with seeds harvested. However, its primarily documented usage was more in terms of fodder. Though outside of the study area, there is documentation that this plant was used as fodder for animals such as sheep and horses in the later periods (Vestal 1952).

The documentation of phlox usage primarily regards its use as a medicinal aid, both within the study are and outside. Usage was demonstrated as eye medicine, as a gastrointestinal aid, as a medicinal aid in pediatric care, and as a venereal medicine. There is also evidence of use as an antidiarrheal, an antirheumatic, a generalized dermatological aid, and a cold remedy, with roots being either ingested or rubbed over the body of an affected individual (Train et al. 1957; Whiting, Weber and Seaman 2020). Similarly, antelope bitterbrush has documentation primarily as a medicinal aid for gastrointestinal and anthelmintic use, as well as a general disease remedy and a possible tuberculosis remedy (Train et al. 1957). It also has some documented usage of branches being used as firewood and parts of the plant's bark for the construction of moccasins (Mahar 1953).

Longleaf hawksbeard has documented usage as both a food and a medical aid amongst different groups. Within the study area, the plant has been identified as being used as an analgesic, with a poultice of seeds being applied after childbirth to reduce soreness in the breasts. Roots of the plant were pulverized and sprinkled in the eyes to dislodge irritating substances (Train et al. 1957). Outside of the study area, there has been documentation regarding the use of the plant as an edible vegetable, with the stems peeled and then eaten raw as a source of greens (Schenck and Gifford 1952).

Basin Wildrye has uses both as an important food source, and as a material used in various forms of construction. Peoples from the Northern Paiute were documented to have used it for its seeds, harvesting primarily in the summer season (Couture et al. 1986). They also were documented weaving the plant into house coverings; if it was temporary housing, they could be used for general coverings, while more sedentary residences would employ multiple branches and bunches of the grass woven together for tighter protection (Couture et al. 1986). They were also reportedly used as brushes, woven together to make strong, hardened hairbrushes (Fowler 1989). Finally, beyond this, the plant can be great covering for smaller prey animals including rabbits, and good forage for elk, dear, and other ungulates (USDA 2020).

Finally, Bluegrass and Idaho Fescue have documented uses by indigenous American groups across the Great Basin that include subsistence forage and general construction. Idaho fescue was used as scouring material in similar semi-arid environments, while Bluegrass was used as boot linings and bedding by indigenous Canadian groups (USDA 2020). These grasses also had their seeds harvested as materials for food (Turner, Bouchard, and Kennedy 1980; Moerman 1998), though documentation specifically within the study area is somewhat limited. This does not mean that these materials were not used in the Owyhee area; due to the similar nature of the ecosystems in which these were used, it is highly possible that there was some use for these plants amongst foragers in the area.

A last mention should be given to three important geophytes that are not indicated in the USGS reports as commonly linked with the MUSYM areas, but notably preferring the soil type and habitat range of the study area. First is bitterroot (*Lewisia rediviva*), a perennial plant suited to well-drained, gravelly soils, especially those found in sagebrush steppes. The plant has documented usage primarily as a food, with the roots being dried and often cooked, then mixed with other food types such as berries and meats (USDA 2021). Bitterroot has high storage capabilities (USDA 2021). Secondly, Gray's Biscuitroot (*Lomatium grayi*) is suited to the habitat and elevation of the most prominent site clusters, and has documented range within the area (USDA 2021). It also is highly correlated with several other plant types that are associated with the significant soil types (USDA 2021). Biscuitroot would be considered a rather highly-ranked plant in terms of an HBE framework, and would have been an available food source for groups in the area, with harvests of the plant typically taking place in late winter and early spring depending on the group and the need for food (Fowler 1989).

Finally, there is a third significant food plant not currently associated with the area: camas (*Camassia*). This, however, is a theoretical suggestion, based on recent research done on mapping environmental variables to plot for desirable plant habitat with a species distribution model. If this mapping is correct, there is a likelihood that the camas plant ranged near to the highest site densities near soil types 162 and 206 (Johnson 2020).

Of the plants closely associated with the soil types that display higher site densities, a high proportion of ground coverage in areas with high site density would be considered of low value in a Human-Behavioral Ecology framework (Smith and Winterhalder 1985; USDA 2021). When combined with the other ecological factors valued, the most likely plant type to widespread at areas of particularly dense site clusters would be sedges. This vegetation type prefers the elevation, slope, and soil found throughout these clusters, and grows particularly well in well-irrigated areas close to water sources (USDA 2020). This is interesting for its sense in the HBE models discussed in the theoretical framework; to maximize potential net returns of foraging vegetation, it would make more sense for camps of foragers to be placed nearer to plants with lower overall ‘value’, yet within logical distance of higher-ranked resources – such as sagebrush and juniper. Working from an HBE framework would suggest that people are making the decisions to best benefit themselves, which would be supported by the propensity for sites to be located near to usable resources and within a distance that would allow them to make use of smaller resources while saving energy to harvest more ‘important’ ones.

Of further note is the viability of sedges and other plants as forage material for animals ranked highly in the diet-breadth of Archaic foragers (Plew 2009). At the narrowed-down probable locations of sites within the area, OFT places these locations within difficult distances of other lower-ranked, arid-environment resources, such as bluebunch wheatgrass, western wheatgrass, and Thurber’s needlegrass; however, since these plants are attractive forage to highly-ranked animals, it begins to make more sense. They are still located within the area of viability for travel while inside of the mapped soil-type zone, and potentially would have enough attractiveness to be worthwhile for travelling to slightly farther patches.

That turns the discussion to why, if sedges are also desirable forage, camps are located near to them and not other low-ranked resources. However, the vegetation itself does not necessarily change the proximity to another demonstrably important resource: water itself. Water is, and likely always will be, a critical resource, especially during times of drought and aridity such as those conditions present in the Archaic period. Placing camps – both temporary and more sedentary – near sedge patches would put foragers both close to an easy-access plant resource with use as construction material and food, near to a large variety of other resources that occasionally help each other to flourish (USDA 2021), and near to a perennial water source necessary for the flourishing of plants like sedges. Within the soil zones listed above, foragers potentially would then be within an expedient travel distance to other, higher-ranked resources, but able to fall back on easy-access plant materials should other foraging efforts fail, as indicated in studies of similar environments (Soldati et al. 2017).

Furthermore, it should be noted that the water types associated with site locations influence the types of vegetation available when camps are made. The note of the sedges is important, as nearly every perennial drainage within Owyhee County does seem to have at least one instance of cultural materials being located within 500 meters of it; however, not every documented instance of cultural materials is located within 500 meters of a perennial drainage, an important dichotomy. There are high frequencies of site clusters near *intermittent* drainages, greatly impacting the resources that are available based on the time of year during which foragers settle there. The soil types most highly associated with site frequencies also contain sites associated with intermittent drainages, which are good habitat for such vegetation as sagebrush, juniper, and wheatgrass. The time of year of settlement also impacts what resources may be gained from these plants. Juniper, for instance, has different uses depending on the time of year that the plant is being used (USDA 2021). To best understand how a site may have been used, if seasonality can be determined alongside the ecological mapping of a location, water availability and resulting resource availability may greatly aid the toolkit of well-informed observations regarding site type and usage. While the documentation of seasonal movements based on seed production and resource availability is known (Fowler 1989), a deeper understanding of the plant types in the area and their seasonal shifts would be useful.

Overall, the clustering of sites within the boundaries of specific soil-type ranges cannot be ignored. The correlations within specific elevation ranges, <15 percent slope angles, and nearness to a moving water source speak to sites being tied to specific ecological factors, all of which lead to identifiable ranges of available vegetational resources – those that have, or possibly had, uses. Though there have undoubtedly been some environmental shifts since the Archaic period, consistent, slow-changing variables such as those included in this study can potentially give us a glimpse at the environmental conditions of the past.

In future archaeological research, the consideration of plant resource acquisition and the plotting of ecological variables may help to narrow down areas for more thorough inventory surveys. As displayed in the results, there is a visible difference in the locations of focus for archaeological surveys and the actual locations of archaeological materials. Though we find archaeological sites and isolates distributed across the landscape, a location of high sensitivity to the discovery of archaeological materials related to residential camps, temporary camps, or task-specific plant resource gathering sites would likely display all – or most – of the factors shown to correlate in this report:

1. A <111m distance to a perennial water source,
2. A slope of <15 percent (approximately 8.53 degrees),

3. An elevation approximately between 5000 - 6000 feet asl, and
4. An association with a soil type shown to have a greater-than-average clustering of sites.

These factors, when combined, also speak to an environment perfect for the growth of sedges, while still within a viable range of distance for travel to other plant resources with documented uses (Metcalfe and Barlow 1992).

In the future, other variables should be further explored to take this research forward. First, there is the possibility of multiple variables impacting site choice. Foragers were of course aware of their landscape, and likely selected their camp locations for more than one reason. While plant resources may have impacted camp choices in some locations and circumstances, they may have been fortunate happenstance in others as determined by variable weather and shifting climates. Multiple variables are likely in play, and this study will need further narrowing once more data becomes available; namely, further inventory reports and an increase in vegetation range data. An increase in available vegetation data – including geophytes – would also be helpful to further understanding the Archaic landscape, to understand how climate shifts may impact the ways in which plant communities are expressed in the studied soil types. Currently-existing communities cannot necessarily stand in for Archaic ones alone, and, while soil types are slow-changing and can be indicative of the Archaic environment, multiple factors are nevertheless needed for full studies.

Greater increases in the available data of both modern ecosystems and slow-changing variables can help researchers to gain a greater and more rounded look at possible Archaic conditions. There have been some studies that suggest that the importance of plant resources shifted with climate, with plants – especially plants near water, and with the capabilities to store water – becoming more important as conditions became more arid (Turner 2014; Soldati et al. 2017). As more information about the influence of climate upon the range of plant communities is obtained, this may be applied to gain a more complete understanding of the Archaic landscape with every little documented climatic shift. This can then be applied to exploring whether the sites studied in this project followed resource shifts with changes in aridity and environment.

Lastly, in terms of weaknesses, making note of all of the ecological variables noted in this project is not always possible in the field, or by lone archaeologists with limited equipment. Simply looking at the landscape while surveying may not be enough to judge the resources that would be available. Identifying soil types either requires previous knowledge of the zone being researched, or the ability to recover and type soils in the field. Measuring slope, elevation, and approximate distance to water also similarly requires either previous knowledge of the field location, or the ability to measure these variables while working. While doing pedestrian surveys, such observations may also not always be immediately possible or prepared due to the oftentimes large area of ground to cover or the possible lack of appropriate maps and the required tools. However, the measurements of these variables are all possible with appropriate planning, purposeful observation, and methodical analysis. When done appropriately, taking these variables into account has the potential to greatly impact the ability of archaeologists and cultural management specialists to narrow down not only the areas most likely to contain cultural materials, but the potential uses of such areas.

Similar to the above points, future research into the correlations of ecological variables, plant data, and site locations must also be continuously updated with new site data as they become available to help researchers continuously be aware of their surroundings and the environment of their surveys and excavations. Such an extension may either further continue to correlate site density with the identified variables, or, may move centers of focus to be correlated with entirely separate variables. Regardless of outcome, to continue suggesting any correlation would require a constant updating of results as better datasets become available.

The purpose of this project is not to say that floral ranges should be considered at the expense of all other possible variables, or that all locations were selected solely because of floristic resources. Rather, these results suggest that flora is one important variable that often gets set aside in studies due to lacking paleoenvironmental data. As mentioned above, proximity to groundwater appears highly correlated to site location, and may also play a large role in selection, and should not be ignored for the role it seems to play on both the environment and possible decisions. Rather, this project and its findings ask: in an area with so many water sources of varying types, why were sites placed at *these* locations? Where can we expect to see temporary versus more sedentary campsites? Proximity to perishable materials has been demonstrated to have an impact on site location in similar environments (Soldati et al. 2017), and it is important to note that foragers likely took stock of the whole of their surroundings when making decisions. Floral resources are an important part of the landscape, and foragers undoubtedly noted available resources to make conscious decisions regarding camp locations, whether they intended to stay there briefly or for a length of time.

As a final note, researchers should consider plant types and correlated ecological variables when determining both site use and environmental variability. Much as the ecological variables discussed can be used to infer plant communities, flora can be used, to an extent, to speak to the environment of a setting. Although anthropogenic disturbances have altered many parts of the landscape, examining vegetation and the ecological variables of a location can be used, with detailed study, to speak to the general setting of the environment where foragers settled. Observing resources in an area can also possibly help with making informed inferences regarding site use; where plants are concerned, the lack of portability of some milling technology makes it logical for areas of both settlement and dedicated processing to be near to the resources themselves (Buonasera 2015). Due to the lack of preservation of plant remains in many contexts, observing the full picture of both the archaeological materials themselves and the area around the material remains can help to inform the inferences of archaeologists. If we use this research to make well-informed inferences about the propensity for foragers to choose some camp locations with correlations to plant variables, cultural resource management specialists and site stewards can also use this information to help make decisions regarding inventory work and excavation decisions.

This research has furthered the work begun by the Bureau of Land Management to correlate site spread with ecological variables for the purpose of predicting ‘hot spots’ for archaeological materials (Hall et al. 2015). While previous research has focused largely on a wide host of variables, this project suggests that individual, correlated ecological variables may hold a critical key to understanding motivation behind an important driver of site location: resource proximity and acquisition. If areas with useable resources can be identified, this may correlate to archaeological remains. With programs such as ArcGIS®, such an identification may be performed with the examination of ecological variables plotted onto a map. Furthermore, being able to identify locations of higher probability for significant sites, those eligible for listing on the National Register of Historic Places and having great research potential, may help to reduce the expended time and costs of archaeological surveys; agencies like the Bureau of Land Management may find it productive to focus efforts on areas of high probability for finding significant resources.

# REFERENCES

Arkush, Brooke S., and Denise Arkush. "Aboriginal plant use in the central Rocky Mountains: Macrobotanical records from three prehistoric sites in Birch Creek Valley, eastern Idaho." *North American Archaeologist* 42, no. 1 (2021): 66-108.

Bettinger, Robert L. "Aboriginal human ecology in Owens Valley: prehistoric change in the Great Basin." *American Antiquity* 42, no. 1 (1977): 3-17.

Bettinger, Robert L. "Doing Great Basin archaeology recently: Coping with variability." *Journal of Archaeological Research* 1, no. 1 (1993): 43-66.

Binford, Lewis R. "Willow smoke and dogs' tails: hunter-gatherer settlement systems and archaeological site formation." *American antiquity* (1980): 4-20.

Bradley, Bethany A. "Regional analysis of the impacts of climate change on cheatgrass invasion shows potential risk and opportunity." *Global Change Biology* 15, no. 1 (2009): 196-208.

Buonasera, Tammy Y. "Modeling the costs and benefits of manufacturing expedient milling tools." *Journal of Archaeological Science* 57 (2015): 335-344.

Bureau of Land Management. *Owyhee County Inventory Resource Report.* 2021.

Burman, R. D., J. L. Wright, and M. E. Jensen. "Changes in climate and potential evapotranspiration across a large irrigated area in Idaho." *Transaction of the ASAE* 18, no. 6 (1975): 1089-1093.

Butler, B. Robert. *A guide to understanding Idaho archaeology*. Idaho State University Museum, 1968.

Butler, B. Robert. *A Guide to Understanding Idaho Archaeology: The Upper Snake and Salmon River Country*. Idaho Museum of Natural History, 1978.

Connolly, Thomas J., Catherine S. Fowler, and William J. Cannon. "Radiocarbon evidence relating to northern Great Basin basketry chronology." *Journal of California and Great Basin Anthropology* (1998): 88-100.

Connolly, Thomas J. "Implications of new radiocarbon ages on coiled basketry from the northern Great Basin." *American antiquity* (2013): 373-384.

Connolly, Thomas J., Pat Barker, Catherine S. Fowler, Eugene M. Hattori, Dennis L. Jenkins, and William J. Cannon. "Getting beyond the point: textiles of the terminal pleistocene/early holocene in the Northwestern Great Basin." *American Antiquity* (2016): 490-514.

Couture, Marilyn D., Mary F. Ricks, and Lucile Housley. "Foraging behavior of a contemporary northern Great Basin population." *Journal of California and Great Basin Anthropology* 8, no. 2 (1986): 150-160.

Daubenmire, R. "Ecologic plant geography of the Pacific Northwest." *Madrono* 20, no. 3 (1969): 111-128.

Davis, Scott. *GIS for web developers*. Dallas: Pragmatic Bookshelf, 2007.

Davies, Benjamin, Iza Romanowska, Kathryn Harris, and Stefani A. Crabtree. "Combining geographic information systems and agent-based models in archaeology: part 2 of 3." *Advances in Archaeological Practice* 7, no. 2 (2019): 185.

Dering, Phil. "Earth-oven plant processing in Archaic period economies: an example from a semi-arid savannah in south-central North America." *American Antiquity* (1999): 659-674.

Eastman, Meghan Kim. "Recent archaeological investigations at Three Island Crossing: insights regarding late archaic diet breadth and mobility." (2011).

Fowler, Catherine S. "Subsistence." In *Handbook of North American Indians,* vol. 11 (1986): 64-98.

Fowler, Catherine S., ed. *Willard Z. Park's ethnographic notes on the Northern Paiute of Western Nevada: 1933-1940*. University of Utah Press, 1989.

Fowler, Catherine S. "Tule technology: Northern Paiute uses of marsh resources in Western Nevada." *Smithsonian Folklife Studies* (1990).

Gruhn, Ruth. *The archaeology of Wilson Butte Cave, south-central Idaho.* No. 6. Idaho State College, 1961.

Ingbar, Eric, and Teresa Wriston. *Owyhee Land Exchange Cultural Resource Model Version 3*. Bureau of Land Management, 2017.

Hall, Jeremy, Mike Drews, Eric Ingbar, and F. Halford. "GIS Modeling of the Owyhee Country of the Snake River Plain, Idaho: Creative Approaches to Section 106 Compliance." *Idaho Archaeologist* 38, no. 1 (2015).

Harris, Jack Sargent. "The White Knife Shoshoni of Nevada." PhD diss., D. Appleton-Century Company, 1940.

Johnson, Royce. "Using a Species Distribution Approach to Model Historic Camas (Camassia quamash) in Southern Idaho and Implications for Foraging in the Late Archaic." (2020).

Liljeblad, Sven Samuel. *Indian peoples in Idaho*. Idaho State College, 1957.

Lowie, Robert Harry. *The Northern Shoshone*. The Trustees, 1909.

Lowie, Robert Harry. "Notes on Shoshonean ethnography. Anthropological papers of the AMNH; v. 20, pt. 3." (1924).

Mahar, James Michael. "Ethnobotany of the Oregon Paiutes of the warm springs Indian reservation. Reed College." PhD diss., BA thesis, 1953.

McGrath C.L., A.J. Woods, J.M. Omernik, S.A. Bryce., M. Edmondson, J.A. Nesser, J. Shelden, R.C. Crawford, J.A. Comstock, and M.D. Plocher. 2002. Ecoregions of Idaho (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,350,000). ftp://ftp.epa.gov/wed/ecoregions/id/id_eco_lg.pdf

McGuire, Kelly R., and William R. Hildebrandt. "Re-thinking Great Basin foragers: prestige hunting and costly signaling during the Middle Archaic period." *American Antiquity* (2005): 695-712.

Meatte, Daniel S. *Prehistory of the western Snake River basin*. No. 35. Idaho Museum of Natural History, 1990.

Mehrer, Mark W., and Konnie L. Wescott, eds. *GIS and archaeological site location modeling*. crc Press, 2005.

Metcalfe, Duncan, and K. Renee Barlow. "A model for exploring the optimal trade-off between field processing and transport." *American Anthropologist* 94, no. 2 (1992): 340-356.

Miller, Richard F., and Peter E. Wigand. "Holocene changes in semiarid pinyon-juniper woodlands: response to climate, fire, and human activities in the US Great Basin." *BioScience* 44, no. 7 (1994): 465-474.

Moerman, Daniel E. 1998. *Native American Ethnobotany*. Portland, Oregon: Timber Press.

Moseley, Robert K. "Riparian and wetland communities in southwestern Idaho: Second-year inventory results and preliminary catalog of community types." *Unpublished report on file at the Conservation Data Center, Idaho Department of Fish and Game, Boise, ID* (1999).

Murphy, Robert F., and Yolanda Murphy. *Shoshone-Bannock subsistence and society*. Good Press, 2019.

Nelson, Nathan A., and Jennifer Pierce. "Late-Holocene relationships among fire, climate and vegetation in a forest-sagebrush ecotone of southwestern Idaho, USA." *The Holocene* 20,

NRCS. “Natural Resources Conservation Service Climate Information.” Climate Information | NRCS Idaho. United States Department of Agriculture, 2021. https://www.nrcs.usda.gov/wps/portal/nrcs/detail/id/snow/products/?cid=nrcs144p2_046671.

O’Connell, James F., and Kristen Hawkes. "Alyawara plant use and optimal foraging theory." *Hunter-gatherer foraging strategies: Ethnographic and archaeological analyses* (1981): 99-125.

Owyhee Watershed Council. "Owyhee Subbasin Plan." *Final Draft. Submitted to the Northwest Power and Conservation Council, Portland, Oregon* (2004).

Pate, Donald. "The effects of drought on Ngatatjara plant use: an evaluation of optimal foraging theory." *Human Ecology* 14, no. 1 (1986): 95-115.

Plager, Sharon, Mark G. Plew, and Christopher A. Willson. *The Archaeology of Antelope Creek Overhang, Southeastern Oregon*. Boise State University, Dept. of Anthropology, 2006.

Plew, Mark G. "A prehistoric settlement pattern for the Southcentral Owyhee Uplands, Idaho." PhD diss., Indiana University, 1985.

Plew, Mark G. *An Introduction to the Archaeology of Southern Idaho.* Boise State Univ Bookstore, 1986.

Plew, Mark G. "ARCHAEOBOTANICAL REMAINS FROM SOUTHERN IDAHO." *Journal of the Idaho Academy of Science* 43, no. 2 (2007): 1-10.

Plew, Mark G. "Archaic hunter-gatherer diet breadth and prey choice on the Snake River Plain." *Journal of Northwest Anthropology* 43, no. 1 (2009): 27-56.

Plew, Mark G. 2016. The Archaeology of the Snake River Plain. 3rd ed. Boise, ID: Boise State University, Department of Anthropology.

Powers, Stephen. *Aboriginal Botany*. Proceedings of the California Academy of Science, no. 5 (1874): 373-9.

Schenck, Sara Moffatt, and Edward Winslow Gifford. *Karok ethnobotany*. Vol. 13, no. 6. University of California Press, 1952.

Schlegel, Melissa E., Alan L. Mayo, Steve Nelson, Dave Tingey, Rachel Henderson, and Dennis Eggett. "Paleo-climate of the Boise area, Idaho from the last glacial maximum to the present based on groundwater δ2H and δ18O compositions." *Quaternary Research* 71, no. 2 (2009): 172-180.

Sohrabi, Mohammad M., Jae H. Ryu, John Abatzoglou, and John Tracy. "Climate extreme and its linkage to regional drought over Idaho, USA." *Natural Hazards* 65, no. 1 (2013): 653-681.

Soldati, Gustavo Taboada, Patrícia Muniz de Medeiros, Reinaldo Duque-Brasil, France Maria Gontijo Coelho, and Ulysses Paulino Albuquerque. "How do people select plants for use? Matching the ecological apparency hypothesis with optimal foraging theory." *Environment, Development and Sustainability* 19, no. 6 (2017): 2143-2161.

Steward, Julian Haynes. *Nevada Shoshone*. University of California Press, 1941.

Steward, Julian Haynes. *Culture element distributions: XXIII. Northern and Gosiute Shoshoni*. Berkeley and Los Angeles: University of California Press, 1943.

Steward, Julian. "The concept and method of cultural ecology." *The Environment in Anthropology. A Reader in Ecology, Culture, and Sustainable Living* (2006): 5-9.

Stewart, Omer C. "Burning and natural vegetation in the United States." *Geographical Review* 41, no. 2 (1951): 317-320.

Stoffle, Richard W., David B. Halmo, Michael J Evans, and John E. Olmsted. "Calculating the cultural significance of American Indian plants: Paiute and Shoshone ethnobotany at Yucca Mountain, Nevada." *American Anthropologist* 92, no. 2 (1990): 416-432.

Swanson Jr, E. H., and Guy Muto. "Recent Environmental Changes in the Northern Great Basin." *Tebiwa, Journal of the Idaho Museum of Natural History* 18 (1975): 49-57.

Tabor, Neil J., and Timothy S. Myers. "Paleosols as indicators of paleoenvironment and paleoclimate." *Annual Review of Earth and Planetary Sciences* 43 (2015): 333-361.

Tennant, Edward W. "A sample geodatabase structure for managing archaeological data and resources with ArcGIS." *Technical Briefs in Historical Archaeology* 2 (2007): 12-23.

Train, Percy, James R. Henrichs, William Andrew Archer, and W. Andrew Archer. *Medicinal uses of plants by Indian tribes of Nevada*. Quarterman Publications, 1957.

Turner, Nancy J., Randy Bouchard, and Dorothy ID Kennedy. *Ethnobotany of the Okanagan-Colville Indians of British Columbia and Washington.* 1980.

Turner, Nancy. *Ancient pathways, ancestral knowledge: ethnobotany and ecological wisdom of indigenous peoples of northwestern North America*. Vol. 74. McGill-Queen's Press-MQUP, 2014.

USDA. Plants 3. United States Department of Agriculture, 2020. https://plants.usda.gov/home.

USDA. Plants 3. United States Department of Agriculture, 2021. https://plants.usda.gov/home.

U.S. Geological Survey. National Hydrography. United States Geological Survey, 2021. https://www.usgs.gov/core-science-systems/ngp/national-hydrography.

Vestal, Paul A. *The Ethnobotany of the Ramah Navaho*. Papers of the Peabody Museum of American Archaeology and Ethnology 40, no. 4(1952):1-94.

Whiting, Alfred F., Steven A. Weber, and P. David Seaman. *Havasupai Habitat: AF Whiting's Ethnography of a Traditional Indian Culture*. University of Arizona Press, 2020.

Smith, Eric Alden, and Bruce Winterhalder. "On the logic and application of optimal foraging theory: a brief reply to Martin." *American Anthropologist* 87, no. 3 (1985): 645-648.

Yeates, Samuel HM. "Optimal Foraging and Population Dynamics: An Archaeological Investigation at the Birch Creek Rockshelters, Idaho." (2019).

# APPENDIX A

## Plants with Documented Usage by Peoples in the Study Area

| **Plants with Documented Usage by Peoples in the Study Area** | **General Use** | **Citation** |
|---|---|---|
| *Achillea millefolium L.* | Medicinal | (Fowler 1986; Moerman 1998; USDA 2021) |
| *Achnatherum hymenoides (Roemer & J.A. Schultes) Barkworth* | Food (seeds) | (*ibid.*) |
| *Achnatherum thurberianum* | Food (seeds) | (*ibid.*) |
| *Allium anceps* | Food (bulbs) | (*ibid.*) |
| *Allium parvum Kellogg* | Food (bulbs) | (*ibid.*) |
| *Allium sp.* | Food (bulbs, stems) | (*ibid.*) |
| *Angelica lineariloba Gray* | Medicinal | (*ibid.*) |
| *Apocynum cannabinum L.* | Fiber; Construction material | (*ibid.*) |
| *Artemisia douglasiana Bess.* | Medicinal | (*ibid.*) |
| *Artemisia tridentata Nutt.* | Medicinal; Food (gum) | (*ibid.*) |
| *Asclepias cryptoceras S. Wats.* | Medicinal | (*ibid.*) |
| *Atriplex argentea Nutt.* | Food (seeds) | (*ibid.*) |
| *Atriplex confertifolia (Torr. & Fr,m.) S. Wats.* | Medicinal | (*ibid.*) |
| *Balsamorhiza hookeri (Hook.) Nutt.* | Food (roots) | (*ibid.*) |
| *Bromus carinatus* | Food (seeds) | (*ibid.*) |
| *Calochortus nuttallii Torr. & Gray* | Food (roots, tubers) | (*ibid.*) |
| *Carex sp.* | Food (roots, tubers, stems); Construction material | (*ibid.*) |

| | | |
|---|---|---|
| *Cercocarpus ledifolius Nutt.* | Medicinal | (*ibid.*) |
| *Chenopodium fremontii S. Wats.* | Food (seeds) | (*ibid.*) |
| *Chenopodium nevadense Standl.* | Food (seeds) | (*ibid.*) |
| *Claytonia perfoliata ssp. perfoliata* | Food (leaves) | (*ibid.*) |
| *Claytonia umbellata S. Wats.* | Food (roots) | (*ibid.*) |
| *Crepis acuminata* | Food (stems); Medicinal | (*ibid.*) |
| *Cyperus esculentus L.* | Food (roots, tubers) | (*ibid.*) |
| *Datura wrightii Regel* | Drug (hallucinogen, poison) | (*ibid.*) |
| *Descurainia incana ssp. incana* | Food (seeds) | (*ibid.*) |
| *Descurainia pinnata (Walt.) Britt.* | Food (seeds) | (*ibid.*) |
| *Descurainia sophia (L.) Webb ex Prantl* | Food (seeds) | (*ibid.*) |
| *Eleocharis palustris (L.) Roemer & J.A. Schultes* | Food (sap) | (*ibid.*) |
| *Elymus elymoides* | Food (seeds); Prey forage | (*ibid.*) |
| *Ephedra viridis Coville* | Medicinal; Food (stems) | (*ibid.*) |
| *Eriastrum sparsiflorum (Eastw.) Mason* | Medicinal | (*ibid.*) |
| *Ericameria nauseosa ssp. nauseosa var. nauseosa* | Food (bark) | (*ibid.*) |
| *Festuca idahoensis* | Food (seeds) | (*ibid.*) |
| *Glycyrrhiza lepidota Pursh* | Medicinal | (*ibid.*) |
| *Glyptopleura marginata D.C. Eat.* | Food (leaves, stems) | (*ibid.*) |
| *Helianthus annuus L.* | Food (seeds) | (*ibid.*) |

| | | |
|---|---|---|
| *Helianthus cusickii Gray* | Food (roots) | (*ibid.*) |
| *Heracleum maximum Bartr.* | Medicinal | (*ibid.*) |
| *Juncus balticus Willd.* | Food (stems) | (*ibid.*) |
| *Juniperus occidentalis* | Food (berries); Construction | (*ibid.*) |
| *Juniperus osteosperma (Torr.) Little* | Medicinal | (*ibid.*) |
| *Lewisia rediviva Pursh* | Food (roots, leaves) | (*ibid.*) |
| *Leymus cinereus* | Medicinal; Fiber; Construction | (*ibid.*) |
| *Lomatium dissectum (Nutt.) Mathias & Constance* | Medicinal; Construction | (*ibid.*) |
| *Lomatium grayi* | Food (roots, stems) | (*ibid.*) |
| *Lomatium macrocarpum (Nutt. ex Torr. & Gray) Coult. & Rose* | Food (roots) | (*ibid.*) |
| *Lomatium nevadense (S. Wats.) Coult. & Rose* | Food (roots) | (*ibid.*) |
| *Lycium andersonii Gray* | Food (berries) | (*ibid.*) |
| *Mentha arvensis L.* | Medicinal | (*ibid.*) |
| *Mentzelia albicaulis (Dougl. ex Hook.) Dougl. ex Torr. & Gray* | Food (seeds) | (*ibid.*) |
| *Mirabilis alipes (S. Wats.) Pilz* | Medicinal | (*ibid.*) |
| *Monarda sp.* | Medicinal | (*ibid.*) |
| *Opuntia polyacantha Haw.* | Food | (*ibid.*) |
| *Orobanche fasciculata Nutt.* | Food (stems) | (*ibid.*) |
| *Osmorhiza occidentalis (Nutt. ex Torr. & Gray) Torr.* | Medicinal | (*ibid.*) |

| | | |
|---|---|---|
| *Pascopyrum smithii* | Forage | (*ibid.*) |
| *Penstemon deustus Dougl. ex Lindl.* | Medicinal | (*ibid.*) |
| *Perideridia gairdneri (Hook. & Arn.) Mathias* | Food (roots) | (*ibid.*) |
| *Phlox sp.* | Medicinal | (*ibid.*) |
| *Phragmites australis (Cav.) Trin. ex Steud.* | Food (sap); Construction material | (*ibid.*) |
| *Pinus jeffreyi Grev. & Balf.* | Food (sap) | (*ibid.*) |
| *Pinus monophylla Torr. & Fr,m.* | Food (gum, nuts) | (*ibid.*) |
| *Poa sp.* | Food (seeds); Construction material | (*ibid.*) |
| *Populus sp.* | Medicinal; Construction Material | (*ibid.*) |
| *Prunus virginiana var. demissa (Nutt.) Torr.* | Food (berries) | (*ibid.*) |
| *Pseudelymus saxicola* | Food (seeds); Forage | (*ibid.*) |
| *Pseudoroegneria spicata* | Food (seeds); Forage | (*ibid.*) |
| *Psorothamnus polydenius (Torr. ex S. Wats.) Rydb.* | Medicinal | (*ibid.*) |
| *Purshia tridentata* | Medicinal; Fuel material; Construction material | (*ibid.*) |
| *Ribes aureum Pursh* | Food (berries) | (*ibid.*) |
| *Sagittaria cuneata Sheldon* | Food (roots) | (*ibid.*) |
| *Salix exigua Nutt.* | Medicinal; Fiber | (*ibid.*) |

| | | |
|---|---|---|
| *Salvia dorrii (Kellogg) Abrams* | Medicinal | (*ibid.*) |
| *Sambucus racemosa var. racemosa* | Food (berries) | (*ibid.*) |
| *Sarcobatus vermiculatus (Hook.) Torr.* | Medicinal | (*ibid.*) |
| *Schoenoplectus acutus var. acutus* | Food (stalks, stems, leaves); Fiver; Construction material | (*ibid.*) |
| *Schoenoplectus maritimus (L.) Lye* | Fiber; Food (seeds) | (*ibid.*) |
| *Schoenoplectus pungens var. pungens* | Food (seeds) | (*ibid.*) |
| *Suaeda calceoliformis (Hook.) Moq.* | Food (seeds) | (*ibid.*) |
| *Symphoricarpos oreophilus* | Medicinal | (*ibid.*) |
| *Typha domingensis Pers.* | Food (stalks, seeds, rhizomes, shoots); Fiber; Construction material | (*ibid.*) |
| *Typha latifolia L.* | Food (stalks, seeds, rhizomes, shoots); Fiber; Construction material | (*ibid.*) |
| *Urtica dioica L.* | Medicinal | (*ibid.*) |
| *Veratrum californicum Dur.* | Medicinal | (*ibid.*) |
| *Xanthium strumarium L.* | Medicinal | (*ibid.*) |
| *Zigadenus paniculatus (Nutt.) S. Wats.* | Medicinal | (*ibid.*) |
| *Zigadenus venenosus S. Wats.* | Medicinal | (*ibid.*) |