Archaic Sites, Ecological Zones, and Wetlands Resources in the Eastern Great Basin

Lindsey R. Lyle
Brigham Young University

Follow this and additional works at: https://scholarsarchive.byu.edu/etd

Part of the Family, Life Course, and Society Commons

BYU ScholarsArchive Citation
https://scholarsarchive.byu.edu/etd/9649

This Thesis is brought to you for free and open access by BYU ScholarsArchive. It has been accepted for inclusion in Theses and Dissertations by an authorized administrator of BYU ScholarsArchive. For more information, please contact ellen_amatangelo@byu.edu.
Archaic Sites, Ecological Zones, and Wetland Resources

in the Eastern Great Basin

Lindsey R. Lyle

A thesis submitted to the faculty of
Brigham Young University
in partial fulfillment of the requirements for the degree of

Master of Arts

James Allison, Chair
John E. Clark
Zachary Chase

Department of Anthropology
Brigham Young University

Copyright © 2022 Lindsey R. Lyle
All Rights Reserved
ABSTRACT

Archaic Sites, Ecological Zones, and Wetland Resources in the Eastern Great Basin

Lindsey R. Lyle
Department of Anthropology, BYU
Master of Art

Archaeological data has increased significantly with Cultural Resource Management agencies finding and recording archaeological sites all across Utah. With the site data from the Utah State Historical Preservation Office, I examine the expansion of Archaic sites in the Eastern Great Basin from the Early Archaic through the Late Archaic, through the lens of elevation and ecological zones and proximity to wetland resources. I argue that the aridness of the Middle Holocene caused the people to expand into the mountains of Utah, and that the expansion continued into the Late Archaic period, even though the environment became more moist again. I also argue that the people of the Archaic stayed near to wetlands and wetland resources throughout the Archaic.

Keywords: wetland resources, elevation, ecological zones, archaic
# TABLE OF CONTENTS

LIST OF FIGURES .................................................................................................................. iv
LIST OF TABLES ..................................................................................................................... v
1 | Introduction ......................................................................................................................... 1
   Organization ....................................................................................................................... 2
2 | Previous Research of the History of the Great Basin ......................................................... 5
   Early Holocene ................................................................................................................... 6
   Early Archaic ....................................................................................................................... 8
   Middle Holocene ................................................................................................................ 9
   Middle Archaic ................................................................................................................... 12
   Late Holocene .................................................................................................................... 13
   Late Archaic ....................................................................................................................... 14
3 | Methods ............................................................................................................................. 17
   Physical and Temporal Parameters ..................................................................................... 18
   Retrieving and Organizing Cultural Resource Management Data ..................................... 19
   Archaic Site Elevations and Ecological Zones .................................................................. 20
   Wetland Resources in Utah ............................................................................................... 23
4 | Results ............................................................................................................................... 26
   Archaic Sites across the Landscape .................................................................................. 26
   Great Salt Lake .................................................................................................................. 37
   Owyhee High Plateau ....................................................................................................... 38
   Wasatch Mountains North .............................................................................................. 40
   Wasatch Mountains South ............................................................................................. 41
   Average Distances from Archaic sites to Wetlands ............................................................ 42
5 | Discussion .......................................................................................................................... 48
6 | Conclusion .......................................................................................................................... 52
References ............................................................................................................................. 54
LIST OF FIGURES

Figure 3.1: Map of Physical Boundaries of Research Parameters ........................................ 18
Figure 3.2: Major Land Resource Areas (MLRA) of Utah .................................................. 21
Figure 3.3: Map of Shapefiles of Utah Freshwater Emergent Wetlands from the Utah Geological Society .................................................................................................................. 24
Figure 4.3: Map of Shapefiles of Utah Freshwater Forested/Shrub Wetlands from the Utah Geological Society .................................................................................................................. 24
Figure 3.5: Map of Shapefiles of Utah Lakes from the Utah Geological Society ............. 24
Figure 3.6: Map of Shapefiles of Utah Freshwater Ponds from the Utah Geological Society 24
Figure 4.1: Map of Projectile Point types dated from 11,000 to 9,000 years BP in Utah ...... 29
Figure 4.2: Map of Projectile Point types dated to 8,000 years BP in Utah ......................... 30
Figure 4.3: Map of Projectile Point types dated to 7,000 years BP in Utah ...................... 31
Figure 4.4: Map of Projectile Point types dated to 6,000 years BP in Utah ...................... 32
Figure 4.5: Map of Projectile Point types dated to 5,000 years BP in Utah ...................... 33
Figure 4.6: Map of Projectile Point types dated to 4,000 years BP in Utah ...................... 34
Figure 4.7: Map of Projectile Point types dated to 3,000 years BP in Utah ...................... 35
Figure 4.8: Map of Projectile Point types dated to 2,000 years BP in Utah ...................... 36
Figure 4.9: Distribution of projectile point types in the Great Salt Lake Land Resource Area 38
Figure 4.10: Distribution of projectile point types in the Owyhee High Plateau Land Resource Area .......................................................................................................................... 39
Figure 4.11: Distribution of projectile point types in the Wasatch Mountains North Land Resource Area .......................................................................................................................... 40
Figure 4.12: Distribution of projectile point types in the Wasatch Mountains South Land Resource Area .......................................................................................................................... 42
LIST OF TABLES

Table 3.1: Projectile point types of the Great Basin and their dates in the archaeological record
..................................................................................................................................................20

Table 4.1: Histogram chart of Archaic Site Elevations from each Time period......................27

Table 4.2: Histogram chart of Elevations of Archaic Sites with Groundstone from each Time
period.................................................................................................................................................27

Table 4.3. Archaic Site Distribution in the Great Salt Lake Land Resource Area Ecological
Zones by Time Period........................................................................................................................37

Table 4.4. Archaic Site Distribution in the Owyhee High Plateau Land Resource Area
Ecological Zones by Time Period.......................................................................................................39

Table 4.5. Archaic Site Distribution in the Wasatch Mountain North Land Resource Area
Ecological Zones by Time Period........................................................................................................40

Table 4.6 Archaic Site Distribution in the Wasatch Mountain South Land Resource Area
Ecological Zones by Time Period.........................................................................................................41

Table 4.7. Number of Archaic sites in closest proximity to each wetland type.................43

Table 4.8. Average Distances (in kilometers) of Archaic Sites to the closest proximity wetland
from each Archaic Period ....................................................................................................................43

Table 4.9. Average distances (in kilometers) of Archaic projectile point types to the closest
proximal wetland.................................................................................................................................45
1 | Introduction

Although not the only reason for cultural change, environmental change can be, and often is, attributed as a main reason cultural change happens, especially in the Great Basin during the Archaic period. This is evident in the archaeological literature of the Great Basin and was especially described in Dave Madsen’s (1982) book chapter, “Get it where the getting’s good: a variable model of Great Basin subsistence and settlement based on data from the eastern Great Basin”.

Madsen composed a model for Great Basin subsistence and settlement that he hoped would expand on data archaeologists already had and had yet to discover. He then described how the data they had in 1982 fit with his model: people during the Early Archaic lived near lake edges, and possibly had relatively permanent settlement. As the climate warmed and peaked in the Middle Holocene, people during the Middle Archaic spread out looking for more resources in the upland areas. The Late Holocene brought more moisture back to the area, and Madsen believed people were flooded out of lake periphery and marshland resources that their predecessors had taken advantage of, and instead exploited resources in the uplands, especially the relatively newly arrived pine nuts in the region (Madsen 1982).

As forty years have passed since this was published, I examined whether current data suggests that the environmental-climatic changes over the course of the Holocene affected settlement and subsistence for people during the Archaic period. I ask two basic questions: (1) did climatic changes affect how people expanded across the landscape during the Archaic and
how did they expand? And (2) did the people during the Late Archaic move away from the lake periphery sites to other wetland resources and, if so, where specifically did they move?

My physical boundary for answering these questions is in the Eastern Great Basin, which generally covers the western half of Utah and a small portion of the eastern side of Nevada. The Great Basin includes the western half of Utah, Nevada, southeastern Idaho, southeastern Oregon and Southeastern California. For the purposes of this project, I focus on just the Utah area of the eastern Great Basin. By focusing my research on just the western half of the state of Utah, I was able to efficiently acquire Cultural Resource Management information from the Utah State Preservation Office and it made the data more manageable and provided a groundwork for answering my questions and understanding the possible reasons for those answers. My temporal boundary is the Archaic period, which ranges from approximately 10,000 BP to 2,500 BP.

**Organization**

This thesis is organized into five more chapters as follows: Background, Methods, Results, Discussion, and Conclusion. These subsequent chapters will explain the results of the questions I examine. My analyses show that there was a significant difference of distributions between sites from the Early Archaic to the Late Archaic. These changes, especially between the Early and Middle Archaic, can be attributed to climatic changes and its resulting changes to the food resources available, as the people expanded into more mountainous regions and went to higher elevations to retrieve more resources. Early Archaic sites stay mainly in the Great Salt Lake area at lower elevations and closer to water resources. The Middle Archaic sites are more spread out across the landscape, more frequently occurring at higher elevations. The number of sites in the Late Archaic nearly doubles, and these sites, as I will show, moved closer to water resources overall, but not to lake periphery sites. Late Archaic sites are also more
spread out across the landscape, according to latitude and longitude and elevation. The changes from the Middle Archaic to the Late Archaic are attributed to both environmental and social pressures.

The background chapter highlights some of the research explaining the physical conditions of the ecology and archaeology. This chapter is divided into smaller sections explaining the different Holocene periods and the ecological data and the corresponding Archaic periods with its archaeological data. The Archaic period lasted approximately eight thousand years, and the Early, Middle, and Late periods each cover a few thousand years.

The Methods chapter explains how I organized my data and employed statistical analyses to investigate answers to my questions described above. For each question, I employ similar statistical testing methods to determine if there are any significant patterns present in the data. The first set of data is elevation data from the site forms and Analysis of Variance, and Tukey-Kramer tests are calculated. Utah is made of different ecological zones depending on the part of the landscape. The Chi-Squared analysis is employed to determine whether there is a significant difference of what is predicted versus what is observed within these ecological zones. The average distances from the Archaic sites to Utah’s wetlands are calculated through Haversine formula, and they, too, are analyzed through Analysis of Variance and Tukey-Kramer tests.

The results of the analyses are reviewed in the Results chapter. The chapter will be organized in a corresponding fashion as the Methods chapter. The results of each statistical analysis are reviewed.

The Discussion chapter will explore the ramifications and implications of any patterns present and determine how climate could have affected any changes in the archaeological record or what social reasonings there could be as well.
The final chapter will conclude this thesis by recapitulating the answers to the questions to be considered and to consider what other research could be done to further understand the people of the Archaic.
2 | Previous Research of the History of the Great Basin

The Great Basin has long been an inhospitable land. To those who lived here on the edge of subsistence, the slightest change, an unusually dry period, for example, could mean disaster. More than once, groups must have moved out of this area, not knowing what lay before them, but well aware that death lay behind them (Wormington 1955: 117).

Marie Wormington was not alone in how she described the Great Basin. The consensus among professional and amateur archaeologists working in the Great Basin was that life prehistorically would have been very difficult and many wondered how people had survived in such a barren area. Two reasons for this perception were that archaeological discoveries were evaluated through a cultural ecological model created by Julian Steward and was also evaluated through ethnographies both implicitly and explicitly (McBrinn and Roth 2016; Madsen 1982).

The idea that the Great Basin was unlivable changed with an adjusted focus in archaeological thought, which studied “why” and “how” questions of people’s behavior. This change occurred around the 1980s. Interdisciplinary collaboration with palynology, zoology, botany, ecology, and other disciplines was, and is, key to answering questions about people’s behavior from the archaeological record. In many instances, the archaeological research in the Great Basin heavily focused on the Human Behavioral Model, inhibiting other explanations for the archaeological and cultural material (McBrinn and Roth 2016). Nevertheless, a clearer image of what challenges people may have faced and the human ingenuity to face those problems in the Great Basin became, and is still becoming, more transparent. Interdisciplinary collaboration and a more scientific approach to answering archaeological questions created a
different picture that could not be explained through ethnographic data (Madsen 1982: 208). This collaboration also helped create opportunities to look at archaeology through a new lens creating a clearer understanding of the Early, Middle, and Late Holocene and Archaic periods.

The early, middle, and late Holocene periods had some stark differences between them environmentally which created some different behaviors in the archaeological data between the Early, Middle, and Late Archaic periods. It should be explicitly stated environmental impacts were never the only reason for cultural change. This chapter will summarize some of the relevant knowledge and research that provides an in-depth background of the ecological conditions of the Great Basin during these periods. Most of the research pertains to the Eastern Great Basin, as some environments in the Great Basin were impacted somewhat differently by the environmental changes during the Holocene. The archaeological information from the Archaic period also focuses on the Eastern Great Basin for the same reasons as the environmental data. The background information includes ecological, faunal, palynological, flora, and archaeological data. The wetlands in Utah will also be discussed briefly.

**Early Holocene**

The Early Holocene began approximately 10,000 radiocarbon years ago. The pluvial lakes of the Late Pleistocene had diminished and became many different wetlands and marshes created by a complex series of stream channels (Grayson 2011; Oviatt et al. 2021; Murchison 1990). As the Early Holocene became warmer, sediment particle size analysis shows that lakes, marshes, and streams started drying out. Areas that once had minor lakes and marshes, now had no lakes or marshes, and those areas with major lakes and marshes are now much smaller in size (Grayson 2011). The diminishment of these wetlands occurred at various times but ended no later than 7,500 years ago (Grayson 2011), at the “start” of the Middle Holocene.
Palynological and flora research corroborates the geological evidence of a moister environment. Hackberries, spruce trees, and sagebrush are all moisture dependent plants. Palynological research shows these plants were present during the Early Holocene, indicating there was enough moisture in the area for them to survive (Louderback 2007; Morris et al. 2012; Madsen and Currey 1979; Louderback and Rhode 2009). Hackberries were discovered in Homestead Cave and have been shown to have disappeared around 7,100 years ago as the environment transitions to hotter and drier (Louderback 2007).

Spruce trees were abundant in the lower elevations of the Eastern Great Basin with few pine trees. As the area became drier, this ratio changed. Spruce trees, preferring wetter areas, migrated upward into the mountains as the area started drying up and the pine trees began covering the lower elevations (Morris et al. 2012; Madsen and Currey 1979).

Sagebrush pollen and Chenopodium/Amaranthus (cheno-am) pollen from the sediments of Blue Lake show a similar change as the spruce and pine trees. Sagebrush typically prefers cooler, moister environments, whereas cheno-am plants typically prefer warmer, drier environments. The pollen in the sediments of Blue Lake show a decline in sagebrush pollen and an increase cheno-am pollen in the Early Holocene, and by 8,500 years ago, cheno-ams became dominant (Louderback and Rhode 2009; Morris et al. 2012). The researchers also noted the only time sagebrush pollen was substantially more abundant than cheno-am pollen was before 9,500 years ago. This occurred again about 5,700 years ago, as the environment became moister, and the presence of sagebrush pollen increased dramatically (Louderback and Rhode 2009).

Zooarchaeological data concurs with the palynological and ecological data. Remains of many small mammal species migrated into higher elevations as the environment became warmer and drier. Pikas are one example. Today, they are found at 8,000-ft elevation, but during the Early Holocene period they were living at an elevation of 5,500-ft. Similarly, pygmy
rabbits, busy-tailed woodrats, and marmots left the area by 8,000 years ago (Grayson 2006; Grayson 2011). Large mammal remains are less prevalent in the archaeological data, which has caused archaeologists to come to two conclusions: either the evidence is so poor from the Early Holocene that there is little record of large mammals living there, or that there were no large mammals in the Great Basin because the foliage was not adequate for them to thrive in the area (Grayson 2006; Grayson 2011).

**Early Archaic**

The people during the Early Archaic mainly depended on the wetland resources of the Early Holocene. Habitual occupation sites, typically rockshelters and caves, have been found near lake-edge and wetland resources (Madsen 2016; Madsen 1982; Simms 2008). Uplands were often explored for medicinal plants, toolstone, fibers, minerals for paints and special wood, but the lack of identified open residential sites would suggest the Uplands were merely explored and not resided in (Simms 2008). The Early Archaic people were mobile (Madsen 2016) and consumed a broad-spectrum diet. Faunal evidence shows that jackrabbits were a common food source, or at least a common food bone found by archaeologists in caves, as well as sage grouse, deer and pronghorn, fish, and birds (Simms 2008; Jones and Beck 2014). Other resources they exploited were from marsh area, large river deltas, and upland resources (Madsen 2016).

The technologies to process, store, and cook foods were more intensely developed during the Early Archaic. One such technology was waterproof basketry, a hallmark technology of the time (Simms 2008). Twining basketry appeared in the caves of the Eastern Great Basin around 8,600 years ago, as evidence of seed consumption began (Geib and Jolie 2008; Rhode et al. 2006). Basketry evolved in technological sophistication and economic importance. Seed processing and consumption became a staple in their diet. These watertight
baskets have also been found to be used for cooking (Simms 2008). The use of grinding stones (and milling stones) also showed up in the archaeological record around this time (Geib and Jolie 2008; Rhode et al. 2006) but became more widely used toward the beginning of the Middle Archaic (Rhode et al. 2006).

Other lithic tools in their toolkits have been a point of discussion as archaeologists have debated whether there was fluidity between some projectile point types (Madsen 2016; Goebel and Keene 2014; Grayson 2011; Beck and Jones 2010). Great Basin stemmed and fluted points are found throughout the Early Archaic period, as well as Northern side-notched and Hawken side-notched points (Grayson 2011; Justice 2002b). Great Basin stemmed and Great Basin fluted points had different uses in the lithics toolkit.

The lanceolate points, fluted or not, are often found on the same sites as stemmed points but appear to have had different functions. The former seem to have served most often as weapon tips, perhaps on throwing or thrusting spears or as atlatl dart points. The latter seem to have had multiple uses, perhaps only rarely serving as true points. Since the two kinds are so often found together, perhaps they are different tools in the same tool kit” (Grayson 2011: 430).

Whatever the purposes of these projectile points, it corroborates, along with the basketry and groundstone, that there were specialized tasks requiring some specialized tools, which would also indicate that there would be some group settings to pass on these technologies (Simms 2008). These group setting would have been on a more localized scale, as there is no evidence that would suggest a more regional level of trading (Simms 2008).

**Middle Holocene**

As the Holocene environment transitioned from cool-wet to hot-dry, the flora and fauna changed with it. This hot-dry period is referred to as the Middle Holocene and began approximately 7,500 years BP and lasted roughly 3,000 years. It is hypothesized that the Great Basin had become so hot and dry that the Great Salt Lake may have dried up for a short period
of time (Oviatt 2021; Murchison 1990). The geological, flora and faunal data all demonstrate the shift that the environment experienced.

Geological work done by Stuart Murchison (1990) on the Great Salt Lake shows that for part of the Middle Holocene the Great Salt Lake was greatly reduced in size, or completely dried up, between 7,100 and 5,900 years ago. Murchison suggests huge desiccation polygons were formed during this time, which would be an appropriate conclusion considering the aerial photography work done by Don Currey (1980) that shows these desiccation polygons. Desiccation polygons are formed by a long duration of very fine clay being exposed and drying out. Cracks are then formed and create polygons. The desiccation polygons in the Great Salt Lake are huge, some 50 to 330 feet across (Currey 1980).

As the area became even so hot the Great Salt Lake dried up, different pollen records also showed shift in vegetation. Peter Mehringer’s (1985) pollen record in the northern Great Basin suggested that after 9,000 years BP rising temperatures contrasted sharply with the previous cool-moist conditions. Gary Fry (1976) inferred the same warming trend at Hogup Cave around 8,300 years BP from human coprolites that exhibit the ingestion of halophytic vegetation foods and high sodium excretion. Though these dates precede the 7,500 years of the “start” of the Middle Holocene, it demonstrates how the temperatures were rising and vegetation was influenced by the environment and how people consumed it.

Other pollen and flora data suggest a gradual increase of temperature for a couple more thousand years. This is shown through the migration of Pinyon Pine trees. Pinyon Pine trees migrated into the Eastern Great Basin as early as 6,700 years ago based on packrat middens found in Danger Cave (Rhode and Madsen 1998) and other caves in the Great Basin as well (Madsen 1986; Rhode 2000; Rhode and Thomas 1983; Thompson 1984). The current singleleaf pinyon that resides in the Great Basin thrives in a drier climate, only needing 1.5-inches of water during the summertime. Pinyon Pine is believed to have spread quite quickly
after arrival and is presumed to have become a very important food source for Native Americans (Rhode and Madsen 1998). Aspen pollen also increased, as well as drought-tolerant plant pollen, at Purple Lake. Some of these drought plants were Mormon tea, buckbrush and goosefoot (Morris et al. 2012).

Zooarchaeological work shows animals adjusted to the hotter, drier climate. A study surrounding woodrats (Neotoma cinerea) coprolites in the Holocene shows that their body size changed as the temperatures did. During the middle Holocene, Smith and Betancourt (2003) found that woodrats body sizes were drastically smaller and seen at lower elevation sites. For some time, between the Middle and Late Holocene, there is little evidence of woodrats found in cave excavations, when prior to this disappearance of woodrats, coprolite pellets were in abundance (Smith and Betancourt 2003).

Pygmy rabbits were also once in abundance in the Great Basin but failed to adapt to the climatic changes that occurred during the Holocene. Pygmy rabbits thrived in sagebrush-grassland areas and were not adept to living in woodland areas, even in sparsely distributed areas of pinyon-juniper trees. Because of their inability to adapt to wooded areas, data shows a causation between the loss of sagebrush habitat and the decline of pygmy rabbit population (Grayson 2011; Grayson 2006; Schmitt et al. 2002). This decline in population occurred on three different occasions: the first, at the end of the Pleistocene, the second, associated with the on-set of the Middle Holocene, and the last within the first few hundred years of the presence of pinyon-pine, approximately 5,000 years ago, when, in the Eastern Great Basin, pygmy rabbits declined by 80 percent and never recovered (Grayson 2006). Other small mammals were adversely affected by the rise in temperature throughout the Great Basin causing an overall decline in mammalian taxonomical richness that was once present during the early Holocene (Schmitt et al. 2002).
Middle Archaic

With the onset of environmental change in the Holocene, the people during the Middle Archaic adapted to ongoing climatic pressures and discovered new resources to exploit as the plants and animals evolved to these same pressures. Archaeological evidence from the Middle Archaic is somewhat sparse and the peoples’ overall footprint is light (Louderback et al. 2011). Archaeologists questioned whether the area had been abandoned by those who had been residing in the area because of these environmental pressures, although they have found that was not true (Simms 2008). Many sites have likely been obscured by natural processes of deterioration, but basketry and other evidence show that there had been a continuity of heritage and lifestyle between the Early and Middle Archaic (Simms 2008; Jones and Beck 2014). Their foraging and subsistence patterns changed as shown by their lithic toolkits. And their division of labor likely changed as well.

People during the Middle Archaic are thought to have been more spread out across the landscape and inhabiting more areas intermittently than any other era (Simms 2008). Their population size was likely less than either the Early or Late Archaic periods (Louderback et al. 2011). Wetlands were drying up and other areas, like dunes, had more available resources. As such, people were moving from foragers to collectors (Young 2014; Simms 2008). In studying other areas of the Great Basin, archaeologists point to the likelihood of prestige-seeking behavior in communities (Young 2014; McGuire and Hildebrant 2005). The adaptation for more specialized tasks can be seen in the archaeological record as the people during the Middle Archaic had more hunting camps at higher elevations and more diverse caves were habited (Simms 2008).

Some of these higher elevational regions saw the migration of the Pinyon-pine trees which provided a new food resource that was very demanding to process but seemed to be in high demand (Grayson 2011; Louderback and Rhode 2009; Simms 2008). Processing seeds
became a food staple for the people during the Middle Archaic, even though the processing costs were high (Jones and Beck 2014). Seeds were a great storable resource countering the negative aspect that they were arduous to process (Simms 2008). Other resources, such as grouse, mule deer, and bighorn sheep moved upward following their own food resources, proving the need for the people during the Middle Archaic to migrate more across the landscape for those resources (Jones and Beck 2014; Grayson 2011).

**Late Holocene**

Approximately 4,500 years ago the Holocene began to cool and become moister, like the climate we experience in the Eastern Great Basin today. This transition was punctuated by oscillating climatic events that created drastic environmental shifts in a short period of time. For instance, between 4000- and 3700-years BP, the area became much wetter, followed by a drought in 2900 years BP and then another great wet period around 2,500 years BP. Then around 500 years BP another drought occurred followed by a new wet period until 200 years BP (Grayson 2011; Louderback and Rhode 2009).

These climatic changes are substantiated by faunal and floral changes. Cheno-Am, a pollen discussed in the Early Holocene section, prefers hotter-drier climates. Cheno-Am deposits from approximately 4700 years BP at Diamond Pond, Oregon sites, record decreasing levels of pollen from their Middle Holocene record levels to a return to Early Holocene levels. Sagebrush pollen is shown to have increased; sagebrush prefers cooler-moister climates. This data demonstrates the climatic change between the Middle and Late Holocene. Marshes also had become deeper and sagebrush pollen had reached its highest frequencies since the Early Holocene (Louderback and Rhode 2009). An increase in sagebrush is also shown in the pollen record of Purple Lake, Utah, but the pollen counts never increased to match Early Archaic amounts (Morris et al. 2012). Purple Lake also shows an increase in sedges, meadow rue, and
willows to amounts closer to the Early Holocene; all are flora that are moisture dependent (Morris et al. 2012).

The cool-moist environment created conditions for repopulation of western harvest mice in the area after a long hiatus during the Middle Holocene. Their population increase oscillated just as the environment did (Byers and Broughton 2004). Other faunal data suggests an increase in deer, sheep, and rabbits in the region. The Utah sucker fish count also increased as the Great Salt Lake became less saline (Simms 2008).

Water sources in the Great Basin were deeply affected by the different climatic events that took place during the Late Holocene. Valley sediments collected near Humboldt River, Nevada indicate the river was nearly dry between 6,700- and 5,500-years BP and was nearly dry again between 2,500 years ago and 1,900 years ago (Grayson 2011). The Great Salt Lake reached its highest amount between 3,400 year and 2,000 years BP ago to 4,221 feet in depth, causing the Great Salt Lake to overflow into and cover the Great Salt Lake Desert. At 2,400 years BP, the Great Salt Lake Desert became a desert again (Grayson 2011; Murchison 1990). Tree ring data from juniper and pine trees of the Sierra Nevada reinforce dates of these dry periods (Graumlich 1993; Stine 1994).

All environmental data reinforces the oscillating climatic changes in the Late Holocene. Although the area was, in general, cooler, and moister during Late Holocene from the Middle Holocene, the Late Holocene shows more dramatic climatic changes in shorter spurts of time than either the Early or Middle Holocene.

**Late Archaic**

The Late Archaic is an interesting era for Utah archaeology because the population exploded from what it was during the Early or Middle Archaic. People were all over the landscape (Byers and Broughton 2004; Simms 2008). This is demonstrated by the increase in
frequency and percentage of Elko projectile points, a burst in rock art production, and an increase in open site villages, as opposed to rockshelters and caves. Some of these villages began appearing near the shifting wetland habitats and it is believed people participated more in central foraging methods (Simms 2008). Snare manufacturing supports this idea (Simms 2008).

As populations grew, the archaeological evidence conveys that the people during the Late Archaic had more ideas on private goods, kinship arrangements, and territoriality. Foragers still practiced group fluidity but those who started to settle in the wetlands showed more hierarchical systems built on prestige based on big game hunting (Simms 2008). Big game became the targeted resource as shown by the shift in tool making – a decline of cordage used to make traps and snares with an incline in making projectile points and bows and arrows (Byers and Broughton 2004). High population areas during the Late Archaic are also characterized by a depression of artiodactyl herds (Byers and Broughton 2004). While not a top priority, trapping and snaring were still a reliable resource and likely brought in more calories than large game hunting (Simms 2008). Men were the hunters and women were the foragers based on evidence of their osteoarthritis (Grayson 2011). Resources were gathered and stored in long term storage. This is evidenced through coprolites in some Utah rockshelters, which have seeds from different seasons in the same coprolite (Grayson 2011).

Kinship arrangements are hypothesized to be shown through split-twig figurines. These figurines were another phenomenon of the Late Archaic. Nancy Coulam and Alan Schroedl hypothesize that these split-twig figurines were “pass[ed] down generation to generation and helped reinforce and maintain kinship ties and the status of their members” (Simms 2008: 180). Kinship ties must have been very important to the people during the Late Archaic, especially as the population grew, division of labor became more apparent, and farming was introduced into their culture.
The people of the Great Basin prove human ingenuity in difficult times. “To understand the past archaeologists must also have a thorough knowledge of these resources and how prehistoric peoples used or even changed those resources” (McBrinn and Roth 2016: 6). The Holocene-Archaic period was filled with change and adaptations to those changes by flora, fauna, and people through innovativeness and knowledge of their land and its resources (McBrinn and Roth 2016).
3 | Methods

While a great deal of research has been done in the Great Basin, as shown in the previous chapter, to explore the implications of my own questions, I performed statistical analyses to distinguish whether there is a corresponding relationship to how people settled on the landscape. The analyses will show a migration from lower elevations to higher elevations between the Early and Middle Archaic, and a great expansion across the landscape during the Late Archaic. The analyses will also show that Archaic sites always stayed near wetland areas.

Three sets of data were necessary to determine the relationship between the Archaic sites and the impact the environment had during these three periods. The first is obviously the archaeological data provided by the Utah State Historic Preservation Office. The second was retrieved from the USDA Agricultural Handbook 36. This handbook has the current vegetation at each elevational level and soil conditions. And the last set of data was retrieved from the Utah State Geological Society. It was a shapefile of the wetlands in the state of Utah.

This chapter contains four sections. The first section clarifies the physical and temporal boundaries. The second section discusses the method of data collection from the data provided by the Utah State Historic Preservation Office. The third section delves into the methods to understand how people moved across the landscape. And the last section reviews the methods that determine the proximity Archaic sites had to wetlands, and whether people during the Late Archaic moved nearer to wetlands than lake periphery sites.
Physical and Temporal Parameters

As has already been discussed, the data focuses on the Eastern Great Basin during the Archaic period. The Archaic period has been reviewed broadly in the Background chapter and will not be reiterated here. But one important aspect not previously mentioned is Archaic sites are pre-ceramics. For the purposes of this project, sites with ceramics that could be considered contemporaneous were removed from the data.

Figure 3.1. Map of Physical Boundaries of Research Parameters. Physical boundaries follow the arbitrary Utah borders on the northern and western sides of the site, and follows the physical boundaries of the Wasatch Mountain land resource areas on the eastern and southern sides.
The area of the Eastern Great Basin is shown in Figure 3.1. The Eastern Great Basin is mostly covered by the Great Salt Lake Area on its western boundary and the Wasatch Mountains on its eastward boundary. Although the northern boundary normally extends across the arbitrary border between Utah and Idaho for the purposes of this project, it will stop at the border. The southern boundary follows the Wasatch Mountains and Great Basin resource area boundaries. It does not descend to the southern border of Utah. The other large portion of the state of Utah, or the Eastern half, is referred to as the Colorado Basin and Plateau.

Retrieving and Organizing Cultural Resource Management Data

The site data was collected from the Utah State Historic Preservation office. I requested a list of Archaic sites using identifiable Archaic projectile points that could be obtained from their system. This list of identifiable Archaic projectile points came from the Intermountain Antiquities Computer Systems (IMACS) User Guide. The IMACS was the form that Great Basin archaeologists developed to create continuity in the site forms in the research area. The projectile point types included: Elko series, Northern Side-notched, Pinto series, Humboldt Concave Base, McKean Lanceolate, Sudden side-notched, Hawken Side-notched, San Rafael Side-notched, Great Basin Stemmed, Rocker Side-notched, Laddie Creek, Gypsum, Surprise Valley Split Stem, Steamboat, Duncan, Hanna, Mallory, Tuscan, Besant, Pelican Lake, Pahaska Side-notched, Blackwater Side-notched, Lookingbill, Martis, Yonkee, Wedding of the waters, Triangular Unnotched, and Gatecliff. The State Preservation Office provided a list of Smithsonian Trinomial site numbers and the Archaic artifacts associated with each of the sites. It was a list of several thousand “Archaic” sites. I put Archaic in quotations because some of the sites were not associated with Archaic artifacts. The contents of the sites with Archaic artifacts were compiled into a spreadsheet. Ultimately, the original list was whittled down from the original list from the Utah State Historic Preservation Office to only include
sites with known Archaic artifacts, leaving 2,981 Archaic sites in my dataset. Some projectile points were present in the Great Basin for many thousands of years, I put the information of the projectile points in Table 3.1, organizing them by data, rather than by a specific Archaic period.

### Table 3.1. Projectile Points of the Great Basin and their dates in the Archaeological Record.

<table>
<thead>
<tr>
<th>Point Type</th>
<th>Date</th>
<th>Number of Sites</th>
<th>Number of Sites with Groundstone</th>
<th>Number of Sites with Evidence of Fire</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Great Basin Stemmed</td>
<td>11,000 – 8,000</td>
<td>386</td>
<td>33</td>
<td>5</td>
<td>Justice 2002b</td>
</tr>
<tr>
<td>Northern</td>
<td>8,000 – 5,000</td>
<td>151</td>
<td>38</td>
<td>18</td>
<td>Justice 2002b</td>
</tr>
<tr>
<td>Pinto</td>
<td>8,000 – 2,000</td>
<td>453</td>
<td>76</td>
<td>54</td>
<td>Justice 2002b</td>
</tr>
<tr>
<td>Humboldt</td>
<td>8,000 – 2,500</td>
<td>302</td>
<td>83</td>
<td>34</td>
<td>Justice 2002a</td>
</tr>
<tr>
<td>Hawken</td>
<td>7,600 – 5,000</td>
<td>31</td>
<td>8</td>
<td>2</td>
<td>Kornfeld et al. 2016</td>
</tr>
<tr>
<td>Sudden</td>
<td>6,500 – 4,000</td>
<td>17</td>
<td>4</td>
<td>0</td>
<td>Justice 2002b</td>
</tr>
<tr>
<td>Rocker</td>
<td>6,500 – 4,000</td>
<td>25</td>
<td>7</td>
<td>5</td>
<td>Justice 2002a</td>
</tr>
<tr>
<td>Gatecliff</td>
<td>5,000 – 3,000</td>
<td>103</td>
<td>30</td>
<td>15</td>
<td>Justice 2002a</td>
</tr>
<tr>
<td>Yonkee</td>
<td>5,000 – 2,500</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>Hranicky 2011</td>
</tr>
<tr>
<td>McKean</td>
<td>5,000 – 2,500</td>
<td>28</td>
<td>6</td>
<td>4</td>
<td>Hranicky 2011</td>
</tr>
<tr>
<td>Elko</td>
<td>4,500 – 1,500</td>
<td>1308</td>
<td>351</td>
<td>125</td>
<td>Justice 2002a</td>
</tr>
<tr>
<td>Mallory</td>
<td>4,500 – 3,500</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>Justice 2002b</td>
</tr>
<tr>
<td>San Rafael</td>
<td>4,500 – 3,500</td>
<td>27</td>
<td>7</td>
<td>1</td>
<td>Justice 2002b</td>
</tr>
<tr>
<td>Gypsum</td>
<td>4,000 – 2,800</td>
<td>237</td>
<td>60</td>
<td>13</td>
<td>Justice 2002b</td>
</tr>
<tr>
<td>Other</td>
<td>--</td>
<td>28</td>
<td>10</td>
<td>0</td>
<td>--</td>
</tr>
</tbody>
</table>

Archaic Site Elevations and Ecological Zones

As each site form not only contains the contents of the site, but the elevation and location data for each site, I was able to take that information to investigate the answer to my first question: did climatic changes affect how people expanded across the landscape during the Archaic and how did the people of Archaic expand? The elevation and location data from the site forms and identified projectile point artifacts, along with the second set of data from the United States Department of Agriculture Agricultural Handbook, can resolve this question. It will show that climatic change indeed affected how people expanded across the landscape. The
USDA Agricultural Handbook assisted in organizing each site into the different ecological regions in their major land resource areas based on their elevation and on their date, shown in Figure 3.2. The physiography, geology, soil, climate, potential and present natural vegetation, and land use have been recorded, creating an opportunity to understand what resources have been and are available. The Early, Middle, and Late Archaic have floral and faunal data that is similar to current ecoregions because the current ecoregions are so large, each covering a couple thousand feet of elevation (United States Department of Agriculture 2018). The ecoregions are essential in understanding the resources that could have been used by people while occupying those ecoregions.

To determine whether there is a difference between how the people during the Archaic occupying the Eastern Great Basin area, I completed several calculations. The first is just a
basic histogram of the site elevations from each time period, determining the averages and the quartiles. This is to get a general idea of any difference in the range and average elevations between the eras. The second calculation is an Analysis of Variance between the average elevations of the Early, Middle, and Late Archaic periods. The Analysis of Variance determines whether there is a difference between means by calculating whether there is an overlap between each group mean and the grand mean of each group (Carlson 2017: 178). If there is a difference between the means, Tukey-Kramer Honest Significant Differences test is calculated. The Tukey-Kramer test compares the two means through the difference of the two means and dividing that amount by the Standard Error. The Tukey-Kramer test determines which pair of comparisons are significant (Zaiontz 2018)

Lastly, by organizing the sites by major land resource areas and counting how many sites were in each ecoregion, I was then able to calculate chi-square tests on each of the ecoregion tables. Chi-square tests establish whether the outcomes of the ecoregions are independent or associated (Carlson 2017). Unfortunately, for some of the analyses, there are some expected values that resulted in zeros, which will cause some issues with chi-square analyses.

These analyses are done for both all sites and sites specifically with groundstone present. Additional analyses were done with sites with groundstone because groundstone was extremely significant to the people of the Archaic and showed that there was some permanence at the sites and likely both men and women at these sites (Simms 2008).

These calculations can aid in interpreting how and when people were populating the landscape and if there were any resource zones that were more populated than others at any given time.
Wetland Resources in Utah

As Madsen briefly discussed, water/wetland resources dramatically changed from the Early Holocene to the Late Holocene, and this change resulted in how the people during the Archaic tied themselves to water resources. These environmental changes would have had a serious impact on how the people, during the times of more limited resources, acquired valuable resources. In the Late Holocene the environmental changes were increasingly unsteady (Grayson 2011; Louderback and Rhode 2009). These climatic episodes would have created challenges for the Late Archaic people, causing some shifts in how they adapted to their evolving environment. Although there is not a perfect way of determining exactly how the people of the Archaic associated with water resources, determining the distances between the different wetland types to each Archaic site, and how those distances changed over time, using current wetland conditions as the proxy for prehistoric wetlands, will hopefully provide a clearer insight as to how people during the Late Archaic were associating with lake edge areas or marshlands.

There are 290,991 wetlands in the state of Utah – 86,311 freshwater emergent wetlands (marshes), 23,563 freshwater forested-shrub wetlands (swamps), 58,207 freshwater ponds, 4,471 lakes, and 118,539 riverine environment (Utah Geological Society 2022). The freshwater emergent wetlands, freshwater forested-shrub wetlands, freshwater ponds, and lakes were mapped in Figures 3.3-3.6.

Using the geolocational data from the wetland shapefile, I calculated the latitude and longitude of the center of each wetland sphere and the radius. With those coordinates and radii, I calculated the distances from each site to each wetland using the Haversine Great Circle Distance. The Halversine Great Circle Distance calculates “the shortest distance between two points… (‘as the crow flies’)… this method assumes a spherical earth, ignoring ellipsoidal effects” (Sinnott 1984), meaning it includes the earth’s diameter in its calculation, but ignores
Figure 3.3. Map of Shapefiles of Utah Freshwater Emergent Wetlands from the Utah Geological Society

Figure 3.4. Map of Shapefiles of Freshwater Forested/Shrub Wetlands from the Utah Geological Society

Figure 3.5. Map of Shapefiles of Utah Lakes from the Utah Geological Society

Figure 3.6. Map of Shapefiles of Utah Freshwater Ponds from the Utah Geological Society
the equatorial axis, polar axis, and inverse flattening of the earth. It also does not consider terrain and the difficulty of getting to certain locations. The sites were too numerous to adequately accomplish considering terrain. I calculated the Haversine Great Circle Distance with and without the radii of the wetland from each wetland to each site.

As all the distances were calculated, I calculated an Analysis of Variance test of the average distances from the wetland types – freshwater emergent wetlands, freshwater forested/shrub wetlands, lakes, and ponds – and the sites from each era to see if there was a difference between the four wetlands over time. I also completed a Tukey-Kramer analysis to determine which pairs of data show a significant difference. The Analysis of Variance calculations were also completed for specific sites with groundstone. These analyses will indicate a relationship between water resources and people of the Archaic, and water resources people during the Archaic were driven to in different eras. I also completed a chi-square analysis on the distances to wetlands based on projectile point types rather than on time period.

The results of these analyses will identify whether there are probable patterns across the landscape of settlement for the Archaic people both in their expansion across the landscape and their proximity to wetland resources.
The results of the analyses show definite patterns in the archaeological record. These patterns show a distinct expansion over time from the Great Basin Resource zone to more upland areas, especially in the Middle Archaic. The Late Archaic has a rapid expansion. The Archaic sites are also shown to remained closer to marshlands and ponds throughout the Archaic and having a fair distance away from lake-edge areas.

The results for the analyses will be described in the same order as they were explained in the previous chapter. First, I will discuss the overarching histogram and Analysis of Variance results of the elevations of the Archaic sites, and then will discuss each major land resource zone. I will also discuss the distribution differences by projectile point. I will briefly discuss any overarching trends that are observed from the average distances to wetlands from Archaic sites over time. I will discuss the results of the Analysis of Variance tests, the Tukey-Kramer test, and a chi-square test of the average distances of wetlands to Archaic sites based on projectile points.

**Archaic Sites across the Landscape**

The data from the Archaic sites show that the people during the Archaic gradually spread across the landscape. This began with a transition to higher elevations during the transition to the Middle Archaic and continued through to the Late Archaic. Tables 4.1 and 4.2 show this expansion. Table 4.1 highlights the overall Archaic sites from each period, whereas Table 4.2 specifically conveys Archaic sites that contain groundstone as well. In each of these tables, the Early Archaic shows very low elevation numbers. Around 8,000 BP, three new
projectile point types were introduced to the archaeological record – Northern side-notched, Pinto series, and Humboldt series – toward the turn of the Early Archaic to Middle Archaic, and the average elevations of the sites with those point types increased significantly, by approximately 700ft, and continued to increase through toward the end of the Late Archaic period.

The ranges for the sites with groundstone portray a pattern. It seems the sites with groundstone increased in elevation from the Early Archaic to the Late Archaic, and then the averages of the elevations, both the median and mean averages decreased.

<table>
<thead>
<tr>
<th>Table 4.1. Histogram chart of Archaic Site Elevations from each Time Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
</tr>
<tr>
<td>Minimum</td>
</tr>
<tr>
<td>1st Quartile</td>
</tr>
<tr>
<td>Median</td>
</tr>
<tr>
<td>3rd Quartile</td>
</tr>
<tr>
<td>Maximum</td>
</tr>
<tr>
<td>Average</td>
</tr>
<tr>
<td>Count</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 4.2. Histogram chart of Elevations of Archaic Sites with Groundstone from each Time Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
</tr>
<tr>
<td>Minimum</td>
</tr>
<tr>
<td>1st Quartile</td>
</tr>
<tr>
<td>Median</td>
</tr>
<tr>
<td>3rd Quartile</td>
</tr>
<tr>
<td>Maximum</td>
</tr>
<tr>
<td>Average</td>
</tr>
<tr>
<td>Count</td>
</tr>
</tbody>
</table>
In analyzing the Archaic sites over time from the Early Archaic to the Late Archaic, there is a visual difference over time. This can be seen in Figures 4.1-4.8, from 9,000 BP to 3,000 BP. The Early Archaic sites start more in the Great Salt Lake area, and then expand outward, especially at the transition between the Early and Middle Archaic. And from the Middle Archaic to the Late Archaic as the sites boom with the introduction of the mass production of Elko points throughout the Eastern Great Basin.

Figures 4.1-4.8 also convey the difference shown by histogram chart on Tables 4.1 and 4.2. Most Early Archaic sites were in the lower Great Basin region. There were a few that were in higher elevation toward the south and east. It also looked like there were two areas that Early Archaic sites congregated. Around 8,000 BP, three more projectile points were introduced into the archaeological record in the Eastern Great Basin. Figure 4.2 shows final dispersion of the projectile points, not how the projectile points were dispersed. But the map would portray that the northwest corner of the Utah became an area of greater importance in the Middle Archaic and would continue to do so through the Late Archaic. The sites also seem to congregate more toward the south. This could be for a variety of reasons. As the Late Archaic occurs, many more sites are plotted.

This visual representation of the data indicates the same results as Analysis of Variance and Tukey-Kramer Significance tests. The Analysis of Variance Tests between these same periods as the histogram charts produced p-values that can be rounded to 0 for all Archaic sites and 0.000249 for Archaic sites with groundstone. As these p-values are under 0.05, there is some significance about the averages of the elevations of the different periods. The Analysis of Variance test coupled with the Tukey-Kramer test produced significant correlations of all pairs except the pairs of the Middle Archaic and the transition from the Middle Archaic to the Late Archaic (around 5,000 BP), and the Late Archaic and toward the end of the Late Archaic (around 2,000 BP). Based on the results, this elevation expansion must have occurred.
Figure 4.1. Map of projectile point types dated from 11,000 to 9,000 years BP in Utah
Figure 4.2. Map of projectile point types dated to 8,000 years BP in Utah.
Figure 4.3. Map of projectile point types dated to 7,000 years BP in Utah
Figure 4.4. Map of projectile point types dated to 6,000 years BP in Utah
Figure 4.5. Map of projectile point types dated to 5,000 years BP in Utah.
Figure 4.6. Map of projectile point types dated to 4,000 years BP in Utah.
Figure 4.7. Map of projectile point types dated to 3,000 years BP in Utah
Figure 4.8. Map of projectile point types dated to 2,000 years BP in Utah
Archaic sites with groundstone showed a different result from the Analysis of Variance test and Tukey-Kramer tests. The Analysis of Variance test proved to be significant with a p-value of 0.000249 as stated above, but the Tukey-Kramer tests showed that only the group pairs with Early Archaic sites were significant. So there is a statistical difference between the Early Archaic and the transition from the Early Archaic to the Middle Archaic and the Early Archaic and the Middle Archaic. This would also indicate a significant expansion from the Early to Middle Archaic periods.

While understanding these elevation differences in each resource area, it is important to reiterate the elevational ranges from each major land resource area were designated by the United States Department of Agriculture based on environmental resources in these zones. There are four important resource areas – the Great Salt Lake, Owyhee High Plateau, and Wasatch Mountains North and South. The Great Salt Lake was obviously a very important resource zone, and the numbers correspond with that.

*Great Salt Lake Land Resource Zone*

The Great Salt Lake land resource area covers the Great Salt Lake and the Great Salt Lake Desert. This major land resource area has the greatest site count compared to the other

<table>
<thead>
<tr>
<th>Ecological Zone</th>
<th>Elevation (feet)</th>
<th>Early</th>
<th>Transition to Middle Archaic</th>
<th>Middle</th>
<th>Transition to Late Archaic</th>
<th>Late</th>
<th>Transition from Late</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desert</td>
<td>4100-5100</td>
<td>336</td>
<td>579</td>
<td>373</td>
<td>401</td>
<td>602</td>
<td>516</td>
</tr>
<tr>
<td>Semidesert</td>
<td>4300-6000</td>
<td>129</td>
<td>415</td>
<td>338</td>
<td>405</td>
<td>784</td>
<td>653</td>
</tr>
<tr>
<td>Upland</td>
<td>4300-7000</td>
<td>136</td>
<td>538</td>
<td>465</td>
<td>540</td>
<td>1104</td>
<td>931</td>
</tr>
<tr>
<td>Mountain</td>
<td>5200-8600</td>
<td>34</td>
<td>296</td>
<td>289</td>
<td>335</td>
<td>772</td>
<td>645</td>
</tr>
</tbody>
</table>
major land resource areas. It, too, also has four ecological zones: desert, semidesert, upland, and mountains. Table 4.3 shows the distribution of those sites from each period.

The chi-square test results showed the distribution as significant and intentional for the Great Salt Lake Resource Area. This is hardly surprising considering the number of sites in the area, in every ecological zone. Table 4.3 displays the distribution of sites from each era.

Figure 4.9 displays the distribution of projectile points for the Great Salt Lake resource area. Almost all projectile points from the data I collected are found in the Great Salt Lake; the only exception is Gypsum. Interestingly, there are significant numbers of earlier projectile points, and as the projectile points become associated with later periods, they lack presence in the area, except San Rafael projectile point. The chi-squared analysis for the distribution of projectile points in the Great Salt Lake resource area also gave a significant result.

**Figure 4.9.** Distribution of projectile point types in the Great Salt Lake Land Resource Area

---

**Owyhee High Plateau Land Resource Zone**

The Owyhee High Plateau is found in the northwest corner of the State of Utah and branches out through Idaho. It has four ecological zones: uplands, mountains, high mountains,
Table 4.4. Archaic Site Distribution in the Owyhee High Plateau Land Resource Area Ecological Zones by Time Period

<table>
<thead>
<tr>
<th>Ecological Zones</th>
<th>Elevation (feet)</th>
<th>Early</th>
<th>Transition to Middle Archaic</th>
<th>Middle</th>
<th>Transition to Late Archaic</th>
<th>Late</th>
<th>Transition from Late</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upland</td>
<td>5000-7000</td>
<td>0</td>
<td>28</td>
<td>28</td>
<td>29</td>
<td>174</td>
<td>50</td>
</tr>
<tr>
<td>Mountain</td>
<td>6000-8600</td>
<td>0</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>26</td>
<td>21</td>
</tr>
<tr>
<td>High Mountain</td>
<td>8000-9000</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Subalpine</td>
<td>9000-9300</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Figure 4.10. Distribution of projectile point types in the Owyhee High Plateau Land Resource Area

and subalpines. Table 4.4 shows the results of the distributions. Surprisingly, it shows there are no Early Archaic sites in the Owyhee High Plateau resource area. There are some sites dating to the transition to the Middle Archaic and in the Middle Archaic. The number of sites increases exponentially during the Late Archaic. Only a few kinds of projectile points are found in the Owyhee High Plateau resource area, as shown in Figure 4.10; these include Pinto series, Humboldt, McKeans, and Elko series projectile points. With there being so few projectile point types, it is unsurprising that there are so few sites in this resource zone.

The chi-square analyses showed that neither the distribution by the time periods nor by projectile point were significant. The p-value for the chi-square analysis by projectile point...
type was 1. The p-value for the chi-square analysis by era was just above 0.05. This could be because there were no projectile points found in the High Mountain or Subalpine regions.

**Wasatch Mountains North Land Resource Zone**

As the name would indicate, the Wasatch Mountains sector covers the Wasatch Mountain range. The Wasatch Mountains are divided into northern and southern areas as the areas vary enough that they are considered different resource areas. This is the furthest edge of the Great Basin area on the east side. The Wasatch Mountains reach above 10,000 ft and there are archaeological sites in those regions. There are four other ecological zones in the Wasatch

<p>| Table 4.5. Archaic Site Distribution in the Wasatch Mountain North Land Resource Area Ecological Zones by Time Period |
|---------------------------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|</p>
<table>
<thead>
<tr>
<th>Ecological Zones</th>
<th>Elevation (feet)</th>
<th>Early</th>
<th>Transition to Middle Archaic</th>
<th>Middle</th>
<th>Transition to Late Archaic</th>
<th>Late</th>
<th>Transition from Late</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upland</td>
<td>4300-7000</td>
<td>2</td>
<td>37</td>
<td>37</td>
<td>42</td>
<td>103</td>
<td>95</td>
</tr>
<tr>
<td>Mountain</td>
<td>5200-8600</td>
<td>1</td>
<td>23</td>
<td>27</td>
<td>29</td>
<td>84</td>
<td>71</td>
</tr>
<tr>
<td>High Mountain</td>
<td>6000-9000</td>
<td>1</td>
<td>12</td>
<td>15</td>
<td>19</td>
<td>58</td>
<td>55</td>
</tr>
<tr>
<td>Subalpine</td>
<td>8000-10000</td>
<td>0</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>Alpine</td>
<td>&gt;10000</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

![Figure 4.11. Distribution of projectile point types in the Wasatch Mountains North Land Resource Area](image)
Mountains North: Upland, Mountain, High Mountain and Subalpine areas. The number of sites also grows over time in this region, having very few in the Early Archaic, increasing in the Middle Archaic and tripling in the Late Archaic, as shown in Table 4.5. The sudden increase in the Late Archaic is due to the number of Elko sites, as there are significantly more Elko projectile points found in this resource zone than other projectile points, as shown in Figure 4.10.

The chi-square analyses for the Wasatch Mountains North, for time and projectile point, showed different results. The projectile point distribution had a p-value of 0, the data organized by projectile points seems to be significant, but the p-value by era was almost one, and not significant. This could be because some values for the Early and transition to the Middle Archaic were missing, whereas the values were all present for all ecological zones when organizing the data by projectile points.

Wasatch Mountains South Land Resource Zone

The Wasatch Mountains South covers a smaller area than Wasatch Mountains North but has more archaeological sites. It also has the most ecological zones between any group, but oddly the elevations are not published for the four higher ecological zones, making it hard to determine how to categorize some sites that were higher than the two recorded resource zones.

While it is not recorded, I placed these values in Mountain ecological zone in Table 4.6, but the

<table>
<thead>
<tr>
<th>Ecological Zone</th>
<th>Elevation (feet)</th>
<th>Early</th>
<th>Transition to Middle Archaic</th>
<th>Middle</th>
<th>Transition to Late Archaic</th>
<th>Late</th>
<th>Transition from Late</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semidesert</td>
<td>5000-7000</td>
<td>3</td>
<td>35</td>
<td>43</td>
<td>51</td>
<td>145</td>
<td>123</td>
</tr>
<tr>
<td>Upland</td>
<td>6800-8500</td>
<td>2</td>
<td>63</td>
<td>77</td>
<td>88</td>
<td>285</td>
<td>260</td>
</tr>
<tr>
<td>Mountain</td>
<td>Not written</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>29</td>
<td>28</td>
<td>0</td>
</tr>
<tr>
<td>High Mountain</td>
<td>Not written</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Subalpine</td>
<td>Not written</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Alpine</td>
<td>Not written</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
values could be in the other ecological zones. Each type of projectile point was found in the Wasatch Mountain South resource area, except Mallory projectile points. Most are in very small numbers, except Hawken projectile points and Elko projectile points, as shown in Figure 4.12. Based on the Wasatch Mountain numbers, it seems Hawken projectile points were used a lot in the Upland areas in both resource areas.

Like its northern counterpart, the Wasatch Mountain South chi-square analyses show there are no correlations. Both chi-square analyses for the projectile points and for the eras had high p-values that were out of range. Perhaps this is because in part the ecological zone data is limited to the two lower ecological zones, or perhaps it is because it because the few sites in the resource area compared to the area it covers.

**Average Distances from Archaic sites to Wetlands**

The wetlands of the Holocene would have been the most important resource for the people during the Archaic, whether it was a marsh, swamp, lake, or pond. These wetlands not only provided water, a valuable resource, but they also provided food resources in plants and
animals. Although the wetland data is not a perfect set of data because the wetland data are of current locations and sizes rather than contemporaneous to the Archaic artifacts, the results show an imprecise proxy of wetland-Archaic site distances. Overall, there are significantly more Archaic sites in closer proximity to ponds and then marshes than any other wetland type, but the distance of the Archaic sites to the ponds are rarely the smallest averages from each wetland type. This data is shown in Tables 4.7 and 4.8.

In the Early Holocene, the landscape would have looked significantly different with larger bodies of water, and more wetlands surrounding those bodies of water and in the surrounding areas. And the Middle Archaic would have had significantly less marshes and swamps and lakes and ponds. As I said in the Background chapter, the drought was so significant that the Great Salt Lake either dried up completely, or almost died up completely. Nevertheless, the averages of the distances of the current wetlands and Archaic sites show farther distances in the Early Archaic than other periods, and closer distances in the Middle Archaic, but the likelihood is that the distances were closer during the Early Archaic and the

<table>
<thead>
<tr>
<th>Table 4.7. Number of Archaic sites in closest proximity to each wetland type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wetland Type</td>
</tr>
<tr>
<td>-------------------------------------</td>
</tr>
<tr>
<td>Freshwater Emergent Wetlands</td>
</tr>
<tr>
<td>Freshwater Forested/Shrub Wetlands</td>
</tr>
<tr>
<td>Lakes</td>
</tr>
<tr>
<td>Ponds</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 4.8. Average Distances (in kilometers) of Archaic Sites to the closest proximity wetland from each Archaic Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wetland Type</td>
</tr>
<tr>
<td>-------------------------------------</td>
</tr>
<tr>
<td>Freshwater Emergent Wetlands</td>
</tr>
<tr>
<td>Freshwater Forested/Shrub Wetlands</td>
</tr>
<tr>
<td>Lakes</td>
</tr>
<tr>
<td>Ponds</td>
</tr>
</tbody>
</table>
people were either living in the wetlands or very near the wetlands during that time, and these values reflect the smaller marshes, swamps, lakes, and ponds of the wetlands at their current conditions. During the Middle Archaic, the data suggests people remained close to the wetland resources that were present, as the averages indicate they were closer to wetlands than the Early Archaic, but farther from wetlands than the Late Archaic.

The averages in the Late Archaic are the smallest averages for lakes and ponds and freshwater emergent wetlands (or marshes), but freshwater forested wetlands are a farther distance away from Late Archaic sites than Middle Archaic sites.

This trend is different for average distances between Archaic sites and the four types of wetlands. The average distances are shown in Table 4.8. Archaic sites move closer to freshwater emergent wetlands during the Middle Archaic and then farther away again, this is true for lakes as well, but the data seems to show closer distances for freshwater forested wetlands and ponds during the Early Archaic with an increase into the Middle Archaic and then a continued increase in the Late Archaic but a decrease in association with pond areas.

While initial observation seems to show that there is a difference of averages between the different periods, an Analysis of Variance test would indicate statistically whether there is a difference. Between average distances for each Archaic site overtime to each wetland type calculated to a p-value rounded to zero, and the average distances for each Archaic site with groundstone overtime to each wetland type also produced a p-value rounded to zero. Both p-values would signify statistical significance.

As a consequence of this statistical significance, I also calculated Tukey-Kramer significance test to see where the significant comparisons were in the data. The results of this analyses were very different between all Archaic sites and the Archaic sites with groundstone. Most of the comparisons computed through the Kramer-Tukey were not statistically significant. Freshwater emergent wetlands showed the most significance between the Early Archaic periods
Table 4.9. Average distances (in kilometers) of Archaic projectile point types to the closest proximal wetland

<table>
<thead>
<tr>
<th>Wetland Type</th>
<th>Great Basin Stemmed</th>
<th>Pinto</th>
<th>Northern</th>
<th>Humboldt</th>
<th>Hawken</th>
<th>Sudden</th>
<th>Rocker</th>
<th>Gatecliff</th>
<th>McKean</th>
<th>Elko</th>
<th>San Rafael</th>
<th>Gypsum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freshwater Emergent Wetland</td>
<td>6.32</td>
<td>3.64</td>
<td>2.09</td>
<td>2.30</td>
<td>0.69</td>
<td>0.48</td>
<td>3.15</td>
<td>2.60</td>
<td>4.25</td>
<td>2.13</td>
<td>2.74</td>
<td>2.65</td>
</tr>
<tr>
<td>Freshwater Forested/Shrub Wetland</td>
<td>1.22</td>
<td>0.75</td>
<td>1.47</td>
<td>0.95</td>
<td>2.08</td>
<td>1.46</td>
<td>1.07</td>
<td>0.93</td>
<td>2.49</td>
<td>1.22</td>
<td>0.31</td>
<td>1.08</td>
</tr>
<tr>
<td>Lake</td>
<td>6.50</td>
<td>4.67</td>
<td>3.30</td>
<td>5.89</td>
<td>0.26</td>
<td>#DIV/0!</td>
<td>2.96</td>
<td>3.45</td>
<td>1.20</td>
<td>3.31</td>
<td>#DIV/0!</td>
<td>0.57</td>
</tr>
<tr>
<td>Pond</td>
<td>7.04</td>
<td>10.56</td>
<td>5.06</td>
<td>8.30</td>
<td>9.36</td>
<td>4.05</td>
<td>3.40</td>
<td>5.39</td>
<td>1.76</td>
<td>8.13</td>
<td>3.28</td>
<td>5.86</td>
</tr>
</tbody>
</table>
and the transition from the Early Archaic period and the rest of the time periods. These comparisons had a higher q-critical values. Other comparisons that were significant were Early Archaic distances to lake areas with Late Archaic distances to lake areas, and the same with pond areas – Early Archaic distances to ponds with Late Archaic distances to ponds.

The Archaic Sites with groundstone showed only significant comparisons between ponds and freshwater emergent distances, there were no significant comparisons between average distances to the same wetlands.

I also divided the data by projectile point type and calculated an Analysis of Variance for the data based on their averages to different wetland types. The average distances for each projectile point to each wetland type is listed in Table 4.9. The Analysis of Variance produced a p-value of 0.000132 which would indicate statistical significance, but the chi-square test results would indicate otherwise. The resulting p-value for the chi-square test was 0.636182.

Briefly, there are several wetland codes that occurred most often for each wetland type. The wetland codes for the freshwater emergent wetlands that occurred most often were PEM1A, PEM1B, PEM1C, AND PEM1J. “P” refers to Palustrine, which means marshy environment. “EM” refers to Emergent; the 1 refers to Persistent and the A, B, C, and J refer to how often the wetlands are flooded. “A” is temporarily flooded, “B” is seasonally saturated, “C” is seasonally flooded, and “J” is intermittently flooded. Freshwater Forested/Shrub wetlands had one occurring type of wetland – PSSA/B/C – meaning Palustrine for “P”; “SS” is scrub-shrub and “A”, “B”, and “C” are temporarily flooded, seasonally saturated and seasonally flooded. Ponds are also a Palustrine environment, but the rest of their ‘codes’ in that some of them are unconsolidated shore, unconsolidated bottom, or aquatic bed. They are then also more often semi-permanently flooded, intermittently flooded, or seasonally flooded. Lakes are the only different habitat in that the codes verifies it is a Lacustrine environment, meaning associated with lakes, littoral meaning shore with an unconsolidated shore. Unconsolidated
shores are “areas covered with less than 75 percent of bedrock, stone, or boulders” (Solar Energy Development Programmatic EIS Information Center 2008) and the vegetation covers less than 30 percent of the area.

As the data suggests, people during the Archaic lived closer to other kinds of wetland areas than to lakes. Although, there is not much difference between a pond and a lake, and most people confuse them and use the wording interchangeably, ponds are described as a marshland according to the Federal Geographic Data Committee, which means that rarely are people living near lakes at any point in the Archaic time than the other various wetlands.
5 | Discussion

The data, along with previous research, presents a plausible narrative of the settlement of people during the Archaic period. As shown by the location of the artifacts left behind by the people of the Archaic, environmental factors must have been one of the leading factors for the expansion of Early Archaic people toward higher elevation ranges as the Holocene started becoming more arid during the Middle Holocene. Around 8,000 years BP, several changes occurred in the ecological and archaeological record. As stated in the Background chapter, small mammals that once populated the Great Basin either migrated or went extinct around 8,000 BP because of environmental forces. The cool, moist environments they needed to survive had become hot and dry. In the archaeological record, three new point types were introduced to the region: Northern side-notched, Pinto series, and Humboldt projectile points. These points can be found at higher elevations, especially compared to the Great Basin Stemmed points that were already present in the region before 8,000 years. In the Great Basin resource area alone, the percentage of Archaic sites in lower ecological zones decreases approximately 50 percent from the Early Archaic to the Middle Archaic, whereas the numbers increase in the upper ecological zones at a much smaller increment. There is less than a 20 percent difference. In the more mountainous regions of the Owyhee High Plateau region and both Wasatch Mountain areas, there are very few sites in the Early Archaic located in these regions, but the number of sites jumps significantly from the Early Archaic to the transition from the Early Archaic and the Middle Archaic to the Middle Archaic. Archaic sites, from the Early Archaic to the Late Archaic, show average distances moving closer to wetlands. This,
though, is because of the imprecise nature of the proxy information. The lakes and wetlands would have been much larger than they are now. As it could be, these Early Archaic sites may have been in some wetland areas based on their current proximity to their current conditions and with the understanding that these wetland resources – both palustrine and lacustrine – were significantly larger than now.

The Middle Archaic was arid. The average distances to wetlands were smaller than the other time periods, but it was likely that these distances were somewhat larger than what was calculated because the palustrine and lacustrine resources were much smaller than current conditions. Given that knowledge, reason would imply that during the Middle Archaic, if sites were near or in wetlands then, those sites would be in the middle of at least some, if not most, wetlands now, and would be much harder to find, particularly if the areas were flooded. There could be significantly more Middle Archaic sites that have not been found.

While there were still plenty of Archaic sites from the Middle Archaic still in the Great Salt Lake resource area, the sites are more often found higher in elevation than before. The tables of numbers of sites show that there are many more sites in the mountainous resource zones as compared to the Early Archaic, although most sites stayed between the upland and mountain ecological zones; the sites do not venture as far up in elevation as during the Late Archaic.

Upland ecological zones in the Wasatch Mountains North and South became particularly important when pinyon pine trees migrated into the region, approximately 6,700 years BP. Exploitation of these pine nuts likely started around the transition from the Middle Archaic to the Late Archaic (Rhode and Madsen 1998, Madsen 1986, Rhode 2000, Rhode and Thomas 1983). Unsurprisingly, Archaic sites with groundstone during the Middle Archaic and the transition to the Middle Archaic have an average of about 5,800 ft, which is in the upland
region of all the Wasatch Mountains regions, and the interquartile range stays right in the Upland ecological zones.

When people were hunting in the region, it seems as though they did not extend into much higher elevations than the mountain ecological zones of the Wasatch Mountains resource area, but the data suggests the sites were lower in elevation, which could indicate that although the people during the Middle Archaic moved to higher elevations, they also continued to navigate through the lower elevations of the Great Salt Lake area, never entirely giving up the area and the resources in the area. The people during the Middle Archaic could have also participated in prestige hunting with the decrease of resource, it would have been very difficult and prestigious if someone would have hunted large animals (McGuire and Hildebrandt 2005; Hockett 2005). Archaeologists also suggest that group sizes would have remained small during this period (Hockett 2005). If group sizes were small family units and resources sparse, it would stand to reason that the family unit would travel together and traveling across wide elevation ranges would have been difficult, which might explain why the elevation range during the Middle Archaic is smaller overall than the other the other eras.

Sites from the Late Archaic dramatically increased from any previous period. This is unsurprising as the climate became more tenable to reside in because it became cooler and moister again. The Late Archaic sites covered a broader elevation range than the Middle Archaic and the Early Archaic, covering similar lower elevations as the Early Archaic and extending to higher elevations than the Middle Archaic more frequently.

Two explanations can account for this elevation range; the first explanation is the people during the Late Archaic participating in big game hunting and the second explanation is population growth and the third is the exploitation of pine nuts. All are plausible. Bryan Hockett speculated that communal hunting for pronghorn caused the people of the Late Archaic to form larger groups than that of the Middle Archaic to accomplish the hunts and that these
hunts were on a regional basis rather than broad scale. He also states that the Late Archaic did not have more consumption of artiodactyls, or there would be less consumption of small game taxa (Hockett 2005). David Byers and Jack Broughton found that artiodactyl herds were thinned by intensive human hunting as human populations were high during the Late Archaic and later (Byers and Broughton 2004). The different conclusions of these ideas would suggest that the high human populations and the prestige hunting they participated in forged bonds between groups.

Elevation data also validates that many of the sites in the Late Archaic are in ecological zones that contain Pinyon pine trees. Pine nuts were a valuable resource, especially in the Wasatch South and Great Salt Lake resource zones. This can be insinuated through the sheer number of sites in the region compared to other regions.

Research conducted by Kyle Cordain from the Late Archaic suggested that “[s]emi-sedentary settlements strategically posited near wetland ecosystems were preferred for efficiency and close proximity to resources” (Cordain 2014: 5). The average distances of Late Archaic sites to wetlands are likely the most accurate averages compared to the other eras because current environmental conditions are most similar to present environmental conditions. The distances show that Late Archaic sites were closest to marsh and swamp lands, and furthest from lakes; interestingly, Late Archaic sites with groundstone are almost just as close, on average, to lake (or lacustrine) areas as they are to the marshes and wetlands. Ponds are the furthest, on average from Late Archaic sites, but also have the most sites that are closer in proximity to any wetland area from all four types of wetland resource areas. It would be reasonable for this to be accurate because marshes and swamps would be the areas rich in resources.
Conclusion

The data collected and analyzed indicate wetland resources, on average, were within a couple of kilometers from Archaic sites in the Eastern Great Basin. It is unsurprising that the areas with water and other resources would be populated throughout the Archaic. While the wetland data is not perfect for each era, it can be safe to assume that the opposites would have occurred for the Early and Middle Archaic periods. The average distances would have been nearer than calculated for the Early Archaic and farther than calculated for the Middle Archaic, but it would show that palustrine resource areas, marshes, swamps, and ponds, were nearer to Archaic sites than lacustrine, or lake, resources.

More research can always be conducted to continue to understand the people of the Archaic period. Some of this research could be done in some of the wetlands that had higher numbers of Archaic sites in proximity. There are obviously some resources at these wetlands that were significant throughout the Archaic periods that people either hunted or settled near these wetlands.

The elevation ranges for each Archaic era would convey that while there was an exodus from the lower elevations from lake periphery areas toward the end of the Early Archaic as the environment became hot and arid. The expansion across the elevation range continued through the Middle and Late Archaic because of social reasons, such as population increase, big game hunting, and an abundance of resources across the multiple elevation ecological zones and wetland areas.
While imperfect, cultural management resource data can provide further insight to broader questions about human behavior and activity and create further questions to investigate in pursuit of these answers.
References

Beck, Charlotte, and George T. Jones

Byers, David A., and Jack M. Broughton

Carlson, David L.

Cordain, Kyle

Currey, Don R.

Fry, Gary F.

Geib, Phil R. and Edward A. Jolie

Goebel, Ted and Joshua L. Keene

Graumlich, Lisa J.

Grayson, Donald


Hockett, Bryan
Hranicky, William Jack

Jones, George T., and Charlotte Beck

Justice, Noel

Kornfeld, Marcel, George C. Frison, and Mary Lou Larson

Louderback, Lisbeth A.

Louderback, Lisbeth, Donald Grayson, and Marcos Llobera

Louderback, Lisbeth, and David Rhode
2009  15,000 years of Vegetation Change in the Bonneville Basin: The Blue Lake Record. *Quaternary Science Reviews* 28: 308–326.

Madsen, David B.

Madsen, David and Currey, Don
McBrinn, Maxine and Barbara Roth

McGuire, Kelly R. and William R. Hildebrandt

Mehringer, Peter J. Jr.

Morris, Jesse L., Andrea Brunelle, A. Steven Munson, Jessica Spencer, and Mitchell J. Power
2012 Holocene Vegetation and Fire Reconstruction from the Aquarius Plateau, Utah, USA. Quaternary International 310: 111-123.

Murchison, Stuart. B.
1990 Fluctuation History of Great Salt Lake, Utah, during the last 13,000 years. PhD dissertation, Department of Geography, University of Utah, Salt Lake City.

Oviatt, Charles G., Genevieve Atwood, and Robert Thompson

Rhode, David

Rhode, David, and David B. Madsen

Rhode, David, David B. Madsen, and Kevin T. Jones

Rhode, Dave, and D. H. Thomas

Schmitt, Dave N., David B. Madsen, and Karen D. Lupo
Simms, Steve  

Sinnott, Roger W.  

Smith, Felisa A. and Julio L. Betancourt  

Solar Energy Development Programmatic EIS Information Center  

Stine, Stuart  

Thompson, Robert S.  

United States Department of Agriculture  

United States National Parks Service  

Utah Geological Society  

Wormington, Hannah Marie  

Young, D. Craig  

Zaiontz, Charles  