PREHISTORIC WETLAND USE IN THE MONO LAKE BASIN, EASTERN CALIFORNIA.

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PREHISTORIC WETLAND USE IN THE MONO LAKE BASIN, EASTERN CALIFORNIA.

A Thesis

by

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Abstract

of

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The present research investigates prehistoric use of near-shore wetland habitats in the Mono Lake basin. Wetland types are stratified into three classes in order to assess the use of these lakeshore habitats through time. The research seeks to identify the role of wetlands in prehistoric lifeways and how this changed through time.

Project data were recovered through a random stratified surface survey of 10 km^2 distributed around the near-lakeshore area. Spatial associations of artifacts and debitage were recorded and samples collected for analysis. In addition to techno-morphological analysis, obsidian artifacts were also subject to visual, X-ray fluorescence source, and obsidian hydration analysis.

Results of the analysis suggest that the near-shore wetlands of Mono Lake basin were subject to varied use throughout the past, ranging from duration of stay to activity undertaken. This may be due in part to lake elevation fluctuations affecting the habitats, as well as population pressure and diet breadth expansion.

Mark E Basgall, Committee Chair
Mark E. Basgall, Ph.D.

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Craig Skinner graciously provided XRF obsidian source identification at a reduced rate; his interest is appreciated. Sourcing was generously funded by a scholarship grant from the Sacramento Archeological Society, as well as further support provided by the graduate student research fund at the Archaeological Research Center, CSUS. Much gratitude is given to Tim Carpenter in providing the obsidian hydration readings at no cost, in addition to his demonstrations of proper slide mounting techniques. Tony Overly also gave valuable advice in the process of slide preparation.

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CHAPTER 1

INTRODUCTION

A significant debate in Great Basin archaeology surrounds the importance of wetland habitats. For mobile hunter-gatherers in arid environments, wetlands are frequently characterized as especially rich areas for resource acquisition. Other ecozones, such as pinyon woodlands, appear to have also played a pivotal role in certain Great Basin ethnographic subsistence and settlement patterns (Thomas 1983). Opposing views regarding the significance of wetland habitats disagree about the characteristics of these environments -- whether they were more or less preferable places to be relative to surrounding areas. Following this debate, the present research investigates the use of varied wetland habitats that occur within Mono Lake basin, eastern California. Prehistoric use of wetland settings is understood through the distribution of surface artifacts across the habitats.

Wetlands may at times be preferable places to forage within relative to surrounding arid environments. The Mono Basin provides a unique context to test assumptions about the productivity and potential benefits of foraging in Great Basin wetlands. Varied environmental constraints create a mosaic of wetland habitats around the lake, identified here as freshwater, brackish, and saline wetlands. These distributions, as well as long-term changes in lake level may affect productivity, which, in turn, influences patch-choice decisions among hunter-gatherers traveling through or residing in the basin for periods of time. The decision to use a particular wetland may be related to its productivity and its use by earlier peoples who incorporated specific foodstuffs in their subsistence systems. These factors likely changed through time.

Previous ethnographic and archaeological research pertaining to hunter-gatherer land-use and the role that wetlands played within regional settlement strategies are used to make testable predictions about the archaeological record at Mono Lake. In the eastern Great Basin, wetlands have been argued to provide sufficiently abundant resources to permit year-round occupation (Madsen 1982). Further evidence regarding the potential of wetlands is underscored by wetland-specialized gear found in dry caves proximal to extensive marshes in the western Great Basin (Heizer and Napton 1970; Loud and Harrington 1929; Thomas 1985). Likewise, ethnographic data from the Carson Sink suggest that wetlands provided important foraging opportunities for people residing in their vicinity (Kelly 2001:18-23; Wheat 1967). Although it is apparent that considerable time was spent gathering subsistence and other resources in wetland habitats, task groups were also known to travel away from these areas to hunt or gather (Kelly 2001:22).

Past settlement and mobility patterns may be understood through the presence or absence of sites with abundant and/or functionally varied artifact classes. Interpreting toolkits through a framework of technological organization can help identify patterns of land-use. Artifact type and diversity of tool classes within particular areas denote prehistoric lifeways and the importance of a particular habitat to a given economy.

Land-use patterns around Mono Lake's wetlands are studied through probabilistic surface surveys that sampled the three wetland habitats. Forty randomly selected 500 x 500 m tracts of land (totaling 10 km^2) were investigated as a stratified sample of the three wetland areas. During the survey, prehistoric archaeology was recorded using a non-site approach. Artifact and debitage distributions were recorded as well as ground and battered stone artifacts. Flaked stone artifacts and debitage samples were collected and subject to technological analysis, which included obsidian source and hydration analyses where applicable. When contrasted to a prehistoric lake fluctuation curve that describes past lake levels and wetland size, these data can inform where and how hunter-gatherers used the near-shore wetlands at Mono Lake throughout the Holocene.

The thesis is divided into seven chapters. The following chapter (Chapter 2) provides the environmental context of the Mono Basin. Geologic history and environmental characteristics of the basin are discussed. Descriptions of the varied wetland habitats are provided, and information suggesting how the habitats may have changed given fluctuations in the elevation of Mono Lake are offered.

The anthropological context of the study is presented in Chapter 3. First, discussion focuses on the ethnographic record of the Mono Basin, in addition to that pertaining to broader regional populations and their use of especially wetland habitats. An outline of pertinent regional land-use studies conducted in the central and western Great Basin follows. The present research model depends on this information. Finally, implications for the archaeological record are discussed, again through a review of archaeological research in the Mono Basin and surrounding areas.

Chapter 4 outlines the structure of the research question which includes the theoretical and methodological background used to study wetland use patterns and the archaeological record of human behavior. Additionally, the chapter outlines the methods used for surveying and recording the surface record around Mono Lake. It also describes the analytical methods that were employed in the laboratory, including obsidian sourcing and hydration studies.

Descriptions of the survey quadrats, and the artifacts contained are presented in the first part of Chapter 5. This includes environmental and archaeological variability. The second part of this chapter discusses results of the technological analysis of the collected and field-recorded artifacts, in addition to general distributions of these items.

Spatial and temporal distributions of the artifacts are discussed in Chapter 6. This assesses assemblage-wide artifact dispersion relative to wetland class, basin geography, and elevation. Additionally, obsidian hydration and source data are brought to bear on the implications of these artifact distributions and variance in temporal use of Mono Lake's wetlands.

Finally, Chapter 7 summarizes the project data and presents conclusions of the study, assessing where expectations were met and where they were not. Changes in the manner and location of exploitative activities across Mono Lake's wetlands have occurred throughout the Holocene period. These appear to be related to environmental, technological, and demographic changes that affected prehistoric adaptations in the Mono Lake basin and adjacent areas.

CHAPTER 2

ENVIRONMENTAL CONTEXT

The Mono Lake basin is a dynamic habitat that has undergone significant changes from its formation ca. 500,000 years ago. These alterations have continued into the recent past, and likely affected the way that people used the area. The following chapter outlines the geography of the Mono basin and some of the more recent geologic events that produced the landscape visible today. Current environmental conditions are described as a baseline for understanding past hunter-gatherer use of the various habitats. Finally, a discussion of the paleoenvironment presents information about past lake fluctuations and how they affected the habitats under study. This understanding brings insight about past lifeways as seen through the archaeological record. What today are largely barren dune fields may have been lush wetlands in the past.

Geologic History

The Mono Lake basin is located at the western edge of the Great Basin adjacent to the fault scarped Sierra Nevada mountains in eastern California. In the central-western portion of the basin is Mono Lake, a terminal lake that is the remnant of larger Pleistocene Lake Russell. Without an outlet, the waters of Mono Lake are highly saline and alkaline and supporting no fish habitat. The basin was formed through tectonic deformation and sedimentation (Russell 1889). Numerous faults occur throughout the basin floor and surrounding ranges. This tectonic movement has produced volcanic activity throughout the Quaternary (Wood 1977), which has influenced the region's topography, geology, and vegetation distributions (Jones and Stokes Associates [JSA] 1993; National Academy of Sciences [NAS] 1987; Stine 1993). Due to geographic variation, it is important to review the recent geologic history of Mono Lake basin as a basis for understanding how the landscape has changed in the context of human occupation during the Holocene.

The geologic history of Mono Lake basin was first described by Russell (1889) and has since been elaborated upon by other researchers (Gilbert et al. 1968; Lajoie 1968; Sieh and Bursik 1986; Stine 1987, 1990; Wood 1977). Substrate within the depression is predominately a fine, ashy sand and/or pumice, though, sediment size and parent material varies across the basin (JSA 1993:Table Q-3). Much of this material was deposited from eruptions of the Mono Craters, and to a lesser extent the Inyo Craters (Miller 1985; Wood 1977).

The Mono Craters comprise a relatively young, north-south trending chain of volcanoes with a northern limit at Panum Crater, near the southwest shore of the lake. Tephra from Mono Craters has been identified at regional archaeological sites (Arkush 1995; Carpenter 2001; Wickstrom and Jackson 1993). The most recent tephra dates to ca. 605 B.P. and is associated with the formation of Panum Crater (Sieh and Bursik 1986:12,557). The most pertinent effect of the latest eruption at Panum Crater relates to the fact that it produced a new source of obsidian, accessible to populations using the area. The dome was formed over a ten-year period with most activity likely occurring within a period of months.

The second volcanic tephra layer dates to ca. 1245 B.P. and is believed to have erupted from the southern portion of the chain. Much of this ash went to the south and west, away from the basin (Stine 1987; Wood 1977). Both periods of volcanic activity correlate temporally with eruptions recorded at the southern Inyo volcanic chain suggesting that these eras saw heightened volcanic activity (Miller 1985).

Supportive evidence relating to the volcanic activity comes from a recent core sample taken from Mono Lake that contained eight distinct volcanic ash layers (Davis 1999). Five correlate with previously identified Mono Craters ash layers, and two are related to Mt. Mazama in Oregon. A previously unidentified Mono Craters tephra was provisionally dated to 7200 years old; it demonstrates the longevity of volcanic activity in the region.

Other sources of volcanic change can be found in and around Mono Lake itself at three major landforms. The oldest, Black Point, is located on the northwest shore of the lake and was formed by an eruption ca. 13,100 B.P. (Wood 1977: 90). This eruption occurred entirely below water as the lake was lowering from its Pleistocene high stand of 2152 m (Russell 1879: 299). The next volcanic formation, Negit Island, was created through a series of at least three volcanic events. These have been relatively dated by the presence or absence of the aforementioned tephra layers. One portion of the island formed before 1610-1990 B.P, the second before 1245 B.P., and the last formed after 605 B.P. (Stine 1987:318). Finally the large "pinkish" island, Paoha, apparently arose when the lakebed was uplifted just 200-300 years ago (Benson et al. 2003; Stine 1987). The estimated age of this event is based on the location of an incised terrace, in conjunction with tree ring cores taken from trees on the island.

Environment

Adjacent the eastern scarp of the Sierra Nevada, Mono Lake receives most of its freshwater through snow melt from the mountains by way of five streams (Stine 1987:23). This comprises 80% of the freshwater that enters Mono Lake annually. Remaining water comes from precipitation, groundwater percolation, and artesian springs. The flow is affected by tectonic deformation along fault lines, especially in the east (Sinclair 1988; Stine 1993:12-14) Precipitation is low with an annual average rainfall of 36.8 cm in the western basin. A rainshadow effect is apparent as one moves east from the mountains, causing only 14.0 cm of annual precipitation to fall on the eastern side of the lake (Stine 1987:16). Mean annual temperature is 48.5° F (9.2° C). As a terminal lake, all water leaving the basin must do so through evaporation. This causes an increase in the salt and mineral content of the water, giving it higher salinity than the ocean (NAS 1987). Additionally, the salt and mineral content prevent fish from surviving in the lake's water, leaving brine shrimp (*Artemia monica*), and brine fly larvae/pupae (*Ephydra [Hydropyrus] hians*) as the main aquatic life; even the populations of these taxa fluctuate with lake elevation due to changes in salinity (NAS 1987:189).

Lake level is sensitive to changes in water runoff as well as evaporation rates. Evaporation and lake level appear to correlate with changes in solar radiation (Vorster

1985). These appear to reflect large-scale climatic events, but may also be affected by local conditions (Benson et al. 2003). Historic and prehistoric lake fluctuations have been the focus of extensive study and allow for lake level reconstructions to be interpreted in conjunction with other paleoenvironmental data to describe how past environments may have changed (Benson et al. 1990, 2003; Lajoie 1968; Stine 1987; 1993).

Vegetation distributions around the lakeshore have been studied in detail, including fine-grained mapping and description of the near-shore plant communities (JSA 1993; NAS 1987; Stine 1993). These lines of evidence can be used to understand temporal changes in wetland communities relative to the overall environment.

The basin floor covers 650 km^2, although the greater hydrographic catchment is much larger at around 1800 km^2 (Figure 2.1). The present lake elevation is about 1945 m asl, with surrounding peaks rising up to over 2300 m. Viewed within typical Great Basin environmental schemes, this region may be segregated into three general plant communities: Desert Scrub (1220-1980 m), Pinyon Woodland (1980-2590 m), and Mixed Coniferous Forest (2590-2900 m) (Bettinger 1982:17-19; Billings 1951). Such generalized communities are useful for exploring human land-use between valley systems, but for the current research a detailed vegetation analysis is required. Dryland habitats in the study area consist mainly of desert scrub, although some higher elevations support pinyon and juniper trees.

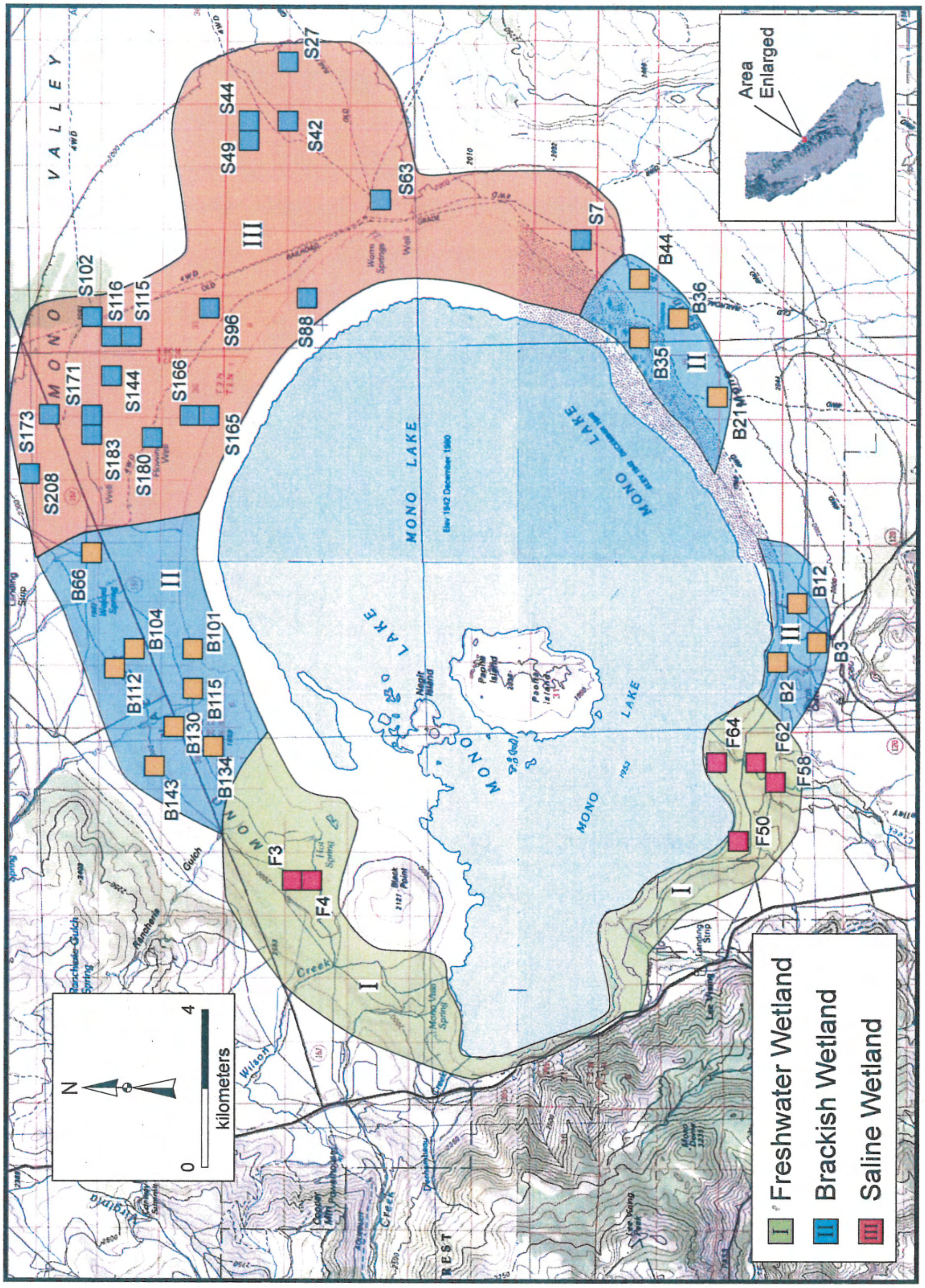


Figure 2.1. Map of the Mono Basin with Wetland Habitats and Surveyed Quadrats.

A more relevant biotic taxonomy is described by Constantine (1993), who identifies six plant communities in the Mono Lake basin. These include Alkali Sink Scrub, Freshwater Marsh, Sagebrush Scrub, Pinyon-Juniper Woodland, Jeffrey Pine Forest, and Riparian Forest. The scrub, marsh, and riparian habitats are most pertinent here as these fringe the lakeshore.

The location and manner in which water enters the basin affects the distribution of vegetation such that more fine-grained distinctions can be made in near-shore plant communities. The National Academy of Sciences (1987:143-146) describes seven near-shore wetland communities as Wet Marsh, Transition Marsh/Dry, Alkaline Herbs, Wet Shrub, Dry Open, Transition Dry/Shrub, Dry Scrub. These vegetation communities were derived using a vegetation map of the near-shore areas that outline smaller subdivisions of dominant plants (NAS 1987: Figure 5.3). Variation in the distribution of the communities around the lakeshore is illustrated by four transects from different areas around the lake that extend from the lake to between 150 m and 1100 m from the shoreline (NAS 1987: Figure 5.4). Notable differences are indicated between vegetation groups in transects along the well-watered western portion of the basin compared with those from the more arid eastern area. Slope also varies and affects the amount and type of vegetation growing around the lakeshore. The transects show a pattern of more lush, herbaceous growth in the west and dryland scrub or non-vegetated habitat predominates in the east. Also, slope is steeper along the Sierran front than in the east, making the potentially more productive wetland regions aerially constrained relative to the more expansive, yet water-poor eastern areas.

Further evidence for the variability of lakeshore wetland communities is found when studying estimates of water recharge volume and soil alkalinity (JSA 1993: Table Q-3). This study groups wetlands into eighteen distinct units around the lakeshore that differ predominantly according to geology and hydrology. This classification notes type, amount, and quality of water inflow, in addition to sediment size and leaching ability among other characteristics. For purposes of the present study, these categories (JSA 1993: Appendix Q), in conjunction with the vegetation distributions (NAS 1987: Figure 5.3), were used to segregate three major wetland types: freshwater, brackish, and saline (Figure 2.1). Table 2.1 lists typical plants that may be found in each of the three wetlands.

Freshwater wetlands have a high incidence of willow (*Salix* spp.), grass and herbaceous growth, including more rabbitbrush (*Chrysothamnus nauseosa*) than other areas. The high incidence of rabbitbrush demonstrates the presence of alkali soil within this community, but the presence of willow and grasses along with the lack of saltgrass (*Distichlis spicata*) and alkali scrub show that soil alkalinity is low relative to the other two groups. The brackish habitat has more marsh wetlands including saltgrass and non-vegetated areas than other wetland types. Plant cover is not as dense as in the freshwater unit, and it does not have the same diversity of grass and herbaceous growth. Saline wetlands have the least marsh habitat with a predominance of alkali scrub and saltgrass, as well as non-vegetated areas. Plant cover in this community is more sparse than in the other two areas.

Table 2.1. Plants of Mono Lake Wetlands.*

Freshwater **Lush herbaceous growth**	**Brackish** **Less diversity of herbaceous species**	**Saline** **>5% scrub cover with few herbaceous plants**
Scirpus americanus	Less *Scirpus* spp.	*Distichlis spicata*
Scirpus nevadensis	*Distichlis spicata*	*Chrysothamnus nauseosa*
Typha latifolia	*Salsola pestifera*	*Bassia hyssopifolia*
Hordeum jubatum	*Psathyrotes annua*	*Artemisia tridentata*
Juncus spp.	*Bassia hyssopifolia*	*Purshia tridentata*
Carex spp.	*Artemisia tridentata*	*Prunus andersonii*
Chrysothamnus nauseosa	*Chrysothamnus nauseosa*	*Sarcobatus vermiculatus*
Sarcobatus vermiculatus	*Purshia tridentata*	*Descurainia sophia*
Prunus andersonii	*Prunus andersonii*	
Artemisia tridentata	*Sarcobatus vermiculatus*	
Chenopodium fremontii	*Descurainia sophia*	
Muhlenbergia asperifolia		
Mimulus guttats		
Epilobium adenocaulon		
Polypogon spp.		
Cleomella parviflora		
Puccinellia airoides		
Trifolium spp.		

*From: Constantine 1993; Jones and Stokes Associates 1993 (Appendices F, and Q); NAS 1987

As with vegetation, the distribution of animals also varies between wetland habitats (NAS 1987: Appendix A, B). Two predominant types of animals found within the basin are mammals and birds. The distribution of mammals is similar to that of vegetation in that a greater number of species are found in the freshwater habitat (n=40), slightly fewer in the brackish (n=38), and the least in areas classified as saline (n=18), (Table 2.2) (NAS 1987: Appendix B).

The distribution of birds around the wetlands at Mono Lake is more difficult to quantify in part because of the largely migratory population that is found at the lake in different seasons (NAS 1987: Appendix A). In total, over 290 different species of birds may be found in the Mono Lake basin throughout the year (NAS 1987:163), although the most numerous are eared grebes, Wilson's phalaropes, and California gulls. They are found predominantly on the lake's waters (NAS 1987:92).

Grebes and phalaropes consume invertebrates living in the lake's waters to put on fat before continuing their migration to the California coast and South America respectively. The largest population densities are reached in the fall when the number of grebes may be upwards of 900,000 in October (NAS 1987:95). The number of phalaropes is less, numbering in the tens of thousands. California gulls occur in greatest numbers in late spring and early summer when they nest on the islands and islets of the lake with population numbers of 40,000-50,000.

While these three species comprise the largest bird populations in the basin, varied bird species distribution may be found in each of the three wetland habitats. Again, freshwater habitats have the greatest number of species at 209, followed by 182 in

Table 2.2. Mammals of Mono Basin Wetlands.*

Freshwater	Brackish	Saline
Vagrant Shrew	Vagrant Shrew	Merriam's Shrew
Dusky Shrew	Dusky Shrew	Broad-handed Mole
Water Shrew	Water Shrew	Blacktailed Rabbit
Mt. Lyell Shrew	Mt. Lyell Shrew	Nuttall's Cottontail
Inyo Shrew	Broad-handed Mole	Pygmy Rabbit
Broad-handed Mole	Blacktailed Rabbit	Townsend Ground Squirrel
Blacktailed Rabbit	Nuttall's Cottontail	Panamint Chipmunk
Nuttall's Cottontail	Pygmy Rabbit	Least Chipmunk
Pygmy Rabbit	Mountain Beaver	Great Basin Pocket Mouse
Mountain Beaver	Townsend Ground Squirrel	Panamint Kangaroo Rat
Townsend Ground Squirrel	Belding Ground Squirrel	Dark Kangaroo Mouse
Belding Ground Squirrel	Beechy Ground Squirrel	Ord's Kangaroo Mouse
Beechy Ground Squirrel	Golden Mantled Ground Squirrel	Deer Mouse
Golden Mantled Ground Squirrel	Yellow Pine Chipmunk	Northern Grasshopper Mouse
Panamint Chipmunk	Panamint Chipmunk	Sagebrush Vole
Least Chipmunk	Least Chipmunk	Kit Fox
Beaver	Northern Pocket Gopher	Long-tailed Weasel
Northern Pocket Gopher	Great Basin Pocket Mouse	Bobcat
Great Basin Pocket Mouse	Western Harvest Mouse	Pronghorn
Western Harvest Mouse	Deer Mouse	
Deer Mouse	Northern Grasshopper Mouse	
Northern Grasshopper Mouse	Western Jumping Mouse	
Western Jumping Mouse	Pinyon Mouse	
Panamint Kangaroo Rat	Panamint Kangaroo Rat	
Montane Vole	Montane Vole	
Long-tailed Vole	Long-tailed Vole	
Sagebrush Vole	Sagebrush Vole	
Porcupine	Red Fox	
Red Fox	Kit Fox	
Kit Fox	Gray Fox	
Gray Fox	Long-tailed Weasel	
Racoon	Short-tailed Weasel	
Long-tailed Weasel	Mink	
Mink	Badger	
Badger	Bobcat	
Striped Skunk	Mountain Lion	
Spotted Skunk	Mule Deer	
Bobcat	Pronghorn	
Mule Deer		
Pronghorn		

*Data from NAS 1987:Appendix B

brackish habitats, and 144 in the saline areas (NAS 1987: Appendix A). Similar to vegetation diversity, faunal distributions appear to vary across different wetland habitats.

Effects of Lake Fluctuation on Wetlands

Lake elevation affects the size and productivity of these various wetland areas. Much of the ecological research conducted at Mono Lake was done to assess the impacts of water diversion by LADWP which, between 1940 and 1982 causing drastic reductions in lake elevation (Stine 1993:4). Studying changing lake level, JSA (1993) reported on how maintenance of the shoreline at different elevations would affect the type of shoreline habitat present.

Table 2.3 demonstrates how different lake elevations are expected to affect the local wetland habitats. For the table, areas are grouped mainly as areas with vegetation (Group 1), areas where lagoons would form and hold water (Group 2), and areas of exposed lakebed (Group 3), which lacks vegetation. As lake level falls, there is more extensive exposure of this latter category (Group 3). At intermediate elevations, Group 1 habitats remain relatively large while Group 3 is substantially smaller than at lower elevations. This group is located predominantly in the east where there is a low slope gradient and limited freshwater inflow to leach the soil and allow for vegetation renewal. Likewise, Group 1 habitats shrink at upper elevations because of the increased slope in the northern and western lakeshore areas. Wetland habitats may migrate up or down slope in response to lake fluctuations (NAS 1987:194), although water inflow and soil characteristics play a significant role in its coverage and its diversity (NAS 1987:148).

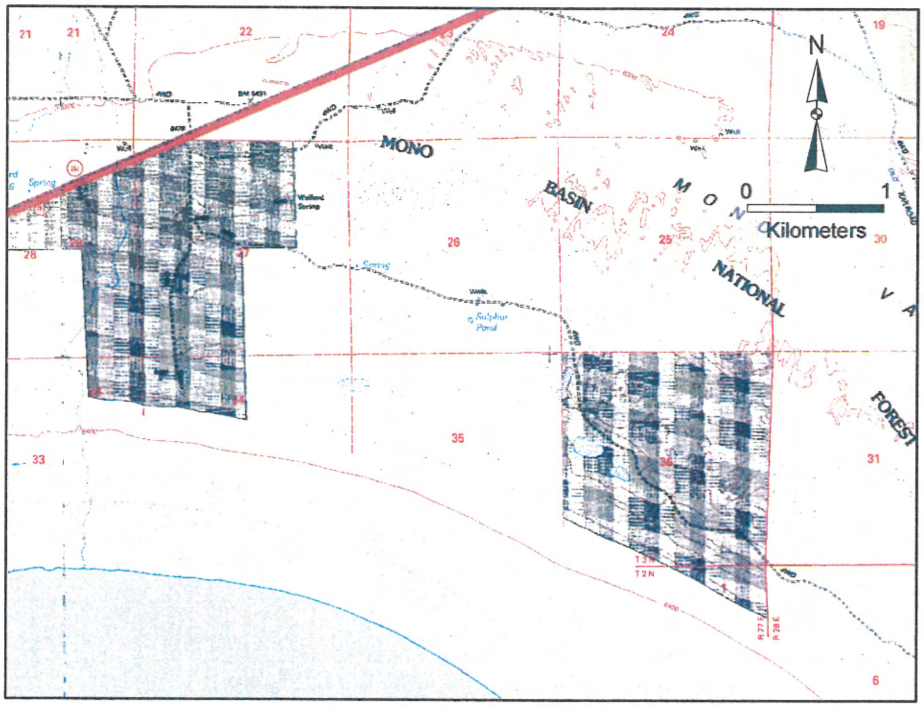
Table 2.3. **Summary Comparison of Effects: Lake-Fringing Vegetation.***

Alternative or Condition	Acreage of Marsh, Wet Meadow, Alkali Meadow, Riparian Scrub (Group 1)	Acreage of Acreage of Lagoons (Group 2)	Alkali Lakebed (Group 3)
No-Restriction	313	0	9,512
1942 m.	2,859	1	3,883
1944 m.	2,625	1	1,492
1946 m.	2,325	6	521
1948 m.	2,071	16	377
1954 m.	754	261	157
No-Diversion	358	261	0

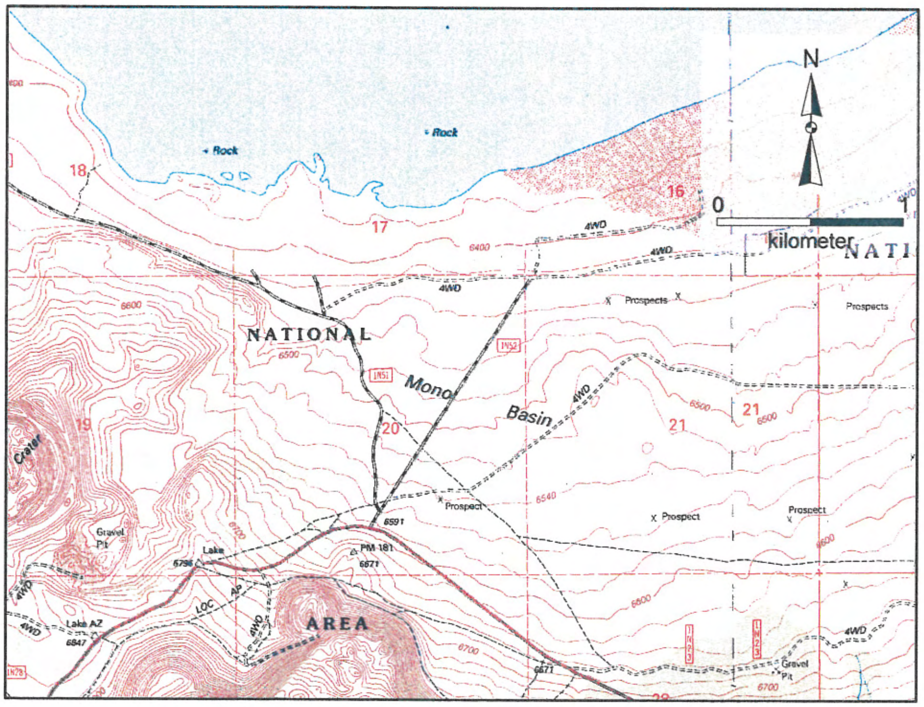
*Data taken from Jones and Stokes 1993: table 3C-15

The process of wetland transgression, expansion, or disappearance is complex and significant variables change as one travels around the lakeshore. As a result, locations that are sparsely vegetated today may not have been at times in the past, and the converse is true. Changes may occur because of precipitation deficits not recharging groundwater, tectonic activity opening and closing artesian springs, or newly exposed lakeshore sediments not being leached and remaining unvegetated (Stine 1993).

To further understand how local wetland communities may vary with lake level, two examples are used to illustrate potential ways in which the wetlands can change. The first area is located in the northeastern portion of the lakeshore in the vicinity of Sulphur Pond (Figure 2.2:A), within the saline wetland community. Currently, the area is dry, but topography and historical records demonstrate this was not always the case. In 1919 the



A. Sulphur Pond Area



B. Navy Beach Area

Figure 2.2. Maps of Sulphur Pond and Navy Beach Areas.

lake elevation was up to nearly 1960 m asl and there were extensive lagoons. The upslope crestal elevation of these was 1961.7 m, corresponding to a high stand that occurred at ca. A.D. 1650 (Stine 1993:17). Water flow is low in volume, and comes from springs, gravity fed groundwater, and relict lake water. There is limited sediment leaching and the soil is highly alkaline below 1950.7 m. Sediments are fine-grained and poorly drained (JSA 1993: Table Q-3).

There are low dunes that form complex topography, such as relict lagoon depressions between 1956.8 m and 1969.0 m, as well as gently sloping terrain. These factors would produce moderately diverse saline wetlands that would attract animals such as birds to the lagoons. It is likely that the area would see decreased productivity above 1969.0 m, and below 1956.8-1950.7 m depending on topography and spring location. Individual marshlands were noted in aerial photos taken in 1973 when the lake was below 1946.1 m. These marshlands were concentrated at springlines (elevations: 1953.5, 1951.3, and 1947.7 m) west of Sulphur Pond near Bridgeport, Cottonwood, and Rancheria Creeks. The springlines likely came about due to gravity-fed groundwater from these ephemeral streams (Stine 1993:32-33). This occurrence points out the localized variability of wetland habitat that freshwater springs may create.

The second example of wetland variation is found in a brackish wetland area along the south Mono Lake shorelands near the South Tufa Preserve, and Navy Beach (Figure 2.2:B). Here freshwater inflow mainly occurs via gravity-fed groundwater from the Cowtrack Mountains (to the south), rather than artesian springs. Coarse-grained sediments allow for more rapid soil leaching than in the northern area. Sediments are moderately saline-alkaline and the topography forms a gently sloping shoreline (JSA 1993:Table Q-3). Aerial photos from 1940 (lake elevation 1956.2 m), 1951, and 1954 (lake elevation 1952.4 m) show narrow bands of wetlands indicating, that they moved downslope without expanding or contracting much. After a lake elevation rise and fall during 1967-1969 (lake elevation 1947.7 m), the area supported wet meadow vegetation, which reverted to dry meadow as the lake elevation and water table lowered (Stine 1993:48). These wetlands are absent today, suggesting that upslope irrigation may have made this area more productive than it would have been naturally.

Temporal change in the wetlands of this area provides insight into how the region may have been in the past. That the coarse sediments allow for rapid soil leaching is illustrated by the changes that occurred to local vegetation in the past century. The paucity of natural springs suggests that while these may leach soil and support very localized "brackish" wetland vegetation, they are unlikely to produce a highly productive wetland. In contrast, the effects of upslope irrigation point out that gravity water percolating underground from higher elevations may provide enough soil leaching and water to support the mixture of brackish vegetation. Therefore, wetter times with more precipitation would likely correspond to intervals that were most productive for plants and animals. This should correlate with times of rising elevation or stability in the lakeshore elevation.

Paleoenvironment

The Inyo-Mono region has seen much research investigating Holocene paleoclimatic change through the study of proxy paleoenvironmental indicators. These data come from fossil pollen (Batchelder 1970; Davis 1999), packrat (*Neotoma*) middens (Koehler and Anderson 1995; Thompson 1990), tree rings (Graumlich 1993), tree line fluctuations (Jennings and Elliot-Fisk 1993; LaMarche 1973), lake level fluctuations (Bacon et al. 2006; Benson et al. 1990; Stine 1987, 1990, 1995), and more recently from $\delta^{18}O$ values from sediment cores (Benson et al. 2003). Many of these data have been reviewed to identify periods of warming and cooling along with increasing or decreasing moisture patterns, which can be used to identify general trends in paleoclimatic change (Bettinger 1982:16-18; Elston 1982; Grayson 1993; Skinner et al. 1990:13-16; Stine 1990; 1995; Wigand and Rhode 2002). However, these data may lead to conflicting results regarding the onset of warming or cooling trends, as well as variations in effective precipitation. Incongruence between these indicators suggests that various paleoenvironmental signatures do not record climate change and vegetation transitions at the same rate, nor do they react to similar events in the same manner through time (Woolfenden 1996:51). This conclusion is supported by other studies on the dynamics of vegetation expansions and contractions, which note the significance of local characteristics, such as the effects of soil substrate, slope, and aspect on vegetation change (Burwell 1998; Millar and Woolfenden 1999:1210).

Dramatic environmental changes, such as the Younger Dryas event at the Pleistocene-Holocene transition, have allowed for rapid displacement of vegetation communities (Post 2003). Yet Holocene climate is believed to have remained relatively stable when compared to the earlier Pleistocene (Richerson et al. 2001). However, past climate has changed dynamically in both time and space across the Great Basin (Mehringer 1977, 1986). The current vegetation mosaic appears to have emerged in the Mono Lake basin by about 2000 years ago, well into the interval of cool/wet Neoglacial conditions that began ca. 4000 B.P. (Davis 1999).

While generally viewed as more stable, the Holocene also contains periods of environmental variance that have historically been argued to be the cause behind certain archaeological patterns identified in western North America. Before the onset of Neoglacial conditions, the middle Holocene is a period which historically has been viewed as predominantly warm and dry. Although not strongly believed today, this was termed the Altithermal (7000-4500 B.P) and comprised the middle of a tripartite scheme (Antevs 1948). The Altithermal was used to help explain the low number of archaeological sites in the Great Basin during this time frame (Baumhoff and Heizer 1965). Today, through an increase in local paleoenvironmental data, the middle Holocene is understood to be a warmer period interspersed with cooler times (Mehringer 1986:49). The degree of aridity is not uniform across the Great Basin, and it appears that sparse Great Basin populations may have adapted to these warming trends by integrating seed processing and staying near dependable water (Grayson 1993:248; Kelly 1997:8-9).

Likewise, during the purported cool and wet Medithermal (late Holocene), there are two dry periods, which together are termed the Medieval Climatic Anomaly (MCA) These dry intervals, the first cool and the second warm, occurred between ca. AD 910-

1110 and ca. AD 1250-1350 (Stine 1994; 1998:46). These were interspersed with a moist interval where climate ameliorated somewhat. Recently, the wide reaching effects of this climatic change has been argued to be a dominant factor in times of drastic social change seen throughout western North America (Jones et al. 1999). However, the timing of these events is poorly correlated across space, suggesting that other factors, such as those related to demography and subsistence, may have influenced events. Climate change affects the options that people have to choose from, but whether environmental perturbations may create a crisis among past populations is something to be demonstrated archaeologically rather than simply assumed.

Varied responses to climate change may be found when comparing full time agriculturists with more flexibly adapted hunter-gatherers. A drought may devastate crops of the agriculturists, while the hunter-gatherers may opt for different food options or more favorable areas. In fact, drought may prove advantageous for certain economically important plant species, as appears to be the case for aborigines in Australia (Basgall 1999; Bettinger 1999b; Pate 1986).

Bettinger (1999c) identifies a population increase during the late Holocene in the Owens Valley that grows unabated through the Medieval warm period. He suggests that population growth was not affected by this dramatic climatic period due to a change in social relations of production, namely the privatization of seed resources. Additionally, in the Inyo-Mono region, a compilation of radiometric dates and obsidian hydration readings shows no decrease in occupational intensity during the MCA (Basgall 2000). People's decisions about how to respond to periods of climate change are the point of interest rather than the correlation of isolated causative forces. That paleoclimatic data often record different aspects of past environments leads to congruities or incongruities in different characterizations of past environments.

For example, in the southern Owens Valley there are periods when Owens Lake appears to have desiccated (Bacon et al. 2006; Li et al. 2000; Stine 1995). However, nearby packrat middens do not indicate drastic changes in local biota for the past 8,000 years (Koehler and Anderson 1995). Together with archaeological data (Delacorte 1999:8), these lines of evidence suggest that lake desiccation was not exceptionally catastrophic for local populations. Lake fluctuations appear to be more sensitive to certain types of environmental change than regional vegetation mosaics. In contrast, changes in lake elevation, or desiccations have more direct effect on near-shore wetland habitats. By understanding the effects of these alterations at Mono Lake, one can identify stronger correlations between habitat change and human use of the resource patch.

In any event, paleoenvironmental data reflect global as well as local environmental changes (Mayewski et al. 2004). For example, Benson et al. (1990) use radiocarbon dates from lake sediment cores, tufa, ostracode valves, wood from lagoonal and deltaic environments, and packrat middens among other lines of evidence to argue for similarities in the fluctuations of four internally draining Great Basin lakes, Lake Bonneville, Lake Lahontan, Lake Russell (Pleistocene Mono Lake), and Lake Searles. Here, variation in the timing and degree of fluctuation are argued to partially result from differences in lake depth and surface area. Fluctuation trends in the four basins appear to reflect warming and cooling trends identified in the North Atlantic ice cores as well as

Pacific Decadal Oscillations that reflect changes in solar radiation (Bacon et al. 2006; Benson et al. 1998, 2003). Vorster (1985) identified solar radiation variance as a major cause behind Mono Lakes's elevation fluctuations.

Regionally, changes in shoreline elevations at Pyramid, Owens, and Mono Lake have been found to fluctuate with similar tempo (Benson et al. 2002). Only Walker Lake fails to conform with patterns seen in the other basins. The discrepancy may be due to periodic diversion of the lake's main water source, the Walker River, into the Carson Sink (Benson et al. 1991).

Using stratigraphy and other paleoenvironmental indicators, Stine (1987, 1990) constructed a fine-grained fluctuation curve for Mono Lake, dating back to ca. 3800 B.P. With fluctuation curves from Mono Lake and other nearby lake basins, one can project lake level to pre-3800 B.P. These are generally more coarse-grained than Stine's work, yet they still provide information about Holocene lake level fluctuations (Benson et al. 1990; Lajoie 1968) (Figure 2.3) and may explain how Mono Lake's near-shore wetlands were affected by changes in lake elevation for greater time depth.

As mentioned above, lake fluctuations may be more sensitive to certain aspects of climatic change than other indicators. As such, it is important to compare lake fluctuations among regional lakes along with other lines of paleoenvironmental data (Mehringer 1977, 1986). This will help to understand particular attributes of what past environments were like and how these changes may have affected people in the past.

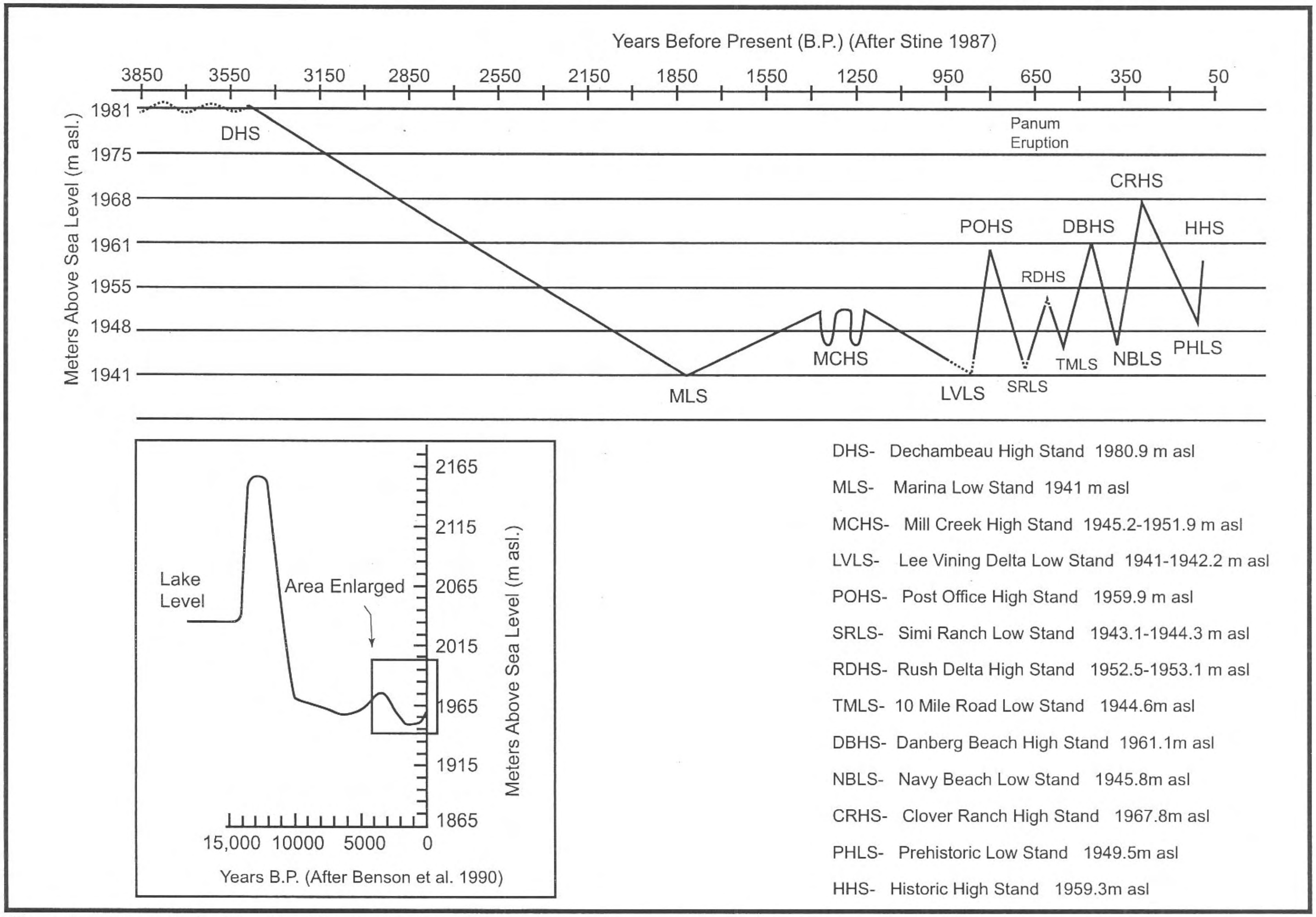


Figure 2.3. Mono Lake Elevation Fluctuation Curve.

Late Pleistocene environments in the Great Basin appear to have been generally wet and cool until the Younger Dryas event (ca. 12,500 B.P.) when lake levels are seen to decrease. After the cool-dry Younger Dryas, lake levels rose again at Owens and Mono Lakes in response to greater effective moisture until ca. 8000-7000 B.P. (Bacon et al. 2006; Benson et al. 1990). This time period demonstrates vegetation changes in both packrat midden and fossil pollen data that reflect changes from the Pleistocene/Holocene transition (Woolfenden 1996:62).

Mid-Holocene aridity is indicated at multiple levels with a rapid decrease in lake levels at Owens, Mono, and Pyramid Lakes (Bacon et al. 2006; Benson et al. 2002). As mentioned previously, the aridity coincides with Antevs's (1948) Altithermal event as well as other changes in the archaeological record (Baumhoff and Heizer 1965:705; Grayson 1993:244). Paleoclimatic data demonstrate considerable variability within the Altithermal period. Thompson (1990:221) uses plant macrofossil data to argue for rapid vegetation change between 7000-6000 years ago, as manifested in the appearance of pinyon (*Pinus monophylla*). Although debated, one factor affecting the change may be a shift from winter to summer precipitation (Grayson 1993:207). This period from ca. 8500-6000 B.P. coincides with evidence of warm-dry conditions, indicated by an elevated tree line in the White Mountains (LaMarche 1973). Other paleoenvironmental indicators between 7500 and 5500 B.P. are limited, possibly reflecting severe drought in the broader region (Wigand and Rhode 2002:338). Local data imply, however, an alternating shift from cool-moist (6000-5300 B.P.) to warm-dry (5300-3400 B.P.) conditions (Halford 1998). Between ca. 6000-4000 B.P., Mono Lake's shoreline rose to a high stand, which may have persisted for a period of several hundred years before dropping again at ca. 3800 B.P. (Stine 1990). This is an example of poor concordance between lake levels and other data as lake elevation rises during the predominantly warm and dry "Altithermal."

Finally, the late Holocene (after ca. 4000 B.P) is a period with generally cooler and moister conditions (Grayson 1993:221). It is also during this time that Mono Lake underwent more rapid fluctuations than those previously identified. There are two warm-dry periods between ca. 1100 B.P. and ca. 850 B.P. identified at Mono Lake that generally correlate to the MCA (Jones et al. 1999; Stine 1990, 1995, 1998). Interestingly, there are an additional four more recent fluctuation events at Mono Lake that appear to represent similar environmental perturbations (Figure 2.3) yet are not associated with periods of cultural "crises". In any event, other paleoclimatic indicators suggest that, aside from the MCA, the late Holocene transitions from initially warm-dry to cool and wet, then dry climate (LaMarche 1973:656-657). Additionally, vegetation mosaics in the Mono Lake basin appear to have achieved modern distribution with an increase in desert scrub species after 2000 B.P. (Davis 1999:249). Plant macrofossils recovered from packrat middens in the southern Owens Valley indicate that fully modern vegetation appeared by ca. 2800 B.P., though the late Holocene record shows continued aridness throughout the time period (Koehler and Anderson 1995).

A sediment core from Mono Lake's deep water sediments indicates that for at least the past 300 years, lake level fluctuations can be correlated with Pacific climatic events (Benson et al. 2003). When comparing this to Sierran tree ring records to the north and south (Graumlich 1993; Meko et al. 2001), there are inconsistencies in the timing of wet and dry times, likely indicating variable precipitation patterns in the northern and southern Sierra Nevada (Benson et al. 2003:157). That the core data generally coincide with lake fluctuations identified by Stine (1987, 1990) strengthens the argument.

These periods of climate change affect the diversity, composition, and distribution of wetland habitats at Mono Lake. Earlier discussion describes the general effects of lake fluctuations on wetland habitats. Additionally, lakeshore instability may have more drastic consequences on wetland migration when undergoing recessions rather than transgressions. As lake elevation decreases due to regional aridity, there is less moisture to the environment which may reduce the rate of mineral leaching from freshly exposed lakebed, preventing the downslope migration of wetlands.

Greater consequences from lake recessions would be manifest in the more arid, eastern sector of the basin, whereas wetlands are able to migrate or expand more effectively along the Sierra Nevada in the west. Likewise, upward transgressions would be beneficial for wetland migration around the lake as soil is leached and revegetation occurs more rapidly as a result of greater effective moisture. These factors, in addition to elevation gradient, would affect the size and productivity of the wetlands, as well as decisions about whether to exploit a patch or not.

Past environments at Mono Lake can be studied through various proxy data which, in composite, inform about paleoclimate, warming and cooling trends as well as wetter or drier times. At varied levels of resolution, these data align with the Mono Lake fluctuation curve, suggesting that they reflect similar patterns of climatic change. Most pertinent to the study is how lake fluctuation affects wetlands. Additionally, water inflow and elevation stability strongly effect the habitats that hunter-gatherers would have used in the past and when they may have been viewed as "good" or "bad" places to visit throughout prehistory (*sensu* Elston 1982).

Discussion

The present distribution of plant communities, as well as past lake fluctuations and environmental perturbations, has implications for how these areas were used in the past. Ecological studies demonstrate distinctions in vegetation and wetland "type" around the lake's margin. It is likely that these wetland contexts would be targeted and used for different purposes by hunter-gatherers traveling through the basin, depending on seasonality, duration of stay, and subsistence focus (e.g., hunting vs. plant processing).

Freshwater wetlands would likely be the most preferred habitats for foragers, especially in the spring. These contexts have abundant freshwater, high plant density and species diversity with grasses and herbs. Brackish wetlands should be the next preferred habitat for foragers. Water is more seasonally limited in this wetland group as streams may dry up by middle or late summer. Vegetation is less diverse, with more saltgrass and non-vegetated areas; however, there is also more shallow marsh habitat, which may be preferable for waterfowl that are seasonally abundant at Mono Lake. Finally, saline wetlands are expected to be the least preferred places to be relative to the other two types. They have the least influx of freshwater along with decreased vegetative diversity, and a predominance of alkali scrub and saltgrass vegetation. Waterfowl may be attracted to lagoons found along the northeastern lakeshore, although lake fluctuations greatly affect their presence or absence. Additionally, saline wetlands may be more desirable during times that place an importance on hard seed processing of plants such as sagebrush or saltgrass. Most habitation would be focused in the freshwater wetlands on the west shore of the lake, with decreased use radiating eastward across the basin.

When considering lake-level fluctuations, wetland habitats would have shifted in size and plant composition depending on whether the lake was rising or falling. For example, considering Table 2.3, the acreage of alkali lakebed shrinks as lake elevation increases. With more introduced water, the soils would become leached and allow more salt intolerant plants to migrate inward. With the low slope gradient found in eastern saline areas, a small increase in lake level may cover a widespread area, eventually creating more expansive marsh habitat. This type of habitat is found presently near Simons Spring (near quadrat B35), but could likely be re-created at higher elevations. Likewise, increase in lakeshore elevation would cause a decrease in freshwater wetland area which might make the area less preferable to inhabit due to restricted surface area. Instead, the brackish or saline habitats could offer more benefits for hunter-gatherers by presenting more abundant subsistence options.

In contrast to periods of lakeshore elevation increase, elevation decreases would potentially be most detrimental in saline habitats. As the lake elevation falls, alkali lakebed would be exposed, but not revegetated for considerable time due to low quantities of freshwater and minimal soil leaching resulting from small sediment size. Conversely, freshwater habitats could more easily colonize downslope areas because of greater soil leaching capabilities. This result is true to a lesser extent in brackish wetlands.

While present vegetation distributions, allow for informed predictions about hunter-gatherer land-use in Mono Lake basin, one must also understand how past lake fluctuations and other climatic events affected the distribution and composition of the wetlands. These proposed relationships can be correlated with the archaeological record to determine how past inhabitants responded to the different opportunities and constraints.

CHAPTER 3

ANTHROPOLOGICAL CONTEXT

Land-use descriptions provided by local and regional Great Basin ethnography and archaeology, offer a means to develop expectations about the types of activities that might be represented in the prehistoric record of Mono Lake basin. Besides the ethnography conducted in the Mono Basin, two other western Great Basin populations, the Owens Valley Paiute and the *Toëdokado* of the Carson Desert, who occupy wetland habitats will also be discussed. These examples help to fill potential gaps in the ethnographic lifeway noted by Davis (1965) , while also acknowledging similarity and variability in some regional cultural traits. These data provide behavioral possibilities for past lifeways in the Mono Lake basin by showing how different wetlands and other elements of the ecosystem were used.

Following the ethnographic discussion, attention turns to the research context in which certain archaeologists have attempted to understand prehistoric land-use in the Great Basin. Some exemplary projects and their conclusions are outlined. The archaeological record of the southwestern Great Basin will also be discussed. Beginning initially with the more extensively studied Owens Valley, the focus then shifts Long Valley prehistory before returning to the Mono Lake basin. These areas experienced overlapping use ethnographically, and were likely within the mobility ranges of single or related populations earlier in prehistory.

Ethnography

In order to develop expectations about the archaeological record in a particular area, researchers often turn to ethnographic data to see how native peoples were living near the time of contact. In addition, post-contact ethnographies can provide information about earlier native lifeways. Often this is based on childhood recollections or stories about the past told by parents and grandparents. This "memory culture" can provide insights to pre-contact lifeways, but inferences must be tempered by the fact that ethnographers may not spend much time with informants and their memory of past activities may be incomplete. Also it is entirely possible that these behaviors have nothing in common with lifeways of the more distant past (Wobst 1978). Due to these complications, the present study looks to ethnographic work with the aboriginal inhabitants of the Mono Lake basin, the *Kutzadika'a* [*Kuzedika*] Paiute, along with the Owens Valley Paiute and the *Toëdokado* who share similar environments. These data are compiled to gain a more full understanding of pre-contact *Kutzadika'a* subsistence-settlement patterns and their implications for prehistoric wetland use at Mono Lake.

Historic Accounts

Although reports by early explorers in the region mention Mono Lake and its inhabitants, these are usually in passing, and most date to the late 1800s or afterwards. Until recently, the initial European discoverer of the Mono Basin was thought to be Jedediah Smith in 1825. Smith noted that the native inhabitants of Mono Lake basin were not aggressive, and fled upon their arrival (Davis 1965:7). Based on other historical documents and journals, Fletcher (1987:11) discounts this history using information from a lost portion of Smith's diary (Farquhar 1965:26). Rather, the first European to enter the Mono Basin appears to have been Lt. Tredwell Moore in 1852 while on a military expedition against Chief Teneiya and a band of Yosemite Miwok who had reportedly killed and robbed a miner (Fletcher 1987:18). Although he entered the Mono Lake basin there is no discussion of the native inhabitants.

Later, in 1865, another account briefly mentions the *Kutzadika'a* Paiute when the author describes a deposit of worms two feet high and three to four feet thick circling the lake for miles (Browne [1865] 1981:67-68). He mentions that the local Indians dry these "*cuchaba*" (brine-fly pupae) in the sun and often mix them with acorns, berries or grasses, as well as eating them plain or fried. The pupae are more commonly referred to as *kutsavi*, from which the *Kutzadika'a* [*Kuzedika*], or "fly larva eaters," get their name (Davis 1965:5). One account states that the Mono Basin Paiute had claims on specific lakeshore *kutsavi* gathering grounds (Cain 1961:104). Problems may arise periodically when Indian groups from more distant places come to gather *kutsavi*, as has been noted of the Washoe and Yosemite Miwok (d'Azevedo 1986:471; Muir 1894:80).

Other activities noted are the collection of *piyegU* (pandora moth caterpillars) in the mountains south of the lake, as well as hunting ducks for sale to the white settlements (Cain 1961:46, 103). It is likely that these practices were the focus of early reports due to their novelty to explorers of European descent. Harvest time for these species is seasonal, so it is likely that they do not provide an integrated picture of annual *Kutzadika'a* lifeways.

While some general activities of the aboriginal inhabitants of the Mono Lake basin are described in early accounts, travelers had difficulty estimating how many Paiute were actually year-round residents. One informant estimate was as high as 1000 people or more (Davis 1965:7). In 1870, an Indian agent from the Walker River Reservation, Franklin Campbell, reported a population of about 300 *Kutzadika'a* residing between Mono Lake and east to Smokey Valley (Davis 1965:7). Kroeber's discussion of Mono demography (1976:587) lumps western Mono (Monachi) with Owens Valley Paiute and Mono Lake Paiute and he estimates the pre-contact population to have been between 3,000-4,000 people.

Difficulty arises when estimating aboriginal population size because most reports include areas outside of the basin within their totals. Likewise population movements common among people residing in the Great Basin and adjacent Sierra Nevada may provide skewed observations of more resident populations. Working with Campbell's estimate, it appears that the population of the Mono Lake basin itself was likely around 200. This number accounts for the larger area that Campbell was describing in conjunction with environmental productivity and carrying capacity of the basin. An estimate of 200 to 300 people living within Mono Lake basin seems plausible when considering that Kroeber's estimate includes Owens Valley populations as well as lands west of the Sierra Nevada.

These appraisals should not be viewed as more than approximations of average population since most ethnographic and ethnohistoric reports note that movement between the western Great Basin and Sierra Nevada was fluid (Davis 1962, 1965; Gayton

1948; Gifford.1932:19; Lee 1998; Steward 1933, 1938). As a result, populations likely fluctuated from year to year depending on resource productivity and shifts in inter- and intra-group relations. Due to mobility, subsistence adaptation, and linguistics, the *Kutzadika'a* Paiute are viewed as Northern Paiute, although noted to have "freely associated" with the Owens Valley Paiute and Eastern Miwok (Fowler and Liljebad 1986:438). It appears that the dispersed nuclear family-focused settlement pattern of the Northern Paiute and intergroup mobility prevented accurate estimates of Mono Basin's native population during early historic times.

By the latter part of the 19th century, most arable land was being farmed by Europeans, mining was being undertaken in the mountains, and extensive logging of pinyon and jeffrey pine led to the operation of mills southeast of Mono Lake. The lumber was then transported by boat and or train to the mining towns of Bodie and Aurora (Fletcher 1987). Even confronted by these disturbances, the Paiute carried on with many traditional subsistence practices. Men often worked at wage labor, while women gathered subsistence resources and produced goods for trade or sale, such as baskets (Dean et al. 2004:77-9; McCarthy 1996:91-92). During this early post-contact period, many *Kutzadika'a* began to reside at locations for longer periods of time than they had previously (Arkush 1987). This change may have been due to economic incentives to remain close to sources of wage labor, as well as displacement by incoming populations.

European encroachment and land-use practices likely prevented the *Kutzadika'a* from accessing many of the areas they had previously used for subsistence purposes (Davis 1965:7). About the turn of the century, the first permanent Paiute settlement was established in the meadows along Rush Creek. Led by Young Charlie and his family along with eight to ten other families, these settlers would sometimes still spend winters in their old camps east of Mono Lake (McCarthy 1996:88-89). Young Charlie practiced some subsistence agriculture using irrigated ditches, in addition to participating in wage labor and subsistence hunting. In the 1930s, Los Angeles Department of Water and Power bought much of the land along Rush Creek, coinciding with the establishment of reservations in Bishop and Coleville. Paiute residing around Mono Lake were given the opportunity to move to either of these and many did. Today few families remain in the Mono Lake basin as most have dispersed to undertake other endeavors.

Kutzadika'a [Kuzedika] Ethnography.

Emma Lou Davis conducted ethnographic research in the basin between 1959 and 1960. At that time there were 37 Paiute living in the town of Lee Vining. Based on interviews with various informants, Davis outlines a typical annual subsistence-settlement system for the local residents (Davis 1962, 1965). The lifeway depicted is one that she views as representing a "Desert Culture" adaptation (*sensu* Jennings and Norbeck 1955) one that is generalized and focuses on a wide variety of resources throughout the year. These are often found at disparate locations that necessitate at least short-term residential mobility.

Two food resources of importance reported by Davis (1965), noted earlier, are *kutsavi* and *piyegU*. While she describes these foods as important staples, further documentation points out seasonal and annual change in their availability. The two foods do appear to have been important during times of abundance due to their ease of procurement and storage (Davis 1965:33).

Kutsavi, as mentioned previously, are pupae of the brine fly (*Ephydra hyans*) that were collected along the shores of the lake. This activity occurred in late summer or early fall when the pupae would be blown ashore in windrows. Earlier reports (Davis 1965; Heizer 1950) described these as being in the larval stage of development, yet more recently it has been suggested, based on the time of year, that it was not the larvae but the pupae that were the focus of procurement (Sutton 1988:46). In any case, the practice of eating the pupae or larvae of the species is also reported at Owens Lake to the south (Steward 1933:256; Wilke and Lawton 1976:30) as well as at other saline lakes of the Great Basin (Stewart 1941); however, the activity appears most well-documented at Mono Lake.

Heizer (1950) summarizes many historical references on the procurement and consumption of *kutsavi* at Mono Lake and other localities. He cites a report from 1869 by the National Academy of Sciences that notes a rise of Mono Lake's shoreline by six feet, accompanied by a decrease in salinity causing disappearance of the larvae/pupae. Lake salinity, as well as temperature and substrate is known to affect the invertebrate populations of Mono Lake (Herbst 1988, 1990). These accounts suggest that *kutsavi* may not have been a resource that could be counted on annually, with population size varying widely in response to environmental conditions. Furthermore, that *kutsavi* are not found today in the numbers reported historically supports the notion that the resource underwent population fluctuations throughout prehistory and may not have always comprised a reliable part of the diet. Davis (1965:33) reports that *kutsavi* was processed by rubbing pupae between the palms to remove the "husk," then they were winnowed in a tray. As this behavior is unlikely to leave much archaeological residue, artifacts recovered near the shoreline are likely related to other activities.

The second resource noted by Davis (1965) to have been of particular importance is *piyegU*, the caterpillar of the pandora moth (*Coloradia pandora*) that is found mainly in Jeffrey and yellow pine trees. Jeffrey pine forests are found south of Mono Lake in Long Valley where large numbers of the caterpillars may be found (Aldrich 1921; Carolin 1971). Similar to *kutsavi*, *piyegU* was harvested by many aboriginal groups, mostly those residing in the Sierra Nevada and east of the mountain range (Sutton 1988:34). Sierran groups ate the chrysalids of the moth after they had descended from feeding in the trees; whereas east of the Sierra Nevada, the Mono Lake and Owens Valley Paiute ate the caterpillars (Gifford 1932:23).

The Mono Lake Paiute and Owens Valley Paiute were both known to have procured the caterpillar of the pandora moth (*piyegU*) in the Jeffrey pine forests located between their two territories east of Mono Craters (Aldrich 1912, 1921; Eldredge 1923; Englehardt 1924; Essig 1934; Patterson 1929; Steward 1933:256). These early accounts describe the basic process of procuring the caterpillars, as well as the life cycle of the species, but discrepancies in the accounts suggest that the descriptions are based on second hand information, rather than direct observation. Weaver and Basgall (1986) sort through these reports, focusing on accounts based on direct observation. Fowler and

Walter (1985) describe ethnographically observed caterpillar harvesting techniques practiced by some Owens Valley Paiute elders.

There is a two-year life cycle for the pandora moth, which would make the caterpillars available in alternating years with a peak in populations every 20 to 30 years. Adult moths appear from pupal casings in July and mate soon thereafter. They lay their eggs in the bark or on the needles of the Jeffrey pine. By late summer the larvae hatch and ascend the trees to feed on the pine needles. They continue to feed throughout the fall and overwinter in the tree tops. The following spring, they resume feeding on pine needles until around the beginning of July, when they descend the trees to burrow and pupate in the loose volcanic soils (Aldrich 1912, 1921; Miller and Wagner 1984).

PiyegU were gathered at this time when the caterpillars descended the trees. Trenches would be dug, or old ones re-excavated around the trees to trap the caterpillars on their descent. These pits were about 25-41 cm deep and 61 cm wide (Weaver and Basgall 1986:165). Some reports describe smudge fires being used to make the caterpillars drop from the trees (Aldrich 1912; Davis 1962:27, 1965:32; Steward 1933:256); however, Paiute informants deem this practice unnecessary, as "they come down on their own" (Fowler and Walter 1985:159). Additionally, an historic first-hand report does not describe the use of such fires (Way 1920a, 1920b; cited in Weaver and Basgall 1986).

When gathered, *piyegU* were roasted for thirty to sixty minutes in heated pits and then dried in the shade to prevent spoiling (although Davis [1965:32] reports that they were sun dried). Caterpillars were consumed by boiling or stored near the location for later retrieval (Fowler and Walter 1985). Davis (1965:32) conveys that they would also be roasted on sticks for immediate consumption. Archaeological evidence indicates that the storage facilities were conical structures, with one intact surviving example measuring approximately 2.0 m by 1.2 m at the base, and 1.1 m tall (Weaver and Basgall 1986:169).

One account (Miller and Hutchinson 1928:60) reports an expedition that collected 1.5 tons of larvae, and the group leader claims to have gathered caterpillars 35 times in his life. The year following their initial ethnographic research, Fowler and Walter returned to the pine groves to investigate the efficiency of harvesting *piyegU* with or without trenches. Unfortunately, a population collapse had occurred, and it continued the next four years until the article was published. This collapse not only prevented further study of harvesting techniques, but also illustrates the variable productivity of the resource.

Based on historic and ethnographic observations as well as biological data, it is apparent that during some years both *kutsavi* and *piyegU* could be harvested in great quantities. The storability of the resources may be questioned, as most accounts note that the high fat content makes them prone to rancidity. Rather than being kept for long-term or winter storage, it may be likely that the resources were consumed while harvesting other, more storable resources such as seeds or pine nuts. Additionally both *kutsavi* and *piyegU* were reported to have been traded across the Sierra Nevada for other goods, such as acorns. Through this they could exchange surplus for other goods less prone to spoilage. Alternatively, when these two resources were captured in windfall years or at least in storable quantities, it is likely that they both could be retrieved throughout the winter to supplement a diet largely based on stored resources.

Results indicate that while these two resources were at times important ethnographically, when looking at long-term regional settlement patterns, it is unlikely that these would greatly affect a seasonal mobility pattern observed archaeologically relative to Mono Lake's near-shore wetlands. Rather they were simply practiced as short-term logistical forays. Storage locations were visited in order to retrieve food caches and bring them to residential camps in the lowlands.

Plants and small game are the other resources that make up the bulk of the subsistence regimen for the *Kutzadika'a*, with little emphasis on large game (Davis 1962:25). Davis (1965) outlines a typical annual subsistence-settlement round of the Mono Basin Paiute. She notes that creeks and their water offer the basis for resources exploited by the *Kutzadika'a*. In spring, people would move from their winter camps in the east to the well-watered canyons of the west to gather early greens and bulbs and to hunt deer and marmots in the uplands.

With the onset of summer, people would move down to the foot of the Sierra Nevada to harvest grass seeds in the sub-irrigated meadows near the mountain streams. It is here Davis (1962:26) reports that the *Kutzadika'a* had their largest population aggregation and site occupation duration. From here they could procure food and travel over the mountains for trade. Additionally, the area could serve as a base camp for *piyegU* harvesting or hunting forays in the Sierra Nevada. McCarthy's (1996:91) informants recall harvesting both *piyegU* and *kutsavi* when they were children. Sheep and deer were hunted at their summer ranges in the mountains. Animals killed far from home were butchered in the field and carried back to camp when the meat was dried (Davis 1965:33). Obsidian quarrying areas are located near the summer camps, providing easily acquired toolstone. A wide variety of activities ranging from acorn processing in bedrock mortars, to harvesting and processing seeds, berries, roots and tubers occurred at the camps and the vicinity,.

Men would collect gull eggs on the islands of Mono Lake by making rafts out of willow branches (Davis 1964:255; McCarthy 1996:91). This most likely occurred in the early summer around May or June, when California gulls (*Larus californicus*) converge on the lake and nest in great numbers on Negit, and to a lesser extent Paoha Islands (Winkler 1983:10). Historically, between 1500 and 3000 adult birds have been estimated to nest on the islands, making for abundant egg gathering (Nichols 1938; Young 1952). Commercial egg collection to meet demand at Bodie and other nearby towns substantially impacted this resource and may have affected bird populations in the 19th century (Fletcher 1987:40).

In late summer, *kutsavi* may be blown onto the north shore in windrows (Herbst 1990) and could be easily gathered (Davis 1965:33). Other late summer resources mentioned by Davis include deer, sheep, ant eggs, crickets, rabbits, and small rodents. One of McCarthy's informants (Augie Hess) recalled a rabbit drive that was held near the west shore of the lake between Lee Vining and Rush Creeks when she was a young girl (1996:91). Rabbit and antelope drives were also reported to have occurred in the sand fields east of Mono Lake (Steward 1933:254). Other summer resources were the desert peach, serviceberries, elderberries, and buckberries (Davis 1965:33). In earlier times the berries would be dried and stored for winter, but more recently they are made into jam (McCarthy 1996:91).

In late summer or early fall, people would move to the mountains west, north, and east of the lake to gather pine nuts to be cached for winter stores (Davis 1965:33-34). This important food source continued to be gathered into historic times. McCarthy (1996:91) reports that her informants also recall harvesting pine nuts. The women and children would be taken by wagon to groves north of the lake where they would camp and gather nuts while the men remained working at wage labor. The pine nuts would be brought back to the home in sacks and stored. Similar to *kutsavi* and *piyegU*, pinyon pine is also know to fluctuate in productivity (Lanner 1981; Sutton 1984), although it still can be viewed as a resource that often constituted an important aspect of annual subsistence practices.

Davis (1962:27-28) describes how the *Kutzadika'a* moved to the mountains in the late summer to harvest the green, closed pine cones and cache them in rings of stone covered with brush and branches. If the harvest was productive, they would build structures near their caches and spend the winter in dispersed communities among the pine trees (Davis 1965:35). If the harvest was poor, families would move down to areas near the east side of the lake. Apparently this location is a bit warmer and drier, in addition to making other food caches such as *kutsavi*, *piyegU*, or other seeds more accessible. Without enough food stores, winter was difficult for the *Kutzadika'a*. To avoid starvation they sometimes would spend winter with the Yosemite Miwok (Steward 1933:257).

Fluid movements between populations residing both east and west of the Sierra Nevada suggest that although some accounts imply ownership of particular lakeshore areas or *piyegU* trenches, organized territoriality was weak in the Mono Lake basin. Evidence contradicting this interpretation comes from several conversations that Davis (1965:15) had with Mono Lake Paiute informants who identified two distinguishable groups within the basin. These were simply described as the north- and south-side people. In Davis's time and likely earlier, the groups intermarried. They were viewed by some to have distinction in their manner of speaking.

McCarthy's (1996:89) data on the residents of the first permanent Paiute settlement, "The Camp," near the banks of Rush Creek in 1900 identifies eight families, many of whom were related through maternal kin (Andrews pers. comm. 2005). With the apparently low population density of the Mono Basin and variable mobility of people, it seems possible that the two groups were likely extended family communities with little internal structure. This would also follow from the fact that the *Kutzadika'a* Paiute did not have any long-term leader beyond temporary roles such as the rabbit or antelope drive boss (Davis 1965:15).

Residential fluidity is a theme of many early accounts; travelers of European descent note encounters with Paiute and other Indian groups in the mountains often carrying large amounts of goods for exchange (Muir 1894, 1916). Trade was common across the mountains with the Yosemite Miwok. Many foods exchanged include salt, projectile points, pine nuts, baskets, red and white paint, and obsidian. In return for these goods, the *Kutzadika'a* would reportedly receive acorns, arrows, baskets, manzanita, and sowberries. Shell ornaments from the Pacific coast were also traded. Trade goods moved in all directions from the Mono Lake basin, most often for items unavailable in the local area (Davis 1961:20-22; 1965:21).

In addition to trade-related movement, there are also several accounts of individuals or families moving across the Sierra Nevada, or to the north or south simply for a change of scenery (e.g., Bennyhoff 1956:9; Gayton 1948:258; Gifford 1931:19). Reasons for the movement could be personal issues, unusual resource abundance at the location visited, or to maintain social ties with family members (Davis 1965:21). Many groups would come to the shores of Mono Lake to harvest *kutsavi* in the late summer, including the Washoe and Yosemite Miwok (d'Azevedo 1986:471; Sutton 1988). Owens Valley Paiute and Mono Lake Paiute both harvested *piyegU* from the pine forests between their two valleys (Davis 1965; Liljebad and Fowler 1986; Fowler and Walter 1985). Many of these groups who traded and interacted also intermarried.

The degree of movement is characteristic of western Great Basin groups (Fowler and Liljebad 1986). While ethnographic literature about the Mono Paiute has a moderate degree of detail, there are other aspects of the lifeway that seem to be missing or under-represented in the record. To identify other practices of western Great Basin lifeways that may have been part of the Mono Lake Paiute seasonal repertoire, the following discussion will briefly review some aspects of the lifeways of people who lived in other Great Basin areas with similar environmental characteristics. These data are crucial in attempting to understand how people may have lived or used the Mono Basin under different demographic, organizational, and environmental constraints in the past.

South of Mono Lake

As discussed above, the Long Valley caldera immediately south of Mono Lake basin is at an even higher elevation (2800 m) and subject to more harsh winters. While ethnographies (Davis 1965; Steward 1933) discuss this area as being used by various groups for hunting and *piyegU* collection, information about a substantial residential population is lacking. The next main permanent aboriginal population south of the Mono Basin is the Owens Valley Paiute.

The Owens Valley is distinct from the Mono Lake basin in that its elevation is over 500 m lower with a longer growing season and more permissive winters. Also there is a freshwater river flowing down the middle of the valley that, before historic water diversions, emptied into the saline Owens Lake at its southern extent. Owens Valley had a larger population with possibly the highest density in the Great Basin (Steward 1938:233). Residences here were reportedly more stable as some Owens Valley Paiute historically practiced irrigation of owned, wild seed plots (Steward 1933:247). The antiquity of this practice is open to debate, but it underscores the importance of wetland seed resources (Bouey 1979; Lawton et al. 1976; Steward 1933:247-250).

In some areas people were known to congregate in "villages" which were often near streams running from the Sierra Nevada (Steward 1938:50). A greater abundance of resources in a more restricted area implies that the Owens Valley Paiute practiced more of a "Desert Village" settlement pattern (Bettinger 1978; Steward 1933:237). This is also seen through greater sociopolitical organization than is found in other regions of the western Great Basin (Liljebad and Fowler 1986).

The Owens Valley Paiute harvested seeds such as rice grass *(Achnatherum [Oryzopsis] hymenoides*) in the volcanic tablelands to the north, as well as other hard seed plants found in the desert scrub plant community. Some seeds identified by Steward were harvested by both the Mono Lake and Owens Valley Paiute. These include goosefoot (*Chenopodium* spp.), sunflower (*Helianthus bolanderi*), sagebrush (*Artemisia tridentata*), and rose (*Rosa* spp.). A wider variety of specific vegetation was reported to have been gathered in Owens Valley (Steward 1933:242-246), but this may have been a function of data quality.

A resource of primary importance to the Owens Valley Paiute is the pinyon pine (*Pinus monophylla*) (Liljebad and Fowler 1986:416). Pine nuts were gathered in the fall and were an important stored food. The trees are found in the mountain slopes above the valley floor. Acorns were also traded with the western Mono.

Although the Owens Valley Paiute hunted ducks, they did not comprise as great a part of the diet as with other Northern Paiute groups (Liljebad and Fowler 1986:418). Owens Valley people reportedly did not use nets to capture the ducks, as is noted for other western Great Basin groups (Fowler 1990, 1992). Rather, they would use bundles of tules (*Typha* spp.) to float out to where the ducks were. Historic accounts report the taking of grebes in certain windfall situations (Delacorte 1994). Large quantities of eared grebes (*Podiceps nigricollis*) were recovered in archaeological context at the Lubkin

Creek site (CA-INY-30), suggesting their mass collection prehistorically at Owens Lake (Hildebrandt 1988:335). *Kutsavi* is another resource that was harvested at the lake (Wilke and Lawton 1976:19-20).

Despite the variation, the overall adaptation was probably similar. The people gathered seeds and hunted small game in the riverine or desert scrub areas, as well as hunted waterfowl and gathered eggs in the vicinity of the lake. Deer or mountain sheep were hunted in the mountains, with pinyon harvested in the same area during the fall. Trade was common in all directions spring through fall, including much interaction with the Western Mono or Monache (Davis 1961; Gayton 1948).

There are certain differences in the lifeway of the Owens Valley Paiute, but general activities practiced throughout the year appear to be comparable. Population density and aggregation were greater in Owens Valley than in the Mono Lake basin; however, both groups targeted similar resources and habitats throughout the year. People made significant use of wetland and river resources, along with other easily accessible habitats for subsistence-related and other activities.

More Northern Wetland Areas.

When describing western Great Basin environments, the Mono Lake basin is classified as a Piedmont sub-area due to its high elevation and proximity to the Sierra Nevada (Fowler and Liljebad 1986:437). Generically, these characteristics suggest a montane focus, but ethnographic data point to the importance of plant and small game resources with little importance placed on montane resources (Davis 1962, 1965;

McCarthy 1996). Pinyon is used, as is common throughout the Great Basin, wherever available (Thomas 1983). However, the ethnographic importance of near-shore wetlands in the Mono Lake basin suggest correlation with populations inhabiting more rich wetland habitats, such as those found in the Carson and Humboldt sinks (Fowler and Liljebad 1986:438).

Located at one of the lowest elevations in the Great Basin, marsh wetlands were extensive in the Carson Sink. The *Toëdokado* Paiute resided there where marshes, desert scrub, and mountains were used simultaneously by men and women (DeQuille 1963 [1885]; Fowler 1992:43). Similar to Mono Lake, population movement largely depended on the season and location of resources exploited. Wetland plants comprised an important part of the diet, as did seeds and small mammals in the desert scrub. Many of the plants used in this region are the same or have counterparts in the Mono Lake basin.

Toëdokado ate waterfowl eggs that they collected by wading or using tule balsas in the spring and summer (Fowler 1992:46; Wheat 1967). Most Northern Paiute were noted to gather this easily retrieved resource, although it likely could be done only for a short period of time. Waterfowl were important in the Carson Desert and Pyramid Lake (Fowler 1990; Knack and Stewart 1984), as well as the Humboldt Sink (Heizer and Napton 1970).

Discussion

The *Kutzadika'a* Paiute appear to have practiced a pattern of regional land-use that emphasized wetlands within the basin. This is similar to both the Owens Valley and

Carson Sink Paiute populations. Mobility ranges appear to have varied in relation to the size of the area inhabited among other factors. Mono Lake Paiute practiced more wide-ranging residential mobility than groups to the south, the extent of this varying in response to the amount of foods stored during the year. People resided within the basin depending on the relative availability of local resources like *piyegU*, *kutsavi*, pinyon, hard seeds, and game. Early reports and ethnography suggest that the *Kutzadika'a* were not as tethered to the landscape as the Owens Valley Paiute because there was a more generalized subsistence focus and dispersed populations. Mobility would likely have been even greater in the past when populations appear to have been more sparse.

Based on descriptions of group aggregation and the duration of residence in the moist meadow wetland areas of western Mono Lake basin, lakeshore plants and animals likely played an important and predictable role in the annual subsistence round. Davis (1965:12) notes that the *Kutzadika'a* ate fruits of the desert peach (*Prunus andersonii*), unnamed grass seeds and pine nuts, but does not mention other plants specifically. Animals noted are *kutsavi*, *piyegU*, deer, sheep, rabbits and hares, small rodents, porcupine, shorebirds, and suckers (Davis 1965:11). To develop a clearer understanding of which plants and animals may have been important to people in earlier times, one can turn to paleobotanical and faunal samples recovered from archaeological sites.

Table 3.1 shows paleobotanical remains from contexts in the Inyo-Mono region that produced robust samples of seeds near wetland contexts. Data provided for site MNO-891 boast the largest archaeobotanical sample for the Mono Lake basin. The table shows aquatic and streamside plants to comprise an important aspect of paleodietary

Table 3.1. Select Paleobotanical Remains from the Inyo-Mono Region.*

Site **Locus**	**Iny-3778** **B**	**Iny-3769** **all loci**	**Iny-2750** **A**	**Iny-30** **Marana**	**Iny-30** **Newberry**	**Mno-891** **2**
Aquatic/Streamside Plants						
Typha sp.	>5050	>41,008	2830	69	531	-
Scirpus sp.	39	3	3	621	43	-
Juncus sp.	-	6	-	80	31	-
Rootstalks/tubers	-	-	-	7	1	-
Atriplex sp.	6348	7	2	30	3	-
Chenopodium sp.	424	94	-	5	85	9
Chenopodiaceae	3002	264	258	46	85	-
Elymus	-	-	-	1	-	-
Hordeum	-	-	-	4	4	-
Rosa sp.	-	-	-	-	11	-
Rumex	-	-	-	-	11	-
Ruppia	-	-	-	564	4	-
Sprorobolus	-	4	-	2	23	-
Helianthus sp.	3	-	-	11	4	-
Trifolium	-	-	-	-	-	18
Dryland/Upland Plants						
Achnatherum hymenoides	2	-	-	-	-	-
Agrostis	-	-	-	1	-	-
Amaranthus	-	-	-	5	2	2
Amsinkia sp.	-	-	-	6	9	-
Artemisia tridentata	-	-	-	18	4	-
Asteraceae	-	3	-	3	10	-
Brassicaceae	-	-	-	-	8	-
Cryptantha sp.	-	3	-	2	-	-
Descurainia sp.	-	1	-	899	854	4
Eragrostis	-	-	-	1	4	1
Eremalche	-	-	-	1	2	-
Fabaceae	3	-	-	22	11	-
Laniaceae	-	-	-	5	-	-
Lycium sp.	8	2	-	10	52	-
Malvaceae	-	2	-	4	10	-
Mentzelia sp.	1	9	1	51	44	-
Muhlenbergia	-	-	-	1	7	1
Oryzopsis	-	-	-	2	44	-
Panicum sp.	-	-	-	-	-	1
Phalaris	-	-	-	2	1	-
Pinus monophylla	62	14	1	-	-	-
Poaceae	6	21	3	2	8	-
Potentilla	-	-	-	1	35	-
Purshia	-	-	-	1	1	-
Salvia sp.	4	13	-	1	2	-
Sphaeralcea	-	-	-	1	4	-
Stipa sp.	-	-	-	1	1	-
Vigueria	-	-	-	2	6	-
Vulpia sp.	-	-	-	-	58	-

*Unless otherwise noted, contexts date to Haiwee/Marana intervals (1350 B.P.-Historic); Data from Basgall and McGuire 1988; Delacorte 1999; Wickstrom and Jackson 1993.

remains. Likewise, especially evidenced at the Lubkin Creek site (CA-INY-30), dryland and upland plants were also used by native peoples.

While samples are small in the Mono Lake basin, more robust regional samples from Owens Valley indicate a pattern of plant use that places importance on wetland plants in earlier times (3200-1350 B.P.) with little use of dryland plant species. (Basgall and Wohlgemuth 1988; Pierce 2003). More recent samples (650 B.P.-historic) exhibit greater variability in plant species although wetland plants still greatly outnumber dryland plant species and may have even been used more intensively in late prehistoric times (Delacorte 1999:388).

These archaeological examples, as well as ethnographic sources from the western Great Basin indicate an emphasis on wetland resources. Still, the importance of such habitats depended also on the relative productivity of other local and regional resources (Fowler and Liljebad 1986; Knack and Stewart 1984; Wheat 1967). Plant species recovered regionally as paleobotanical remains are found in Mono Lake's extant wetland communities at varied frequencies (Table 2.1), demonstrating that these habitats contain different degrees of economically important plants. Due to the small paleobotanical sample from the Mono Basin, it is also possible that a wider variety of locally available plants were also exploited. Moreover, Table 3.1 appears to show the greatest reliance on plants from freshwater habitats with fewer plants found in saline wetlands present in prehistoric samples; this information suggests that saline habitats were less desirable.

Turning to the question of animals that were important contributors to prehistoric diets, one may look to archaeologically recovered animal remains and compare them to the distribution of fauna within the three wetland habitats under investigation. Similar to paleobotanical remains, prehistoric fauna are generally sparse at sites around Mono Lake. Davis (1964:Appendix 2) reports on a test pit near Black Point that recovered porcupine, coyote, raccoon, hares and rabbits, cow, sheep, bobcat, dog (?), deer, and birds. The context of this test pit is unclear. Again, expanding the breadth of view to areas with larger faunal samples, one may look at a series of sites in the Owens Valley where valley floor/wetland contexts have produced more robust samples of faunal remains (Table 3.2). Of note are the high frequencies of grebes and other water birds. Moreover, large mammals, lagomorphs, and, to a lesser extent, rodents also comprise significant proportions in most samples. Although local environmental variability would invite certain numbers, the overall pattern shows that particular animals have been targeted for economic reasons in and near wetland habitats.

Animal remains from archaeological sites correspond to certain species found today around the wetlands at Mono Lake. Returning to Table 2.2, it appears that large mammals, such as deer and pronghorn, are found in freshwater and brackish wetlands, while deer are not expected in saline environments. Various lagomorphs, rodents and other animals are found in each of the three habitats and would likely have been there in the past.

The importance of wetland resources to the diet of the *Kutzadika'a* Paiute may have varied in the past relative to the productivity of surrounding environs. This may be related to non-wetland as well as different types of wetland areas. Ethnographic data for the *Kutzadika'a* and other Great Basin groups highlight the importance of these habitats

Table 3.2. Faunal Remains Recovered from Select Archaeological Contexts in Owens Valley.*

Site Component	Iny-182 Early	Iny-30 Newberry	Iny-3806 Haiwee	Fish Slough Late	Iny-30 Marana
Herpetofauna	9	5	2	50	11
Fish	334	5	-	96	23
Grebes	2	111	868	4	383
Water birds	-	-	307	1	2
Birds	4	3	148	41	-
Small Mammal	123	-	-	76	-
Medium Mammal	-	-	27	346	-
Large Mammal	54	823	294	505	1576
Artiodactyl	2	59	11	40	120
Big Horn Sheep	-	14	13	1	9
Deer	-	2	-	17	2
Pronghorn	-	2	-	1	11
Carnivore	-	13	9	13	28
Marmot	-	1	-	-	-
Lagomorph	4	26	4	59	22
Jackrabbit	5	190	44	314	209
Cottontail	5	53	21	36	56
Wood Rat	-	8	8	24	13
Kangaroo Rat	4	18	1	36	41
Rodent	5	37	5	72	67
Indeterminate	-	4537	-	725	13543
Total	**555**	**5925**	**3769**	**2492**	**16314**

*Data compiled from Delacorte 1999:Appendix C; Early = pre-3500 B.P.; Newberry = 3200-1350 B.P.; Haiwee = 1350-650 B.P.; Marana = 650-Historic; Late = 3500-Historic.

for annual subsistence and settlement strategies. Both plant and animal resources recovered as archaeological remains demonstrate that the pattern of ethnographic wetland use extends into the past with different types of resources being more or less important through time. Seasonality and subsistence focus, as well as resource density and habitat size play roles in whether or not given wetland patches are exploited. Understanding how Mono Lake wetlands varied in this manner throughout the past suggests that different areas were more prolific at some times than others. Productivity depends on lake elevation, corresponding slope, and whether the shoreline is undergoing a transgressive or recessive phase. The present study seeks to gain a better understanding of prehistoric wetland use through systematic study of Mono Lake's varied near-lake habitats.

Archaeological Research Context

The structure of the project research question and manner in which it is tested is an outgrowth of over three decades of regional land-use studies undertaken in the central and western Great Basin. It is important to understand how archaeologists view regional land-use patterns and use different types of data to test propositions and interpret results. Most often hypotheses are related to ecological variables and test earlier assumptions about regional adaptive stability within the basin.

When regional studies were first initiated, a common goal was to test the temporal persistence of the "Desert Culture," later termed "Desert Archaic" (Jennings 1957, 1964, 1968; Jennings and Norbeck 1955) adaptation in the Great Basin. This is conceived as a generalized adaptation where people flexibly exploited a wide variety of resources within a mobile context for the best adaptive fit to a region. It was originally developed using evidence from Danger Cave in the eastern Great Basin (Jennings 1957), but is often viewed as the archaeological manifestation of Great Basin ethnographic adaptations described by Julian Steward (Beck 1999:22). This application of the direct historical approach initially posited that the lifeway extended back to the early Holocene, although more recently this position is not held by most (cf. Jennings 1986a).

Steward (1938) described the cultural ecology of many Great Basin populations and viewed local environmental conditions as important factors affecting lifeways within the region. The environment is viewed as an important but not determining factor for particular adaptations (Steward 1938:260). Because of the relatively simple technology and social organization found within the region, archaeologists have disagreed about whether differences seen ethnographically are variations of a single, "generalized" adaptation or represent adaptations that are significantly distinct (cf. Delacorte 1990:1-11).

Interpretation of adaptive variability is most notable in the study of archaeological remains. How far back does the ethnographic pattern apply, and what degree of variation signifies a distinct adaptation? These questions have been the focus of research and construed differently by various researchers (Bettinger 1977a, 1989; Cannon et al. 1990; Delacorte 1990, 2002; Kelly 1985, 2001; Raymond and Parks 1990; Thomas 1973, 1985; Zeanah 1996; among others). These accounts may vary in interpretation due to the scale of area studied, as well as what is believed to comprise a distinct manner of living. When investigating areas with different habitats, the amount and type of artifacts recovered may signify a difference in previous manners of living.

Identified through temporally varied artifact assemblages, an alternative to the Desert Culture hypothesis was proposed for one particular environmental context in a marsh/wetland focused adaptation in the Humboldt Sink of the western Great Basin. In such areas, wetland resources were viewed as being sufficiently productive to develop sedentary or semi-sedentary lifeways (Ambro 1967; Cowan 1967; Heizer 1956, 1967;

Heizer and Napton 1970). The model, often termed the "limnosedentary" hypothesis, is derived from the presence of many wetland-specialized tools and food remains from "cache caves" (Heizer 1967:7; Kelly 2001:8; Thomas 1985:18-20). Further arguments regarding the importance of wetland environments are made for the eastern Great Basin (Madsen 1982; Madsen and Lindsay 1977).

This pattern represents a vastly different, marsh/wetland-focused adaptation than that characterized by the so-called Desert Culture. In comparison, this latter model has been alternatively termed the "limnomobile" hypothesis (Thomas 1985:18-20). A limnomobile lifeway focuses on wetland resources when they are particularly abundant, especially when other resources have decreased productivity. To date, neither hypothesis has proven entirely true; however, they have been important models against which to test archaeological data in the Great Basin (Bettinger 1993:45; Fowler and Fowler 1990:8). This discourse has set the stage for more complex theoretical models that focus on local environmental constraints, often using neo-Darwinian frameworks such as evolutionary ecology (cf. O'Connell et al. 1982). Applications of these models are interpreted in relation to concepts such as foraging efficiency, mobility patterns, and technological organization (Jones and Madsen 1989; Kelly 1988, 2001; Simms 1987; Zeanah and Simms 1999).

Regional Land-Use Studies.

Early reconstructions of Great Basin prehistory were derived largely from the archaeological record of deeply stratified cave/rockshelter sites. For mobile hunter-gatherers, these locations would likely have served different purposes throughout prehistory, depending on how their placement articulates within broader settlement and subsistence patterns. For example, both Lovelock and Hidden Caves are notable for caches of wetland-focused tools such as duck decoys and nets, as well as the remains of wetland plants (Kelly 2001:15). On the other hand, representing an earlier period of use, Stratum II at Danger Cave contained many grinding stones as well as chaff and the remains of ingested pickleweed (*Allenrolfa* spp.) seeds. It appears that at that time the cave was used for the processing of seeds rather than for caching specialized wetland gear (Grayson 1993:243-4). Here there are two similar landforms in different environmental contexts that were used in divergent ways. In an effort to better understand regional differences in prehistoric lifeways, many researchers turned to the study of broader landscapes, such as valley or lake basins to determine how larger settlement and subsistence patterns are structured (cf. Bettinger 1977a; O'Connell 1975; Thomas 1973; Weide 1968).

Reese River Valley

An early study of this kind was initiated in the Reese River Valley of central Nevada (Thomas 1973). Indirectly testing the Desert Culture hypothesis, Thomas used the ethnographic pattern of the Reese River Shoshone, as reported by Steward (1938, 1941), to develop predictions for the archaeological patterns of artifact discard within that locality. The predictions were used to develop a computer simulation model (Thomas 1972), which was tested using a surface survey of 140 randomly selected 500 m x 500 m quadrats (Thomas 1973:168). These were distributed over four environmental zones (riverine, sagebrush flat, pinyon-juniper belt, and upper sagebrush-grass) (Thomas 1973:158). The main question that Thomas sought to test was how far the ethnographically observed settlement pattern could be projected into prehistory.

Theoretically, the model is based in cultural ecology, as described by Steward (1938, 1955). Cultural ecology, while not environmentally deterministic, views a successful adaptation as one which is largely related to local ecological constraints (Steward 1938:260). While this can be used to describe the complex interaction of a system, it falls short of explaining why the adaptation looks a particular way, how it changed, or why it would change to a different form. In effect, it is a neofunctional explanation that works best describing cultural stasis (Bettinger 1991b:57-58).

Using a non-site approach to surface survey, Thomas (1973; 1975:163) tabulated the artifacts recovered from each survey unit and conducted statistical analysis focusing on tests of artifact density and dispersion. His comparison of results across different environmental zones found a 75% success rate at predicting archaeological remains within the Reese River Valley (Thomas 1973:172). The accuracy implied that the settlement pattern described by Steward persisted for the duration of the valley's occupation (from ca. 4500 B.P.). Thomas (1973:173) characterizes this as a "Central-Based Wandering" pattern that is focused on two types of settlements, riverine shoreline and pinyon ecotone habitation sites. These are situated in different locations annually based on the position of productive resources with riverine shoreline sites being occupied in the summer and the pinyon ecotone settlements in the winter. He is quick to point out that the implications of the study describe a unique pattern that arose associated with local ecological circumstances and should not be applied to other areas such as the Danger or Lovelock Cave regions, as these areas have their own unique ecological constraints (Thomas 1973:174).

Important aspects of his study have been noted, such as the non-site approach to characterizing archaeological assemblages and the comparison of assemblages across environmental zones. Chronological controls were established using time-sensitive projectile points. Here the technique may have had a homogenizing effect combining assemblages relating to different time periods into contemporaneous toolkits simply if they fall within the same 500 m x 500 m grid (Jones and Beck 1992:174). Possible support for this assertion lies in the fact that he did not identify any patterns of adaptive change, though Thomas would argue that there simply were not any.

Southwestern Great Basin

Owens Valley. Following this initial research program, Bettinger (1977a) conducted a regional survey of the Owens Valley, again testing predictions of prehistoric land-use derived from Steward's (1933, 1938) ethnographic research. Bettinger (1977a:3) sought to test two alternative positions in cultural ecology, whether Great Basin lifeways vary in response to local conditions or represent variations on a single adaptation (e.g., the Desert Culture). Similar to Thomas, he also sought to identify variability in prehistoric adaptation over time and space.

Bettinger's survey covered randomly selected 500 meter-square units across four environmental zones of the Owens Valley. Unlike Thomas, Bettinger used a site-based approach to data analysis and inspected the entire surface of the quadrats surveyed (Bettinger 1977a:7). Similar to the Reese River study, chronology was also determined using projectile points as chronological markers. Based on statistical analyses such as coefficients of dispersion and identifying temporal differences in site type and distribution, Bettinger's model achieved only a 44% success rate (1977a:12). Because the ethnographic land-use pattern did not fit the archaeological record with much accuracy, he argues that there were three distinct adaptive shifts in the Owens Valley. The first, during the Cowhorn Phase (1500 B.C - A.D. 600) is a shift in emphasis from riverine resources to those of the desert scrub community, seen by a shift in base camp location. The second shift is the inception of intensive pinyon procurement during the early part of the Baker Phase (A.D. 600-1000), with an increase in the number of pinyon camps. The remaining adaptive change relates to a decrease in large game hunting after A.D. 1000 (Bettinger 1977:15), supported by the disuse of upland and desert scrub hunting stations.

He argues that these three changes represent significant adaptive shifts that emerge by forces such as environmental change, population increase, or population replacement. Lacking an explanatory model, he is unable to assess the validity of one proposition over the other. In an effort to strengthen his arguments for adaptive variability, Bettinger (1978) further outlines this distinction in the Great Basin using data from five separate localities (Bettinger 1977a; Heizer and Napton 1970; O'Connell 1971, 1975; Thomas 1973; Weide 1968). He concludes that there were two competing adaptive solutions in the Great Basin, the "Desert Culture" and the "Desert Village" strategies. The latter strategy relies on permanent villages and aggregated populations, occurs in the Owens Valley, Surprise Valley, and the Lower Humboldt region. Additional support for his argument concerning adaptive change is presented using multivariate statistical analyses to strengthen arguments that were previously based on more intuitive observations (Bettinger 1979). This analysis was criticized (Hall 1981), but the degree to which it misrepresents the data may be open to interpretation (Bettinger 1981b), as the overall implications of the project appear to hold true (Bettinger 1999a).

Deep Springs Valley. A similar study in adjacent Deep Springs Valley supports adaptive variability in the Great Basin. Delacorte (1990) conducted a regional, random stratified surface survey of 151 quadrats, again measuring 500 m x 500 m, and spanning six environmental zones. He describes a pattern of adaptive change that occurred mostly as a post A.D. 600 phenomenon and identifies two distinct adaptations present in Deep Springs Valley (Delacorte 1990:358-360). The first (1200 B.C.- A.D. 600) is one characterized by seasonal occupation of the lowlands as part of a strategy with far-ranging annual mobility and coupled with high logistical mobility. The second adaptive pattern consists of more intensive lowland use with decreased logistical mobility apparent through fewer specialized sites. Residential occupation within the valley expands and greater settlement mobility is observed through site locations occurring in new environments, such as the high elevation alpine zone. Subsistence correlations to the changes in mobility include increased use of a wider variety of resources, along with more intensive processing techniques.

The adaptive shift in Deep Springs Valley may be due to environmental changes affecting the productivity of lowland seeds. In addition, population pressure, or even replacement, could have brought about greater competition for resources within the larger area observed through the use of more labor-intensive practices on lower ranked food resources which had previously comprised a more marginal part of the diet (Delacorte 1990:365). The research concludes by comparing the settlement pattern at Deep Springs with three other valley systems (Owens, Reese River, and Fish Lake Valleys) and the Coso region, and identifies sufficient variation across the five regions to argue that there are distinct adaptations to diverse local environmental constraints. Moreover, differential distribution of pinyon in the four areas likely contributed to variations in the late prehistoric settlement and subsistence adaptations (Delacorte 1990:366).

Carson Desert

Land-use studies conducted largely within the western Great Basin have demonstrated a variety of adaptive diversity at a scale that varies across environmental zones. These changes are manifest in the increased use of previously under-exploited habitats, such as upland areas, along with new or more labor intensive processing techniques. By focusing on a particular environmental zone, one can also find variability in land-use, although unlike the previously discussed studies, articulation within the greater settlement-subsistence system is more difficult to understand.

One area that has been extensively studied and subject to increasingly sophisticated models of land-use is the Carson Desert and Stillwater Marsh of the western-central Great Basin. Studied using both surface survey (Kelly 1985; Raven 1990; Raven and Elston 1989; Zeanah 1996; Zeanah et al. 1995) and excavation (Kelly 2001), this research tested and refined predictive land-use models. It has largely been conducted under the rubric of evolutionary or behavioral ecology, which uses individual reproductive success as the mechanism for cultural change (Bettinger 1991b:153-154; Kelly 1995:50-51; O'Connell et al. 1982). Behavior is studied using economic models of resource acquisition, where energetic returns on the effort expended foraging are compared among different resources and subsistence strategies. Additionally, the predictive models involve more fine-grained environmental classification than earlier studies. The most recent synthesis of regional land-use at the Carson Sink will form the basis of this discussion (Kelly 2001).

Kelly's research, stemming from the discussion of the "limnosedentary" hypothesis, sought to test whether hunter-gatherers of the Carson Sink were sedentary hunter-gatherers living year round consuming varied resources in the productive marsh habitat (Kelly 2001:5). Two questions raised are why do hunter-gatherers become sedentary, and how that adjustment relates to resource abundance. There appears to be many factors that lead hunter-gatherers to become sedentary (Kelly 1992), such as territorial circumscription or new technologies.

Initial efforts by Kelly (1985) did not identify evidence for sedentism in the Stillwater Marsh, but heavy rains in the mid 1980s exposed substantial residential features that implied the opposite. Further research (Raven 1990; Raven and Elston 1989; Zeanah 1996) suggested that different mobility strategies were used in the Carson

Desert throughout prehistory (Kelly 2001:296). Kelly argues that prior to 1500 B.P., wetlands had a tethering effect on residential mobility where people would return to them on a regular basis. It is of note that cave caches of wetland-related gear are not present after 1500 B.P. After 2000 B.P., people began to reside at the wetlands for periods of time (perhaps multiple years) unless foraging returns were better elsewhere. This behavior is associated with an interval of drier, more variable climate. Based on survey data from upland areas, Kelly (1985, 2001:102-136) contends that residential occupation did not occur in the uplands when it was not in the marsh. Kelly concludes that increased productivity of wetland resources relative to the surrounding environment affected more intensive use of that resource patch. When other patches became more productive than the wetlands, foragers opted for a different residential pattern.

This conclusion is different than that reached by Bettinger (1977) and Delacorte (1990), and may be related to lower productivity of upland resources in the Stillwater Mountains compared to the Sierra Nevada and White Mountains (Delacorte 1990:362; Zeanah 2000, 2002). The variation described above illustrates the diversity of Great Basin adaptations and some of the factors that lead to these divergent patterns.

Assessing Land-Use Strategies and Adaptive Diversity

The three regions described above have been subject to large-scale archaeological reconnaissance which suggests that there is significant temporal and spatial variability in Great Basin adaptations. Separation of environmental types and/or sub-types can provide a useful means for identifying changes in hunter-gatherer settlement and subsistence practices. Assemblage variability can shed insight into the roles that different ecozones played within the larger settlement system. One potential pitfall when using surface assemblages is the difficulty of temporal control. Earlier studies relied largely on time-sensitive projectile point types, which may be successful at one level, but leave undated those assemblages that lack such artifacts. It may be possible to overcome this problem in obsidian-rich areas such as the Mono Lake basin by using obsidian hydration. Greater temporal control should prevent homogenization of assemblages by not combining tools or artifact aggregates that are related to different temporal events.

Rather than focusing on the notably rich assemblages of Great Basin cave sites, regional land-use studies have empirically demonstrated that people living within the greater region neither practiced the same generalized subsistence pattern for thousands of years, nor were they always residentially tethered to rich wetland habitats. Instead, adaptations appear to vary by environment and population size among other factors. One can understand the dynamics of varied settlement strategies by studying the distribution of artifacts across different ecological zones. These artifacts may be compared singly or as aggregates to better understand changing patterns of land-use or subsistence practices.

Archaeological Research in the Southwestern Great Basin

When discussing variable adaptations in the western Great Basin, two problems appear, one related to scale and the other to interpretation. Using the classification of the Desert Archaic to identify a generalized adaptation that persists 7000 years or more in the Great Basin appears to mask variability that might exist on a more local level. While it is true that most Great Basin hunter-gatherers never adopted agriculture and subsisted predominantly on wild game and plant foods, it seems folly to simply label non-agriculturalists under a single normative unit. Archaeological data point to changing pattens of mobility, group aggregation, technological change, and land-use patterns. Similar environments are used with differing levels of intensity for various reasons throughout the Holocene.

While the concept of an "Archaic" adaptation generalizes land-use patterns across a large area (Jennings 1986b:113), a more fine-grained scale of analysis is fruitful in characterizing variability at the local or regional level. Changing patterns of land-use, technology, and resource focus interact to create an "adaptive peak" (*sensu* Bettinger and Baumhoff 1982) where the lifeway practiced in later time periods is dramatically different than the one practiced earlier. A return to earlier modes of living would be difficult given the present constraints. Particular adaptations are constrained by population pressure, environmental factors, scheduling conflicts, as well as social organization such as the sexual division of labor and mobility patterns.

Overall patterns of prehistoric change in the Great Basin generally appear to change from a highly mobile lifeway focused on hunting with little importance placed on plant processing in the early Holocene to low mobility and intensive use of plant and seed resources in the late Holocene (Grayson 1993; Kelly 1997; Elston and Zeanah 2002). This pattern is not uniform across space and time, as certain periods exhibited increased large game hunting and varied degrees of logistical versus residential mobility (Hildebrandt and McGuire 2002; Zeanah 2004). At a general level, the pattern described for the western Great Basin often explains culture change via fluctuations in population density and environmental conditions (Elston 1982). In a more recent synthesis, Elston (1986) describes how the Archaic pattern varied among sub-regions of the western Great Basin yet concludes that the Archaic lifeway persisted for the last 7000 years by "resisting change through change" (1986:148). Clearly, this demonstrates that the scale of cultural adjustment needed to signify an "adaptive change" varies by context.

The Inyo-Mono region of the western Great Basin has seen a substantial amount of archaeological research, mostly within the past three decades. Some regions, such as the Mono Lake basin are thought to represent a generalized Archaic/ Desert Archaic adaptation (Bettinger 1982:74; Davis 1964). At one level there is a trend toward decreased emphasis on hunting and increasingly intensive seed processing over the Holocene, demonstrating adaptive flexibility rather than distinct adaptations (Davis 1964:286). In contrast, culture change in the Owens Valley appears to be drastic enough to represent distinct ecological adaptations (Bettinger 1977a).

Evidence cited shows a more intensive use of previously under-exploited environments (Basgall and Giambastiani 1995; Bettinger 1991a; Zeanah 2000), more labor-intensive processing techniques, such as threshing floors (Basgall and Delacorte 2003; Basgall and Giambastiani 1995) and green cone pinyon procurement (Bettinger and Baumhoff 1983; Bettinger 1993), as well as more intensive use of low-ranked resources such as freshwater mussel (*Anodonta* sp.) (Basgall and McGuire 1988; Delacorte et al. 1995; Delacorte 1999). Together, along with variability in site distributions over time, these data point to a more territorially constrained lifeway where people were forced to make a living via more intensive processing of a wider variety of resources from more localized areas (Bettinger 1999). Implications move beyond strict subsistence changes where the overall social organization must become realigned to different patterns of scheduling, group movement and dispersion, as well as intergroup social relations like those pertaining to land tenure.

The following discussion focuses initially on archaeological research in the Owens Valley where there has been much debate about prehistoric lifeways. While arguments regarding prehistoric culture change are central in this region, they are only intermittently applied north to the Mono Basin (cf. Bettinger 1981; Nelson 2001; Wickstrom and Jackson 1993). Here, prehistory is still generally understood to be represented by a persistence of a Desert Culture lifeway (Bettinger 1982:74), not unlike that described by Davis (1962, 1963). The topic of culture change will be further evaluated after a discussion of Owens Valley prehistory, moving north to Long Valley, and finally to the Mono Lake basin. Temporal periods used in the Owens Valley will be described, as these form a rough framework for expectations about regional land-use in the Mono Lake basin.

Owens Valley

The Owens Valley is located ca. 80 km south of the Mono Lake basin, and the two regions share sufficiently similar characteristics. Both are adjacent the eastern scarp of the Sierra Nevada with similar vegetation communities and fauna throughout the Holocene (Bettinger 1982; NAS 1987). Owens Valley is at a lower elevation (ca. 1400 m), with a longer growing season and less severe winters than the Mono Basin. Additionally, the Owens River is a large freshwater river that runs the length of the valley where, before current water diversions, the river emptied into saline Owens Lake at the southern extent of the valley (Bacon et al. 2006; Li et al. 2000).

Cultural sequences in the Owens Valley were initially described based on Bettinger's (1977a) survey in conjunction with a chronological framework developed using temporally sensitive projectile point styles (Bettinger and Taylor 1974). Whereas Elston (1982) identifies generalized cultural patterns in relation to broad environmental changes, here cultural sequences are linked to the material archaeological record and activities associated through the distribution of recognized projectile point types. Initially grouped into four local phase designations (Bettinger 1977a), later research has predominantly employed temporal periods indicative of a larger geographic area (cf. Basgall and McGuire 1988; Basgall et al. 2003). Because certain parts of the cultural sequence (especially before ca. 3200 B.P.) lack robust samples, phases may be lumped into more general categories, either due to lack of adequate temporal control, or to emphasize differences in the archaeological patterns discussed (Basgall et al. 2003; Bettinger 1999; Delacorte et al. 1995; Delacorte 1999) (c.f., Table 3.1).

Results of several large-scale excavations have further refined the model initially proposed by Bettinger (1977a) for Owens Valley prehistory (Basgall and Delacorte 2003; Basgall and Giambastiani 1995; Basgall and McGuire 1988; Basgall et al. 2003; Bettinger 1989, 1999; Bettinger et al. 1984b; Delacorte et al. 1995; Delacorte 1999; Delacorte and

Basgall 2003; Delacorte and McGuire 1993; Gilreath 1995; King et al. 2001; Zeanah and Leigh 2002, among others). Many of these projects were conducted in the context of transportation corridors; therefore, they provide a large sample extending north to south along the valley and located largely within the desert scrub community. Other research conducted in purported "marginal environments" have supplemented these data to provide a dynamic picture of land-use in the context of changing adaptive strategies (Basgall and Giambastiani 1995; Bettinger 1991b). Topics of interest include decreasing mobility range, logistical vs. residential based foraging patterns, diet breadth expansion, use of more labor-intensive processing techniques, and the development of hunter-gatherer sedentism.

For present purposes, the most ancient occupation falls within the Terminal Pleistocene/Early Holocene period ranging from 7500-12,500 B.P. Next, the pre-Newberry period dates from 3200 B.P. to 7500 B.P. This era was previously known as Lake Mohave and Little Lake periods (cf. Bettinger and Taylor 1974). As a result of poor chronological control and fleeting archaeological presence, not much is known about how people lived before this time. Acknowledging the unknown, the two periods were more recently combined into a single unit, pending new data (cf. Basgall et al. 2003; Zeanah and Leigh 2002). The current project uses this as a coarse-grained culture-historical unit to describe people's lifeways from 3200-7500 B.P.; however, for present purposes the pre-Newberry period is also segregated into four intervals. These divisions isolate smaller pieces of time, help identify chronological changes in land-use, and recognize how these may correlate with Mono Lake's fluctuations (Table 3.3).

Table 3.3. Temporal Units Used in the Present Study.

Temporal Unit	Abbreviation	Time Span
Terminal Pleistocene/Early Holocene	(TP/EH)	12,500-7,500 B.P.
Pre-Newberry IV	(PN-IV)	7,500-6,000 B.P.
Pre-Newberry III	(PN-III)	6,000-5,000 B.P.
Pre-Newberry II	(PN-II)	5,000-4,000 B.P.
Pre-Newberry I	(PN-I)	4,000-3,200 B.P.
Newberry II	(NW-II)	3,200-2,275 B.P.
Newberry I	(NW-I)	2,275-1,350 B.P.
Haiwee	(HW)	1350-650 B.P.
Marana	(MR)	650 B.P.- Historic

The pre-Newberry period is marked by a wide ranging mobility pattern, as seen through high lithic material diversity within the flaked stone toolkits (Basgall 1989; Basgall and McGuire 1988). In addition to the stone diversity, there is a presence of what are either prepared cores or scraper planes (Delacorte 1999; Delacorte et al. 1995). These tools are part of a highly mobile toolkit which, although present, does not have a strong emphasis on biface technology. There is very little ground stone associated with these early components, and assemblages appear generalized in nature with few specialized tools.

Lifeways during the Newberry era (ca. 3200-1350 B.P.) appear to reflect more regularized mobility, as demonstrated by a reduction in flaked stone material diversity (Basgall 1989; Delacorte 1999). Again for improved chronological resolution, the present study splits the Newberry period into two parts to provide a more fine-grained understanding of land-use relative to Mono Lake's fluctuations (Table 3.3). Regularized mobility during this interval is also supported by the incidence of tool caches (Basgall and McGuire 1988:172-174, 295; Bettinger et al. 1984) such as curated ground stone tools and large, finely made bifaces (Bettinger et al. 1984; Delacorte et al. 1995). Bifaces become an important part of the toolkit and are produced in large quantities at major obsidian quarries, possibly for trade, exchange or even prestige during the latter part of the sequence (Gilreath and Hildebrandt 1997; Goldberg et al. 1990; Hall 1983; Hildebrandt and McGuire 2002; Singer and Ericson 1978).

A pattern of greater logistical mobility with large residential occupation sites (Basgall and McGuire 1988; Basgall et al. 2003) along with logistical camps, are seen through specialized assemblages that often contain a high diversity of tools relative to sample size (Delacorte 1999). It has been proposed that logistical mobility at this time was in the context of extended forays for big game hunting (Hildebrandt and McGuire 2002) with residential bases in the Owens Valley being relatively more stable than previously thought (King et al. 2001). However, toolstone diversity profiles (Basgall 1989) and caching behavior (Bettinger et al. 1984b) suggest that residential mobility was still occurring, but possibly at a smaller scale than earlier, with more time spent at each base camp. Additionally, the wide variety in size and types of sites represented provides for a settlement pattern that includes residential as well as logistical mobility (Basgall et al. 2003:357).

Finally, wetland resources appear to have been important relative to later times, as demonstrated by regional paleobotanical and faunal remains. Wetland resources are consistently recovered in Newberry and earlier deposits yet are present later only at sites immediately adjacent wetlands (Basgall et al 2003; Delacorte 1999; Pierce 2002, 2003; Zeanah and Leigh 2002).

The Haiwee interval (1350-650 B.P.) marks the beginning of a change in the overall organization of subsistence and settlement patterns in the region that correlates with the introduction of the bow and arrow as represented by Rose Spring and Eastgate projectile points (Bettinger 1999a; Delacorte 1999). Researchers have proposed that this technological innovation made hunting more efficient and allowed for the privatization of plant resources among family groups, as seen through evidence of food storage (Bettinger 1999a). This is believed to coincide with a pattern of resource intensification where a wider diet breadth is represented by increased variety of dryland seed remains and the inception of intensive green cone pinyon procurement (Bettinger 1989; Bettinger and Baumhoff 1982, 1983; Delacorte 1990; Eerkens et al. 2002).

Although pinyon is present in earlier contexts (Basgall and McGuire 1988; Pierce 2002, 2003), the resource is found with greater ubiquity in Haiwee and later deposits. It is during this period that specialized pinyon camps appear in the mountains, and sites are found in a wider range of habitats such as alpine and lakeshore areas (Delacorte 1999:19; Gilreath 1995). However, pinyon may have been more intensively exploited in later

Marana times, as suggested by the greater presence of Desert series points in upland contexts relative to Haiwee marker types (Delacorte and McGuire 1993).

The Marana period (650 B.P.-Protohistoric) is one with apparent high population density in the Owens Valley. Marana components are often represented by both Desert Side-notched and Cottonwood projectile points and Owens Valley Brown ware ceramics along with diverse faunal and paleobotanical remains (Pierce 2004). Following accounts (Steward 1933, 1938) of sedentism and district organization of ethnographic populations, researchers have focused attention on the antiquity of hunter-gatherer sedentism. However, through the excavation of many late period components, late prehistoric populations were residentially mobile at a more reduced scale than earlier times and organized around the nuclear family (Delacorte and Basgall 2004). Further evidence for decreased residential mobility may be found in raw material profiles, where Marana contexts often show a prevalence of local rather than extra-local obsidian sources (Basgall 1989; Delacorte 1999; Gilreath and Hildebrandt 1997).

Marana period sites are often less intensively occupied than in earlier (Newberry) times and are represented by similar assemblages recovered in different environmental contexts (Bettinger 1999; Delacorte et al. 1995; Delacorte 1999). Environments previously used for task specific activities, such as hunting, show evidence of more long-term habitation by family groups (Basgall and Giambastiani 1995; Bettinger 1991a). Here also, pinyon and other plants were intensively processed and stored (Basgall and Giambastiani 1995; Eerkens and King 2001). The Marana period in Owens Valley is characterized by more intensive use of a variety of local habitats because of high population densities, among other possible factors.

Long Valley

Immediately south of Mono Basin and north of Owens Valley, Long Valley is a region which, at higher elevations appears to have an archaeological record representing more specialized tasks such as obsidian acquisition/biface production, pinyon camps, and *piyegU* gathering sites (Basgall 1983; Eerkens and King 2001; Goldberg et al. 1990; Hall 1983:72; Weaver and Basgall 1986). Prehistory of the region dates back to the terminal Pleistocene/early Holocene (Basgall 1988; Jurich et al. 2000) and includes reoccupied "magnet" localities (Overly 2003a), along with rockshelters representing less recurrent use (Davis 1959, 1964; Enfield and Enfield 1964). The caldera has been surveyed by Meighan (1955), Davis (1964); Bettinger (1977b), and Jackson (1985).

Chronological units in the region are essentially the same as in Owens Valley, although different suites of activities are represented due to environmental differences. Long Valley is encompassed by earlier subsistence and settlement patterns, traveled through by people who visited both Mono Basin and Owens Valley (Basgall 1989; Bettinger 1982, 1999). This is a widespread occurrence of local obsidian (especially Casa Diablo), which is found transported across the Sierra Nevada (Hull 2002a, 2002b) as well as to the north and south. Presumably related to obsidian abundance and its importance in regional prehistoric economies, diachronic trends relating to the production and distribution of obsidian tools has been a central topic of local research. This focuses largely on a fluorescence in quarry use for the production and use/distribution of bifaces during the late Newberry period, which then rapidly declines during the Haiwee interval (ca. 1,000 B.P.). Explanations have been related to the timing of volcanic activity (Hall 1983) to sociopolitical interactions (Bouey and Basgall 1984), and to changes in regional land-use and technology (Basgall and McGuire 1988; Bettinger 1999a; Delacorte 1999; Delacorte et al. 1995).

Mono Lake Basin

Initial professional archaeological research in the region was conducted by Meighan (1955), where he reported on the survey of five tracts of land between the Owens Valley and Walker River; he recorded 315 sites. Closest to the Mono Basin, his Crooked Meadow survey block of five square miles in the Long Valley Caldera at elevations exceeding 9,000 feet contained only five sites. In contrast, tracts in the pinyon-juniper zone of the Benton Range and East Walker River yielded almost twice as many sites per square mile as other environmental settings. Following this initial effort, Emma Lou Davis spent several years investigating the archaeology of Mono Lake basin (1959, 1961, 1964) and conducted ethnographic research that culminated in her reconstruction of the pre-contact lifeways of the *Kuzedika* [*Kutzadika'a*] Paiute (1962, 1963, 1965).

In addition to reporting on a child burial (1959) and petroglyphs (1961), Davis surveyed various areas of the Mono Basin and Long Valley and examined collections from local relict hunters and avocational archaeologists. Her survey recorded 165 sites that she grouped into eight descriptive categories based on site constituents. Although lacking more than intuitively based chronological control, Davis describes a regional pattern that initially was focused on hunting (8,000-10,000 B.P.), but gradually changed with an increased emphasis on plant and seed processing in the late prehistoric interval (Davis 1964). Overall, she saw the importance of game and plant resources as fluctuating due to environmental changes, and she proposes that this lifeway should be identified as the Piedmont aspect of the Desert Culture (Davis 1964:287).

More recent prehistoric research in the Mono Lake basin draws upon similarities with both Owens and Long Valleys. Excavated sites relating to residential occupation are few (Arkush 1987, 1995; Bettinger 1981a; Carpenter 2001; Nelson et al. 1992; Wickstrom and Jackson 1993), but most prehistoric sites do not suggest long-term residence. Although there was year-round occupation of the basin ethnographically, how far back this pattern extends is not known. Rather, the Mono Lake basin is more often viewed as an area that was seasonally occupied being a crossroads for trade and obsidian acquisition (Bettinger 1981a, 1982; Davis 1964). Protohistoric communal game drive features and house structures have been reported from the eastern Mono Basin (Arkush 1987, 1995). Tracts in the pinyon zone north of the lake have been surveyed (Darcangelo et al. 2005), some site distributions within the Mono Basin Scenic Area have been described (Reynolds 1986), and the regional distribution of bedrock mortars has been discussed (Haney 1992). In addition, there is evidence of early Holocene use of the region from early point forms reported by Davis (1964) and two sites with early Holocene components from the eastern edge of the Basin (Hall 1990).

Both Bettinger (1982:72) and Davis (1963, 1964) view prehistoric inhabitants of Mono Basin as practicing a "Desert Culture" lifeway relying on generalized subsistence practices and seasonal mobility. Davis (1964:286-287) notes a gradual increase in seed processing within the region but does not view the change as representing a drastically different lifeway since it appears to fluctuate in importance.

Based on excavations at site MNO-891, where researchers argue for the presence of two opposing adaptive strategies identified in the region as travelers and processors (Wickstrom and Jackson 1993:135; *sensu* Bettinger and Baumhoff 1982). The first, lower component represents a temporary hunting camp that was also used for the production of bifaces and dates to pre-Newberry/Newberry times. The upper component (Haiwee/Marana age) represents a wider range of activities, including plant processing along with a decreased emphasis on stoneworking. Of note, the lower component contained projectile points and material manufactured predominantly from Casa Diablo obsidian, while the upper component had a wide variety of sources represented although none were made from Casa Diablo obsidian. Temporal changes in use of the western Mono Lake basin support an earlier pattern identified by Bettinger (1981a) at the Lee Vining site (MNO-446).

Temporal change in obsidian source diversity is found to coincide with shifts in land-use. Casa Diablo obsidian is found to make up the bulk of Newberry and earlier assemblages in the western Mono Basin (Bettinger 1981a; McGuire 1994). Indeed, Casa Diablo obsidian has been used as a rough and ready measure to date surface assemblages along the Rush Creek drainage that lacked typable projectile points. This pattern correlated with diagnostic projectile points when they were present (Gilreath 1996:56). Along the drainage, site densities are noted to be greater (1 site/15 acres) further away from Mono Lake (west of US 395), while the near-lake portion (east of US 395) had lower site densities (1 site/50 acres), suggesting greater use of areas away from the lakeshore.

Research along the Rush Creek drainage also suggests that core reduction becomes more prevalent than biface reduction in later times although bifaces were the most common tool recovered, followed by flake tools (Gilreath 1996:95). The variety of tools in the area appear to represent residential occupation; however, lacking a regional sample, it is difficult to interpret how this area would have articulated with the greater subsistence and settlement patterns of the Mono Basin.

Characteristic of its era, earlier research in the Mono Basin did not disclose a pattern of drastic cultural change, but rather one of gradual adjustments to a generalized pattern (Davis 1962, 1964). Inasmuch as this view was common among Great Basin archaeologists at the time, more recent evaluations in the southwestern Great Basin suggest that marked cultural change was occurring as technologies, settlement patterns, and subsistence practices underwent a drastic reorganization to more localized, labor intensive food resources, which may previously have been under-exploited. Although not well documented in the Mono Lake basin, it seems likely that similar patterns of subsistence intensification and social reorganization identified in Owens Valley transpired in this area. It was the intent of the present sample survey to assess Mono Lake basin for evidence of changing land-use patterns and socio-cultural adaptations. The following chapter outlines the rationale for the present survey methodology.

CHAPTER 4

CONCEPTUAL AND ANALYTICAL METHODS

Field methods and analytical protocols are developed to understand how past land-use at Mono Lake may have varied. Survey methods to understand landscape-scaled patterns derive from debate about the concept of site and non-site analysis. Treating the landscape and artifact/debitage distributions as equal provides a different framework of study than using a more traditional "site-based" approach. Archaeologists can use other models and analytical methods such as ethnoarchaeology and studies of technological organization to better understand prehistory. These concepts help to understand what a discarded artifact signifies. Following this discussion, field and analytical methods for tools analyzed and collected on the present project are outlined, including those related to obsidian studies.

Non-Site Archaeology

In attempts to understand particular aspects of prehistory, archaeologists have undertaken research programs using a variety of field methods. One example, discussed earlier, relates to the investigations of deeply stratified cave sites versus larger distributions of open-air sites. Both furnish data that are informative to prehistory, but recovered assemblages differ in that cave deposits often provide perishables and datable remains, while open-air deposits produce greater information on land-use and technological patterns. Land-use and technology differ in relation to catchment area or local environmental characteristics which inform about past adaptations (Foley 1981a). As the landscape is used in different manners by hunter-gatherers (cf. Binford 1980), excessive attention to sites or large artifact aggregates, may retract one's study to particular questions or mislead the investigator about certain aspects of a settlement pattern.

The extent to which site-based analysis may skew the archaeological record has been argued strongly from similar stances under the labels of off-site (Foley 1981b), non-site (Dunnell and Dancy 1983; Thomas 1975), or distributional (Ebert 1992) archaeology. These are similar in that they view the archaeological record as continuously distributed across the landscape and use the artifact as the unit of analysis rather than the site. However, neither site nor non-site based approaches are devoid of their own problems (cf. Binford 1992). At Little Hot Creek, eastern California, Overly (2003a) argues that dispersed artifacts and sparse scatters often date to earlier times than the more dense artifact aggregates. Therefore, it appears that the archaeological record reflects changes in settlement and mobility patterns.

Similar to how cave and open air sites can provide data pertaining to different questions, dense and sparse artifact scatters represent different aspects of a settlement pattern and bias interpretation if one is sampled more frequently than the other. In an attempt to provide an unbiased understanding of artifact distributions across the landscape, a non-site approach was chosen to collect the data for this study. Survey quadrats are walked with transects spaced at a given distance apart. The location of artifacts and debitage encountered on transect are recorded. Distributions of these cultural items are compared against different environmental types or locations. In this way denser artifact aggregates are not disproportionately represented against more ephemeral scatters .

The sample of artifacts recovered is used to analyze settlement patterns at Mono Lake in relation to its near-shore wetland habitats. Prehistoric settlement patterns have been studied for over fifty years in American archaeology (Billman and Feinman 1999; Willey 1953). Two important lines of evidence that have developed from this research are studies base on ethnoarchaeology and the organization of technology.

Ethnoarchaeology

The "new" archaeology brought settlement pattern studies to the forefront of archaeological research as people sought to understand the articulation of hunter-gatherer subsistence and settlement systems in relation to the environment and social organization. To better understand certain aspects of past lifeways, archaeologists ventured out to study how extant hunter-gatherers lived, manufactured and used their tools, and located various activities throughout the year (cf. Binford 1978a, 1978b; David and Kramer 2001; Yellen 1976). Much of this research focused on tool acquisition, use, and discard relative to residential bases and other areas. Some examples focus on differential use of a single locale (Binford 1978a), raw material acquisition and tool use (Gould 1978), including settlement patterns practiced by general foragers (Yellen 1976) as well as more logistically organized arctic groups (Binford 1978b). This "middle-range research" provides for analogies, rather than direct correlations, which can inform about past behavior and its manifestation in the archaeological record. These studies, among others (cf. O'Connell 1987), illustrate the variability of hunter-gatherer decision making. They demonstrate why one must be wary of the context of artifact associations, as artifact discard may occur during unconnected events. Artifact spatial proximity may not always represent related behaviors (Binford 1982).

An important outgrowth of this line of research is the forager-collector model. As described by Binford (1980), this construct uses a survey of ethnographic cultures to demonstrate a pattern of variation in hunter-gatherer settlement organization relative to effective temperature. He identifies groups who are predominantly "foragers" located in areas with high effective temperature and low seasonal variation, and "collectors" in areas with low effective temperature and high seasonal variation (also see Kelly 1983). Posed this way it seems that the two strategies are dichotomous, but as initially envisioned foragers and collectors are but two points on a continuum of decisions that hunter-gatherers make in the context of daily and seasonal activities. To focus on the behavioral implications of this, we can simply state that foragers are more residentially mobile mapping onto foraging patches, whereas collectors tend to be more logistically organized bringing resources to the base camp (Binford 1980).

These two types of settlement patterns have implications for the types of sites that are created, as well as where artifacts are manufactured, used, and discarded. For example, hunter-gatherers practicing a residentially mobile strategy would have two main types of sites, residential bases and locations. Residential bases are where most processing, manufacturing and maintenance occurs. Locations are places where a variety of task-specific tool and non-tool using activities are undertaken. These could be anything from field processing game to monitoring animal movements or plant productivity. In contrast, logistically organized groups create a wider variety of sites. These may include field camps, stations, or caches (Binford 1980:10). Some hunter-gatherers may practice one type of settlement and mobility rather than another, yet others may switch strategies throughout the year or for periods of years. For example, a foraging group that typically "maps on" to resources may send out task groups on logistical forays to acquire or cache resources for the larger group at other times. Hunter-gathers may change a particular settlement strategy to more effectively exploit important resources if other factors, such as the environment or demography are altered. A new strategy for mobility and resource acquisition may be needed to maintain a successful adaptation under new conditions.

One possibility for settlement patterns in the Mono Lake basin may be that earlier populations practiced a more far-reaching mobility range, moving to strategic locations and mapping onto particularly rich resource patches, moving on when they are depleted. Later, with denser regional populations, people in the area may have been more territorially constrained, sending task groups out to procure or process and cache particular resources that would be transported back to the larger group at a later time. In this case the group may be larger than earlier foraging groups, possibly residing in one area for a longer period of time as more distant resources are procured and returned to the base camp. Differences may be seen as similar to those of a residentially mobile versus a logistically organized group.

Technological Organization

Artifact discard may occur differentially across the landscape depending on the context of use. If a given tool is not particularly difficult to manufacture, it may be discarded more readily than another implement which takes more investment to acquire or make (cf. Binford 1976; Gould 1978; Shott 1989). Gould (1978) illustrates this concept using ethnoarchaeological data from Australia, where tools manufactured expediently from local raw material were often discarded at their location of use. In contrast, items made from exotic stone were curated and rejuvenated until the stone was reduced to a useless "slug". Tools may be differentially discarded depending on effort invested in their manufacture, toolstone availability, or the presence of replacements.

In developing expectations for the archaeological record of Africa's Amboseli Plain, Foley (1981a, 1981b) uses ethnographic data to calculate the number of sites a hunter-gatherer group may be expected to "make" over the course of a year. Also he uses the concept of "home range" to identify where most artifacts would be used and discarded while a group resides at a location. Home range size should affect the density of artifacts deposited (Foley 1981a:8). Likewise, the types of tools and their frequency of discard also have a role in artifact distribution. Based on his estimates of artifact discard rate, archaeologists are only recovering a small sample of items that were discarded throughout prehistory. One outcome of this is that isolated artifacts may represent more than one visit to the area because sometimes tools may not have been discarded, or other tools may not be visible due to depositional processes.

Artifact discard can occur differently depending on the context of the activity (Shott 1989). Binford (1982) describes how mobile hunter-gatherers may use the same location for different purposes throughout the year. A residential base may also serve as a logistical hunting camp, a food processing locality, or an area for information gathering during different seasons or over alternate years. This base would depend on the proximity of the group to resources or activities that they are interested in undertaking at that time. This overlaying of the archaeological record from distinct, unrelated activities argues that the simple presence or absence of an artifact is important, yet overall composition of the deposit may represent a variety of unrelated activities. As a result, context must be understood to make specific inferences about the particular activities undertaken at a site as it may have seen a wide variety of uses through the course of years.

As an alternative to this issue, it may be better to view discarded tools in the context of other discarded tools across a larger area. This will help to identify variations or redundancy of artifact discard and associations between artifacts across the landscape to inform about past land-use patterns.

Fluctuations in settlement organization, as well as general variation in mobility patterns, assure that one site cannot be used to explain or describe the many aspects of how hunter-gatherers moved around and used the landscape throughout prehistory. Since sites and the tool aggregates contained within them may be the result of various occupations possibly for different purposes, individual tools should be studied to identify design characteristics that people have been attempting to control. These characteristics relate to the item's use-life, which has been termed the study of technological organization (Nelson 1991). The line of inquiry is similar to that discussed by Foley (1981b) and Schiffer (1976) and focuses on the advantages gained through design characteristics and the decision of when to discard or repair/rework a tool. Choices are often made to improve "efficiency," but other factors also seem to affect this trait, such as toolkit composition, scheduling, and time stress (Torrence 1983, 1989). Formal studies to identify patterns of use and discard are discussed by Nelson (1991) and arguments have been tested using empirical data from artifact samples (Bamforth 1986; Bleed 1986; Brady 2004, 2005; Nelson and Lippmeier 1993).

One level of inquiry relates to the distribution of expedient versus curated tools across the landscape and through time. These describe the manner of tool use, not specific tools themselves, because situational constraints will affect how long a tool remains usable in a given toolkit (Nelson 1991:63). Binford (1978a; 1979) discusses contexts where personal gear, such as specialized tools, are retained with the person and used for specific and more general tasks. Situational gear is used for a specific activity and may be discarded after use. This type of tool would be used expediently. Personal gear is often curated and should most often be recovered at a residential base where the item would be reworked or replaced when no longer usable (Binford 1979:285).

Flake tools, often expedient implements, are expected to occur in a wide variety of localities which include use areas such as field processing, or with activities undertaken at a residential or logistic base camp. Curated tools that have had more effort invested in their production, such as projectile points or bifaces, occur most frequently at residential bases or more formal logistical camps. It is here that the broken tool would be assessed for rejuvenation, or discarded and replaced. Likewise, flake tools are easy to produce and have short use-lives, suggesting that they should be more common in the archaeological record relative to more "expensive" tools such as bifaces or projectile points. The distribution and association of these tool classes should elucidate general patterns of land-use around Mono Lake, informing one about the relative presence of residential occupation versus more short-term exploitation of the near lakeshore areas. Additional evidence suggesting more long-term or recurrent use may come from non-portable milling equipment, bedrock milling stations, caches, or rock ring features.

Discussion

Implications of tool distributions, technologies represented, artifact use-wear and design characteristics can help inform about how past peoples variously used the landscape. Spatial associations between artifacts are a strong line of evidence to understanding settlement and mobility patterns. These show how activities may co-occur or vary across the landscape due to the placement and duration of activity. Suites of artifacts found in particular spatial contexts are used to understand levels of residential stability. At a general level diverse flaked and ground stone artifacts associated with rock ring features indicates high residential stability; whereas more short-term use is suggested when one or more of three groups is lacking. Obsidian hydration is an important tool for studying temporal variation in technology and habitat type, while obsidian source representation can provide insights into toolstone acquisition patterns and mobility range.

Non-Site Field Methods

Using tool distribution and morphology to study past behavior, there are different limitations of site and non-site approaches. Site-based surveys provide easily manageable units of study by comparing different site types (c.f. Bettinger 1977a; Delacorte 1990). Also focusing attention on artifact aggregates and subsurface deposits allows one to collect a larger sample of artifacts and debitage as well as the added potential of using ^{14}C as a dating technique for subsurface features (cf. Basgall and McGuire 1988). The principal drawback to site-based investigations is that sites are often the result of multiple reoccupations that likely occurred for various reasons. Identifying components within the deposit is important to understand site function, a difficult enterprise using survey level data. While likely an overstatement, some researchers (Dunnell 1992) argue that sites deposits represent such varied activities that no sort of behavioral interpretation may be made.

When using a non-site approach, much discussion has focused on the size of the survey units as well as the transect spacing. Some researchers (Burger et al. 2002-2004; Ebert 1992; Holdaway et al. 1997) argue for narrow transect spacing at around 2 m per person so that every artifact is recorded for the sample. This spacing allows for excellent analytical resolution, but is often uneconomical. Rather, to cover large areas, wider spaced transects (25 m) are more commonly used, and important archaeological patterns may still be identified.

In addition to transect spacing, the size of the unit surveyed has also been discussed in several contexts (Burger et al. 2002; Ebert 1992; Foley 1981b; Irwin-

Williams et al. 1988; Kvamme 1998; Wandsnider 1998a). These vary due to different constraints such as a homogeneous or heterogeneous environment, geographic features, and the scale of the phenomenon being studied (e.g., residential vs. single activity use) (Stafford and Hajc 1992; Wandsnider 1998b). Focusing on the variation in use across a landscape, one recognizes the importance of sampling different environmental zones or habitat types. Such is the case comparing the three wetland types in the current example. Square units 500 m on the side provide an appropriate-sized, contiguous sample to encompass behavior that occurs at both large and small scales without allowing for too much environmental variability within a unit. Additionally, this size can provide comparison with previous landscape-scaled studies although data collection methods are distinct (cf. Bettinger 1977a; Delacorte 1990; Thomas 1973).

Individual sites have interest of their own although, when attempting to understand variability in land-use, data must be collected across a more extensive area. Through this method, trends between artifact associations may be identified. Site formation processes, artifact discard patterns and the implications of technological organization can provide a framework to understand the implications of artifact distributions and to inform about past behavior.

Methods Employed During the Mono Basin Wetland Survey

Field methods follow information provided by the paleoenvironmental record, and previous research in the region, along with considering the methods applied to non-site field studies. Artifacts and debitage collected or recorded in the field were used to maximized the information obtained, while minimizing the actual impacts to the archaeological resources. Artifact analytical methods largely follow that conducted in other research in the southwestern Great Basin.

Field Methods

At initial conception, the Mono Lake Wetland Survey was attempting to understand prehistoric land-use relative to Stine's (1987, 1990) lake fluctuation curve which dates back ca. 3800 years (Figure 2.3). At that time the lake appears to have risen from a lower elevation to its high stand at 1981 m (Stine 1987). Information about the duration of this previous low stand and earlier lake fluctuation activity has also been discussed by others (Benson et al. 1990; Lajoie 1968). The composite of these is used to reconstruct the paleoenvironment around Mono Lake's wetlands although the record for the post-4000 year period is more fine-grained.

Using these lake level studies, one can account for the ancient shorelines at different times. Lake levels fluctuated within the last 4000 years between the maximum (1981 m) and a minimum elevation of 1941 m (Figure 2.3) To include potential activity in relation to the (Dechambeau) high stand, areas from 30.5 m above the high stand (2012 m), down to the present lakeshore (1945 m) were included. The upper "buffer zone" to the lake level provides added horizontal coverage that varies with elevation gradient as it changes around the lake. This procedure also encompasses lakeshore areas that would have been exposed at the end of the Pleistocene. In order to make the area sampled more manageable without unduly biasing it, this area was pared down by omitting regions beyond a one kilometer radius from a drainage or stream visible on USGS 7.5" topographic maps.

Vegetation distributions, in addition to edaphic and phreatic conditions noted in Chapter 2 (Constantine 1993; NAS 1987; JSA 1993; Stine 1990, 1993) were used to create the sampling area for the freshwater, brackish, and saline units (Figure 2.1). A grid of 500 m x 500 m units was place over the entire study area, creating 461 potential survey units that encompass 57 acres. The survey sample investigated a total 10 km^2 (4.8 acres), covering 8.7% of the potential region. A random sample of units was selected from each wetland type. The number chosen was weighted by the relative presence of each wetland in the sample, including 19 saline, 15 brackish, and six freshwater (Table 4.1). UTM datum coordinates (SW corner) and unit names are provided in Appendix A, and shown graphically in Figure 2.1.

Table 4.1. Number of Potential Survey Units by USGS Quad, and Number Surveyed.

USGS Quad	Saline	Brackish	Fresh	Total
Alameda Well	25	-	-	25
Lee Vining	-	13	32	45
Lundy	-	-	19	19
Mono Mills	19	38	-	57
Negit Island	8	102	20	130
Sulphur Pond	166	19	-	185
Total	**218**	**172**	**71**	**461**
Percentage of Total (n=440)	47.3	37.3	15.4	100
# of Units to be Sampled (n=40)	19	15	6	40

Survey methods operated at two different scales. For the main part of the survey, transects were spaced at 25 m intervals. Each surveyor was provided an aerial photograph of the unit with transects overlain on it. Distances were split into 100 m segments oriented north-to-south. Additionally, the two surveyors on the outside edges employed Trimble handheld GPS receivers for spatial control. Survey pacing, aerial photos, and GPS receivers were used to keep people on their transect and aware of their location within the unit. When encountering debitage, surveyors would plot its location on the aerial photograph. Flaked stone artifacts were plotted and collected, but ground stone artifacts were recorded in the field and plotted on the aerial. Survey coverage includes the area within 1-3 m on either side of the surveyor. If a site was encountered, artifacts and debitage found on the transect were first plotted on the form, then the site was investigated for other tools or features to help delineate boundaries. Beyond materials associated with the initial sweep, these latter data are not included in the present analysis but used strictly for the completion of DPR site records.

The second scale of survey occurred in the southwest 100 m x 100 m area of each quadrat. Here transects were more tightly spaced at 10 m intervals. In addition to any flaked stone tools, debitage was also collected to provide a debitage sample for technological and source analysis. One unit, B2 contained so much flaking debris that only a sample of 28 pieces was collected. These were the first 28 flakes encountered from the southwest portion of the unit. Also, unit B3 contained scattered debitage along with a single segregated reduction locus (SRL). The non-SRL debitage was collected, but the SRL was left intact. All spatial data recorded were converted to UTM coordinates

(NAD 27, zone 11) and entered into an Access database upon returning from the field. The elevation of each point was calculated by linking the UTM coordinates to a digital elevation model (DEM) using ArcGIS8.0.

After the survey of each unit, biotic and geographic characterizations were recorded on a separate form (Appendix B). This identified primary and secondary land forms, vegetation, slope (when available), and the presence of water or relict stream channels/lagoons. Often, slope could not be accurately reported due to the number and size of sand dunes or other irregularities in a unit. These attributes were recorded so that later comparisons could be made between units based on reported biota and geomorphology rather than solely using the initial wetland classification system.

Artifact Analytical Methods

Tool morphology reflects various aspects of hunter-gatherer settlement and mobility practices. Stone tools are often found to be fabricated differently depending on artifact use-life, degree of reworking, and availability of toolstone (Andrefsky 1994; Brady 2004; Kelly 1988; Shott 1989; Torrence 1989) among other factors (cf. Torrence 1983). These have been dichotomized into relationships (technological strategies) such as expedient or curated technologies (Binford 1979) although artifact classes can hardly be viewed as either wholly expedient or wholly curated. Furthermore, design characteristics such as maintainability and reliability (Bleed 1986), flexibility and versatility (Shott 1986) have been used to identify how artifact form reflects certain concerns that the maker is trying to control for, such as allowing quick repair or greater durability (cf. Nelson 1991). This has been used to analyze both flaked and ground stone artifacts (Hayden et al. 1996; Horsfall 1987). One problem is that the characteristics often may not represent mutually exclusive traits or the variety of tool uses according to situational contraints (cf. Binford 1979; Odell 2004:191).

Understanding prehistoric technological organization through the use of design theory can investigate several questions of interest at Mono Lake. Are there different patterns of technological organization relative to the three wetland types? If toolkit distribution does not vary by wetland type, does technology vary by geography, elevation, or some other factor? Might potential for toolstone shortfall or artifact failure have an effect on the distributions where certain artifacts are brought and used? To address these questions, not only artifact spatial distributions, but also techno-morphological analysis was undertaken.

Initial artifact characterization focused on use-wear and tool manufacture, separating flaked stone from ground and battered stone. Flaked stone artifacts were then further classified as projectile points, bifaces, flake tools, cores, core tools, and assayed cobbles on the basis of morphology, use-wear and flaking patterns. Ground stone was classified as a handstone, millingstone, pestle, bedrock mortar (BRM), or miscellaneous ground stone. Ground stone was not collected, but analyzed in the field. The following discussion focuses on analytical procedures, first with the collected flaked stone artifacts, then with the uncollected ground stone artifacts.

Flaked Stone. Collected flaked stone artifacts were measured and analyzed in an effort to characterize the manner and degree of use on an implement. This largely followed analytical procedures conducted with assemblages collected further to the south in the Owens Valley (cf. Basgall et al. 2003; Delacorte 1999; Zeanah and Leigh 2002). All artifacts received initial characterization of maximum length, width, and thickness as well as artifact condition, whether whole, near-complete, proximal, distal, end, or a margin fragment. Collected artifacts were classified based on the following criteria (see Appendix C for a full list of codes used; the most pertinent are discussed below).

Projectile points are bifacially flaked tools that exhibit modified hafting elements. Those encountered on the current project were classified to types outlined in the Monitor Valley typology (Thomas 1981). In addition to the metrical variables proposed there, further attributes recorded are degree of patination, and evidence of use-wear and/or impact fractures.

Items that are flaked on opposing sides from the same platform and lack a diagnostic hafting element are bifaces. Additional to the general linear measures, bifaces were classified by stage (1-5), which informs about tool reduction strategy employed to form the item. Stage 1 bifaces are percussion flaked on two opposing surfaces but are still relatively irregular. They are thick in cross section and have uneven margins due to initial percussion-based reduction. Stage 2 forms exhibit more regularity, are thinner in cross section, and more extensively flaked. Stage 3 bifaces generally have good planar symmetry and extensive percussion flaking, creating an even platform. Flake scars may pass the artifact's mid-section and minimal pressure flaking may be present on the margin. Stage 4 artifacts are almost completely symmetrical, lenticular in cross-section, and often have extensive pressure flaking. Stage 5 bifaces are finished tools that exhibit extensive pressure flaking around the margin and lack hafts that would make them diagnostic as projectile points. These are often knives or broken point fragments. In addition to this measure, the number of arrises present on 1 cm of the margin was used as another measure of biface reduction. This method is viewed as less subjective than the "stage-based" approach, yet provides data to answer the same types of questions (cf. Eerkens and King 2002; King et al. 2001). Spine plane angle was measured to the nearest 5°, and where it could be identified, end shape was described as rectangular, convex-pointed, convex-rounded, concave, straight, or indeterminate. Size was used to estimate whether the biface was likely the fragment of an arrow, dart point, or a knife/blade. If possible, original form of raw material was identified, i.e., whether the biface originated from a cobble or a flake preform. Finally, evidence of use-wear was noted with unifacial or bifacial micro-chipping, edge flaking, grinding, or battering.

Flake tools are largely unmodified flakes that are the result of biface, core or other reduction activities. Standard metric attributes of maximum length, width, thickness (mm), and weight (g) were recorded for each item. Tool condition was also determined, whether the piece is whole, near-complete, proximal, distal, end, medial or a margin section. Technological analysis recorded whether the flake was produced during decortication, interior percussion, or biface thinning activities, among others. Number of edges modified (1-3), edge shape (concave, convex, or straight), surface used (dorsal, ventral, both), and type of wear were recorded. Wear pattern was recorded as even or irregular, along with the type of edge modification (unifacial, bifacial micro-chipping or edge flaked, rounded, step-fractured, etc.).

Cores are culturally modified cobbles that have at least five flake removal scars. Some of the units surveyed contained large amounts of raw material, and cobbles with fewer than five flake removal scars. These were treated as assayed cobbles, noted on the survey transect sheet and left *in situ*. Those with five or more flake scars were collected and analyzed. This was done by first measuring maximum length, width, and thickness as well as weight. Core condition was described, and original core form was noted as tabular, globular, angular, split cobble, or pebble. Based on the orientation of flake removal scars, core form was noted with only two types occurring in the sample, unidirectional or bidirectional. Platform type was reported as either cortical, interior, prepared, or cortical and interior. Finally, maximum length of the largest flake removal scar was measured (mm).

Cobbles that exhibit five or more flake removal scars, in addition to having evidence of use as a tool were classified as core tools. Again, standard metrical characterizations were made. Similar to core analysis, the original core form, core type, number of platforms, platform configuration and type along with maximum flake length were noted. Location of damage was recorded as end, margin or perimenter. Edge modification was noted as micro-chipped, flaked, rounded, battered or step fractured, and the edge angle was measured to the nearest 5°.

After counting and weighing, lithic debitage was classified by material, then by size based on the maximum flake diameter (<1.0 cm, 1.0-2.0 cm, 2.0-3.0 cm, 3.0-5.0 cm, >5.0 cm). Individual flakes were placed into one of fifteen technomorphological categories (see Appendix C). As with the flake tools, these focus on whether the flake was produced during decortication, interior percussion, or biface thinning activities.

Ground and Battered Stone. Tools whose main source of wear is present due to grinding or pounding activities were classified as ground and battered stone and were analyzed in the field. Field analysis sought to assess the size, condition, degree and type of wear evident on a tool. To do this, maximum length, width, and thickness of the artifact was recorded using a tape measure (mm). Incomplete measurements due to broken pieces were noted with brackets. Each artifact class was analyzed in an effort to assess the relative duration of artifact use-life, intensity of use and any specialized shaping or secondary modification.

Cobbles with ground surfaces on one or two sides, flat or convex surfaces, and of a size that could fit in the hand (generally with dimensions <150 mm) were classified as handstones. After initial metric and condition characterizations, the tool was inspected for the number of surfaces ground, and whether the margin was modified through pecking and/or grinding to shape the artifact. These occurrences are more likely to happen with an artifact that is retained in the toolkit for a period of time. Surface shapes were characterized as convex, slightly convex, flat, or slightly concave (artifact #4206 only), with surface texture noted as smooth or irregular. Surface polish and pecking rejuvenation on the grinding surface were noted as being present or absent. Finally, secondary modification in the form of battering or grinding was identified, as well as whether or not the tool had been fire-affected.

Similar to handstones, millingstones were recognized by their larger size and presence of grinding surfaces, although these were either concave or flat rather than convex. Again, after metrical characterization, the number of ground surfaces was identified along with whether or not the margin was shaped through intentional modification. Surface texture, whether smooth or irregular was noted, along with presence or absence of surface polish and surface pecking. Finally, secondary modification of the tool and whether or not the item has been fire-affected was noted.

Representing a different technological focus, one pestle was encountered and recorded during the present effort. First, the artifact was measured and its condition determined. The number of pounding or grinding surfaces was noted along with whether the margin or shaft had been intentionally modified to shape the artifact. Surface shape (convex) of the modified end was noted along with the type of wear and whether the tool had been fire-affected.

Encountered with the same quadrat as the pestle, bedrock mortars were also field recorded. After the location was noted, dimensions of the outcrop were taken (maximum length and width) and the number of mortar cups on each outcrop. Furthermore, the features were photographed.

A few pieces of miscellaneous ground stone were also identified in the field. The locations of these artifacts were noted, but the items were not photographed or formally analyzed.

Stone Bead. One unique artifact that was noted and collected is a small stone bead. Material, condition, and dimensions of the bead (maximum length, width, and thickness) were recorded along with the diameter and type (conical) of the drilled hole. Additionally, the item was inspected for other intentional modification or shaping.

Spatial Analysis

For investigating the artifact spatial distributions, three main types of analysis were undertaken. The first grouped data by wetland class, while the second assessed artifact distribution according to quadrant within the basin, whether southwest, northwest, northeast, or southeast (Table 4.2). Finally, individual artifacts were grouped by elevation to understand their relation to paleo-lakeshores. These analyses were undertaken with ArcGIS8.0, Microsoft Access 2000, Excel 2000 with the tool pack add-in along with an Excel worksheet to calculate Chi-square values and analysis of adjusted residuals. Applications of the statistical measures consulted specified references (Magurran 1988; Thomas 1986; Rohlf and Sokal 1995; Sokal and Rohlf 1995).

Table 4.2. Geographic Quadrat Distributions.

SW	NW	NE		SE
F50	F3	B66	S115	B21
F58	F4	S27	S116	B35
F62	B101	S42	S165	B36
F64	B104	S44	S166	B44
B2	B112	S49	S171	S7
B3	B115	S63	S173	
B1	B130	S88	S180	
	B134	S96	S183	
	B143	S102	S208	

SW = southwest; NW = northwest; NE = northeast; SE = southeast.

Obsidian Studies

Due to the high percentage of obsidian artifacts collected in the sample, along with the robust history of obsidian sourcing and hydration studies in the region, it seems fruitful to integrate these analytical tools to study prehistoric land-use in the Mono Lake basin.

No fewer than six obsidian sources are found within 30 km of the study area, ringing the basin along all except the western front of the Sierra Nevada (Figure 4.1). The dispersed locations of these sources makes it likely that different paths of travel would bring hunter-gatherers to a particular source, allowing them to retool, while other nearby sources might be overlooked because of the direction that a group is traveling or the qualities of a particular material source. While implied differences between early and late prehistoric mobility relate to an emphasis on direct toolstone procurement from obsidian sources, a shift from on- to off-quarry obsidian acquisition reflects changes in mobility and land-use through time. The presence of obsidian from disparate sources in a given context can inform one about prehistoric mobility patterns, whether the material was collected at a particular source or some secondary locality.

Earlier research (Basgall 1983; Bouey and Basgall 1984; Ericson 1977; Hall 1983; R. Jackson 1984; T. Jackson 1974; Ramos 2000) has investigated questions relating to access to a given source possibly being controlled by particular groups for the purposes of trans-Sierran obsidian trade. Based on dated archaeological contexts, it appears that the region was sparsely populated for much of prehistory. This information, in addition to the relatively low quantity/density of economically profitable resources

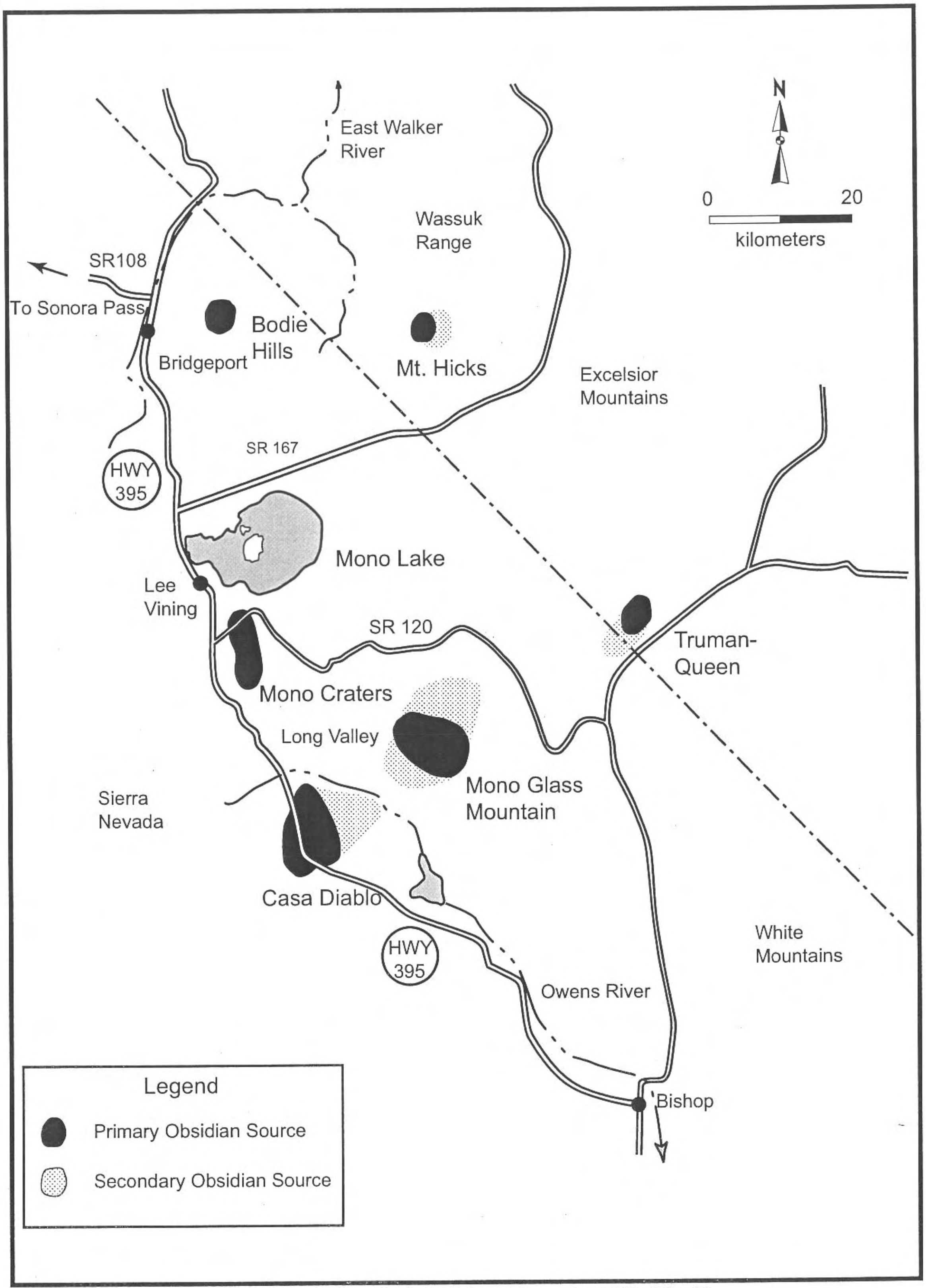


Figure 4.1. Obsidian Source Distributions (Adapted from Carpenter 2001: Fig. 3).

along with little evidence of social stratification, would preclude any strict ownership of a particular obsidian source (Bouey and Basgall 1984; Dyson-Hudson and Smith 1978). If territorial controls were present, one would expect to find more rigid distributions of obsidian relating to a particular source. However, more general trends in obsidian distribution are found (Basgall 1990; Carpenter 2001; Delacorte 1999; Halford 1998; Jackson 1974).

Some obsidian is highly represented a short distance away from the source location, while other sites show a predilection for more distant, but higher quality obsidian. This situation is found on the crest of the Sierra Nevada at Taboose Pass, just west of the Fish Springs obsidian source (Stevens 2002). Fish Springs obsidian dominates the late prehistoric assemblage on the pass at the same time a different suite of obsidian types are found in the valley. This contrast appears to represent direct acquisition at the nearest source by more distant groups while local populations rely on higher quality, yet more distant sources.

However, habitation sites often contain tools made from multiple obsidian sources which have been collected on specific acquisition excursions or in the context of "embedded" behavior (*sensu* Binford 1979). Toolstone could be acquired in minimally three ways: by direct acquisition, through trade, or scavenged from older archaeological deposits (Delacorte 1999; Goldberg et al. 1990:29; Stewart 1941:432). It seems unlikely that any one of these procurement strategies prevailed exclusively over others with all three probably fluctuating in importance throughout the prehistoric sequence (Bouey and Basgall 1984).

Since diverse obsidian sources are present at most sites, several things can be inferred. Using dated components, Basgall (1989) has postulated that in central-eastern California there is often decreased obsidian source diversity represented in more recent archaeological deposits than compared to those of older periods. Similar to temporal incongruities, spatial differences are found when investigating an area with diverse obsidian sources. Stone raw material use varies by tool type, whether curated or expedient, depending on quality and location of the material (Andrefsky 1991, 1994). Proximity to a particular source does not confirm that debitage, simple flake tools, and curated tools such as projectile points will all be manufactured from the local source. Instead, it is likely that items retained in toolkits for longer periods of time will reflect the places that mobile hunter-gatherers had been before arriving to a given locality (cf. Basgall 1989; Jones et al. 2003).

Both the diversity of sources represented and the state in which the artifacts are found vary according to the extent of mobility patterns. Material diversity in the toolkit may vary by distance between sources as well as the size of the toolkit (Ingbar 1994). Ingbar uses three simulations to show how variable source representation arises with the same extent of mobility, but varied toolkit size. He cautions that one should not use source diversity alone to explain mobility patterns. Likewise, Torrence (1994) argues that perspective should be broadened using multiple lines of evidence rather than focusing on stone material diversity to understand the dynamics of past behavior. Stone material diversity and its implication on mobility patterns are important lines of evidence on certain aspects of past behavior and social interaction.

Obsidian source profiles in a region such as the Mono Lake basin can be used, along with other lines of evidence to answer various research questions. The present study investigates both spatial and temporal variability among these data. Along with source- specific obsidian hydration readings and tool class representation, one can recognize how source use varies around the basin. In conjunction with tool and debitage distribution data, these can inform about past settlement systems.

There are two main methods used to ascribe material source to obsidian artifacts. The first uses energy dispersive X-ray fluorescence spectroscopy (XRF) to identify the major and minor trace elements of a sample. Results are compared with a database of specimens that were collected at the location of various obsidian sources. Based on statistical correspondence between the archaeological and control samples, artifacts are ascribed to one of several geologic obsidian sources (cf. Hughes 1986). This method has a history of use and refinement by archaeologists (Hughes 1984, 1989; Jack 1976; Jack and Carmichael 1969; Jackson 1974) to aid in studies of trade and exchange, toolstone procurement, and settlement patterns.

Visual sourcing of obsidian is a second method which has a shorter history of use by archaeologists. This method was chosen when it became apparent that large quantities of source-specific hydration readings were needed in order to study important temporal patterns. Visual sourcing allows for characterization of large obsidian samples without undergoing the sometimes prohibitive costs of XRF with large samples. Although relatively successful in certain contexts, visual sourcing does not have as high reliability as the XRF method. Problems occur when either unexpected sources are present in the sample, or there are errors of commission or omission (Bettinger et al. 1984a). Sometimes visual characteristics of distinct sources have overlapping properties which make distinct sources look similar. In the Mono Basin, previous visual sourcing efforts have had low reliability (Carpenter 2001:37).

Most commonly the two methods are used in conjunction with each other to increase the sample of sourced material without overly extending a budget. Through XRF, visual characterizations can be tested and assessed for their reliability (Basgall and Giambastiani 1995; Bettinger et al. 1984a; Delacorte 1999; Delacorte et al. 1995; Eerkins and King 2002; King et al. 2001; Overly 2002; Stevens 2002).

While restricting hydration efforts to one source is appropriate when working with large samples of artifacts where a single obsidian type occurs in all contexts tested, it is not realistic for the present study. The areal extent of the project area and high source diversity means that different obsidian sources will be represented in greater quantities at particular locations. For example, a source such as Casa Diablo may be prominent in the southwestern area but under-represented or even absent from northeastern localities.

In an effort to better understand obsidian source use and diversity through time in the Mono Lake basin, a program to visually source all collected obsidian artifacts and debitage from the current project was undertaken. To begin, it was necessary to delineate a sample area of sources most likely to be found in the archaeological contexts investigated. Given the area and time period under consideration, including examples of obsidian source diversity found in other regional archaeological contexts (Bettinger 1981; Carpenter 2001; Goldberg et al. 1990; McGuire 1994; Nelson et al. 1992; Wickstrom and

Jackson 1993), six distinct obsidian sources were designated likely to be found in the present collection. These are Casa Diablo (CD), Mono Craters (MC), Bodie Hills (BH), Mt. Hicks (MH), Mono Glass Mountain (MGM), and Truman-Queen (TQ) (Figure 4.1).

Obsidian Source Analysis

To understand variability of source visual characteristics, a review of the regional literature was conducted to look for traits thought to be reliable indicators of specific obsidian. One article (Bettinger et al. 1984a) has quantified the visual characteristics of four of these sources (CD, TQ, MH, BH) and tested their accuracy through XRF analysis. Of the four, the authors found the BH characterization to be the least reliable because of the lack of control and number of archaeological samples from that source. Other reports (Ainsworth 1993; Reynolds 1992; Skinner et al. 1990; Jackson 1985) provide descriptions of the sources in question, but since reliability of the visual attributes is not tested with archaeological samples, most did not shed new light on defining visual characteristics for these materials. To augment and refine this database of source descriptions and to define characteristics for the sources, the author studied a sample of at least 30 geochemically sourced artifacts and/or debitage from each obsidian source included in the sample. This was done using samples of XRF source-determined artifacts from nine collections curated both at CSU Sacramento and UC Davis.

The artifacts were inspected with a variable power (10x-30x) binocular microscope under hand-held, high-powered light. The visual characteristics for each item were described, and a set of attributes was created. These were then applied to the 214 collected obsidian artifacts, and each item was attributed to one of the six sources. Following this, a sample of 50 items was submitted for XRF analysis (Appendix D). Artifacts were chosen to exhibit the greatest variability in source with representative samples of each source submitted.

The results were different than expected and evident inconsistencies were used to reassess the visual sourcing criteria. Most prominent was the extreme variability found in MC. This caused errors of omission with items being attributed to other sources. The criteria was expanded for MC and made more conservative for the other sources, emphasizing more unique traits or suites of traits. These new criteria were then used to re-evaluate the sources ascribed for the remaining obsidian artifacts. To test the new visual sourcing calls, another 30 items were submitted for XRF analysis (Appendix D). Similar to before, items were selected to exhibit the greatest source variability. Results of the second batch of XRF demonstrated a 90% accuracy rate, arguing for the veracity of the remaining visual calls. Visual characteristics used to determine the obsidian sources are summarized below.

Casa Diablo (CD). The main distinction of this source is its noted near-uniform opacity. Earlier studies (Bettinger et al. 1984a) describe traits such as texture and color as not being distinguishing features. Both characteristics can be variable. Color can be black, red, or grey although some show a silky sheen that approaches chatoyance. Texture varies between waxy and coarse grained but is most often matte rather than glassy. Some pieces may have cracks or inclusions in the material although it is often too opaque to identify the presence or absence of these. If light passes through the tapered margin of a flake or tool, it is likely to be grey. Sometimes black or diffuse light grey banding may be visible on these margins. The uniform opacity, which generally does not allow one to see beyond the outermost surface of the artifact, is the most striking feature of this obsidian type.

Mono Craters (MC). This obsidian source is noted for having the greatest amount of irregularities and inclusions of the sources under discussion. It can vary between moderately clear to grey in appearance but is often a rosy reddish brown when candled behind a light. Some may be hazy/smokey clear similar to T-Q, but with a more pinkish tinge and usually more inclusions. There are often many air bubbles, as well as some white, and fewer black phenocrysts of varied sizes. Higher quality artifacts made from this source tend to have many air bubbles and few to no inclusions. The air bubbles may appear to form short linear segments ("air slashes") in irregular whitish splotches. These may be very dense in the artifact, making the piece appear cloudy grey and have a silver sheen under low level light. There may be black or diffuse grey/greenish-grey irregular banding and/or splotchy areas. The greenish-grey bands can be used to distinguish MC from MH. These give thinner pieces or artifact edges a slight greenish tinge, similar to BH. Some pieces have white cracks and/or large white inclusions which appear to be ash or oxidized obsidian. The ash occur in thin, linear bands, and one variant of this source has thick, opaque, black bands interspersed with clear obsidian which may have air bubbles. The greatest distinguishing features of this obsidian are its rosy hue when held behind a light and the great quantities of air bubbles.

Bodie Hills (BH). Although often similar to Mt. Hicks, Bodie Hills is more often cloudy, verging on opaque, rather than clear. The hue tends to be more grey or green-grey (similar to CD, but not as opaque), although some of the splotchy inclusions or bands are more brownish, and/or green-grey, similar to Fish Springs. Banding is most often black, and wavy rather than strictly linear. Infrequently, the former source is confused with the later as it also may demonstrate the iridescence/opalescence of Fish Springs; however, this generally occurs on only a small area. A few specimen sourced by XRF exhibited this trait to a degree more consistent with Fish Springs, and one was even opaque with a greenish tinge and iridescence. This specimen had more uniformity than most Fish Springs obsidian. The splotchy inclusions described earlier do not occur in Mt. Hicks obsidian. Most BH has black and white phenocrysts, as well as many air bubbles. Additionally, some BH has "spicules," which are small rectangular black bars that stand out from other banding or discolorations. These are good indicators of BH as they are not found in other sources. Some pieces have a reddish and black dentritic area which may also be marled with some clear areas. These are often thin colorings, most easily visible under low level magnification. Bodie Hills glass generally lacks the amber hue of Mt. Hicks and Truman-Queen obsidians. The red and brown patches, in addition to the greenish hue and general lack of transparency, are good distinguishing characteristics of this obsidian.

Mt. Hicks (MH). This obsidian source may, at first glance, be confused with Truman-Queen (T-Q) obsidian based on its transparency and banding; however, upon closer inspection, there are some distinct differences. First of all, there are greater quantities of inclusions which are often white flecks and air bubbles, in addition to some small black phenocrysts. It is similar to T-Q in that the transparent portion allows one to see all of the way through the artifact, but there are much more often cloudy grey or black irregularities in the material. Mt. Hicks has a high degree of "glassiness," so even if one cannot see entirely through the artifact due to irregularities, one can generally see beyond the outermost surface and into the artifact a bit. Although banding is present, it is usually highly contorted and may even be dendritic or marled, similar to an irregular spider web. The banding occurs as a black or whitish hue. The clear hue of the obsidian is most often amber (comparable to T-Q) but may also have a bluish tinge, similar to that of Mono Glass Mountain obsidian (the latter has many more phenocrysts). Mt. Hicks may also be confused with the Bodie Hills obsidian source, but can be distinguished by the former's greater transparency. Further inspection of hue, band coloring, and amount of inclusions aids in distinguishing the two.

Truman-Queen (T-Q). As described by Bettinger et al. (1984a), the distinguishing factor of T-Q obsidian is its translucency and lack of minor inclusions. Under magnification one can often identify flake scars on the other side of a bifacially flaked tool. It is most often a dull amber tint, especially with thicker artifacts, although some may tend to be more of a gray tone. Flow banding occurs with parallel planar bands. Some pieces may have a few inclusions, but these are minor when compared to those found in other regional sources. Most are extremely transparent and "glassy," but Truman-Queen may also be mottled red to reddish-brown, black, and clear, with the clear areas being similar to the previously described attributes. Some artifacts attributed to this source through XRF are relatively transparent, but they also have many small air bubbles which give the artifact a near silvery sheen at certain angles and make it difficult to see through the artifact. The transparency and lack of white or black inclusions helps distinguish this sub-type from others that appear similar at first notice. Truman-Queen obsidian is most commonly confused with Mt. Hicks by its transparency and amber hue; however, the latter has more inclusions, irregularities in transparency, as well as highly irregular banding.

Mono Glass Mountain (MGM). This source only recently has been distinguishable from Mono Craters obsidian using nondestructive X-ray flourescence methods (Hughes 1989). MGM obsidian can be visually identified by its high amount of inclusions. Phenocrysts are often larger than those found in Mt. Hicks or Bodie Hills obsidian and are most often black, although small white inclusions are not uncommon. Much of this obsidian is clear and glassy, similar to TQ and MH, but one can see partially into the artifact before the view is obscured by inclusions and irregularities. Much has a bluish-black tinge, often with greyish and black splotches, black contorted bands, or dendritic black inclusions. Banding, although contorted, tends to be oriented more linearly than MH obsidian and is often made by spot inclusions. The source also has white ashy inclusions which cause the surface texture to be slightly irregular. The obsidian is often moderately opaque, but not as much as CD and usually less uniform. MGM may also have red bands or splotches, similar to Bodie Hills, but with more black and/or white inclusions.

The results of the sourcing efforts are presented in Table 4.3. These demonstrate variable source presence across tool and debitage classes, patterns that will be discussed in more depth below. Obsidian source attributes not only help to understand processes of toolstone acquisition but are also fundamental to conducting obsidian hydration analysis.

Obsidian Hydration Analysis

To assess their temporal age, all collected obsidian items were also subjected to hydration analysis. Obsidian hydration is an important chronological tool in central-eastern California where it has been used to identify changes in temporal activity at quarry and near-quarry localities (Basgall 1983, 1984; Gilreath and Hildebrandt 1997; Goldberg et al. 1990; King et al. 2001; Singer and Ericson 1977), and as a means of determining the age of archaeological deposits in off-quarry contexts (Basgall and McGuire 1988; Basgall et al. 2003; Carpenter 2001; Delacorte 1999; Delacorte et al. 1995; Eerkens and King 2002; Zeanah and Leigh 2002, among others).

The rate that an obsidian artifact absorbs water from the atmosphere has been shown to vary most strongly under conditions related to chemical composition, temperature, and relative humidity (Friedman et al. 1997; Tremaine 1993:265). The last two may be estimated by the effective hydration temperature (EHT) (Basgall 1990; Hull 2001). Hydration rate also varies by elevation, which is correlated with temperature (Stevens 2002). The warmer the temperature of the artifact, the faster the hydration band will form (Basgall 1990; Friedman and Long 1976; Friedman et al. 1994; Hull 2001; Stevenson et al. 1998; Tremaine 1989). Effective hydration temperature, along with the

Table 4.3. Toolstone Source Distributions.

		CD	MC	BH	MH	MGM	TQ	CCR	BAS
	Proj. Point	1	-	3	1	1	1	-	-
	Biface	3	2	2	2	1	-	-	-
	Flake Tool	2	25	2	6	-	1	4	-
	Core*	-	6	-	-	-	-	-	-
	Dbtg	2	144	3	3	2	1	4	2
Freshwater	Tools	-	16	-	-	-	-	-	-
	Debitage	-	50	-	-	-	1	-	-
Brackish	Tools	3	7	5	6	-	1	1	-
	Debitage	-	53	1	1	-	-	-	1
Saline	Tools	3	4	2	3	2	1	3	-
	Debitage	2	41	2	2	2	-	4	1
Southwest	Tools	-	17	-	-	-	-	-	-
	Debitage	-	90	-	-	-	1	-	-
Northwest	Tools	3	4	5	5	-	1	1	-
	Debitage	-	12	1	1	-	-	-	1
Northeast	Tools	3	4	2	3	2	1	3	-
	Debitage	2	37	2	2	1	-	4	1
Southeast	Tools	-	2	-	1	-	-	-	-
	Debitage	-	5	-	-	1	-	-	-
1940-1960	Tools	5	8	3	6	2	-	2	-
	Debitage	1	28	2	3	1	-	4	1
1960-1980	Tools	-	14	1	1	-	1	1	-
	Debitage	-	66	1	-	-	1	-	1
1980-2000	Tools	1	4	3	1	1	1	1	-
	Debitage	1	43	-	-	1	-	-	-
>2000	Tools	-	1	-	1	-	-	-	-
	Debitage	-	7	-	-	-	-	-	-
Subtotal	Tools	6	27	7	9	2	2	4	-
	Debitage	2	144	3	3	2	1	4	2
Total		**8**	**171**	**10**	**12**	**4**	**3**	**8**	**2**

*Cores not included in tally; CD = Casa Diablo; MC = Mono Craters; BH = Bodie Hills; MH = Mt. Hicks; MGM = Mono Glass Mountain; TQ = Truman-Queen; CCR = cryptocrystalline; BAS = basalt; Dbtg = debitage; 1940-60 = 1940m-1960m asl; 1960-80 = 1960m-1980m asl; 1980-2000 = 1980m-2000m asl; >2000 = >2000m asl.

artifact's chemical composition appear to be the greatest factors affecting the rate that obsidian develops a hydration band.

The 214 obsidian artifacts and debitage were cut and mounted on slides by the author, following standard procedures. Tim Carpenter of Archaeometrics, Inc. undertook the hydration readings, providing the data for analysis.

Established obsidian hydration rates or correction factors were gathered from the regional literature and were used to place the items into temporal components, as discussed in Chapter 3 (Table 3.3). To achieve this, each obsidian source was assigned a range of micron values, corresponding with each temporal unit (Appendix E).

General artifact distributions around Mono Lakes's near-shore wetland areas inform one about the different habitats which were used synchronically in the past. However, it is also important to assess the temporal variability of these artifact distributions. One must study not only intensity of use through time, but also the variable presence of given toolstone sources in these contexts. As previous studies (Bettinger 1981; Carpenter 2001; Gilreath 1996; McGuire 1994; Nelson et al. 1992; Wickstrom and Jackson 1993) have outlined temporal differences in obsidian source diversity as a point of study, the present project seeks to assess this pattern in relation to the preferential human use of Mono Lake wetlands. The cited studies largely pertain to excavated sites in the southwest portion of the basin although one surface survey project used the relative presence of Casa Diablo obsidian as a coarse-grained dating method for sites recorded along Rush Creek (Gilreath 1996). The current investigation creates a good context to assess land-use patterns and stone raw material distributions relative to space and time.

All obsidian debitage and artifacts were ascribed a raw material source through the geochemical and visual methods noted above. Each piece was subject to obsidian hydration analysis (n=214). Of the artifacts analyzed, four had unreadable bands, 173 had one hydration band, 31 had two bands, and seven artifacts displayed three hydration rinds, providing a total of 256 hydration readings (Appendix E). As mentioned, hydration band formation is affected by several variables, the most significant being source and EHT (Friedman et al. 1997; Hull 2001; Onken 1991; Tremaine 1989). As far as EHT is concerned, the artifacts are from very similar environments, so local variation in temperature should not be an issue. Instead, the presence of six distinct obsidian sources within the sample is a larger matter to contend with (Table 4.3).

Two measures of time were used to interpret the data. The first uses t-tests comparing raw hydration values to identify statistical differences between the samples in question. The second uses established hydration rates to place artifacts into particular temporal periods (Appendix E). From here, variation in artifact deposition could be studied through a temporal framework using hydration values from all six sources.

Initial t-tests compared data sets using pooled source samples which assessed general temporal discrepancies among the samples, and were compared with results from source-specific tests. The tests analyzed hydration values from three different categories: wetland class, quadrant within the basin, and elevation group. Following these results, due to its large sample, MC obsidian was used to identify variability between the same three categories through significant t-values. Values for MC tools and debitage were also compared to assess temporal discrepancies in their discard across the landscape. Analyses were done to identify trends of temporal use across space.

The second method used to understand implications of the hydration data involved using source-specific hydration rates to place the hydration readings into one of nine temporal components (Table 4.4; Appendix E). Hydration rates used have been previously applied with certain levels of success by other researchers (Basgall and Giambastiani 1995; Carpenter 2001; Fredrickson 1991; Hall and Jackson 1989; Overly 2003a). One source, Mt. Hicks (MH) did not have an established hydration rate and a review of regional research documents yielded samples too small to create even a provisional rate. In lieu of that, MH values were converted to years before present using the rate for Casa Diablo obsidian (Hall and Jackson 1989). This rate has also been successfully applied to Bodie Hills obsidian (Fredrickson 1991; Halford 1998), and the outcome of the present effort yielded acceptable results.

Comparing the placement of temporally sensitive projectile points, it is apparent that some are misplaced according to generally accepted chronology (cf., Bettinger and Taylor 1974; Basgall et al. 2003). This issue is not as perplexing as it may seem initially. The three Desert Side-notched points and single Elko Corner-notched specimen grouped into the Haiwee and pre-Newberry II intervals, respectively, all have hydration values greater than are typical in the region. In fact, the three Desert Side-notched and two Rose Spring points have hydration values (Table 4.5) that are essentially equivalent to each other. Source-specific hydration rates were applied to homogenize the effects of source variability and to identify differences in temporal use of wetland areas in question.

Table 4.4. Obsidian Hydration Measurements Corrected for Temporal Period.

Unit	Source	Tool	num	MR	HW	NWI	NWII	PNI	PNII	PNIII	PNIV	EH
Freshwater Units												
F58	MC	FLKTL	1	-	-	-	1	-	-	-	-	-
	MC	DBTG	13	2	5	5	1	-	-	-	-	-
	TQ	DBTG	1	-	1	-	-	-	-	-	-	-
Unit F58 subtotal			***15***	***2***	***6***	***5***	***2***	-	-	-	-	-
F62	MC	BIFACE	3	-	1	-	1	-	-	1	-	-
	MC	FLKTL	23	7	5	6	4	1	-	-	-	-
	MC	CORE	8	3	2	2	-	1	-	-	-	-
	MC	DBTG	31	13	4	7	6	1	-	-	-	-
Unit F62 subtotal			***65***	***23***	***12***	***15***	***11***	***3***	-	***1***	-	-
F64	MC	FLKTL	1	1	-	-	-	-	-	-	-	-
	MC	DBTG	13	3	4	4	1	1	-	-	-	-
Unit F64 subtotal			***14***	***4***	***4***	***4***	***1***	***1***	-	-	-	-
Freshwater Total			**94**	**29**	**22**	**24**	**14**	**4**	-	**1**	-	-
Brackish Units												
B2	MC	FLKTL	3	2	-	1	-	-	-	-	-	-
	MC	DBTG	34	6	4	13	6	2	3	-	-	-
Unit B2 subtotal			***37***	***8***	***4***	***14***	***6***	***2***	***3***	-	-	-
B3	MC	CORE	1	-	1	-	-	-	-	-	-	-
	MC	DBTG	9	-	3	3	2	1	-	-	-	-
Unit B3 subtotal			***10***	-	***4***	***3***	***2***	***1***	-	-	-	-
B12	MC	DBTG	3	2	-	-	1	-	-	-	-	-
B21	MC	FLKTL	1	-	1	-	-	-	-	-	-	-
	MH	FLKTL	1	1	-	-	-	-	-	-	-	-
Unit B21 subtotal			***2***	***1***	***1***	-	-	-	-	-	-	-
B36	MC	FLKTL	2	1	1	-	-	-	-	-	-	-
B44	MC	DBTG	1	-	-	1	-	-	-	-	-	-
B66	TQ	PRJPT	1	-	1	-	-	-	-	-	-	-
B104	BH	PRJPT	1	-	1	-	-	-	-	-	-	-
B112	MC	FLKTL	1	-	-	1	-	-	-	-	-	-
	BH	FLKTL	2	1	-	-	-	-	-	-	1	-
	MH	FLKTL	2	1	-	1	-	-	-	-	-	-
Unit B112 subtotal			***5***	***2***	-	***2***	-	-	-	-	***1***	-

Table 4.4. Obsidian Hydration Measurements Corrected for Temporal Period (continued).

Unit	Source	Tool	num	MR	HW	NWI	NWII	PNI	PNII	PNIII	PNIV	EH
Brackish Units (continued)												
B115	CD	BIFACE	2	-	1	-	-	-	-	-	-	1
	MC	FLKTL	1	-	1	-	-	-	-	-	-	-
	BH	PRJPT	1	-	1	-	-	-	-	-	-	-
		BIFACE	2	-	-	2	-	-	-	-	-	-
		FLKTL	1	-	-	-	-	1	-	-	-	-
		DBTG	1	-	-	-	-	-	1	-	-	-
	MH	PRJPT	1	-	-	-	-	-	1	-	-	-
		FLKTL	2	-	-	1	-	-	-	-	1	-
Unit B115 subtotal			***11***	**-**	***3***	***3***	**-**	***1***	***2***	**-**	***1***	***1***
B134	CD	BIFACE	1	-	-	-	-	-	-	-	1	-
		FLKTL	2	1	1	-	-	-	-	-	-	-
	MC	FLKTL	3	1	1	-	-	-	-	1	-	-
		DBTG	11	3	1	2	-	4	1	-	-	-
	MH	FLKTL	1	-	-	-	-	-	-	-	-	1
		DBTG	1	-	1	-	-	-	-	-	-	-
Unit B134 subtotal			***19***	***5***	***4***	***2***	**-**	***4***	***1***	***1***	***1***	***1***
B143	MC	DBTG	1	-	-	-	-	1	-	-	-	-
Brackish subtotals		South	55	12	10	18	9	3	3	-	-	-
		North	38	7	9	7	-	6	3	1	3	2
Brackish Total			**93**	**19**	**19**	**25**	**9**	**9**	**6**	**1**	**3**	**2**
Saline Units												
S7	MC	DBTG	4	-	1	1	-	-	2	-	-	-
	MGM	DBTG	1	-	-	-	1	-	-	-	-	-
Unit S7 subtotal			***5***	**-**	***1***	***1***	***1***	**-**	***2***	**-**	**-**	**-**
S27	MC	FLKTL	2	1	-	-	-	-	1	-	-	-
		DBTG	7	-	-	-	-	4	2	1	-	-
Unit S27 subtotal			***9***	***1***	**-**	**-**	**-**	***4***	***3***	***1***	**-**	**-**
S42	MC	DBTG	3	-	-	-	2	1	-	-	-	-
S44	MC	DBTG	5	-	-	-	2	2	-	1	-	-
S63	CD	FLKTL	1	1	-	-	-	-	-	-	-	-
	MC	FLKTL	4	1	1	1	-	-	1	-	-	-
		DBTG	11	-	-	1	2	5	2	-	-	1
	BH	PRJPT	1	-	1	-	-	-	-	-	-	-
		BIFACE	3	1	1	-	-	1	-	-	-	-
		DBTG	1	1	-	-	-	-	-	-	-	-
	MGM	BIFACE	1	-	1	-	-	-	-	-	-	-
	TQ	FLKTL	1	1	-	-	-	-	-	-	-	-
Unit S63 subtotal			***23***	***5***	***4***	***2***	***2***	***6***	***3***	**-**	**-**	***1***

Table 4.4. Obsidian Hydration Measurements Corrected for Temporal Period (continued).

Unit	Source	Tool	num	MR	HW	NWI	NWII	PNI	PNII	PNIII	PNIV	EH
Saline Units (continued)												
S102	MC	DBTG	1	-	-	-	-	1	-	-	-	-
	MH	BIFACE	1	-	-	1	-	-	-	-	-	-
Unit S102 subtotal			*2*	-	-	*1*	-	*1*	-	-	-	-
S115	MC	DBTG	3	-	-	-	-	-	1	2	-	-
S116	MC	DBTG	4	-	-	1	-	2	-	1	-	-
S165	CD	PRJPT	1	-	1	-	-	-	-	-	-	-
		BIFACE	2	-	-	1	1	-	-	-	-	-
		DBTG	1	-	-	1	-	-	-	-	-	-
	MC	DBTG	1	-	-	1	-	-	-	-	-	-
	BH	DBTG	1	-	-	-	1	-	-	-	-	-
	MH	BIFACE	1	-	1	-	-	-	-	-	-	-
		FLKTL	1	-	-	-	-	1	-	-	-	-
		DBTG	2	1	1	-	-	-	-	-	-	-
	MGM	PRJPT	1	-	-	-	1	-	-	-	-	-
Unit S165 subtotal			*11*	*1*	*3*	*3*	*3*	*1*	-	-	-	-
S166	MC	DBTG	2	-	-	1	-	-	1	-	-	-
	MGM	DBTG	1	-	-	-	1	-	-	-	-	-
Unit S166 subtotal			*3*	-	-	*1*	*1*	-	*1*	-	-	-
S173	CD	DBTG	1	-	-	-	1	-	-	-	-	-
Saline Total			**69**	**7**	**8**	**9**	**12**	**17**	**10**	**5**	**-**	**1**

MR = Marana (100-650 B.P.); HW = Haiwee (650-1350 B.P.); NW I = Newberry I (1350-2275B.P.); NW II = Newberry II (2275-3200 B.P.); PN I = pre-Newberry I (3200-4000 B.P.); PNII = pre-Newberry II (4000-5000 B.P.); PNIII = pre-Newberry III (5000-6000B.P.); PNIV = pre-Newberry IV (6000-7500 B.P.); EH = Early Holocene (7500-12500 B.P.). CD = Casa Diablo; MC = Mono Craters; BH = Bodie Hills; MH = Mt. Hicks; MGM = Mono Glass Mountain; TQ = Truman-Queen; FLKTL = flake tool; DBTG = debitage; PRJPT = projectile point.

Additionally, placing the artifacts into temporal components assesses differences in the use of particular obsidian sources through time. When using obsidian hydration values to study temporal trends within a site or region, most researchers attempt to focus on a single source for most or all of their analyses (Basgall 1989; Basgall et al. 2003; Delacorte 1999; King et al. 2001; Stevens 2002; Zeanah and Leigh 2002) and, therefore, eliminate potential error introduced by the variable hydration rate between sources. In correcting for varied source hydration values with source-specific hydration rates, the

Table 4.5. Obsidian Hydration Measurements for Collected Tool Classes.

Source	OH Reading	MR	HW	NWI	NWII	PNI	PNII	PNIII	PNIV	TP/EH
Projectile Point										
BH	3.2 (DSN), 3.1 (DSN), 3.2 (RS)	-	3	-	-	-	-	-	-	-
CD	3.1 (RS)	-	1	-	-	-	-	-	-	-
MGM	6.7 (ELK)	-	-	-	1	-	-	-	-	-
MH	6.8 (ELK)	-	-	-	-	-	1	-	-	-
TQ	3.5 (DSN)	-	1	-	-	-	-	-	-	-
Subtotal		-	**5**	-	**1**	-	**1**	-	-	-
Biface										
BH	1.6/3.0, 3.7/4.7/6.1	1	1	2	-	1	-	-	-	-
CD	3.4/11.5, 3.9/5.0, 8.8	-	1	1	1	-	-	-	1	1
MC	3.8, 6.5/8.6	-	1	1	-	-	-	1	-	-
MGM	3.4	-	1	-	-	-	-	-	-	-
MH	3.1, 4.6	-	1	1	-	-	-	-	-	-
Subtotal		**1**	**5**	**5**	**1**	**1**	-	**1**	**1**	**1**
Flake Tool										
BH	1.9/8.3, 6.5	1	-	-	-	1	-	-	1	-
CD	1.6/3.3, 2.3	2	1	-	-	-	-	-	-	-
MC	1.4/3.6, 1.5, 1.6/8.6, 1.7/3.2/4.7, 1.7/3.5/5.8, 1.9/4.5/6.9, 2.1/8.4, 2.1/4.0/6.0, 2.3/5.0/5.9, 2.5, 2.9, 3.1, 3.1/5.0/5.9, 3.3, 3.5, 3.6, 4.0/5.5, 4.1, 4.2; 4.2, 4.7, 5.0, 5.0, 5.6, 5.8, 7.8	14	10	9	5	1	2	1	-	-
MH	1.8, 2.2/3.9, 4.5, 6.1, 8.8, 10.1	2	-	2	-	1	-	-	1	1
TQ	2.4	1	-	-	-	-	-	-	-	-
Subtotal		**20**	**11**	**11**	**5**	**3**	**2**	**1**	**2**	**1**
Core										
MC	1.9/3.3, 2.0/7.2, 2.2/4.1, 4.0, 4.8, 5.1	3	3	2	-	1	-	-	-	-
Tool Total (n=88)		**24**	**24**	**18**	**7**	**5**	**3**	**2**	**3**	**2**
Debitage Total (n=168)		**31**	**25**	**40**	**28**	**25**	**13**	**5**	-	**1**

MR = Marana (100-650 B.P.); HW = Haiwee (650-1350 B.P.); NWI = Newberry I (1350-2275B.P.); NWII = Newberry II (2275-3200 B.P.); PNI= pre-Newberry I (3200-4000 B.P.); PNII = pre-Newberry II (4000-5000 B.P.); PNIII = pre-Newberry III (5000-6000B.P.); PNIV = pre-Newberry IV (6000-7500 B.P.); TP/EH = Terminal Pleistocene/Early Holocene (7500-12,500 B.P.). CD = Casa Diablo; MC = Mono Craters; BH = Bodie Hills; MH = Mt. Hicks; MGM = Mono Glass Mountain; TQ = Truman-Queen.

intent was to overcome these pitfalls. Therefore, the temporal significance of different sources through time could be assessed, and areas with greater source diversity could be more completely represented in temporal context.

CHAPTER 5

SURVEY RESULTS

The descriptions of characteristic survey units within each wetland category are reviewed as a basis for understanding variation in artifact distributions. Discussion then focuses on the dispersion of general tool classes found across wetland types and what attributes of these artifacts suggest about variation in land-use activities.

Environmental Characteristics of Survey Areas

Survey units are first characterized for each wetland class as a group, outlining variation across the units and highlighting similarities within the units of each group. A comparison of the three classes follows with quadrats of distinction considered in greater detail. Artifact distributions with some of the latter units are explored since these usually present a stronger archaeological pattern than the more typical quadrats.

Landforms encountered during the project are characterized by sandsheets, alluvial fans, dunes, exposed lakebed, lakeshore area, wetland patches, and both intermittent and perennial riparian corridors. While some such situations generally occur within each of the three classes, the relative presence of different landform and vegetation appears to have an important effect on foraging decisions in the project area.

The percentage of vegetation coverage was visually estimated for each unit and then compiled by wetland class. The amount of ground that was barren, covered with grasses, shrubs, and trees was described as a percentage of total area. Sixteen different plants were identified and recorded for each unit, whether present or absent. This record served to describe similarities and differences among wetland classes and between units in greater detail.

The presence of seasonal or perennial water was also noted with units containing a variety of wet marshes, flowing streams, and dry stream channels. While these water sources surely support different habitat types, their presence or absence is used in conjunction with the other data to distinguish variability. Table 5.1 presents much of the data pertinent to the following discussion.

Table 5.1. Unit Characterizations by Wetland Type.

	Elevation*		**Vegetation#**				
	Min.	**Max.**	**Barren**	**Grass**	**Shrub**	**Tree**	**% with water**
Freshwater (n=6)							
x̄	1959	1976	26.2	15.5	59.3	0.8	66.7
s.d.	10.8	13.7	17.4	10.7	20.0	2.0	
c.v.	0.5	0.7	66.4	69.0	33.7	250.0	
Brackish (n=15)							
x̄	1966	1987	34.8	18.3	46.5	2.1	46.7
s.d	15.6	21.0	16.4	26.0	17.9	3.7	
c.v.	0.8	1.1	47.1	142.1	38.5	176.2	
Saline(n=19)							
x̄	1971	1979	56.7	5.3	36.8	1.2	15.8
s.d.	11.5	11.8	14.6	7.8	14.9	2.7	
c.v.	0.6	0.6	25.7	147.2	40.4	225.0	

*Derived from GIS DEM. # Based on visual estimates. Min. = minimum elevation (meters asl.); Max. = maximum elevation (meters asl.); Barren = % barren; Grass = % grass; Shrub = % shrub; Tree = % trees; x̄ = average (meters asl.); s.d. = standard deviation; c.v. = coefficient of variation (%).

Freshwater Quadrats

Of the six freshwater quadrats surveyed, all are located near the western edge of Mono Lake. They are characterized primarily as sandsheets or alluvial fans, where riverine and relict wetland/lakeshore is sometimes juxtaposed with exposed lakebed or pan areas. Elevations range from the lakeshore at 1945 m to a maximum of 1993 m. Mean and standard deviations of the minimum and maximum unit elevations are shown in Table 5.1. Vegetation class distribution has the greatest coverage of shrub vegetation (59.3%), the least amount of trees (0.8%) and barren land (26.2%) relative to brackish and saline habitats. Vegetation includes five primary and five secondary taxa. Primary plants comprise sagebrush (*Artemisia tridentata*), rabbitbrush (*Chrysothamnus nauseosa)*, bitterbrush (*Purshia tridentata*), willow (*Salix* sp.), and wood rose (*Rosa woodsii*). Secondary vegetation includes foxtail barley (*Hordeum jubatum*), ricegrass (*Achnatherus hymenoides*), desert peach (*Prunus andersonii*), and greasewood (*Sarcobatus vermiculatus*) as well as grasses (Graminae). Finally, two quadrats contained a freshwater stream (Rush Creek), while two more were adjacent the lakeshore.

Brackish Quadrats

Fifteen quadrats located in brackish wetlands were surveyed and these fell in both southern (n=4; 26.7%), and northern (n=11; 73.3%) areas. Landform/habitat consists primarily of sandsheets/alluvial fans, marsh wetland, lakeshore, and exposed lakebed with secondary representation of sand dunes. This last is not found in the freshwater group, but more important is the presence of marsh wetland in addition to seasonal drainages. The elevation of the brackish units range from 1945 m to 2025 m with a mean minimum and mean maximum of 1966 m and 1987 m, respectively. Compared to the freshwater quadrats, brackish habitats exhibit more barren ground (34.8%), close to the same amount of grasses (18.3%), fewer shrubs (46.5%), and the most tree coverage (2.1%) of any wetland class. It is noteworthy that this habitat includes a greater number of identified plant species than in the freshwater areas. Primary taxa include rabbitbrush, sagebrush, bitterbrush, saltgrass (*Distichlis spicata*), greasewood, tule (*Typha* sp.), juniper (*Juniperus osteosperma*), pinyon (*Pinus monophylla*), and foxtail barley. Secondary vegetation consists of ricegrass, buckwheat (*Erigoneum* sp.), desert peach, and willow.

While the greater diversity of vegetation identified in brackish wetlands may be seen as contrary to expectations with the initial classification, this is not necessarily the case. Initial wetland stratification used vegetation maps to identify greater plant species diversity in the freshwater habitat. Deviations found in the current project are likely due to overlooking less prevalent species (e.g., those grouped as grasses and herbs) since plants noted in the field focused on the more common biota.

Saline Quadrats

Saline unit characterization frequently met expectations pertaining to the type and amount of ground cover, as well as vegetation diversity. Units were frequently homogenous with sandsheets and dunes making up the primary landform and exposed lakebed/pan composing the secondary landform; one unit (S88) also contained a wet meadow habitat. Elevations range from 1948 m to 1999 m although the mean minimum and mean maximum heights are 1971 m and 1979 m. This narrow, 10 m range implies that most elevations fall closer to the center of this elevation distribution. The greatest percentage of barren landscape (56.7%) occurred in the saline wetland class while grasses

(5.3%) and shrubs (36.8%) were least represented here relative to the others. The presence of trees (1.2%) falls between the freshwater and brackish units, but variation is so minor that it likely had a negligible effect on wetland use. Finally, water is present on a much less frequent basis, occurring in only 15.8% (n=3) of the units. Counting two springs and one seasonal drainage, these units do not have the most abundant or diverse archaeological assemblages in the saline category. Primary vegetation is rabbitbrush, greasewood, and sagebrush with sparse secondary cover of saltgrass and occasional ricegrass.

Survey Findings

Archaeological assemblages encountered in the units show a varied distribution of artifacts across the basin. Grouping wetlands by class failed to associate dense, diverse assemblages with one wetland class in particular. Instead, quadrats from all three wetland types yielded at least one unit that contained debitage along with flaked and ground stone tools. These areas likely represent localities where people stayed for periods of time and undertook a variety of tasks using implements often viewed as indicative of both men's and women's activities (cf. Delacorte 1990, 2002; Zeanah 2002, 2004). The range of material within units also varied from little or nothing to diverse collections of flaked and ground stone tools. For this first level of analysis, units are placed into seven different groups based on artifact classes encountered in the quadrats. Table 5.2 outlines the groups, including where units fall; Tables 5.3, 5.4, and 5.5 show the distribution and counts of actual artifacts recovered.

Table 5.2. Unit Constituents by Wetland Type.

	Empty	DEB Only	GSTN Only	DEB & FTL	DEB &FSTN	DEB &GSTN	DEB FSTN&GSTN
Freshwater							
F3	-	+	-	-	-	-	-
F4	-	+	-	-	-	-	-
F50	-	-	-	-	-	+	-
F58	-	-	-	+	-	-	-
F62	-	-	-	-	-	-	+
F64	-	-	-	+	-	-	-
Brackish							
B2	-	-	-	+	-	-	-
B3	-	-	-	-	+	-	-
B12	-	-	-	-	-	+	-
B21	-	-	-	-	-	-	+
B35	+	-	-	-	-	-	-
B36	-	-	-	-	-	-	+
B44	-	-	-	-	-	+	-
B66	-	-	-	-	-	-	+
B101	+	-	-	-	-	-	-
B104	-	-	-	-	+	-	-
B112	-	-	-	-	-	-	+
B115	-	-	-	-	-	-	+
B130	-	+	-	-	-	-	-
B134	-	-	-	-	-	-	+
B143	-	+	-	-	-	-	-
Saline							
S7	-	+	-	-	-	-	-
S27	-	-	-	+	-	-	-
S42	-	+	-	-	-	-	-
S44	-	+	-	-	-	-	-
S49	-	+	-	-	-	-	-
S63	-	-	-	-	-	-	+
S88	-	-	+	-	-	-	-
S96	-	+	-	-	-	-	-
S102	-	-	-	-	-	-	+
S115	-	-	-	-	-	+	-
S116	-	+	-	-	-	-	-
S144	-	+	-	-	-	-	-
S165	-	-	-	-	-	-	+
S166	-	+	-	-	-	-	-
S171	-	+	-	-	-	-	-
S173	-	-	-	+	-	-	-
S180	-	-	-	-	-	+	-
S183	-	+	-	-	-	-	-
S208	-	+	-	-	-	-	-

DEB = debitage; GSTN = ground stone tool; FTL = flake tool; FSTN = formed flaked stone tool.

Table 5.3. Artifact Distribution for Freshwater Units.

Quadrat	COR	BIF	FTL	DEB	C-DEB	HND	MIL	PST	BRM	SRL	ASC	Total
F3	-	-	-	2	-	-	-	-	-	-	-	2
F4	-	-	-	3	-	-	-	-	-	-	-	3
F50	-	-	-	10	-	1	-	-	-	-	-	11
F58	-	-	1	31	11	-	-	-	-	-	-	43
F62	5	2	12	+2000	21	1	1	1	4	8	5	+2060
F64	-	-	1	26	9	-	-	-	-	-	-	36
Total	**5**	**2**	**14**	**+2072**	**41**	**2**	**1**	**1**	**4**	**8**	**5**	**+2155**

COR = core; BIF = biface; FTL = flake tool; DEB = debitage from 500m^2 unit; C-DEB = debitage from 100m^2 unit; HND = handstone; MIL = millingstone; BRM = bedrock mortar; SRL = segregated reduction locus; ASC = assayed cobble.

Table 5.4. Artifact Distribution for Brackish Units.

Quadrat	PPT	COR	BIF	FTL	DEB	C-DEB	HND	MIL	CRTL	MGS	ASC	Total
B2	-	-	-	1	+500	28	-	-	-	-	11	+540
B3	-	2	-	-	+500	7	-	-	-	-	14	+523
B12	-	-	-	-	3	3	-	-	1	-	-	7
B21	-	-	-	2	4	-	-	-	-	1	-	7
B35	-	-	-	-	-	-	-	-	-	-	-	-
B36	-	-	-	1	16	-	-	1	-	-	-	18
B44	-	-	-	-	11	-	1	-	-	-	-	12
B66	1	-	-	-	22	-	4	-	-	-	-	27
B101	-	-	-	-	-	-	-	-	-	-	-	-
B104	1	-	-	-	4	-	-	-	-	-	-	5
B112	-	-	-	3	51	-	-	1	-	-	-	56
B115	2	-	2	4	42	3	-	1	-	-	-	54
B130	-	-	-	-	6	-	-	-	-	-	-	6
B134	-	-	1	5	17	11	-	4	-	1	-	39
B143	-	-	-	-	2	1	-	-	-	-	-	3
Total	**4**	**2**	**3**	**16**	**+1178**	**53**	**5**	**7**	**1**	**2**	**25**	**+1296**

PPT = projectile point; COR = core; BIF = biface; FTL = flake tool; DEB = debitage from 500m^2 unit; C-DEB = debitage from 100m^2 unit; HND = handstone; MIL = millingstone; CRTL = core tool; MGS = miscellaneous ground stone; ASC = assayed cobble.

Table 5.5. Artifact Distribution for Saline Units.

Quadrat	PPT	BIF	FTL	DEB	C-DEB	HND	MIL	CRTL	MGS	BEAD	Total
S7	-	-	-	48	3	-	-	-	-	-	51
S27	-	-	1	25	7	-	-	-	-	-	33
S42	-	-	-	17	3	-	-	-	-	-	20
S44	-	-	-	29	4	-	-	-	-	-	33
S49	-	-	-	5	-	-	-	-	-	-	5
S63	1	2	5	51	11	1	3	1	2	-	77
S88	-	-	-	-	-	-	1	-	-	-	1
S96	-	-	-	18	3	-	-	-	-	-	21
S102	-	1	-	40	1	1	-	-	1	-	44
S115	-	-	-	52	2	1	1	-	-	-	56
S116	-	-	-	31	4	-	-	-	-	-	35
S144	-	-	-	4	-	-	-	-	-	-	4
S165	2	2	3	49	6	1	-	-	-	1	64
S166	-	-	-	17	3	-	-	-	-	-	20
S171	-	-	-	7	-	-	-	-	-	-	7
S173	-	-	1	10	1	-	-	-	-	-	12
S180	-	-	-	6	-	1	-	-	1	-	8
S183	-	-	-	4	-	-	-	-	-	-	4
S208	-	-	-	4	-	-	-	-	-	-	4
Total	**3**	**5**	**10**	**417**	**48**	**5**	**5**	**1**	**4**	**1**	**501**

PPT = projectile point; BIF = biface; FTL = flake tool; DEB = debitage from 500m^2 unit; C-DEB = debitage from 100m^2 unit; HND = handstone; MIL = millingstone; CRTL = core tool; MGS = miscellaneous ground stone; BEAD=bead.

Table 5.2 illustrates the general distribution of artifacts across wetland habitats. While the quadrats grouped by constituents are not significantly different across wetland classes (X^2=17.11; df=12), trends in the distributions inform how the larger regions were used differently in the past. Saline areas were used more frequently when resharpening and/or producing flaked stone tools because of the high amount of quadrats containing only debitage. Although regional use is noted through scattered debitage, tools are more infrequent than in the other wetlands. Much of the saline habitat corresponds to what Davis (1964:256) called "use-areas". Although the habitat was widely traveled, residential or long-term use was infrequent; over half of the units contain only dispersed debitage and just 15.8% (n=3) contain the larger suite of tools. A second apparent trend implies that brackish habitats underwent more long-term use by people who had an array of tools that suggest residential activity. This is apparent in just under half (40%; n=6) of the brackish units surveyed. In contrast to these two, the freshwater habitat patches appear to exhibit a general pattern of land-use where people reside for either short- or long-term periods.

Empty Units

Quadrats B35 and B101 are the only two units of the survey not to produce any archaeology whatsoever. Unit B35 is located near Simons Spring, a large spring at the southeastern lakeshore that is characterized as a marsh wetland with cattails and dense saltgrass obscuring most of the ground's surface. Similarly, B101 is a lakeshore wetland habitat covered with saltgrass and very little unvegetated surface. It is possible that these areas were used in the past for harvesting plant resources, although tools used were either taken away or are currently obscured by the groundcover.

Units with Ground Stone Only

One quadrat, S88, contained one near-complete granitic millingstone. Complete dimensions of the artifact are 350 mm long, 275 mm wide, and 100 mm thick, and it is ground on one surface. The artifact is located at 1953 m, and the unit reaches very close to the eastern lakeshore. Similar to the empty quadrats, S88 is mostly marsh/wet meadow habitat, covered with dense grasses and springs seeping through the ground in many areas. The eastern portion of the unit transitions to sand dunes that move up out of the wet meadow. While one large artifact is present, much of the ground surface is obscured by vegetation which hinders surface visibility.

Units with Debitage Only

The most common archaeological debris encountered was debitage, and fifteen quadrats contained only unmodified flaking debris (Table 5.2). This includes quadrats from each wetland type located in all but the southwestern quadrant. Most (n=11; 73.3%) are saline unit with two each (13.3%) being freshwater and brackish. Seven quadrats contained debitage that was recorded and collected in the 100 m x 100 m sample. The location of surface debitage was recorded in the remaining contexts.

Freshwater units, F3 and F4, are located adjacent to each other and had two and three pieces of obsidian debitage, respectively (Table 5.3). Both are in relatively dry situations between 1965 m and 1981 m. Shrub vegetation predominates in F4, while F3 has more grasses and barren land coverage.

The two brackish units that yielded only debitage are B130 and B143 (Table 5.4). These are located 500 m apart in the northwestern sector of the basin. Unit B130 is at a similar elevation as F3 and F4, ranging between 1965 and 1985 m, while B143 is a bit higher at 1989 m to 2025 m in elevation. Quadrat B130 contained six pieces of obsidian scattered on the southern and eastern portion of the quadrat, while B143 had three pieces of debitage (one collected from the 100 m x 100 m unit).

Eleven saline units yielded only lithic debitage (Table 5.5). Three of these (S42, S44, and S49) are located in dry dune fields near the eastern extent of the survey area. Vegetation is mainly shrubs with much barren landscape, likely due to the lack of springs or other soil leaching processes. These included between five and 33 pieces of debitage lying between 1975 m and 1981 m. Seven pieces of obsidian debitage were collected from this group of units.

Quadrat S7 is similar to these units although it is located in the southeastern quadrant. It has the same elevation range and vegetation as the eastern units, although there was also a dry stream channel observed. Unit S7 contained 51 pieces of obsidian debitage, three were collected.

The remaining seven quadrats (S96, S116, S144, S166, S171, S183, and S208) are in the northeastern area. They range in elevation from 1957 m to 1996 m, being covered predominantly with dunes interspersed with sandsheets and exposed lakebed or deflated pan. The units are more than 50% barren ground surface with the predominant vegetation being sagebrush, rabbitbrush, and greasewood. Grasses make up about 5% of the ground cover in these units, and no springs or dry stream channels were noted. Debitage recorded ranges from four to 35 pieces per quadrat, and only three units had four or fewer flakes collected.

Units with Debitage and Flake Tools

Quadrats where only debitage and flake tools were encountered were segregated from those containing other tools. The distinction relates to expectations about the relative use and discard of expedient and curated tools (see Chapter 3), which may vary by the effort invested in their production and maintenance. Viewed as expedient implements, flake tools may be discarded in the location of use more often than curated items, such as bifaces. It is expected that the latter are base camps for retooling. Perhaps more plant cutting/processing or animal butchering rather than tool rejuvenation or production is implied at units that only contained debitage and flake tools. Five quadrats included debitage and flake tools only. These are distributed in two freshwater (F58, F64), one brackish (B2), and two saline (S27, S173) units supporting similar activities across wetland class.

Quadrats F58 and F64 both contained one flake tool, along with 40 and 35 pieces of debitage, respectively (Table 5.3). Twelve and nine flakes each were collected from each 100 m x 100 m sample. Unit F58 has an annual stream, Rush Creek, running through its eastern portion, while F64 reaches Mono Lake's shore at its northern extent. The mouth of Rush Creek lies just east of the unit. Due to meandering and seasonal variation in water flow, it appears that Rush Creek at times flows through both units. Elevations in F58 range between 1962 m and 1993 m, while F64 sits between 1945 m and 1954 m. Unit F64 is on a sand-covered alluvial fan that is likely a relict wetland. Vegetation is predominantly rabbitbrush although there is a secondary presence of saltgrass, desert peach, and ricegrass. In contrast, F58 has denser shrub growth and less barren ground, with dense thickets of willow and wood rose, especially in the eastern area near the shores of the stream. The northwestern portion of the unit rises up a 40° slope to breach the top of a large, elevated plateau.

The brackish unit B2 is located at the southern shore of Mono Lake, and the northern 200 m of the unit could not be surveyed due to the presence of tufa, a protected resource in the Mono Basin Scenic Area (Table 5.4). The quadrat is also one kilometer northeast of Panum Crater, a volcanic dome that is one of the sources of Mono Craters obsidian. As such, there are many obsidian cobbles in the alluvium. These are most common in the southern portion of the unit where there is a 44° slope that rises 20 meters up to two terrace benches. Elevation in the unit ranges from 1945 m to 1987 m. Predominant vegetation is rabbitbrush in the northern portion where the ground surface is relict lakebed, although in some areas the soil is sufficiently leached to support occasional ricegrass.

One flake tool was collected from the unit, 11 assayed cobbles were observed (one collected), and the obsidian debitage was too abundant to count. Twenty-eight pieces of debitage were collected from the 100 m x 100 m sample area; there was much more present. This portion of the unit contained the densest concentration of obsidian flaking debris along with nine assayed cobbles. Rather than attempting to count the debitage, surveyors estimated the density per square meter and plotted the distribution on aerial photos. These data were later calculated into linear meters for the different densities, and the results are presented in Table 5.6. Linear meters are simply estimates of the north-to-south extent of the given debitage aggregates. This method was used to estimate the relative density of debitage throughout the quadrat. Obsidian flaking debris is denser in the 100 m x 100 m sample than in the rest of the unit. Aggregate estimates account for 29.2% of linear meters surveyed here, whereas it only accounts for 4.5% of linear meters surveyed in the remaining portion of the unit. The flake tool was collected from the lower sandsheet area. The remaining debitage is likely related to toolstone acquisition rather than tool maintenance or resource procurement.

Table 5.6. Artifact Distributions in Unit B2.

	FTL	ASC	DEB	$<20/M^2$	$10/M^2$	$5/M^2$	$<5/M^2$	$<4/M^2$	$2\text{-}4/M^2$	$1/M^2$	L.M.
$100M^2$	-	9	49	36	-	-	160	29	45	22	1000
$500M^2$	2	2	31	330	31	45	26	-	-	-	9600

FTL = flake tool; ASC = assayed cobble; DEB = isolated debitage; $\#/M^2$ = estimated number of flakes per m^2; L.M. = linear meters surveyed.

The last two units that contained only flake tools and debitage are both from the saline habitat (S27, S173). These quadrats represent similar yet different contexts. Unit S27 is in the furthest east part of the project area, with one flake tool and 32 pieces of debitage at an elevation between 1989 m and 1999 m. Landform and vegetation is similar to the other units in the area, characterized by dunes and interspersed with sand sheets and deflated pan areas. About 70% of the ground surface is barren with the remaining area covered by sagebrush, rabbitbrush, or greasewood. Similar to S27, quadrat S173 is characterized by the same landforms but have greater elevation relief, ranging from 1959 m to 1991 m. The quadrat is located in the northeastern portion of the survey area and is one of the most northerly units. One flake tool and eleven flakes (one collected) were encountered on the survey. There is less barren surface than the other units and more denser shrub vegetation along with a limited quantity of ricegrass although no evidence of water was observed in the unit.

Units with Debitage and Formed Flaked Stone Tools

Two brackish units fall into this category (B3, B104), and both appear to be anomalies in relation to the remaining sample. Unit B3, located in the southwestern sector, contains activity residues related to raw material acquisition that produced more than 500 pieces of debitage, 14 assayed cobbles, and two obsidian cores (Table 5.7). Unlike the more continuous debitage distribution observed in B2, most flaking debris in quadrat B3 occurs in segregated reduction loci (SRL); between five and 100 pieces of debitage are often associated with assayed cobbles. This unit is 500 m south and east of B2, and is just over one kilometer from Panum Crater. The landform is a gently sloping alluvial fan ranging from 1978 m to 2003 m in elevation. About 50% of the unit lacks surface vegetation with the remaining area covered by sagebrush and bitterbrush along with a smattering of buckwheat.

Table 5.7. Artifact Distributions in Unit B3.

	ASC	DEB	SRL	SRL DEB	COR	CBTL
100M^2	-	7	1	49	-	-
500M^2	25	32	18	~525	2	1

ASC = assayed cobble; DEB = isolated debitage; SRL = segregated reduction locus; SRL DEB = debitage in SRLs; COR = core; CBTL = cobble tool.

In contrast, B104 is located in the northwestern quadrant between 1967 m and 1981 m in elevation. It contained only four pieces of debitage and one Rose Spring projectile point. The landform is an alluvial fan with low-lying dunes and vegetation consisting of sagebrush, rabbitbrush along with a few juniper and some limited stands of foxtail barley. About 50% of the ground surface is unvegetated.

Units with Debitage and Ground/Battered Stone Tools

Units containing only debitage and ground/battered stone tools were represented in each of the wetland classes, one freshwater (F50), two brackish (B12, B44), and two saline (S115, S180). The freshwater and brackish units are in the southern sector, the two saline units in the north.

The southern units are all characterized by an alluvial fan landform; however, vegetation in the freshwater and brackish units is dramatically different. Unit F50 contained 10 pieces of obsidian debitage and one shaped, bifacial handstone. The unit ranges in elevation from 1945 m (at the lakeshore) to 1967 m and has a diverse array of vegetation including sagebrush, bitterbrush, rabbitbrush, willow, wood rose, tule, saltgrass and various grasses. Roughly 15% of the ground surface was unvegetated, but the rest was covered in shrubs and some grasses.

The elevations of the units B12 and B44 range from 1959 m to 1986 m and 1993 m to 2007 m, respectively. These quadrats both are roughly split 50% each, vegetated and unvegetated. Flora consists of sagebrush, bitterbrush and in unit B44 also rabbitbrush. Unit B12 contained only six pieces of debitage and a core tool while B44 had 11 pieces of debitage, and one shaped, bifacial handstone.

Units with Debitage, Flaked and Ground/Battered Stone Tools

Quadrats that contain a broad array of tool classes were encountered in all of the wetland areas (one freshwater, six brackish, and three saline units). Interestingly, assemblages in freshwater units were not as diverse as expected although one unit produced the greatest quantity and number of tool classes. Proportionally, units fitting this category were least common in saline contexts (n=3; 15.8%), followed by freshwater (n=1; 16.7%), and were most frequent in the brackish stratum (n=6; 40.0%).

Unit F62, the only freshwater unit of this category, is less than 1.3 km from the present lakeshore and adjacent to the Rush Creek drainage. The creek is deeply incised into a 10 m deep channel cut into the alluvial fan forming the unit. Elevations range from 1965 m to 1982 m with about 50% of the ground surface barren, 40% covered in shrubs, and the remaining 10% covered in grasses. Common plants include sagebrush , bitterbrush, rabbitbrush, and lesser quantities of desert peach, foxtail barley, ricegrass. Willow grows along the stream channel. The unit is 1.4 km northwest of Panum Crater, the most recent eruption in the Mono Craters volcanic chain (ca. 650 B.P.), and appears to fall within the "block and ash flow" (Lajoie 1968; Sieh and Bursik 1986; Wood 1977). Obsidian cobbles are therefore abundant in the alluvium, so are large amounts of obsidian debitage. As before, debitage aggregates were estimated by flakes/m^2. Later, these were calculated into linear meters squared (Table 5.8). By splitting the unit in half east-to-west, it is apparent that the greatest debitage density occurs in the eastern half where aggregates occur in 32.8% of the linear meters surveyed; similar concentrations occur in only 15.8% of the survey transects in the eastern half which demonstrates a lesser intensity of stoneworking activities.

Table 5.8. Debitage Aggregate Distributions in Unit F62.

	>20/M^2	<20/M^2	>10/M^2	>8/M^2	>5/M^2	3-4/M^2	2-3/M^2	1-2/M^2	1/M^2	L.M.
West	-	-	-	-	533	-	-	45	151	4600
East	60	166	61	56	932	228	57	61	21	5000

#/M^2 = estimated number of flakes per m^2; L.M. = linear meters surveyed.

In addition to containing the bulk of debitage, the eastern section yielded all five assayed cobbles along with four of five cores and eight segregated reduction loci. The remaining artifacts include two bifaces (one each near-complete Stage 2 and Stage 4 biface ends) and 12 flake tools, only one of which is fabricated on biface thinning debris. Ground and battered stone include one each: handstone, millingstone, pestle, and four bedrock mortars with between one and 16 mortar cups.

The six brackish quadrats containing flaked and ground/battered stone artifacts can be separated into two groups: southern and northern. While the two southern units, B21 and B36, contain both flaked and ground stone tools, neither implies more than ephemeral use of the southeastern Mono Lake basin. Elevations range from 1968 m to 2000 m and are characterized by alluvial fans. Most elevation increase occurs in a step-like fashion that may be related to either old lake shorelines or fault scarps. Vegetation in both units is similar with varying degrees of sagebrush, bitterbrush, and rabbitbrush.

Artifact recovery from these two quadrats was sparse: two flake tools, four pieces of debitage, and one miscellaneous piece of ground pumice coming from B21. Sixteen flakes, one flake tool, and one millingstone were encountered in B36. The flake tools are initial core reduction flakes, and the millingstone is a unifacially-ground fragment of schist.

The four northern brackish units in this group occur in the northwest (B112, B115, B134) and the northeast (B66) sectors. Comparing vegetation and landform, B115 and B134 are similar. They are relatively low in elevation (1951 m to 1963 m) and both exhibit strandlines from old lakeshores. Unit B115 has a deeply incised arroyo crossing the southwestern area along with some relict lagoon depressions, while B134 has a spring present. Vegetation coverage is visually estimated to be about 30% barren, 20% grasses, and 50% shrub growth. Both contain a few juniper and pinyon trees. Shrubs include sagebrush and rabbitbrush while groundcover is comprised of ricegrass and saltgrass; B134 also contains desert peach and foxtail barley.

Units B66 and B112 span a greater elevation range (1974-1983 m and 1981-2018 m, respectively), but support more similar habitats than B115 and B134. Unit B66 is densely vegetated (80%), with sagebrush, rabbitbrush, and desert peach cover. There is also a variety of low-lying and groundcover plants. Quadrat B66 has a seasonal drainage and appears to be relatively well watered due to the density and diversity of vegetation. In contrast, B112 is drier, has more barren ground surface with less shrubs and grasses but also supports pinyon and juniper trees.

Unit B66 contained one Desert Side-notched projectile point, four unifacially ground, unshaped handstones, and 22 pieces of debitage, all aggregated in the northeastern portion of the unit (Table 5.4). With more dispersed artifact distributions, B112 contained three flake tools, one millingstone, and 51 pieces of debitage. In contrast to these off-shoreline units, B115 and B134 contained more flaked stone tools. Quadrat B115 had two projectile points (one Elko Eared and one Desert Side-notched), two bifaces, four flake tools, 45 pieces of debitage and a millingstone that was encountered on one of the relict shorelines. Unit B134 had one biface, five flake tools, 28 flakes, four millingstone fragments (three of which refit), and one piece of miscellaneous ground stone.

Three saline units containing flaked and ground stone tools along with debitage, represent diverse habitats. First, S102 is a typical saline unit characterized by sandsheet and dune landforms with some areas of exposed lakebed or pan. Elevation ranges from 1981 m to 1987 m; the surface area is largely barren except for about 40% covered with sagebrush and rabbitbrush along with some juniper trees, and patches of saltgrass. Forty-one pieces of debitage were identified, together with one large, near-complete biface, one unshaped, bifacial handstone, and one piece of miscellaneous ground stone. These are widely distributed throughout the unit.

Quadrat S165 differs from the previous unit because it is largely unvegetated, comprising mainly of a desert pavement that gently slopes down to the present lakeshore; however, there is also some isolated greasewood and saltgrass. Ranging in elevation from 1951 m to 1957 m, the unit has a large variety of tools and raw material types. Artifacts include two projectile points (one Elko Corner-notched and one Rose Spring), two bifaces, and three flake tools along with 55 pieces of debitage, one pumice handstone, and a small, circular stone bead.

Finally, S63 is located near the eastern shore of the lake near Warm Spring, upslope from a vast expanse of saltgrass. The unit is mostly comprised of sandsheet and dune landforms although some uplifted, apparently volcanic, formations are present toward its southern margin. Elevation ranges from 1963 m to 1975 m with about 60% barren ground; vegetation consists of sagebrush, bitterbrush and rabbitbrush along with a small amount of ricegrass and foxtail barley. The diversity of artifacts recovered is similar to F62, although the density and abundance of material is not nearly as high. One Desert Side-notched point was collected along with two bifaces, five flake tools, and 11 of 62 unmodified flakes. One handstone and five millingstone fragments as well as an igneous core tool and two pieces of miscellaneous ground stone were also recorded.

Discussion

In general, artifacts recovered during the survey did not meet expectations predicted at the beginning of the project. Geographically, the distributions by tool class and overall tool diversity did not vary significantly according to wetland habitat, but rather appear to vary in response to vegetation diversity and the presence of freshwater (springs or seasonal/perennial drainages). The northern portion of the study area, although not containing the main sources of freshwater for Mono Lake, had the highest density of quadrats with formed flaked and ground/battered stone artifacts. These were frequently near springs or seasonal drainages that could provide freshwater as well as leach the alkaline soils to promote plant growth. Units F62 and S63, both situated near abundant water sources, contained the greatest density of artifacts and a wide array of tool classes that together suggest more long-term occupation of these locations. Areas that contain little water and low vegetation diversity, by contrast, tend to have the most homogeneous artifact distribution, one largely restricted to sparse, expansive debitage scatters.

Artifact Analysis

Flaked Stone Tools

Projectile Points. Seven bifacially flaked tools were classified as projectile points (Plate 5.1). The points include three Desert Side-notched (Baumhoff 1957; Baumhoff and Byrne 1959), two Rose Spring (Heizer and Baumhoff 1961, Lanning 1963), and two Elko (Heizer and Baumhoff 1961; Heizer et al. 1968; O'Connell 1967) forms. These

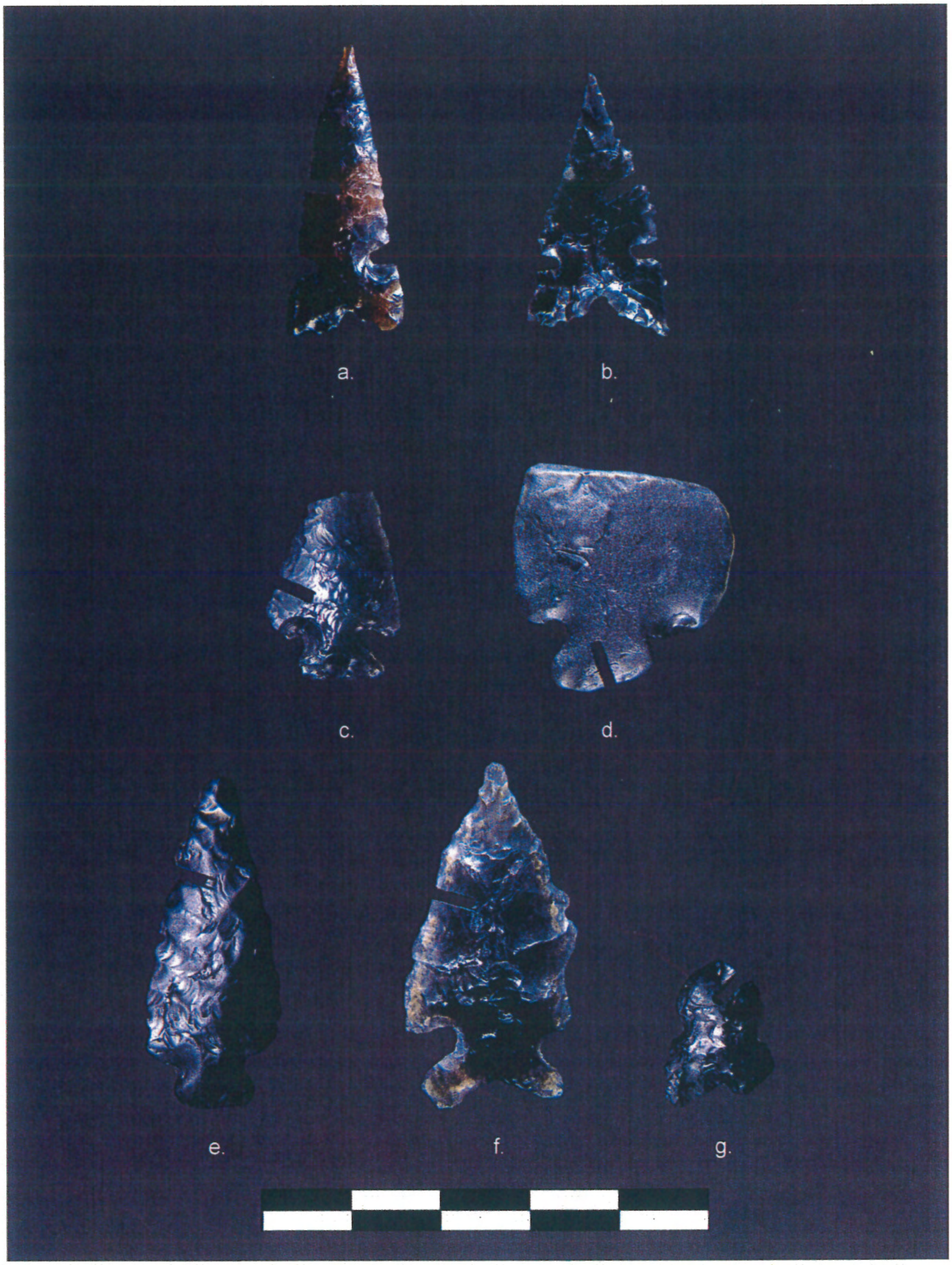


Plate 5.1. Projectile Points. a- 3577; b- 3855; c- 3584; d-3981; e. 3975; f- 3907; g- 3920 (a, b, g- Desert Side-notched; c, e- Rose Spring; d, f- Elko series.

represent occupation spanning perhaps the last 3500 years (cf. Delacorte 1999), and were recorded in six brackish and saline units. No points were recovered in the freshwater habitat. In addition to their unit distributions across the north and northeastern shores of the lake, obsidian sources identified through XRF analysis represent five sources, with none of the points made of local Mono Craters obsidian (Table 5.9). Summary statistics are presented in Table 5.10 and individual artifact attributes are provided in Appendix C.

Table 5.9. Projectile Point Source Distribution and Condition by Unit.

	Material					Condition		
	CD	**BH**	**MH**	**T-Q**	**MGM**	**WHL**	**NC**	**PRX**
Desert Side-Notched								
B66	-	-	-	+	-	+	-	-
B115	-	+	-	-	-	-	+	-
S63	-	+	-	-	-	+	-	-
Rose Spring								
B104	-	+	-	-	-	-	+	-
S165	+	-	-	-	-	+	-	-
Elko Series								
B115	-	-	+	-	-	-	+	-
S165	-	-	-	-	+	-	-	+

CD = Casa Diablo; BH = Bodie Hills; MH = Mt. Hicks; T-Q = Truman-Queen; MGM = Mono Glass Mountain; WHL = whole; NC = near-complete; PRX = proximal.

Representing more varied glass sources than common across the sample, projectile points were relatively complete with three being whole, three near-complete, and one a proximal fragment. The proximal Elko Corner-notched point (#3981) fragment is fashioned of Mono Glass Mountain obsidian, one of the least represented sources in the overall sample. Additionally, a near-complete Rose Spring form (#3584) is broken at the distal end as a result of an impact fracture.

Table 5.10. Projectile Point Summary Statistics.

	ML	AL	SL	MW	BW	NW	TH	DSA	PSA	NOA
Desert Side-Notched (n=3)										
mean	25.9	22.6	8.5	13.8	13.8	7.5	3.1	207	155	40.0
s.d.	8.5	7.9	1.3	2.3	2.3	1.2	0.2	7.6	21.2	18.0
num	3	3	3	2	2	3	3	3	2	3
Rose Spring (n=2)										
mean	36.4	36.4	4.9	14.9	8.9	6.9	4.0	210	125	55
s.d.	-	-	0.7	0.1	0.8	0.9	0.5	7.1	7.1	42.4
num	1	1	2	2	2	2	2	2	2	2
Elko Series (n=2)										
mean	38.6	35.6	8.7	25.1	16.0	10.7	5.2	190	135	52.5
s.d.	-	-	-	-	-	1.3	0.4	28.3	28.3	42.4
num	1	1	2	1	1	2	2	2	2	2

ML = maximum length; AL = axial length; SL = stem length; MW = maximum width; BW = basal width; NW = neck width; TH = maximum thickness; DSA = distal shoulder angle; PSA = proximal shoulder angle, NOA = notch opening angle.

Projectile points are generally viewed as curated tools, often reworked to preserve their utility (Flenniken and Raymond 1986; Flenniken and Wilke 1989, 1991; but see Thomas 1986; Bettinger et al. 1991). Experimental studies on fabricated Elko-type projectile points suggest that points often break upon initial use (Titmus and Woods 1986; Towner and Warburton 1990). Including both dart and arrow points, those in the current sample are not heavily reworked, possibly related to the proximity of multiple obsidian sources in the immediate region. Neither are the points highly fragmented, suggesting that they were discarded relatively early in their use-lives. If toolstone availability affects reworking effort, then relative source proximity may have a role in this pattern. Earlier point forms, like Pinto types, have been argued to be reworked in the Inyo-Mono region more often than later types, such as Elko forms (Brady 2004; Delacorte

1999:371). However, in other regions that lack sources of quality toolstone, such as the Sierra Nevada, Elko points are also described as being heavily reworked (Rondeau 1996).

For mobile hunter-gatherers, knowledge of stone availability in a region plays a part in the conservation and preservation of toolstone. Tools made from exotic stone are more frequently retouched and conserved (Bamforth 1986). This appears to be related in part to the availability of suitable local raw material (Andrefsky 1991, 1994). Depending on quality, local material may be used more expediently while non-local materials often occur as formalized tools. Considering ethnographic accounts of hunter-gatherer familiarity with extended geographic regions, it is not likely that people were ignorant of the dispersed location of quality toolstone sources (Binford 1983; Gould 1978). This is true for larger obsidian sources, such as those characteristic of the Inyo-Mono region. Toolstone conservation may be related to intimate knowledge of the landscape and short-term cycle in the productivity of diverse resources. A more varied pattern of mobility may arise where resource productivity, or lack thereof, would erratically affect mobility decisions and, therefore, create time stress. Uncertainties about future moves may prevent hunter-gatherers from acquiring new raw material from particular sources, even if they are relatively close at hand (Torrence 1983).

Although the projectile point sample is small and unrepresentative of the region, the relative completeness of the points is interesting. This may relate to the local abundance of toolstone, in addition to factors associated with time-stress and the ability to replenish broken tools. Projectile point metrics generally conform with those described by Thomas (1981) although his sample of points comes from central Nevada. Due to spatial and temporal variability, morphological patterns identified at distant locations provide testable hypotheses, rather than treating those patterns simply as a rule. Rose Spring and Elko points are identified as having different metric characteristics in the Owens Valley relative to Central Nevada (Bettinger and Eerkens 1997, 1999), while Desert Side-notched points date to different time periods in the southwestern and northwestern Great Basin (Delacorte 2006). Variability in point form is well documented in different areas of the Great Basin. These studies, in addition to others (Basgall and Hall 2000), identify temporal and morphological differences that explain incongruities in the archaeological record.

Obsidian hydration results from the present sample place the Desert Side-notched and Rose Spring points within the Haiwee interval, the hydration bands on the former specimen are larger than commonly found (Table 4.5). Likewise, hydration analysis on the two Elko forms places one each within the Newberry II and Pre-Newberry II. The older than expected placement of the Mt. Hicks Elko point may be due to inaccuracy of the hydration rate equation, the affect of unrecognized environmental variables, or earlier use of the point form than commonly found. In the Coso region, a thicker "Elko" form (>6.5 mm maximum thickness) is argued to correspond with earlier intervals possibly signifying a more archaic, robust point form (Gilreath and Hildebrandt 1997:71). Neither of the two Elko points exceed the thickness threshold noted above.

Bifaces. Ten bifaces were recovered in seven units, encountered in each of the three wetland classes (Table 5.11; Plate 5.2). Two specimen are whole, three near-complete, one proximal, one medial, and three end fragments. The pair of complete tools

Table 5.11. Select Biface Attribute Data.

	CD	MC	BH	MH	MGM	Total
Condition						
WHL	-	-	2	-	-	2
NC	-	1	-	2	-	3
PRX	1	-	-	-	-	1
MED	-	-	-	-	1	1
END	2	1	-	-	-	3
Stage						
Two	-	1	2	-	-	3
Three	-	-	-	-	1	1
Four	3	1	-	2	-	6
Size						
Arrow	-	-	1	-	-	1
Dart	1	1	-	1	-	3
Knife	1	1	1	1	-	4
Ind.	1	-	-	-	1	2
Use-Wear						
Present	3	2	2	1	-	8
Ind.	-	-	-	1	1	2
Wetland						
Freshwater	-	2	-	-	-	2
Brackish	2	-	1	-	-	3
Saline	1	-	1	2	1	5
Quad						
SW	-	2	-	-	-	2
NW	2	-	1	-	-	3
NE	1	-	2	1	1	5
SE	-	-	-	-	-	-
Elevation						
<1960	3	1	1	1	-	6
1960-80	-	1	-	-	-	1
1980-00	-	-	1	1	1	3
>2000	-	-	-	-	-	-
Total	**3**	**2**	**2**	**2**	**1**	**10**

CD = casa diablo; MC = mono craters; BH = bodie hills; MH = mt. hicks; MGM = mono glass mountain; WHL = whole; NC = near complete; PRX = proximal; MED = medial; END = end; Ind. = indeterminate; Freshwater = freshwater wetland; Brackish = brackish wetland; Saline = saline wetland; SW = southwest quad; NW = northwest quad; NE = northeast quad; SE = southeast quad; <1960 = <1960m asl; 1960-80 = 1960-1980m asl; 1980-00 = 1980-2000m asl; >2000 = >2000m asl.

Plate 5.2. Select Bifaces: a.-3691; b-3643; c- 4175; d- 3983; f- 3644; g- 2208

are Stage 2 forms, fabricated from Bodie Hills obsidian. One additional Stage 2, near-complete biface is of Mono Craters obsidian. There is one Stage 3 biface of Mono Glass Mountain obsidian, and the remaining 60% (n=6) are Stage 4 forms. These are manufactured from Casa Diablo (n=3), Mono Craters (n=1), and Mt. Hicks (n=2) obsidian. The relative abundance of Stage 4 forms suggests that they are more subject to use than Stage 2-3 forms. The latter may have been used more frequently as cores than later stage artifacts (Brady 2005). The only complete length measures 71.3 mm; mean width and thickness are 38.1 mm and 8.7 mm, respectively. All bifaces are made on flake blanks. Three each have ends that are rectangular and convex pointed. Two bifaces with intact ends have a convex-pointed and convex-rounded morphology. Eight of the ten bifaces have visible use-wear. Spine plane angle of the cross section does not vary much by stage, with Stage 2 forms having an angle of 35°, Stage 3 of an angle 40°, and Stage 4 an angle of 37°.

The bifaces tend to be larger than arrow-sized with three dart and four knife-sized tools (Plate 5.2). The overall size and high levels of use-wear on these tools suggest they were used as cutting or scraping implements. One finely made, near-complete biface (#3691) of Mt. Hicks obsidian was recovered in the sand dunes in S102. It has a broad rectangular base with an incomplete length of 81.8 mm, longer than even the whole bifaces. A second notable specimen (#2208) is a convex-pointed end fragment of Mono Craters obsidian recovered from F62. Interestingly, this piece was discarded near a lag deposit of Mono Craters obsidian, although it also has been worked down to a Stage 4 biface. Obsidian hydration places this tool in the Haiwee interval when people in the region may have been more residentially stable relative to earlier times. In contrast, later stage forms represent material originating further away, such as Casa Diablo (n=3) or Mt. Hicks (n=2), consistent with the expectation that bifaces are reduced through use as people move around the landscape. Potentially, bifaces were used more commonly under a settlement strategy that practiced wide-ranging and varied mobility strategies. Elevation of the bifaces ranged from 1955 m to 1987 m with six being below 1960 m and three above 1980 m. The remaining Mono Craters biface was at 1966 m.

The spatial distribution of the bifaces is relatively even; examples were recovered from all three wetland habitats. The greatest number (n=6) are from saline units while most bifaces were found in the northern sector (n=8; 80%).

Bifaces appear to represent a mobile pattern; later stage forms are found more frequently of distant sources, and early stage tools are commonly made from local sources such as Mono Craters or Bodie Hills. Most of the tools are large, reflecting use as dart points or knives. Later stage forms are more frequently broken through use than earlier stage, core-like forms. Obsidian hydration results suggest that bifaces were used throughout the Holocene, but most prevalent during the Newberry I and Haiwee intervals (Table 4.5). The interface of these two periods corresponds to increased use of eastern California obsidian quarries for the production and potential trade of bifaces (cf. Basgall 1983; Gilreath and Hildebrandt 1997; Hall 1983; Singer and Ericson 1977).

Simple Flake Tools. Forty simple flake tools were collected from 12 units that include three freshwater, six brackish and four saline contexts (Table 5.3, 5.4, 5.5; Plate 5.3). These are the most common tools encountered in the project area. Although found

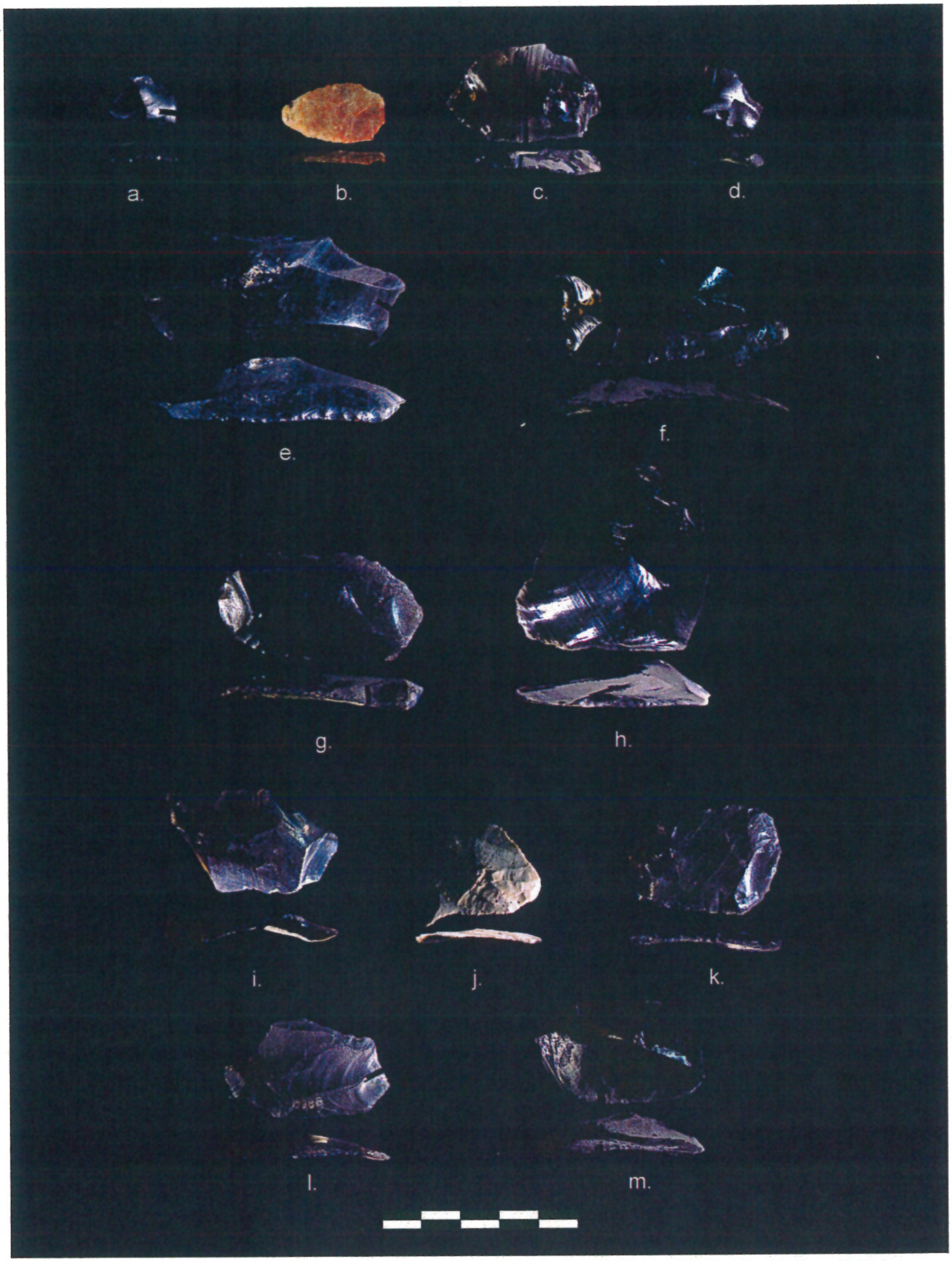


Plate 5.3. Select Flake Tools. a- 4067; b- 3889; c-4071; d- 4020; e.- 2592; f- 4110; g- 3919; h-4183; i- 3596; j- 3776; k- 3660; l- 3888; m- 4188

in each of the three wetland habitats, their relative presence varies; flake tools are most common in freshwater units. They occur in half of the freshwater quadrats (n=3; 50%), in 40% (n=6) of the brackish quadrats, and less than a quarter (n=4; 21.1%) of saline quadrats.

Six stone materials are represented in this tool class, the bulk of tools (n=36; 90%) deriving from one of five obsidian sources and the remaining four being of cryptocrystalline silicate material (Table 5.12). Artifact condition varies across the tools, yet there are no strong trends across stone material types. All but one obsidian source, Casa Diablo, has a tool that is either whole or near-complete (n=27; 67.5%). Of identifiable specimen, near equal numbers of flake tools are made on core reduction (n=15; 42.9%) and biface thinning (n=14; 40%) flakes. The remaining six implements include five (12.5%) decortication and one linear flake (2.5%) fabricated through core reduction. The remaining five specimen were unidentifiable

Further inquiry investigated correlations between flake tool attributes. Artifacts fabricated from decortication, core, and biface reduction debitage are of various sizes and do not tend to be either larger or smaller relative to other examples. Likewise, flake size is not a significant determining factor in the number of utilized edges on a flake tool. Flake tools in the sample manifest one to three edges, half (n=20) having only one modified margin; 15 (37.5%) have two edges with use-wear and five (12.5%) have three edges. The majority of edges with use-wear are either convex (n=29; 44.6%) or straight (n=25; 38.5%), accounting for over four-fifths (n=54) of the total modified edges. Only 11 (16.9%) edge shapes are concave, which may indicate extended use of the edge. That

Table 5.12. Select Attributes of Flake Tools by Material Type.

	Obsidian Source							
	CD	**MC**	**BH**	**MH**	**TQ**	**OBS Total**	**CCR**	**Total**
Condition								
Whole	-	10	-	4	-	14	1	15
Near Complete	-	8	1	1	1	11	1	12
Distal	-	1	-	-	-	1	1	2
Proximal	-	4	1	1	-	6	1	7
Margin	2	2	-	-	-	4	-	4
Flake Type								
Decortication	-	3	-	1	1	5	-	5
Core Reduction	-	11	1	2	-	14	1	15
Biface Thinning	-	7	1	3	-	11	3	14
Linear	-	1	-	-	-	1	-	1
Indeterminate	2	3	-	-	-	5	-	5
Size								
2.0-3.0 cm	-	3	-	-	-	3	1	4
3.0-5.0 cm	2	8	1	4	1	16	2	18
>5.0 cm	-	14	1	2	-	17	1	18
Edges								
One	2	12	1	3	1	19	1	20
Two	-	10	1	2	-	13	2	15
Three	-	3	-	1	-	4	1	5
Edge Shape								
Concave	-	10	-	2	-	10	1	11
Convex	2	17	2	4	1	25	4	29
Straight	-	14	1	4	-	22	3	25
Edge Angle								
<30°	2	16	-	4	-	22	4	26
35-45°	-	12	3	6	1	22	1	23
50-60°	-	5	-	-	-	5	2	7
65-75°	-	4	-	-	-	4	1	5
>80°	-	4	-	-	-	4	-	4
Modification								
Uni-microchipped	1	22	1	5	1	30	4	34
Bi-microchipped	1	18	2	2	-	23	4	27
Uni-edge flaked	-	13	1	7	-	21	1	22
Bi-edge flaked	-	2	1	1	-	4	-	4
Ground/Battered*	-	8	-	-	-	8	1	9
Total Tools	**2**	**25**	**2**	**6**	**1**	**36**	**4**	**40**
Total Edges	**2**	**41**	**3**	**10**	**1**	**57**	**8**	**65**

CD = Casa Diablo; MC = Mono Craters; BH = Bodie Hills; MH = Mt. Hicks; TQ = Truman-Queen; OBS = obsidian; CCR = cryptocrystalline; Size # = cm diameter; Uni- = unifacial; Bi- = bifacial.

most flake tools were used only on one edge, and the edges do not appear significantly worn supports the expedient use of these items.

Similar to edge shape, use-related modification falls mainly within two types, either unifacially (n=34; 52.3%) or bifacially (n=24; 36.9%) micro-chipped. Modification was identified both as primary and secondary attributes where multiple descriptors may be present on a given edge. These are combined in Table 5.12. Micro-chipping was the most common form of wear (n=41; 100%), and very little edge-flaking was identified as a primary attribute (n=7; 10.8%). Finally, edge angles are predominantly less than or equal to 45° (n=49; 75%).

Flake tools recovered from the project appear to have a relatively homogeneous group of attributes, with little to be said about certain "types". The items are generally fashioned on larger pieces of debitage, most of which are obsidian. Flake tools may be used at varied levels of intensity, anywhere between one and three modified edges. These are generally convex or straight with orientations less than 45°. Edge modification is not often more than micro-chipped, although nine edges additionally have polish or batter on them. The homogeneity of the tools speaks to the simple, expedient nature of the technology. These attributes likely represent the at-the-moment needs of the tool user and reflect anything from time to raw material constraints.

As with size and morphology, flake tools do not appear to exhibit variability across stone raw material source. If people came to the Mono Basin from different places at different times of the year, it may have affected the manner in which flake tools were used. That this does not appear to be the case lends further support to the notion that these tools served as part of an expedient, generalized technology used to fulfill *ad hoc* needs.

Table 5.13 outlines the geographic distribution of flake tools grouped by wetland type, quadrant within the basin, and broad elevation classes. Here, flake tools are mostly whole or near-complete in the freshwater and brackish wetland areas. In contrast, flake tools are most fragmentary in the saline region, suggesting greater intensity in use. Likewise, flake tools are poorly represented in the southeastern quadrant of the basin, with only three tools encountered there. Finally, most flake tools (n=30; 75%) were recovered from below 1980 m, supporting the importance of the near-lakeshore areas for subsistence and other activities. Composite obsidian hydration readings on the flake tools

Table 5.13. Flake Tool Distribution Across the Mono Basin.

	Stone Material						Condition				
	CD	MC	BH	MH	TQ	CCR	WHL	NC	DST	PRX	MRG
Wetland											
Fresh	-	14	-	-	-	-	6	6	-	2	-
Brackish	1	7	2	5	-	1	7	4	-	2	3
Saline	1	4	-	1	1	3	2	2	2	3	1
Quad											
Southwest	-	15	-	-	-	-	7	6	-	2	-
Northwest	1	4	2	4	-	1	4	4	-	2	2
Northeast	1	4	-	1	1	3	2	2	2	3	1
Southeast	-	2	-	1	-	-	2	-	-	-	1
Elevation											
<1960	1	7	1	4	-	2	7	3	1	2	2
1960-80	-	13	-	1	-	1	6	6	1	2	-
1980-00	1	4	1	-	1	1	1	2	-	3	2
>2000	-	1	-	1	-	-	1	1	-	-	-

CD = Casa Diablo; MC = Mono Craters; BH = Bodie Hills; MH = Mt. Hicks; MGM = Mono Glass Mountain; WHL = whole; NC = near complete; PRX = proximal; MED = medial; END = end; FRESH = freshwater wetland; BRACK = brackish wetland; SALINE = saline wetland; <1960 = <1960m asl; 1960-80 = 1960-1980m asl; 1980-00 = 1980-2000m asl; >2000 = >2000m asl.

noted a marked increase in values corresponding to more recent time periods, with 75% (n=42) of the sample falling in the range of the Newberry I period (ca. 3200 B.P.) or later (Table 4.5). While flake tools were used throughout the Holocene, they became more important in later times.

Core Tools. Two core tools were encountered on the survey in quadrats B12 and S63. Both items are igneous material; however, only one of the tools was field analyzed. The core tool from S63 (cat. #4079) measures 95.0 mm long, 80.0 mm wide, and 70.0 mm thick. It is battered on the end and has step fractures. Tools such as these are frequently associated with riparian corridor use and were likely used for pulping or chopping activities (Basgall and McGuire 1988:224; Bettinger 1989:143; Overly 2003b:312). The core tool recorded in S63 is near an apparently rich shallow water wetland habitat where roots or other fibrous materials could be procured. The remaining tool from unit B12 is not in such a context; it was found largely amidst stoneworking activities; however, it is not far from the lakeshore where the aforementioned resources may have been present in the past. Unfortunately, the low number of these specimens prevents any strong correlation in potential use.

Cores. Although three units had large quantities of obsidian chipping debris, as well as raw material cobbles within alluvial sediments, only seven cores were encountered during the survey effort. Five of the cores are from quadrat F62, the remaining two from unit B3. Only one of the two cores at B3 was collected, so the following discussion focuses on the six collected cores. The overall paucity of cores in locations with abundant raw material, such as quadrat B3, suggests that the artifacts were usually carried off once manufactured. Unit F62, by contrast, contains other flaked and ground stone artifacts in addition to cores that speak to a wide variety of activities other than simple raw material acquisition.

Most cores (n=4; 66.6%) were made on split cobbles, and one each on a tabular cobble and a globular pebble. The split cobbles are unidirectional cores with one platform (Plate 5.4). The remaining two are bifacial forms with a single platform, although neither has been extensively used. These are the smallest two cores in the sample. One outstanding example of a unidirectional core is the item from quadrat B3 (#3529). This is the largest core in the sample, weighing 966 g and measuring 115.9 mm long, 94.6 mm wide, and 77.4 mm high. It is similar in appearance to cores recovered from middle Holocene contexts in the southern Owens Valley (Delacorte 1999:364-371; Delacorte et al. 1995). These items, which likely were used as portable, dependable flake nuclei, may also have served as tools themselves. Obsidian hydration readings on the cores correspond mostly to the Newberry I and more recent times. One hydration rim falls within the pre-Newberry I period, but there is a noted lack of cores having hydration values relating to earlier periods of use.

Debitage. Flaked stone debitage collected from the 100 m x 100 m sample units was recovered in 21 of the surveyed quadrats. Similar to the simple flake tool distributions, these include three freshwater (50%) and six brackish (40%) units; however, unlike the flake tools, 12 (63%) of the saline units contained flaked stone debitage. This shows more use and maintenance of curated tools, yet less use of expedient flake tools in the saline wetlands. One hundred thirty-four pieces of debitage

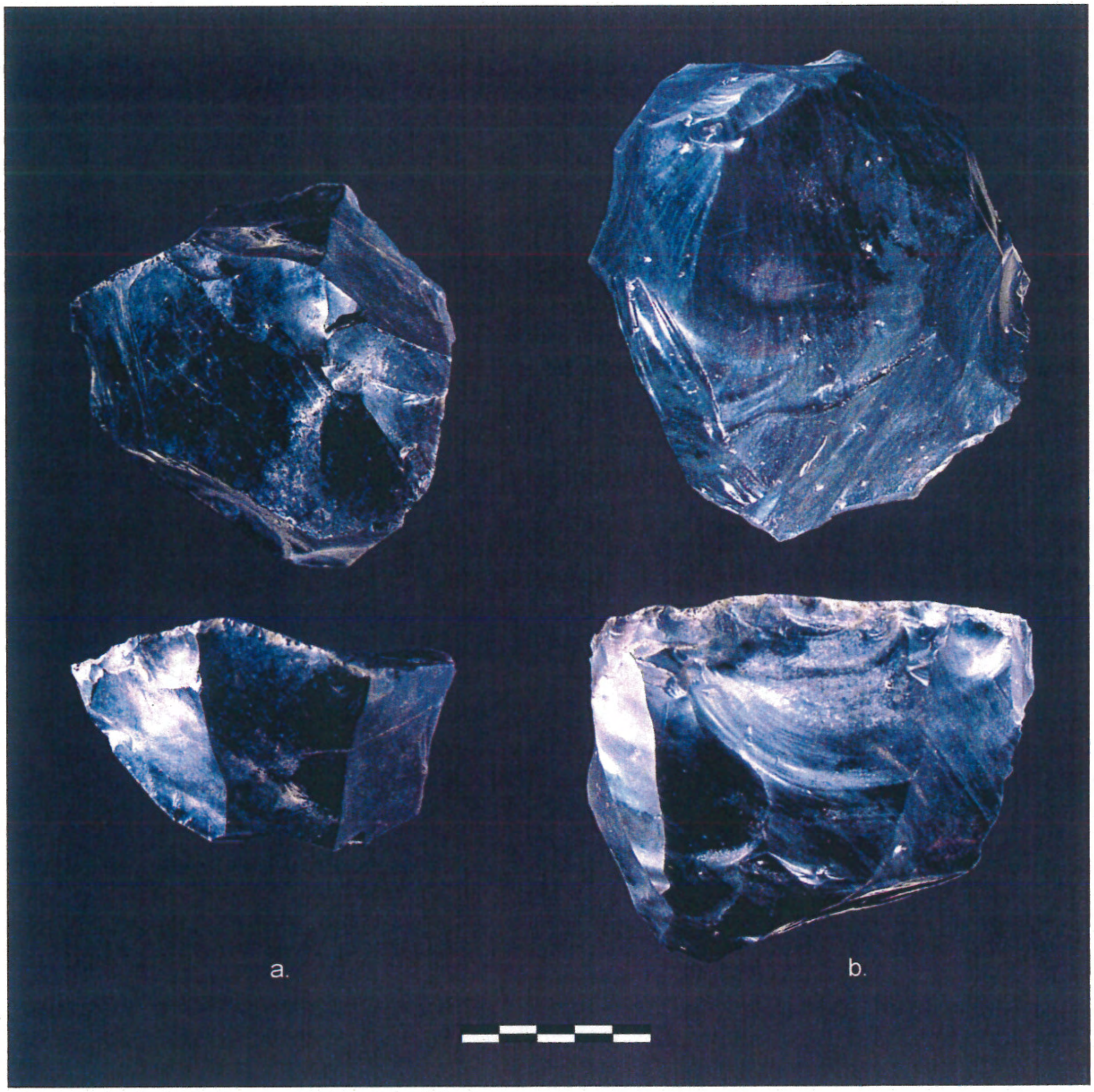


Plate 5.4. Select Cores. a- 1329; b- 3259.

were collected from the 100 m x 100 m sample units. An additional 28 pieces of debitage (23 obsidian, one igneous, four cryptocrystalline silicate) were collected as potential tools in the 500 m x 500 m survey sample. Upon analysis at the lab, these turned out to be unmodified flakes. Due to issues of sampling bias, these latter items are not included in the present discussion.

Most debitage (n=124; 92.5%) represents Mono Craters obsidian. The remaining 10 pieces represent five distinct obsidian sources along with basalt (Table 5.14). The debitage sample is partially weighted toward Mono Craters obsidian since three units

Table 5.14. Debitage Attributes by Material and Context.

	Material							
	BAS	**CD**	**MC**	**BH**	**MH**	**MGM**	**TQ**	**Total**
Size								
<1.0 cm	-	-	2	-	-	-	-	2
1.0-2.0 cm	-	-	41	1	-	-	-	42
2.0-3.0 cm	1	-	24	2	1	2	-	30
3.0-5.0 cm	1	-	37	-	-	-	1	39
>5.0 cm	-	1	20	-	-	-	-	21
Technology								
Decortication	-	-	9	-	-	-	-	9
Percussion	1	-	20	1	-	-	-	22
Biface reduction	1	1	56	1	-	1	1	61
Indeterminate	-	-	39	1	1	1	-	42
Wetland								
Freshwater	-	-	41	-	-	-	1	42
Brackish	1	-	46	1	1	-	-	49
Saline	1	1	37	2	-	2	-	43
Quad								
Southwest	-	-	76	-	-	-	1	77
Northwest	1	-	11	1	1	-	-	14
Northeast	1	1	35	2	-	1	-	40
Southeast	-	-	2	-	-	1	-	3
Elevation								
<1960	1	-	22	2	1	1	-	27
1960-80	1	-	57	1	-	-	1	60
1980-00	-	1	38	-	-	1	-	40
>2000	-	-	7	-	-	-	-	7
Total	**2**	**1**	**124**	**3**	**1**	**2**	**1**	**134**

BAS = basalt; CD = Casa Diablo; MC = Mono Craters; BH = Bodie Hills; MH = Mt. Hicks; MGM = Mono Glass Mountain; TQ = Truman-Queen; F = freshwater wetland; B = brackish wetland; S = saline wetland; SW = southwestern quad; NW = northwestern quad; NE = northeastern quad; SE = southeastern quad; 1940-60 = 1940m-1960m asl; 1960-80 = 1960m-1980m asl; 1980-2000 = 1980m-2000m asl; >2000 = >2000m asl.

(F62, B2, B3) are dominated by local obsidian procurement activities. These units account for 56 (41.8%) collected flakes. However, a predominance of Mono Craters obsidian is hardly surprising as this source comprises almost 90% (n=68; 87.1%) of the remaining debitage sample. As might be expected from other studies in proximity to obsidian sources, local material is usually the most ubiquitous (Bieling 1992; Basgall 1983, 1984, 1998; Fredrickson 1991; Halford 1998; Jackson 1985; Overly 2002, 2004; Richman and Basgall 1998). Not as easily predicted is the varied distribution of the remaining obsidian sources.

Mono Craters obsidian accounts for all but one piece of debitage from the freshwater sample. Saline units are the most toolstone diverse, containing four other stone materials (n=6; 14.0%), and brackish survey units fall in the middle with three other materials; however, these only make up a fraction (n=3; 6.1%) of the brackish debitage. Just under half of the debitage (n=60; 44.7%) was collected below 1980 m in elevation.

Debitage size ranges from <1 cm (n=2) to >5 cm (n=21) in diameter, with the smaller pieces (<2 cm) dominating debitage in the saline habitat (n=32; 74.4%) (Table 5.15). Flakes from the freshwater and brackish contexts generally exceed 3 cm in diameter (n=57; 62.6%). Comparison of mean flake weight across the different units illustrates the varied nature of flaking debris (Table 5.16). Clearly, debitage recovered from the saline units is both less massive and smaller than the lots from freshwater and brackish units, implying differences in toolstone reduction activities between these groups.

Table 5.15. Debitage Attributes by Wetland Class.

	Freshwater	Brackish	Saline	Total
Size				
<1.0cm	-	-	2	2
1.0-2.0cm	6	6	30	42
2.0-3.0cm	9	13	8	30
3.0-5.0cm	20	18	1	39
>5.0cm	7	12	2	21
Technology				
Decortication	5	4	-	9
Percussion	9	12	1	22
Biface reduction	15	23	23	61
Indeterminate	13	10	19	42
Total	**42**	**49**	**43**	**134**

The most common flake types represented in the debitage sample include biface reduction debris (n=61; 66.3%), followed by percussion (n=22; 23.9%), and decortication flakes (n=9; 9.7%) (Table 5.15). While present in the three wetland classes, debitage of indeterminate manufacture is most common in the saline habitats (Table 5.15).

Excluding indeterminate flakes, 95.8% (n=23) of the debitage from the saline habitat are biface reduction debris, with decortication and percussion debris comprising 44.1% (n=30) of the diagnostic flakes in freshwater and brackish contexts (Table 5.15). This suggests different technological foci between the sampling strata. Coupled with the predominance of larger flakes in the latter two areas, the saline habitat appears to be where maintenance, rather than production of bifacial tools occurred. This could represent a pattern of toolstone conservation related to more short-term use of this habitat.

Table 5.16. Debitage Weight per Unit.*

Unit	Count	Total Weight (g)	Weight/Count (g)
F58	12	76.3	6.4
F62	21	422.1	20.1
F64	9	26.5	2.9
Freshwater Total	**42**	**524.9**	**12.5**
B2	28	431.9	15.4
B3	7	55.0	7.9
B115	2	4.8	2.4
B134	11	40.5	3.6
B143	1	0.8	0.8
Brackish Total	**49**	**533.0**	**10.9**
S7	3	1.6	0.5
S27	6	4.7	0.8
S42	3	1.5	0.5
S44	4	3.6	0.9
S63	11	13.8	1.3
S96	3	1.6	0.5
S102	1	1.0	1.0
S115	2	0.2	0.1
S116	4	0.7	0.2
S165	2	0.3	0.2
S166	3	19.0	6.3
S173	1	11.4	11.4
Saline Total	**43**	**26.8**	**1.4**

* Collected from 100m x 100m unit.

In contrast, a wider variety of tool and flake production occurred in the freshwater and brackish areas, as demonstrated by the larger size and greater variety of flake types.

One further note is a comparison of mean flake weight per unit of debitage collection, which is considerably smaller in the saline habitats when compared to the freshwater or brackish ones (Table 5.16). It is significant that the mean average flake weight per unit shows the saline habitats as considerably different than the brackish and freshwater units where debitage is most often larger. It is possible that if larger flakes were created in the saline area, these were most often carried off to preserve available toolstone.

Finally, composite obsidian hydration readings from the debitage sample show fluctuating patterns with an increase in counts until the Newberry I interval (Table 4.5). There is a decrease in the Haiwee interval, quantities rising again in the Marana period, but never exceeding frequencies from the Newberry I era. This could demonstrate a shift from stoneworking activities that create large amounts of debris (like biface production) to those that are more toolstone-conservative.

Assayed Cobble. Although not the only specimen found during the project, a single assayed cobble was collected from unit F62. It measures 90.1 mm in length, 79.1 mm in width, and 64.9 mm in thickness, weighs 353.4 g and has had four flakes removed. The item is visually ascribed to Mono Craters obsidian, which occurs naturally in the southwestern survey area. The other 29 assayed cobbles noted on the survey come from the three units that also contained raw material (B2, B3, F62). These are obsidian cobbles with less than five flakes removed from them. The nodules were noted, but generally not collected.

Discussion. Patterns of flaked stone tool use show differences in spatial as well as temporal distributions. First, projectile points and bifaces were most commonly found in the northern half of the basin, while cores were only recovered in the southwestern quadrant. By contrast, flake tools and debitage were more evenly distributed around the basin. General trends show that there is an increase in hydration readings on bifaces for the Newberry I and Haiwee periods, while hydration readings from flake tools indicate a general increase through time, becoming more prevalent in Newberry I and reaching a zenith during the Marana interval (Table 4.5). Similarly, most of the hydration values from cores correspond to NW-I and later periods. Together, these temporal data suggest a shift from predominantly biface technologies in Newberry/Haiwee and earlier times, to core- and flake-based technologies in the Marana period. This may signify a reduced need for highly transportable, toolstone efficient bifaces to a more expedient flake-based technology. The transition from biface to core- and flake-based technology has been argued to be associated with increased sedentism in the Inyo-Mono region (Basgall and McGuire 1988; Bettinger 1999; Delacorte and McGuire 1993; Delacorte et al. 1995; Gilreath and Hildebrandt 1997), and across North America (Parry and Kelly 1987). A similar late- and terminal prehistoric focus on core technology has been argued to occur in the Rush Creek drainage, though bifaces were viewed to have been used more continually through time (Gilreath 1996:94-95).

Ground Stone Artifacts

Handstones. Twelve handstones were recovered from nine units. These include four whole, four near-complete, and four indeterminate fragments. The mean complete dimensions of the tools is 108.4 mm long, 87.4 mm wide, and 40.1 mm thick. Although few in number, raw material diversity is high with no fewer than seven materials represented (Table 5.17). The wide variety of material and its distribution reflect frequent use of local materials. For example, freshwater units abutting the Sierra Nevada have

Table 5.17. Select Handstone Attributes by Material and Surface Frequency.

	Stone Material							# of Surfaces		
	BAS	IGN	GRN	VBL	PUM	SCH	META	1	2	Total
Condition										
Whole	-	-	1	1	1	-	1	2	2	4
Near Complete	1	1	-	-	1	1	-	2	2	4
Fragment	1	1	1	-	1	-	-	3	1	4
Modification										
Shaped	1	-	1	-	1	1	1	1	4	5
Unshaped	1	1	-	1	2	-	-	4	1	5
Indeterminate	-	1	1	-	-	-	-	2	-	2
Surface Frequency										
One	1	2	1	1	2	-	-	7	-	7
Two	1	-	1	-	1	1	1	-	5	5
Surface Shape										
Convex	1	1	1	-	1	-	-	3	1	4
Slightly Convex	2	-	1	-	3	1	2	2	7	9
Flat	-	1	1	1	-	-	-	2	1	3
Slightly Concave	-	-	-	-	-	1	-	-	1	1
Surface Texture										
Smooth	3	1	3	1	4	2	2	6	10	16
Irregular	-	1	-	-	-	-	-	1	-	1
Pecking										
Present	2	1	3	-	-	2	2	2	8	10
Absent	1	1	-	1	3	-	-	5	1	6
Indeterminate	-	-	-	-	1	-	-	-	1	1
Secondary Modification										
Present	2	-	1	-	-	1	1	1	4	5
Absent	-	2	1	1	3	-	-	6	1	7
Fire Affected										
Present	-	1	-	1	-	-	-	2	-	2
Absent	2	1	2	-	3	1	1	5	5	10

Total Tools = 12
Total Surface = 17

BAS = basalt; IGN = igneous; GRN = granitic; VBL = vesicular basalt; PUM = pumice; SCH = schist; META = metamorphic; # Surf. = number of surfaces ground.

handstones made from locally available basalt and granite while those located in the saline units east of Mono Lake are frequently local pumice.

Five each of the handstones are shaped and unshaped, two others indeterminate. All five of the unshaped manos are located in the northeast (Table 5.18). There are an

Table 5.18. Handstone Modification by Basin Quad.

	Southwest	Northwest	Northeast	Southeast	Total
Modification					
Shaped	2	-	2	1	5
Unshaped	-	-	5	-	5
Indeterminate	-	-	2	-	2
Total	**2**	**-**	**9**	**1**	**12**

additional two shaped handstones in that basin quad as well, with the remaining shaped items located two in the southwest and one in the southeast. Most (n=4; 80%) shaped handstones are bifacial, a majority of unshaped specimens are unifacial (n=4; 80%) (Table 5.17). Over half of the ground surfaces are slightly convex (n=9; 52.9%), with six of these occurring on bifacial handstones. The remaining surfaces are four convex, three flat, and one slightly concave. This last surface is on a bifacially ground, shaped schist handstone (#4206) that may have been fashioned from a broken millingstone. It was recorded in unit B44, southeast of Mono Lake. One surface is smooth, and the other irregular. Eight of nine identifiable surfaces on the bifacial handstones have been pecked while only one unifacial handstone exhibits pecking. Only two handstones are fire-affected, and these both have only one surface ground.

In sum, handstones generally seem to be fashioned of locally available material. The tools tend to be unifacial, and these are most often unshaped without secondary modification. Bifacial handstones are often extensively curated, most being shaped, surface pecked and secondarily modified through battering and/or grinding. Additionally, the two extra-local materials (metamorphic/schist) are within this last category, suggesting they have been transported from other areas, and likely used along the way before being discarded.

Millingstones. Seven millingstone fragments each were encountered in the brackish and saline quadrats, while only one slab millingstone was recorded in the freshwater stratum, for a total of 15 items. Three fragments found less than one meter apart conjoin (Table 5.19). Millingstones are fabricated on a variety of materials, including granite (n=4; 26.7%), igneous (n=2; 13.3%), vesicular basalt (n=1; 7.7%), sandstone/sedimentary (n=5; 33.3%), and schist (n=3; 20.0%). Most millingstones in the sample comprise broken pieces, seven being margin or indeterminate fragments and only one a near-complete grinding tool. The nether grinding stones are mostly ground on a single surface (n=11; 73.3%), just four tools (26.7%) ground on two surfaces. Three of the unifacially ground margin fragments conjoin to form a near- complete milling stone that is 420 mm long; these will be considered a single tool for analytical purposes.

Four (30.1%) of the millingstone fragments are intentionally shaped on the margin. Shaping is present on both unifacial (n=2; 15.4%) and bifacial (n=2; 15.4%) tools, though never common. Two of the unifacially ground slabs exhibit secondary modification with the conjoining margin fragments edge ground. Another igneous fragment is lightly ground on the underside of the slab. This wearing may be due to movement of the stone during use while the margin wear represents either recycling of the artifact or incipient shaping. Nearly half of the surface shapes are flat (n=9; 47.4%),

Table 5.19. Select Millingstone Attributes by Material and Surface Frequency.

	Stone Material						# of Surfaces		
	GRN	IGN	VBL	SST	SED	SCH	1	2	Total
Condition									
Near Complete	1	-	-	-	-	-	1	-	1
Margin	3(1)	2	-	1	-	1	5(3)	2	7(5)
Fragment	-	-	1	3	1	2	5	2	7
Modification									
Shaped	3(1)	2	-	-	-	1	4(2)	2	6(4)
Unshaped	1	-	-	2	-	-	3	-	3
Indeterminate	-	-	1	2	1	2	4	2	6
Surface Frequency									
One	4(2)	1	-	4	1	1	11(9)	-	11(9)
Two	-	1	1	-	-	2	-	4	4
Surface Shape									
Concave	3(1)	1	-	1	-	-	4(2)	1	5(3)
Slightly Concave	-	1	2	-	1	1	2	3	5
Flat	1	1	-	3	-	4	5	4	9
Surface Texture									
Smooth	3(1)	3	2	4	1	5	10(8)	8	18(16)
Irregular	1	-	-	-	-	-	1	-	1
Surface Pecking									
Present	3(1)	3	-	2	-	5	7(5)	6	13(11)
Absent	-	-	2	-	1	-	1	2	3
Indeterminate	1	-	-	2	-	-	3	-	3
Secondary Modification									
Present	3(1)	1	-	-	-	-	4(2)	-	4(2)
Absent	1	1	1	1	1	2	4	3	7
Indeterminate	-	-	-	3	-	1	3	1	4
Fire Affected									
Present	-	-	-	-	-	-	-	-	-
Absent	4(2)	2	1	4	1	3	11(9)	4	15(13)

Total Tools = 15 (13)
Total Surface = 19

GRN = granitic; IGN = igneous; VBL = vesicular basalt; SST = sandstone; SED = sedimentary; SCH = schist; # Surf = number of surfaces ground; (#) = total artifacts including refits.

five each being concave and slightly concave. Surface texture are generally smooth (n=18; 94.7%), with only one irregular example.

Pecking is present on just over half (n=5; 55.6%) of unifacial pieces, but is more common on bifacially ground items (n=6; 75%). The single bifacial millingstone made of vesicular basalt is not pecked because this porous material tends to retain a rough grinding surface even after extended use. If the number of surfaces ground on a millingstone and the relative presence of pecking are measures of tool use-intensity, then one expects unifacial millingstones to be less often pecked while bifacial millingstones should exhibit higher incidences of surface pecking. This assumption appears to be true, given the increased pecking on bifacial millingstones.

Because of the fragmentary state of the millingstones, estimates of their original size are difficult. A rough appraisal of size may be obtained, however, from artifact thickness, which ranges from 40.0 mm to 100.0 mm. The single bifacially ground fragment is 45mm thick, whereas the mean thickness of the five unifacial slabs is 85.0 mm. It appears that unifacially ground millingstones are often thicker that the bifacial ones, though there is still a thin unifacially ground tool that measures 40 mm thick. Based on a compilation of complete measurements, the mean length, width, and thickness of a millingstone around Mono Lake is 323 mm, 252.5 mm, and 75 mm. These analyses suggest millingstone technology to be simple, with variation in size or morphology being largely related to situational needs and constraints.

Pestle. A single igneous pestle was found in unit F62 near two bedrock mortar features. It is complete, unshaped, and battered on one convex-shaped end. The tool measures 194.0 mm long, 148.0 mm wide, and 65.0 mm thick.

Bedrock Mortars. Four bedrock mortar features were recorded within quadrat F62. While one outcrop contained only one mortar cup, the remaining features had six, seven, and 16 cups each. The single-cup feature is on a small (<1m^2) outcrop, the remaining ones displaying a mean length and width of 3.6 m and 2.3 m.

Discussion While ground stone artifacts cannot be directly dated, the hydration measurements from quadrats containing groundstone provide some indication of their age. Table 5.20:A shows obsidian hydration counts split between quadrats that contained groundstone and those that did not. The thickest hydration rim readings are found in quadrats with ground stone present. Counts increase dramatically in the Newberry I, and again in the Marana interval. In contrast, quadrats without groundstone do not have hydration values that date earlier than pre-Newberry III times from which they increase until Newberry I, then decline. To correct for differential span of the temporal components, hydration counts can be converted to their representation for 1000 years in each group.

Results indicate a shifting prevalence of hydration readings from quadrats that contain ground stone artifacts and those that lack the artifacts. The earliest focus on quadrats that contain ground stone may reflect longevity of use in those areas rather than significant use of such implements. Contexts of this antiquity are generally not associated with significant amounts of ground stone tools. Moreover, the four quadrats with these early hydration readings (B112, B115, B134, S63) generally have profiles that span the Holocene with increases in more recent times. This suggests that the grinding

Table 5.20. Temporal Representation at Quadrats With and Without Ground Stone.

	Hydration Frequencies								
	MR	**HW**	**NW-I**	**NW-II**	**PN-I**	**PN-II**	**PN-III**	**PN-IV**	**TP/EH**
A. Count									
With Ground Stone	40	29	29	17	16	7	4	3	3
W/o Ground Stone	15	20	29	18	14	9	3	-	-
Total	**55**	**49**	**58**	**35**	**30**	**16**	**7**	**3**	**3**
B. Count Corrected*									
With Ground Stone	61.5	41.4	31.4	18.4	20.0	7.0	4.0	2.0	0.6
W/o Ground Stone	23.1	28.6	31.4	19.5	17.5	9.0	3.0	-	-
Total	**84.6**	**70.0**	**62.8**	**37.9**	**37.5**	**16.0**	**7.0**	**2.0**	**0.6**

* Count corrected for 1000 years. MR = Marana (100-650 B.P.); HW = Haiwee (650-1350 B.P.); NW-I = Newberry I (1350-2275B.P.); NW-II = Newberry II (2275-3200 B.P.); PN-I = pre-Newberry I (3200-4000 B.P.); PN-II = pre-Newberry II (4000-5000 B.P.); PN-III = pre-Newberry III (5000-6000B.P.); PN-IV = pre-Newberry IV (6000-7500 B.P.); TP/EH = Terminal Pleistocene/Early Holocene (7500-12,500 B.P.).

stones were incorporated in the record at various points in time. At any rate the increased presence in the pre-Newberry III through Newberry I of quadrats that do not contain ground stone shows a change in land-use to a new area -saline habitats- and a weaker correlation with grinding implements. Hydration measurements suggest that ground stone has a less significant role in the activities conducted in the Mono Basin during the pre-Newberry III and Newberry I because of the more intensive use of areas containing mainly flaked stone items.

During the HW interval corrected hydration counts increase in quadrats containing ground stone. Quadrats with ground stone are used more intensively during the Marana Period than in earlier times. While it is unlikely that ground stone artifacts were not used before the Haiwee interval, it appears that their use grew more intensive from this time onward.

Stone Bead. A single stone bead was recovered in unit S165 at 1958 m near the northern shoreline of Mono Lake (#3980). This gray-green steatite ornament measures 17.0 mm long, 16.3 mm wide, and 1.6 mm thick and has a conically drilled hole in the center that measures 2.7 mm in diameter; the bead weighs 0.6 g. It is flat on one surface, and slightly concave/dished on the other, but does not appear to have been shaped on the faces or margins. The bead was found 16 m from an Elko projectile point; therefore, it may be related to Newberry period occupation. Although the deflated scatter in quadrat S165 has hydration measurements dating from the pre-Newberry I to Marana times, the next closest hydration value is from nearly 200 m away.

In southeast Mono Lake basin, Arkush (1995:32) reports on a grayish-green steatite disc bead collected from MNO-2122, Locus 27. This bead is much smaller, measuring 5.7 mm long and 2.4 mm wide (thick) with a 1.9 mm perforation hole. Arkush reports that steatite disc beads are common in central California in Late Archaic contexts. Other steatite and schist beads have been recovered from Inyo-Mono contexts that support their presence in mainly late prehistoric times (Basgall and McGuire 1988:149-152; Lanning 1963; Riddell 1951). The current artifact appears to be locally manufactured because similar material is present at this lakeshore vicinity.

CHAPTER 6

SPATIAL AND TEMPORAL ANALYSIS

The distribution of recovered artifacts provides information about prehistoric wetland use in the Mono Lake basin. Artifact assemblages are analyzed across space, comparing differences among wetland class, basin quadrant, and elevation. Correlations between artifact types inform about how the areas were used. Obsidian source and hydration studies are applied to understand temporal changes in land-use.

Artifact Class Abundance and Diversity

As noted in the previous chapter, morphological variability within individual tool classes may differ across wetland types. Likewise, certain artifact classes appear to be more or less prevalent across wetland areas. The next level of analysis assesses how archaeological residues vary across wetland habitats in terms of artifact density, the distribution of flaked and ground stone tools, debitage, and the overall diversity and evenness of artifact classes in the wetland contexts. These residues convey the relative distribution of activities and highlight certain variation in the uses of the different wetland settings. Certain expectations about land-use intensity and location are tested.

Primary hypotheses predicted the greatest artifact density and diversity to be found in the freshwater habitats while saline environments have more restricted artifact accumulations. Brackish wetlands were expected to fall in between the other two wetlands in terms of tool diversity and density. Artifact diversity and density are expected to generally reflect the duration or intensity of habitation use if people resided for longer periods in freshwater wetlands than in saline contexts.

Initial predictions about the general intensity of use in different environments are supported in terms of overall tool distributions. The greatest density of tools was found in the freshwater habitat (19.3 tools/km^2), followed by the brackish (10.1 tools/km^2), and then saline (6.3 tools/km^2) habitats. While it appears that environmental productivity is a reasonable indicator of tool density, predictions about the variability in tool class did not meet expectations.

Figure 6.1 shows tool abundance by class, corrected for the area surveyed within each habitat. Data show that the relative presence of bifaces, handstones, and millingstones are generally similar. Flake tools are found in all three wetland types, being least common in saline, and most numerous in freshwater habitats. Of further note is the lack of projectile points and presence of cores in freshwater units. Brackish wetlands contain the greatest density of assayed cobbles although they were found in just two of the 15 units, with their occurrence in freshwater contexts less pronounced. Variation found among some classes may be due in part to the small sample size.

One further line of evidence highlighting differences in use is comparing flaked-to-ground stone tool ratios across wetland classes. In this case, flaked stone tool use appears to be more pronounced in the freshwater wetlands (2.63:1), followed by brackish (1.92:1), and saline (1.28:1) habitats. Relating these ratios to Figure 6.1, it seems that the high flaked-to-ground stone ratio in freshwater areas is driven by increased amounts of flake tools and cores found in the toolstone-rich southwestern region,

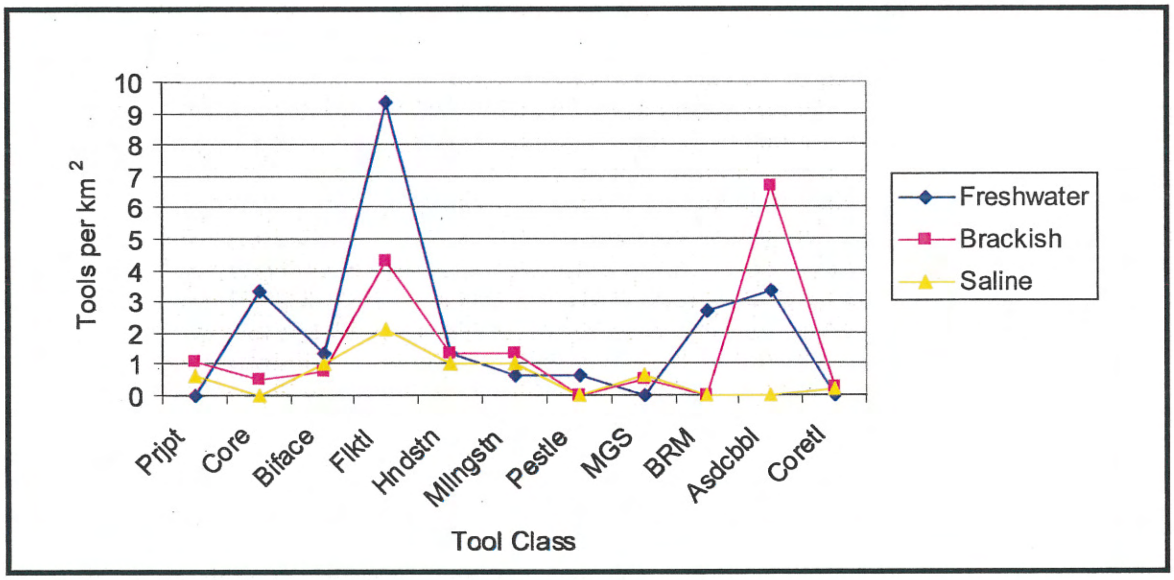


Figure 6.1. Relative Tool Abundance (per km ^{2}).

compared to a pattern of greater toolstone conservation in saline regions, which do not have abundant sources of raw material.

Differences in relative artifact abundance do not necessitate that tool diversity varies significantly across wetland habitats (without regard for debitage). A Shannon-Wiener diversity index can be used to compare the number of tool classes with the number of tools in each class (Magurran 1988; Pielou 1975). Here, the index value H′ is relatively the same across the freshwater (H′=1.881), brackish (H′=1.742), and saline (H′=1.879) wetlands types. The similarity of index values implies, contrary to expectations, that assemblages are equally diverse across the three wetland habitats.

Evenness values calculated from the index for the wetland classes vary among the three, with saline wetlands (E=0.9036) having the most even assemblage, followed by freshwater (E=0.8559), and brackish (E=0.7927) habitats. Composite assemblages with a higher value have more equal proportions of artifacts in each class. It is notable that saline habitats have the most even artifact assemblage, suggesting that a more restricted set of activities was conducted here. That brackish habitats contain the most uneven artifact distributions is interesting, as these quadrats most commonly contained flaked and ground stone tools along with debitage. This signifies that while varied tool classes were used in the brackish wetlands, they served in more specialized capacities less consistent with long-term residential use. Assemblage evenness of freshwater wetlands falls in between the other two groups.

Temporal and Spatial Associations

The following section integrates obsidian hydration results with artifact spatial distributions to explore variation in land-use intensity over time. Comparisons are made with respect to wetland class, quadrant within the basin, and elevation. As flaked stone tools and debitage are the items providing the temporal data, these three are closely associated.

Obsidian hydration data are initially applied to identify temporal variability in land-use through use of t-tests, which assess the relative chronology within the three analytical categories. Differences are shown by larger or smaller mean hydration values. Through t-tests, unconverted hydration readings are used to understand relative age; larger hydration bands signify older use. Patterns found here are further investigated by converting hydration values into absolute intervals.

Source-specific hydration rates or correction factors are used to remedy differences in hydration rate among the obsidian sources and to make them temporally comparable (Appendix D). This creates a more robust sample that overcomes the uneven source distribution encountered in some contexts on the survey. Moreover, the components can be compared with t-test results to identify correlation or discrepancy of the patterns.

Compare the distribution among components using a Chi-square statistic, these data provide more fine-grained information about the intensity of land-use through time. Chi-square statistics that are significant at $\alpha \leq .05$ also include adjusted residuals in the analysis (cf. Bettinger 1999a). Adjusted residuals are used to identify artifact classes or temporal periods that are over- or under-represented, affecting differences in the sample. In these cases patterns are found at two levels of significance. The highest level of significance at $\alpha = .05$ is reached with values greater than or less than 1.96. When counts are more evenly distributed, few temporal components may be highly significant and other temporal units are also contributing to the diversity, but to a lesser degree. In these cases, artifact classes present or absent in slightly significant amounts are those with adjusted residual values greater than or less than 1.00 ($\alpha = .25$). The residuals are simply showing trends in the variability and may only be used once a statistically significant X^2 value ($\alpha \leq .05$) has been calculated. Unlike the t-test analysis which simply evaluates statistical differences between samples, the second method builds from established temporal components that are believed to represent distinct cultural-adaptive patterns (see Chapter 3). As noted above, certain components (Newberry, pre-Newberry) are further segregated to allow for better correlation with the lake fluctuation curve. The tests identify differences in artifact distributions among the contexts of study that imply temporal changes in the use of wetland habitats around Mono Lake.

Variation Across Wetland Categories

T-tests. With pooled obsidian source samples, mean micron values for each wetland habitat show different temporal foci. Mean hydration readings for each wetland are separated by about one micron value, with saline wetlands showing the oldest occupation and freshwater habitats the most recent (Table 6.1:A). When compared, t-values demonstrate significant differences between the hydration samples from each wetland category (Table 6.1:B). When separating source-specific samples, it is apparent that the non-Mono Craters samples are too small to effectively compare across contexts, especially when considering the more robust Mono Craters sample. As such, source-specific t-tests focus solely on the latter obsidian.

Student's t-values comparing Mono Craters obsidian across wetland class corroborates results of the pooled sample, identifying differences between the three wetland classes, with the saline having the largest hydration values and freshwater having the smallest (Table 6.1:C).

To look for contemporaneity in the deposition of tools and debitage, these were separated and compared across wetland class, as well as within each wetland. T-values comparing Mono Craters tools across wetlands yielded no significant results (α=.05), yet

Table 6.1. Obsidian Hydration T-tests Comparing Wetland Classes.

A. pooled hydration measurements by wetland

	num	Mean	s.d	min	max
Freshwater	94	4.2	1.7	1.5	8.6
Brackish	93	5.0	2.1	1.4	11.5
Saline	69	6.1	2.2	1.4	13.5

B. t-test comparing wetlands (all sources)

	t-value	d.f.
F-B	-2.82*	185
F-S	-6.10*	161
B-S	-3.18*	160

C. t-test comparing wetlands (MC)

	t-value	d.f.
F-B	-2.69*	162
F-S	-6.03*	160
B-S	-3.30*	138

D. t-test comparing wetlands (MC)

Tools	t-value	d.f.
F-B	0.23	41
F-S	-1.09	39
B-S	-0.84	12
Debitage		
F-B	-2.91*	104
F-S	-9.52*	96
B-S	-6.14*	88
Tool-Debitage		
Freshwater	0.01	90
Brackish	-1.62	55
Saline	-2.97*	45

F = freshwater; B = brackish; S = saline; MC = Mono Craters; d.f. = degrees of freedom; * denotes values that are significant at α=.05.

all three tests comparing debitage across wetlands showed significant differences between the samples (Table 6.1:D). This demonstrates a relative similarity in the manner and timing in which tools were deposited around Mono Lake. That Mono Craters debitage, in contrast, shows temporal variability by wetland suggests that tools and debitage were deposited at different intensities through prehistory, with most of the tools having smaller hydration values. Furthermore, t-tests comparing hydration values of Mono Craters tools and debitage within each wetland class established them to be statistically similar in the freshwater and brackish contexts. In contrast, tools in the saline habitats are considerably younger than debitage, with mean values of 4.3μ and 6.8μ, respectively. This indicates that while the general intensity of use as measured by hydration bands differs among the three wetlands, saline habitats experienced early short-term use and activity that mainly resulted in debitage production. Later, as people spent more time in the area they deposited tools as well as debitage. In the brackish and freshwater habitats, tools and debitage were both being discarded at about the same rate over time. The initial use of the saline habitat relates to people traveling through the basin in search of periodic, unpredictable resources such as waterfowl or antelope.

Figure 6.2 shows histograms of the Mono Craters hydration readings for each of the three wetland habitats. The hydration values in saline habitats are predominantly larger, representing most of the values greater than seven microns. Freshwater and brackish wetlands, by contrast, contain hydration rims primarily under seven microns. Decreasing slightly at around three microns, hydration for brackish habitats is relatively even through the time-span represented. At about three microns there is a decided increase in hydration counts from the freshwater wetlands.

Results of these analyses suggest that saline contexts saw more intensive early occupation, which shifted in turn to the brackish, and then freshwater habitats. T-tests indicate that the brackish wetlands have significantly older hydration values than the freshwater (Table 6.1). The initial occupation of the Mono Basin did not result in the discard of many tools especially within saline habitats, possibly due to shorter-term ephemeral occupations relative to later times. Later, when tools were more commonly deposited along with debitage, it occurred for a relatively similar time span across the wetland classes, although use-intensity did shift to the brackish and then the freshwater

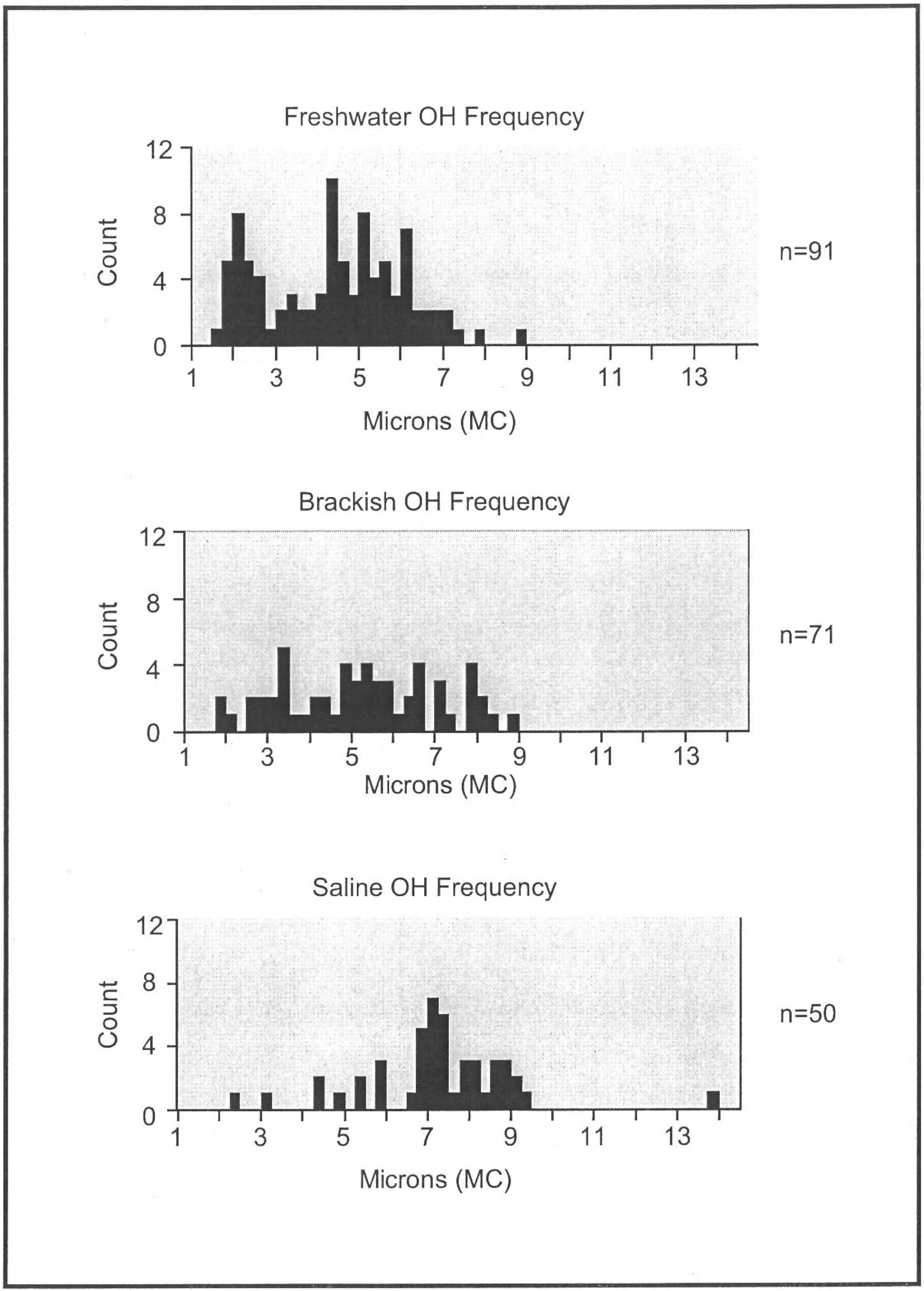


Figure 6.2. Histograms of Mono Craters obsidian hydration values.

areas. These patterns of temporal use are explored further below using source-specific hydration rate-corrected readings from artifacts of all six obsidian sources in the sample.

Temporal Components. The distributions of items by temporal component are grouped by unit in Table 4.4. These are summarized by wetland class in Table 6.2. While the hydration counts themselves are important, differing temporal spans of the time periods unequally weights categories representing greater or fewer years. One can achieve a more even representation by correcting for hydration counts per 1000 years within each category (Table 6.2:C). Now variance can be tested using a Chi-square test and analysis of adjusted residuals (X^2=66.05; df=16; p<.001). Residual values indicate ephemeral use of the three wetlands in TP/EH, which then focuses on the brackish habitat during the PN-IV. After this time, activity shifts to the saline region for the remaining three pre-Newberry periods and into the NW-II. Use intensity transitions back to the brackish wetlands in NW-I, then to the freshwater habitat during the two most recent periods (HW and MR). Earliest use of the brackish habitat contrasts with results of the t-test analysis, but the sample here is small and was apparently masked by the coarse-grained nature of the prior assessment. Brackish quadrats with values dating to the earlier periods (Table 4.4) also have more recent values corresponding to NW-I and later times.

Use of brackish wetlands deserves some comment here. Unlike freshwater and saline habitats, which are contiguous to themselves, brackish wetlands separate into northern and southern sectors (Figure 2.1). Artifact inventories from these two areas suggest that they were used differently (Table 5.4). The northern units contain a variety of flaked and ground stone tools, implying recurrent visitation for at least short periods

Table 6.2. Temporal Distribution Across Mono Basin Wetlands.

	Hydration Frequencies								
	MR	HW	NW-I	NW-II	PN-I	PN-II	PN-III	PN-IV	TP/EH
A. Wetland Count									
Freshwater	29	22	24	14	4	-	1	-	-
Brackish	19	19	25	9	9	6	1	3	2
Saline	7	8	9	12	17	10	5	-	1
Total	**55**	**49**	**58**	**35**	**30**	**16**	**7**	**3**	**3**
B. Segregated Brackish Count									
North	7	9	7	-	6	3	1	3	2
South	12	10	18	9	3	3	-	-	-
Total	**19**	**19**	**25**	**9**	**9**	**6**	**1**	**3**	**2**
C. Wetland Corrected*									
Freshwater	44.6	31.4	25.9	15.1	5.0	-	1.0	-	-
Brackish	29.2	27.1	27.0	9.7	11.3	6.0	1.0	2.0	0.4
Saline	10.8	11.4	9.7	13.0	21.3	10.0	5.0	-	0.2
Total	**84.6**	**69.9**	**62.6**	**37.8**	**37.6**	**16.0**	**7.0**	**2.0**	**0.6**
D. Segregated Brackish Corrected*									
North	10.8	12.9	7.6	-	7.5	3.0	1.0	2.0	0.4
South	18.5	14.3	19.5	9.7	3.8	3.0	-	-	-
Total	**29.3**	**27.2**	**27.1**	**9.7**	**11.3**	**6.0**	**1.0**	**2.0**	**0.4**
E. Wetland Corrected Residual									
Freshwater	3.10	1.22	0.49	0.17	-3.40	-3.26	-1.34	-1.13	-0.62
Brackish	-0.28	0.60	1.36	-1.38	-0.78	0.15	-1.20	1.90	0.50
Saline	-3.15	-2.01	-2.04	1.32	4.65	3.47	2.81	-0.83	0.14
F. Segregated Brackish Corrected Residual									
North	-0.36	0.95	-1.41	-2.64	1.93	0.53	1.24	1.76	0.78
South	0.36	-0.95	1.41	2.64	-1.93	-0.53	-1.24	-1.76	-0.78

* Count corrected for 1000 years. MR = 100-650 B.P.; HW = 650-1350 B.P.; NW-I = 1350-2275B.P.; NW-II = 2275-3200 B.P.; PN-I = 3200-4000 B.P.; PN-II = 4000-5000 B.P.; PN-III = 5000-6000B.P.; PN-IV = 6000-7500 B.P.; TP/EH = 7500-12,500 B.P.

of resource acquisition. In contrast, the southern brackish units have a more restricted artifact inventory. The two most productive units here (B2, B3) contain abundant debitage, two cores, assayed cobbles and segregated reduction loci. Different from the northern sector, these southern units speak more to a restricted set of activities focusing on toolstone acquisition rather than subsistence.

If geographic variability also affects land-use, it stands to reason that there are differences in temporal use of the two areas as well. Segregating converted hydration samples from the northern and southern brackish sectors, it appears to be the case (Table 6.2:B) (X^2=17.50; df=8; p<.05). Adjusted residuals imply that the northern brackish units show significant use throughout most of the pre-Newberry times (Table 6.2:F). In Newberry II and I times, land-use shifts to the southern brackish wetlands likely because of the increased importance of Mono Craters toolstone acquisition. Thereafter, use of brackish habitats is split evenly between the north and south. During this time (Haiwee and Marana intervals) freshwater habitats are subject to the most intensive use (Table 6.2:E).

Artifact Distribution. Moving on to the distribution of tools in these contexts, Table 6.3 shows the results comparing tool abundance across wetland class (X^2=55.61; df=20; p≤.001). Cores, bedrock mortars, and assayed cobbles are the three tool classes present at highly significant levels within a given wetland habitat. Also, bedrock mortars and assayed cobbles are the only tool classes that are significantly absent from given wetland areas.

Among the flaked stone, cores and assayed cobbles are the only items which are over-represented at highly significant levels (α=.05), the first in freshwater wetlands

Table 6.3. Tool Distribution and Adjusted Residuals by Wetland Habitat and Basin Quadrant.

	PPT	COR	BIF	FTL	HND	MIL	PST	MGS	BRM	ASC	CRTL	Total
Wetland count												
Fresh	-	5	2	14	2	1	1	-	4	5	-	34
Brackish	4	2	3	16	5	5	-	2	-	25	1	63
Saline	3	-	5	10	5	5	-	3	-	-	1	32
Residuals												
Fresh	-1.63	2.78	-0.48	1.49	-0.80	-1.36	1.68	-1.36	3.40	-1.38	-0.85	
Brackish	0.45	-1.10	-1.24	-1.35	-0.52	-0.23	-0.98	-0.40	-1.99	4.31	0.03	
Saline	1.14	-1.56	1.92	0.03	1.42	1.66	0.58	1.86	-1.17	-3.59	0.83	
Quad count												
Southwest	-	7	2	15	2	1	1	-	4	30	1	63
Northwest	3	-	3	12	-	4	-	1	-	-	-	23
Northeast	4	-	5	10	9	5	-	3	-	-	1	37
Southeast	-	-	-	3	1	1	-	1	-	-	-	6
Residuals												
Southwest	-2.66	2.78	-1.90	-1.73	-2.34	-2.76	1.03	-2.23	2.08	6.40	0.03	
Northwest	1.78	-1.27	1.05	2.42	-1.69	1.68	-0.47	0.13	-1.95	-2.91	-0.66	
Northeast	1.71	-1.73	1.55	-0.62	3.73	1.29	-0.64	1.58	-1.29	-3.97	0.67	
Southeast	-0.60	-0.60	-0.73	1.03	0.64	0.73	-0.22	1.66	-0.45	-1.38	-0.31	
Count Totals	**7**	**7**	**10**	**40**	**12**	**11**	**1**	**5**	**4**	**30**	**2**	**129**

PPT = projectile point; COR = core; BIF = biface; FTL = flake tool; HND = handstone; MIL = millingstone; PST = pestle; MGS = miscellaneous ground stone; BRM = bedrock mortar; ASC = assayed cobble; CRTL = core tool.

and second in brackish contexts. Although extremely common in freshwater habitats, cores are slightly under-represented in both brackish and saline habitats. Alternatively, assayed cobbles are present at highly significant levels in brackish wetlands but are slightly under-represented in freshwater, and significantly absent in saline habitats. Other tools include projectile points, which are notably rare in freshwater wetlands, are more common in brackish habitats and are slightly more abundant than expected in saline wetlands. Bifaces are also present at slightly higher levels than expected, are less common in freshwater habitats, and uncommon at slightly significant levels in brackish wetlands, relative to the complete assemblage distribution. Flake tools are found at slightly elevated levels in freshwater habitats; they are relatively common in saline contexts and occur at less than expected levels in brackish wetlands. Core tools are relatively common throughout the three wetland habitats.

The flaked stone tool distributions among Mono Lake's wetland habitats illustrate varied use throughout the study area. First, the significant presence of cores in the freshwater habitat appears to be congruent with a boost in flake tool frequencies. Projectile points and bifaces, both reputed curated artifacts, are more abundant than expected in saline habitats. Finally, assayed cobbles occur at very significant levels in brackish wetlands, suggesting that these may be the most toolstone-rich of the three wetland areas.

Ground stone distributions demonstrate an interesting articulation with flaked stone tools. Bedrock mortars are the only ground stone tools found in significant numbers in freshwater habitats, occurring at slightly less or more than expected levels in saline and brackish wetlands, respectively. Handstones and millingstones are both somewhat abundant in saline wetlands, more common in brackish ones. Handstones are common in freshwater habitats whereas the portable nether stones are relatively rare. Accompanying the bedrock mortars, pestles are slightly over-represented in freshwater habitats and less common in both saline and brackish contexts. Similar to handstones and millingstones, miscellaneous ground stone fragments are slightly more common in saline habitats, common in brackish units, and slightly uncommon in freshwater wetlands.

Considering the complete artifact assemblage, particular technologies appear to be present at certain localities together while they are absent from other areas. Bedrock mortars (and pestles) are common in streamside contexts in eastern California. It appears that while acorns were likely processed in mortars (cf. Haney 1992); a more significant use of these stationary features relates to the presence of particular streamside wetland plants such as roots and tubers (Basgall and McGuire 1988:230). This inference is supported by the presence of bedrock mortars further east of the Sierra Nevada at a greater distance to oak groves, but still in streamside contexts (Meighan 1955:12). While mortars and pestles may have been commonly used to process plant material, Davis (1965:12) noted that the *Kutzadika'a* Paiute used these to pound both sowberries and meat. Further, blood residue analysis conducted on milling equipment (including a pestle and hopper mortar) in southern California has shown traces of "rat" and "mouse" blood residues (Yohe II et al. 1991).

Along with mortars and pestles, cores and flake tools are common in freshwater habitats. These represent a relatively expedient technology that could be used in an *ad* *hoc* fashion, especially if raw material is readily available. One freshwater quadrat (F62) contains abundant raw material in the alluvium along with five freshwater cores. Flake tools from the quadrat are very significantly hammer percussion-based, suggesting they were produced from cores rather than biface reduction. Percussion-based flake tools are slightly uncommon in saline contexts but common in brackish ones (Table 6.4:A). In the freshwater habitat, locally procured cores could be used to produce flake tools for a variety of tasks from cutting plant material to butchering animals.

A different association of tools is found in the saline wetlands. While adjusted residuals indicate that no tool classes occur in saline habitats at highly significant levels, some items are present at somewhat elevated levels compared to the other wetland types. In saline habitats there is a slight over-representation of projectile points and bifaces. These curated tools, that people would often retain in toolkits for longer periods of time than other less formalized tools, exhibit more complex use-histories. Based on ethnographic analogy, they may often be discarded or cached at a residential base, rather than at short-term use areas (Binford 1978a). Also, these artifacts are often thought to be associated with hunting activities (Bettinger 1999a).

Ground stone artifacts, slightly over-represented in saline contexts, include handstones, millingstones, and miscellaneous ground stone. That handstones and millingstones are both present in these contexts implies an emphasis on the gathering and processing of plants in saline habitats. Greater use of ground stone tools in this wetland type is shown by the low flaked-to-ground stone tool ratio (1.28:1) (see above). Sandy substrates in the saline habitats are conducive for the growth of plants

Table 6.4. Distribution of Flake Tool and Debitage Technological Types with Adjusted Residuals*.

	Decortication	Percussion	Biface Reduction	Total	
A. Flake Tool					
Count					
Freshwater	2	8	2	12	
Brackish	0	5	9	14	
Saline	3	2	3	8	
Total	**5**	**15**	**14**	**34**	X^2= 10.78 d.f.= 4
Residuals					
Freshwater	0.24	1.96	-2.14		
Brackish	-2.03	-0.83	2.29		
Saline	2.08	-1.25	-0.24		
B. Debitage					
Count					
Freshwater	5	9	15	29	
Brackish	4	12	23	39	
Saline	0	1	23	24	
Total	**9**	**22**	**61**	**92**	X^2=13.70 d.f.=4
Residuals					
Freshwater	-1.63	1.09	-2.01		
Brackish	0.13	1.32	-1.28		
Saline	-1.88	-2.64	3.56		

*Indeterminate flakes not included; **100m x 100m sample only.

producing hard seed resources (such as *Descurainia* spp.), which are most commonly believed to be used with these tools.

Returning to the presence of bifaces in saline habitats, these are often viewed as important tools under certain circumstances due to their durability and versatility. Kelly (1988) discusses the utility of bifaces with potential to serve different roles: a transportable, efficient core, and another as a durable, reliable tool for cutting and scraping functions, in addition to performing as a long use-life tool. Whether serving as a core or a tool of its own, these items would be important for their users when traveling to areas where stone availability is unknown or in short supply. In terms of the present project area, saline habitats would be the area of greatest uncertainty regarding access to toolstone, comprising an expansive, largely redundant terrain of fine sand, volcanic ash, and small pieces of obsidian blast. This would make stone availability severely restricted, and may have affected the decision to bring and use more curated tools into this wetland area. During certain times in prehistory, such as the Newberry period, bifaces are believed to have served a common role hunter-gatherers' toolkits. Temporal data shows that the pre-Newberry time as exhibited the greatest use of the saline wetlands. This information supports the concept of an earlier, biface-focused technology.

Further support for the importance of bifaces in saline wetlands comes from technological analysis of debitage collected in the 100 m x 100 m collection sample (Table 6.4:B). A significant Chi-square statistic (X^2=13.7; df=4; p<.05) was calculated comparing major technological categories of debitage, not including indeterminate specimen, across the wetland categories. Biface reduction debris is present in the saline habitats in highly significant amounts. It appears that bifaces were brought into the saline habitats where they were further shaped and resharpened in the context of ongoing activities. Flake tools are relatively commonly fabricated from bifacial flaking debris in saline habitats (Table 6.4:A).

Adjusted residuals show a different pattern of use for brackish wetlands than the other two habitats (Table 6.3). The only tool class identified as being significantly over-represented in the brackish habitat is assayed cobbles, reflecting the abundance of raw material found largely within the southern portion of this wetland. Projectile points, handstones, millingstones, pestles, miscellaneous ground stone, and core tools may all be viewed as relatively common, while cores, bifaces, flake tools, and BRMs are less abundant than expected.

In relation to evenness values, assemblages in brackish habitats are not as homogeneous as the other two wetlands. Flaked stone tools appear to be present in a disjointed fashion, with projectile points being relatively common and the remaining tool classes somewhat under-represented. However, the high frequency of assayed cobbles indicates that raw material acquisition was an important aspect of use. Based on the presence of flaked stone tools, it seems that brackish habitats were places to hunt but not to process the animals. Obsidian raw material, shown by the assayed cobbles, was also obtained here, but the items manufactured were not necessarily used or discarded here, as shown by the low frequency of cores, flake tools, and bifaces.

Turning to the technological analysis of flake tools and debitage informs one about how different technologies were used. Flake tools in the brackish habitat are fairly commonly fabricated on biface reduction flakes, with percussion flakes being frequent and decortication flakes absent (Table 6.4:A). In contrast, debitage from brackish habitats is often interior percussion flakes, with decortication and biface reduction debris being common and somewhat under-represented in that order (Table 6.4:B). The debitage appears to reflect raw material acquisition whereas flake tools often come from bifaces, which are not very common in the wetland. This implies more short-term activity because bifaces were not typically expended and discarded in this habitat, although they were used to fabricate flake tools.

Other than bedrock mortars, all types of ground stone artifacts are common in brackish wetlands with no particular technological focus as in freshwater and saline areas. There is a significant absence of bedrock mortars, which may be related to fewer freshwater streams providing material to process in the mortars.

Patterns of tool use and discard in brackish habitats correspond with temporal changes in land-use. Notably, use of the southern brackish wetlands increased during the Newberry period. During this period, many areas with available obsidian experienced heightened use in eastern California as people obtained large quantities of material for tool manufacture and possibly trade. This is often associated with biface production. Although the tools are not found in the southern brackish areas, 16 of 27 (59.2 %) technologically identifiable pieces of debitage collected from the area are biface reduction debris, pointing out a trend toward biface manufacture.

Discussion Land-use intensity along with different types of technologies appears to shift across wetland habitats throughout the Holocene. Earliest use of the project area in TP/EH appears to be general across the different habitats although the sample is small. During the PN-IV hunter-gatherers focused on the northern brackish habitats. Earliest hydration results here come from three flake tools and a biface, all of extra-local obsidian (two Casa Diablo, one Bodie Hills, one Mt. Hicks). For the remaining pre-Newberry periods, evidence of occupation is predominantly in saline wetlands where there is a prevalence of bifaces and projectile points with millingstones and handstones. Earlier efforts comparing hydration readings from quadrats with and without ground stone showed increased use of quadrats without ground stone during this time; however, the prevalence of hydration readings corresponding to pre-Newberry times in saline contexts along with the greater relative presence of millingstones and handstones, suggests that milling equipment was also used during this interval as well. During the Newberry period, land-use intensity shifted to the southern brackish habitats where the main focus was on obsidian procurement with few other associated tools. In contrast, northern brackish habitats experienced more steady and continual use throughout the mid- to late Holocene. Finally, during the Haiwee and Marana periods (1350-Protohistoric), land-use intensity focused on freshwater habitat, where there was increased use of cores, flake tools, and bedrock mortars.

While variability in the use of wetlands is apparent, one can look to the distribution of these items in terms of general geography based on the activities in the quadrants within the basin. Environmental variability described in Chapter 2 sheds light on why activities occurred where they did.

Variation Across Basin Quadrants.

T-tests. Segregating raw hydration data by basin quadrant can help provide information on temporal changes in land-use that highlight important points not revealed in the previous analysis (Table 6.5). A pattern of note is the distinctions of the southwest quadrant from the two northern quadrants in the pooled sample (Table 6.5:B). However, when using only Mono Craters samples, the northeast sector stands out from the others in the antiquity of its hydration values (Table 6.5:C). Similar to the tests across wetland class, Mono Craters tools showed no difference across quadrant, yet the debitage

Table 6.5. Obsidian Hydration T-tests Comparing Basin Quadrants.

A. pooled hydration measurements by quad

	num	Mean	s.d	min	max
Southwest	144	4.5	1.7	1.5	8.6
Northwest	37	5.3	2.6	1.6	11.5
Northeast	65	6.0	2.3	1.4	13.5
Southeast	10	4.7	2.3	1.4	8.3

B. t-test comparing quads (all sources)

	t-value	df
SW-NE	-2.42*	179
SW-NE	-5.48*	207
SW-SE	-0.49	152
NW-NE	-1.41	100
NW-SE	0.63	45
NE-SE	1.63	73

C. t-test comparing quads (MC)

	t-value	df
SW-NW	-1.76	158
SW-NE	-8.79*	184
SW-SE	-0.60	41
NW-NE	-3.34*	58
NW-SE	0.43	23
NE-SE	3.10*	49

D. t-test comparing quads (MC)

Debitage	t-value	df
SW-NW	-1.85	113
SW-NE	-9.14*	138
SW-SE	-1.91	106
NW-NE	-3.49*	47
NW-SE	-0.47	15
NE-SE	1.89	40
Tool-Debitage		
Southwest	-1.41	141
Northwest	-0.86	15
Northeast	-3.21*	41
Southeast	-2.56*	6

SW = southwest; NW = northwest; NE = northeast; SE = southeast; MC = Mono Craters; df - degrees of freedom; * denotes values that are significant at $\alpha = .05$.

is of greater antiquity than the northeastern and western sides of the basin (Table 6.5:D). When one looks at differences between the hydration values for Mono Craters tools and debitage, it is apparent that the two classes from both quadrants in the eastern half are statistically distinct. Both have debitage with larger values than the tools [tools: $\bar{x}$=5.1μ (NE), 2.8μ (SE); dbtg.: $\bar{x}$=7.4μ (NE), 6.0μ (SE)]. That the SE quadrant does not totally track the NE in these tests may be due to the small sample of items recovered there.

Results of the t-tests comparing basin quadrants provide more information for understanding temporal variation in land-use. It appears that northern sectors of the lakeshore were used over longer periods of time than the southern. The greatest antiquity of use occurs in the northeast quad, although debitage in the southeast quad implies early visitation as well. However, the visits were for shorter periods of time, as is evident from the tool manufacture and/or maintenance, but not discard. That the tools are represented by smaller hydration values suggests that people spent more time in the region during recent times.

The pooled sample shows some differences between the southwest and northwest, although this does not carry over to the Mono Craters t-tests. The maximum hydration value for all sources in the northwest shows evidence of early use, but the distribution of the hydration readings is more even through time. Therefore, there was greater stability of use through time, because of the wet meadow habitat attracting animals as well as being productive for plant resources. If the importance of these resources (plants vs. animals) changed through time, it would remain a productive place to visit. Also, being more watered than the east, it is likely that the region would have greater wetland stability; by contrast, when the lake elevations dropped, low water flow and soil leaching in the east would cause recently exposed lands to remain unvegetated for longer periods of time.

One final point concerns the southwest quadrant. Three units (F62, B2, and B3) have particularly large quantities of obsidian debitage due to the availability of Mono Craters raw material nearby. However, F62 is distinguished from the two brackish units by the local array of other flaked and ground stone tools in the unit, suggesting a wider variety of activities were undertaken at the locality (Table 5.3). Assemblages recorded in the two brackish units are restricted to a few cores and a single flake tool underscoring a focus toward raw material acquisition (Table 5.4). T-tests comparing hydration readings from the Mono Craters debitage samples show significant differences between the freshwater and two brackish units ($t=3.09$; $df=72$; $p< .01$). The two brackish units have an older mean hydration value (5.2µ), while measurements for F62 are more recent (4.0µ). These data imply that the southwest brackish region saw more focused raw material acquisition activities earlier in time, while activity in F62 may in part be related to more expedient toolstone use. There were other subsistence-related activities rather than solely to procure stone material before moving on.

Temporal Components. Grouping the converted hydration readings by quadrant and correcting for time demonstrates relatively expected yet still informative patterns of land-use (Table 6.6:B). A significant Chi-square ($X^2=127.61$; $df=24$; $p<.001$) and adjusted residuals inform that TP/EH and PN-IV use emphasized the northwest quad, while in the PN-III focus shifts to the eastern half of the basin, then restricts to the northeastern quadrant for the remaining pre-Newberry era (II, I). In the NW-II there is dual importance of the northeast and southwest quads as quarry-based obsidian raw material acquisition becomes important. From the NW-I through the Marana period people targeted the southwest basin; however, a brief expansion to the northwest is observed during the Haiwee interval, possibly related to changing environmental conditions. Use of the southwest was initially for toolstone acquisition, then later

Table 6.6. Temporal Distribution by Quadrant in the Mono Basin Wetlands.

	Hydration Frequencies								
	MR	HW	NW-I	NW-II	PN-I	PN-II	PN-III	PN-IV	TP/EH
A. Basin Quad Count									
Southwest	39	30	41	23	7	3	1	-	-
Northwest	7	8	7	-	6	3	1	3	2
Northeast	7	8	8	11	17	8	5	-	1
Southeast	2	3	2	1	-	2	-	-	-
Total	**55**	**49**	**58**	**35**	**30**	**16**	**7**	**3**	**3**
B. Basin Quad Corrected*									
Southwest	60.0	42.9	44.3	24.9	8.8	3.0	1.0	-	-
Northwest	10.8	12.3	7.6	-	7.5	3.0	1.0	2.0	0.4
Northeast	10.8	12.3	8.6	11.9	21.3	8.0	5.0	-	0.2
Southeast	3.1	4.3	2.2	1.1	-	2.0	-	-	-
Total	**84.7**	**71.8**	**62.7**	**379**	**37.6**	**16.0**	**7.0**	**2.0**	**0.6**
C. Basin Quad Corrected Residual									
Southwest	3.09	0.63	2.52	1.22	-4.35	-3.12	-3.81	-1.62	-0.88
Northwest	-0.27	0.98	-0.39	-2.60	1.20	0.61	-0.72	3.57	1.20
Northeast	-2.79	-1.51	-2.10	1.16	5.01	2.52	1.06	-0.79	0.17
Southeast	-1.06	-0.01	-0.93	-0.86	-1.65	1.12	7.07	-0.36	-0.20

* Count corrected for 1000 years. MR = Marana (100-650 B.P.); HW = Haiwee (650-1350 B.P.); NW-I = Newberry I (1350-2275B.P.); NW-II= Newberry II (2275-3200 B.P.); PN-I = pre-Newberry I (3200-4000 B.P.); PN-II = pre-Newberry II (4000-5000 B.P.); PN-III = pre-Newberry III (5000-6000B.P.); PN-IV= pre-Newberry IV (6000-7500 B.P.); TP/EH = Terminal Pleistocene/Early Holocene (7500-12,500 B.P.).

influenced by the permanence of freshwater and greater environmental productivity, as demonstrated by the density and wide variety of tools recovered there. Notable is the significant scarcity of late prehistoric occupation in the northeast compared to earlier times. Additionally, there are hydration values corresponding to pre-Newberry II through Marana times in the southeast sector. These are relatively few and suggest only incidental use of the area through time.

Temporal use of the four quadrants of Mono Lake basin shows that the intensity of land-use focused on geographic areas. It provides information about more micro-variability within each wetland class. For example, the southeast quadrant experienced little use through time, possibly because of the greater aridity there. This example demonstrates variability within both the saline and brackish habitats where both have abundant artifact accumulations elsewhere. Moreover, emphasis in the southwest sector appears to highlight the importance of annual water sources in the freshwater habitat.

Artifact Distribution. Table 6.3, showing the distribution of tools across basin quadrants, along with the adjusted residuals, presents certain notable patterns in both flaked and ground stone tools (X^2= 93.31, df= 30; p< .001). Of the flaked stone items, only cores, flake tools and assayed cobbles show significant variation across quadrant. Cores and assayed cobbles are abundant in the southwest, flake tools in the northwest. The absence of cores is expected in the southeast quadrant, but these items are under-represented in both northern quadrants. Assayed cobbles are only found in the southwest sector at significant levels whereas they are slightly to strongly under-represented in the remaining three quadrants. In addition to the high prevalence in the northwest, flake tools are somewhat abundant in the southeast, common and slightly uncommon in the northeast and southwest, respectively. The remaining flaked stone tools, projectile points, and bifaces occur at elevated levels in both northern quads with neither being common in the southeast. Points are conspicuously rare from the southwest quad while bifaces are somewhat under-represented. Core tools do not occur at unexpected frequencies in any of the basin quads

Looking at the distribution of ground and battered stone among the basin quadrants, only bedrock mortars and handstones show significant variation, the first being extremely abundant in the southwest quad and the second in the northeast. Adjusted residuals further indicate that bedrock features are common in the southeast and somewhat under-represented in the two northern quadrants. Correlating with the mortar features, pestles are found in the southwest at slight levels of significance. In contrast to their abundance in the northeast, handstones are common in the southeast, slightly and highly under-represented in the northwest and southwest quadrants, respectively. Millingstones are also rare in the southwest; they are present at slightly significant levels in the two northern quads and also occur in the southeast. Different than the millingstones, miscellaneous ground stone is found in the two eastern quadrants at somewhat significant levels, showing a connection to saline habitats.

Patterns of tool prevalence across quadrants provide some insight into how different areas were used. Much of this corroborates what was outlined during discussion of the wetland habitats although a few additional observations emerge. Meaningfully, the northwest sector exhibits a prominent flaked stone assemblage with flake tools being most prevalent; projectile points, bifaces, and pestles are somewhat less common. The flake tools there are strongly associated with bifacial flaking debris, where other technological types are slightly unexpected (Table 6.7:A). Millingstones are present in the northwest sector at slightly elevated levels, whereas corresponding handstones are somewhat under-represented.

Table 6.7. Distribution of Flake Tool and Debitage Technology by Basin Quadrant with Adjusted Residuals*.

	Decortication	Percussion	Biface Reduction	Total	
A. Flake Tool					
Count					
Southwest	2	8	3	13	
Northwest	0	2	8	10	
Northeast	3	2	3	8	
Southeast	0	3	0	3	
Total	**5**	**15**	**14**	**34**	X^2= 15.70 df= 6
Residuals					
Southwest	0.09	1.61	-1.69		
Northwest	-1.56	-1.83	2.97		
Northeast	2.08	-1.25	-0.24		
Southeast	-0.75	2.04	-1.52		
B. Debitage					
Count					
Southwest	9	16	31	56	
Northwest	0	5	7	12	
Northeast	0	1	20	21	
Southeast	0	0	3	3	
Total	**9**	**22**	**61**	**92**	X^2=16.11 df=6
Residuals					
Southwest	2.53	1.31	-2.77		
Northwest	-1.22	1.55	-0.63		
Northeast	-1.72	-2.34	3.19		
Southeast	-0.58	-0.99	1.26		

*Indeterminate flakes not included; **100m x 100m sample only.

Similarly, the northeast quadrant contains enhanced frequencies of such tools as projectile points, bifaces, millingstones, and miscellaneous ground stone. There is also a significant over-representation of handstones, while flake tools occur at expected frequencies. The latter are most commonly found on decortication flakes (Table 6.7:A).

Debitage produced through biface reduction is significantly over-represented in this sector, demonstrating the use and/or reduction of bifaces in the quadrant (Table 6.7:B).

Comparing the more prevalent tool classes in the study area, one discovers that while curated flaked stone tools occur at greater than expected frequencies in the two northern quadrants, expedient flake tools are prevalent in the northwest, but less so in the northeast. Flake tools from the northwest sector are most commonly found as bifacial reduction debris, which is the prominant debitage type in the northeast. Millingstones occur at slightly greater than expected frequencies in both northern quadrants, while handstones are widespread in the northeast and under-represented in the northwest.

Together this may represent a pattern that placed greater emphasis on resource acquisition in the moist northwest, with residential occupation being more common in the northeast. In the west, expedient flake tools were discarded at high rates at their place of use, and millingstones were brought and/or fabricated there due to recurring procurement and processing. Obsidian hydration profiles indicate fluctuating intensities of use of this area through time. In contrast, the northeast quadrant contains a more complete milling assemblage, and expedient flake tools are common. It could be that the northeast sector experienced more residential use with hunting and plant processing occurring there, predominantly from PN-III through NW-II times. The northwest may have been visited for shorter periods of time, mainly for resource acquisition. Millingstones are present there, but the lack of handstones suggests those implements were carried away. A broad suite of activities likely occurred here as well, but on a more intermittent basis.

Contrasting with the moderate number of artifacts recovered from the northern sectors, the southwest quadrant contains greater artifact densities. Items of note are assayed cobbles, cores and bedrock mortars. While assayed cobbles and cores point to the importance of toolstone acquisition and use, bedrock mortars and pestles denote the importance of plant or animal processing. Two bifaces make up the under-represented sample in the southwest quad, but one specimen is a Stage 2 form that could potentially be included with the cores, further diminishing the significance of bifaces in the area. Other tools such as projectile points, millingstones, handstones, and miscellaneous ground stone are extremely uncommon relative to the total sample. Debitage is most prevalent as decortication debris indicative of stone procurement, while flake tools are generally made on percussion debris (Table 6.7). These further highlight the dearth of biface technology and focus on core reduction.

Temporal data highlight the emphasis on southwest occupation from the Newberry period until more recent times. There is an initial emphasis on stoneworking, mainly in the southwestern brackish quadrats. In Haiwee and Marana times, use shifts to the freshwater habitat near annual streams. Bedrock mortars are prominent along with cores, which were used to produce material for flake tools. Non-portable milling gear, along with the array of artifacts found and the proximity of a reliable water source suggest recurrent, if not long-term use of the area.

Brief mention of the southeast quadrant should be made as well. This area comprises both brackish and saline habitats, and although one survey unit (B35) was associated with an expansive marsh, tools and debitage encountered here are relatively sparse. Flake tools and miscellaneous ground stone items are found at slightly elevated levels, and most of the remaining artifact classes are present at expected frequencies. Flake tools are mostly made on percussion debris, while debitage mainly consists of biface reduction flakes (Table 6.7). This dichotomy is of interest, but the sample is small. The southeast quadrant appears to have been subject mainly to periodic ephemeral use, a pattern supported through the obsidian hydration results.

Differences in tool distributions between the two northern quads and the southwest are likely the outcome of differential patch choice that result from the varied geography, geomorphology, and hydrology found within these areas. The southwest is distinct in having two of the largest streams that enter Mono Lake. These likely would have flowed throughout the year in prehistoric times. Additionally, there is also a steeper slope gradient creating fast moving water that is also more channelized. In contrast, the northern area contains more seasonal streams that flow toward the lake over lower slope gradients. These allow the water to spread out across the alluvial fan, creating more wet meadow habitat than in the southwest. This produces a unique environment for both plants and animals that is economically attractive for hunter-gatherers.

Since these streams in the north would flow only seasonally, potentially drying up in summer or fall, timing would be important and patch productivity may be more unstable over both space and time than in the southwest. People stayed for shorter periods at varied locations in the northwest. Further, the possible expansiveness of this wet meadow or marsh habitat made it more desirable to pass more time in the east, set off slightly from the main water sources. The northern area was more productive for processing materials, such as hard seeds on millingstones, and for hunting animals browsing through the area, whereas the southwest served as a reliable location for water, toolstone, and materials that are processed in bedrock mortars. The emphasis shifted from short-term use of the northwest, then the northeast from early Holocene and into pre-Newberry times. The relative importance of ground stone artifacts in these areas along with the strong temporal trend of northeastern hydration readings falling within pre-Newberry and Newberry II times suggests that this area was used for both hunting and plant processing. Land-use focused on the southwestern quad for raw material acquisition in the Newberry era. From the Haiwee interval and continuing into the Marana times, use intensity remains in the southwest quadrant, but shifts the focus to more residential occupation, using bedrock mortar features and staging activities from locations with stable, reliable sources of water.

Variation Across Elevational Swaths

T-tests. When artifacts are grouped by elevation increments, obsidian hydration readings show little temporal patterning relative to the other analyses. Lack of patterning may be due to the fact that particular lake elevation stands were achieved at more than one time in the past. Particular elevations may be exposed for periods of time before being inundated, then re-exposed later, as demonstrated by the lake fluctuation curve (Figure 2.3). It is, of course, also possible that earlier occupations at particular locales may be buried by sediments or washed away during this process, leaving predominantly more recent archaeology exposed on the surface. Nevertheless, there are often multiple processes at work, which may somewhat equalize distortions in the record.

Similarity in temporal spans is shown by the mean hydration values of the pooled sample (Table 6.8). The largest values are in the lowest two strata, while the upper two zones have maximum micron values that are considerably less (though still relatively old). The source-specific tests were again more informative, but evaluations of non-Mono Craters obsidian could not be easily made as over half of these specimen (57%; n=26) were located in the lowest elevation strata. Two main distinctions are apparent in this cross-elevation comparison. A t-test evaluating the differences between <1960 m and 1980-2000 m elevation swaths demonstrates significant differences with the Mono Craters sample, where the lower group has smaller values ($\bar{x}$=4.7μ) than the upper group ($\bar{x}$=5.6μ). Again, this distinction is found with the Mono Craters debitage (Table 6.8:D) rather than the tools.

Secondly, the hydration values of Mono Craters tools and debitage in the intermediate group (1960-1980 m) are significantly different. Nearly 40% (n=29) of the debitage comes from the northeast quadrant, while the remaining debitage (n=45) and most of the tools (n= 30; 85.7%) are from the southwest sector, which is generally younger. Spatial discrepancy in artifact deposition implies that these areas saw use during different lakestands, first mainly in the northeast, then later predominantly in the southwest.

Table 6.8. Obsidian Hydration T-tests Comparing Elevation Swaths^{+}.

A. pooled hydration measurements by swath

	num	Mean	s.d	min	max
<1960	73	4.9	2.1	1.4	11.5
1960-1980	105	4.8	2.2	1.5	13.5
1980-2000	67	5.3	2.0	1.4	8.9
>2000	11	5.0	1.5	2.2	7.6

B. t-test comparing swaths (all sources)

	t-value	d.f.
<1960/1960-80	0.05	176
<1960/1980-00	-1.31	138
<1960/>2000	-0.27	82
1960-80/1980-00	-1.39	170
1960-80/>2000	-0.28	114
1980-00/>2000	0.43	76

C. t-test comparing swaths (MC)

	t-value	d.f.
<1960/1960-80	-0.78	145
<1960/1980-00	-2.53*	100
<1960/>2000	-1.35	54
1960-80/1980-00	-1.76	153
1960-80/>2000	-0.71	107
1980-00/>2000	0.14	62

D. t-test comparing swaths (MC)

Debitage	t-value	d.f.
<1960/1960-80	-0.81	99
<1960/1980-00	-2.20*	79
<1960/>2000	-1.01	39
1960-80/1980-00	-1.16	114
1960-80/>2000	-0.30	74
1980-00/>2000	0.33	54
Tool-Debitage		
<1960	-1.57	45
1960-1980	-2.24*	98
1980-2000	-1.83	53
>2000	-	-

E. <1968/>1968

All Sources	-3.98*	254
Mono Craters	-5.91*	209

$^{+}$ Elevations in m asl.; MC = Mono Craters; d.f.= degrees of freedom; * denotes values that are significant at α=.05.

Figure 6.3 illustrates one final note about the temporal pattern with artifact elevation, which shows the cumulative distribution of artifacts by elevation. Here there appears to be a bimodal distribution of artifacts, with most falling either below ca. 1965 m or above ca. 1970 m, but with flake tools having a more continuous distribution. This pattern can be assessed with the obsidian hydration data. Splitting the assemblage in half at 1968 m, which is the middle of the apparent gap, t-tests comparing the pooled hydration sample yields significant differences (Table 6.8:E). Again, these are due to Mono Craters debitage (t= -5.91; df=155; p<.05), where similar to the pooled sample the

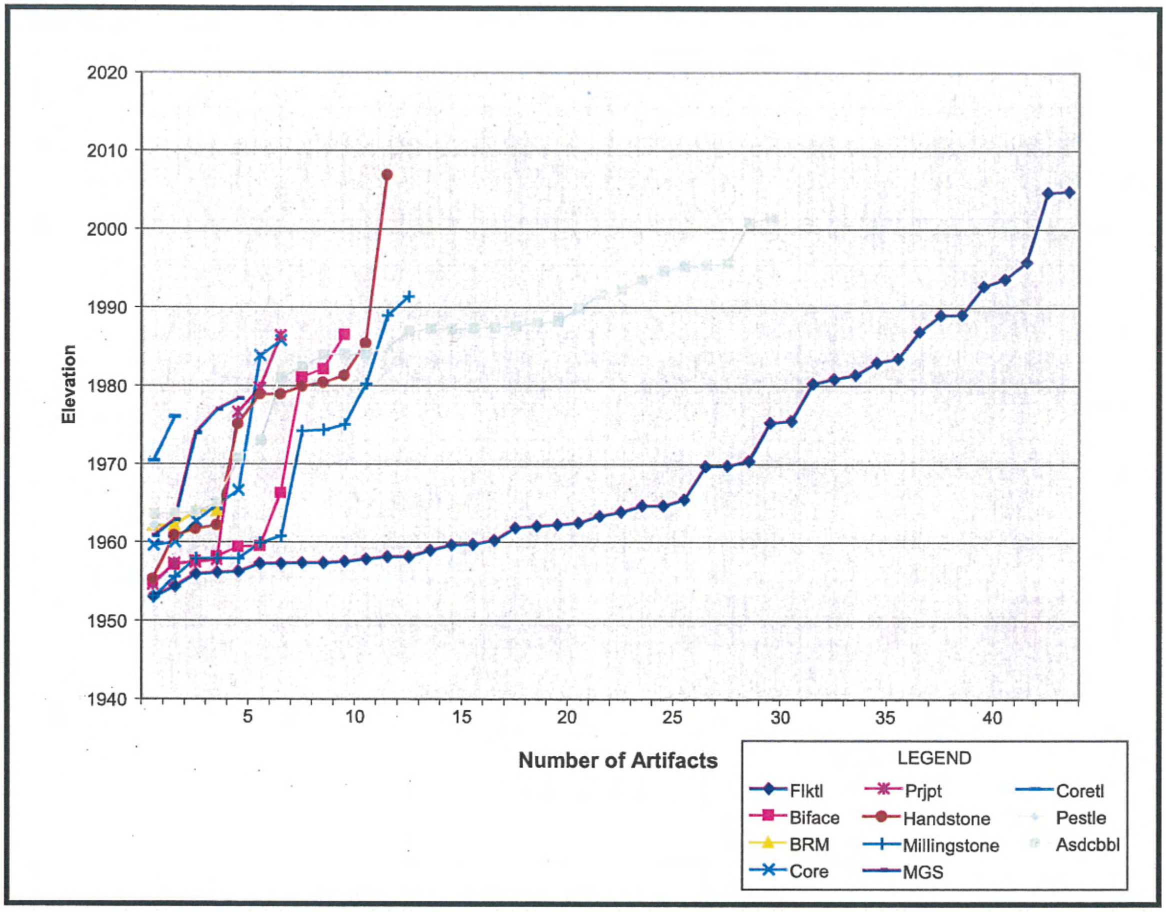


Figure 6.3. Tool Distribution by Elevation.

lower half is younger (x̄=4.4μ) than the upper half (x̄=6.0μ). As noted previously, this could be due to differential erosion and deposition affecting artifact visibility. In fact, Stine's Clover Ranch High Stand (Stine 1990:374) that occurred at ca. 296 B.P. reached just under 1968 m, and earlier high stands reached other points between that elevation and the current lake level (Figure 2.3). That the lower two strata (below 1980 m) contain items with hydration values greater that 10.0μ suggests that these elevations were subject to use during earlier temporal periods, even though the intensity of occupation clearly increases in more recent times.

Temporal Components. Studying the elevation distribution of converted hydration readings by component and correcting for time, also reveals significant variability (X^2=37.58; df=24; p<.05) (Table 6.9:C). Again, the small TP/EH sample suggests general use across elevation class, although only the lowest two classes contain these readings. The pre-Newberry IV period shows intensive use in the lowest elevation class, below 1960 m. These earliest hydration measurements are from the northwest quadrant and would be associated with declining lake levels. Interestingly, significant elevations for PN-III, PN-II, and PN-I suggest that people positioned themselves back from the lakeshore while it remained at its low stand, readjusting their location as the lake rose up to the Dechambeau High Stand (1981 m). The NW-II period finds use dropping in elevation along with the lake. Variation in elevation from NW-I through the Marana reflects first toolstone acquisition from the southwestern brackish units (NW-I), then differential positioning as a reaction to more rapid late Holocene lake fluctuations. The focus on lands below 1960 m during the Marana period is interesting because during this time, the lake shoreline fluctuated between three low stands (two were as low as 1945 m) and three high stands (two exceeding 1960 m). This appears to reflect a greater emphasis on near-shore wetland habitats. Activities are most intensively focused in the northwest quadrant, where just under half (48.6%; n=17) of the tools collected from this stratum were found.

Table 6.9. Temporal Distribution Across Elevation Swaths at Mono Basin Wetlands.

	Hydration Frequencies								
	MR	**HW**	**NW-I**	**NW-II**	**PN-I**	**PN-II**	**PN-III**	**PN-IV**	**TP/EH**
A. Elevation Count									
<1960m	15	16	19	6	8	4	1	2	2
1960-80	28	20	18	19	10	4	5	-	1
1980-2000	11	11	16	8	11	8	1	1	-
>2000	1	2	5	2	1	-	-	-	-
Total	**55**	**49**	**58**	**35**	**30**	**16**	**7**	**3**	**3**
B. Elevation Corrected*									
<1960	23.1	22.9	20.5	6.5	10.0	4.0	1.0	1.3	0.4
1960-80	43.1	28.6	19.5	20.5	12.5	4.0	5.0	-	0.2
1980-2000	16.9	15.7	17.3	8.6	13.8	8.0	1.0	0.7	-
>2000	1.5	2.9	5.4	2.2	1.3	-	-	-	-
Total	**84.6**	**70.1**	**62.7**	**37.8**	**37.6**	**16.0**	**7.0**	**2.0**	**0.6**
C. Elevation Corrected Residual									
<1960	2.91	0.12	0.12	-2.11	-0.77	-0.62	-1.02	1.00	0.57
1960-80	-3.82	1.42	-0.52	2.85	-0.08	-0.77	2.13	-1.01	-0.01
1980-2000	1.23	-1.47	-0.34	-0.96	1.07	1.87	-0.89	0.18	-0.50
>2000	-0.52	-0.28	1.63	0.33	-0.40	-0.92	-0.60	-0.32	-0.17

*Count corrected for 1000 years. MR = Marana (100-650 B.P.); HW = Haiwee (650-1350 B.P.); NW-I = Newberry I (1350-2275B.P.); NW-II = Newberry II (2275-3200 B.P.); PN-I = pre-Newberry I (3200-4000 B.P.); PN-II = pre-Newberry II (4000-5000 B.P.); PN-III = pre-Newberry III (5000-6000B.P.); PN-IV = pre-Newberry IV (6000-7500 B.P.); TP/EH = Terminal Pleistocene/Early Holocene (7500-12,500 B.P.).

Artifact Distribution. In addition to the temporal patterns of use by elevation, one may turn to artifact distributions to see how they relate to past lake levels. Artifact aggregations at certain elevations may reflect more intensive periods of use during particular lake stands, while dispersion may demonstrate a more even distribution of land-use relative to the lake.

Returning to Figure 6.3, which shows the cumulative distribution of tools by elevation, there is the noted bimodal tendency for artifacts to cluster below ca. 1965 m and above 1975 m. This relates to two different periods of use. The upper elevation is linked mainly to artifacts from the northeastern quadrant, where hydration readings point to use emphasis during the PN-III to PN-I, while measurements from the lower elevation group are largely from the southwest sector and dates principally to the Marana interval. Flake tools have a generally continuous distribution but cluster toward lower elevations. This pattern relates to more frequent discard of such items in the place of use, rather than returning it to specific task areas.

Grouping tools into four elevation categories of ca. 20 m to the total area surveyed, a significant Chi-square statistic is calculated (X^2= 67.41, df= 30; p< .001) (Table 6.10). Most of the flaked stone tools, including projectile points, bifaces, and flake tools, are found at highly significant frequencies below 1960 m. Projectile points are relatively common above that elevation although they are somewhat scarce in the 1980-2000 m stratum. Flake tools are conspicuously rare at high levels in the 1980-2000 m stratum, but are relatively common in the groups immediately above and below the stratum. Bifaces, which are frequently below 1960 m, are significantly absent from 1960-1980 m, but occur at expected frequencies above that. Cores and core tools diverge from these other items since they are relatively common across all elevation classes. Assayed cobbles, whose location is most often related to the geologic availability of raw material, are absent from the lowest strata but slightly and highly over-represented at 1960-1980 m and 1980-2000 m, respectively. They may be viewed as common in the

Table 6.10. Tool Distribution and Adjusted Residuals Across Elevation Swath.

	PPT	COR	BIF	FTL	HND	MIL	PST	MGS	BRM	ASC	CRTL	Total
Elevation count												
<1960	4	1	6	15	1	4	-	-	-	-	-	31
1960-1980	2	4	1	15	7	4	1	5	4	6	2	51
1980-2000	1	2	3	8	3	3	-	-	-	22	-	42
>2000	-	-	-	2	1	-	-	-	-	2	-	5
Totals	**7**	**7**	**10**	**40**	**12**	**11**	**1**	**5**	**4**	**5**	**2**	**129**
Residuals												
<1960	2.11	-0.62	2.77	2.40	-1.34	1.00	-0.56	-1.28	-1.14	-3.52	-0.80	
1960-1980	-0.61	0.98	-1.99	-0.32	1.40	-0.22	1.24	2.82	2.51	1.76	-2.50	
1980-2000	-1.06	-0.23	-0.18	-2.04	-0.59	-0.39	-0.70	-1.58	-1.41	5.44	-0.99	
>2000	-0.55	-0.55	-0.66	0.44	0.84	-0.70	-0.20	-0.46	-0.41	0.90	-0.09	

PPT = projectile point; COR = core; BIF = biface; FTL = flake tool; HND = handstone; MIL = millingstone; PST = pestle; MGS = miscellaneous ground stone; BRM = bedrock mortar; ASC = assayed cobble; CRTL = core tool; elevation is m asl.

sample above that elevation. Again, this occurrence is found within the southwest quadrant.

Bedrock mortars and miscellaneous ground stone are the only milling tool classes that vary significantly, both with respect to the 1960-1980 m interval. Both are somewhat uncommon immediately below and above this group, having expected frequencies above 2000 m. With the bedrock mortars, pestles are slightly more frequent than expected in the 1960-1980 m group, where their absence from other elevation swaths is expected. Millingstones appear somewhat common below 1960 m, while handstones are scarce at the same elevations. Millingstones are present above 1960 m, and handstones are found in the 1960-1980 m strata slightly above expected frequencies, and are generally common above that elevation.

Together, the flaked and ground stone artifacts show differing levels of clustering by elevation. In contrast with the flaked stone tools, which are most common below 1960 m, most ground stone artifacts occur between 1960 m and 1980 m; breaking with this pattern, millingstones attain their greatest relative frequencies within the lowest strata. These distributions highlight the importance of near-shore wetlands to prehistoric populations. Obsidian hydration data point out that this lowest stratum shows its strongest emphasis of use during the Marana period in the northwest quadrant, although tools with earlier hydration bands are also found here. Ground stone is more common between 1960-1980 m, while flaked stone tools show a decreasing emphasis. Tools falling within this interval are most prevalent in the northeast sector. Obsidian hydration data suggest that these commonly date to the more recent three parts of the pre-Newberry period. Also of note is the paucity of artifacts above 2000 m. This implies the importance of the near-shore habitats to aboriginal populations of the region, as the highstand ca. 3800 B.P. was at ca. 1981 m, with the lake being lower both before and after this time (Benson et al. 1990; Stine 1990:365).

This highstand corresponds to the PN-I interval. As lake elevation rose, these relatively wetter times would have been productive in the generally more arid eastern, saline habitats. The low slope gradient, lagoons, and expansive marsh wetland habitat that likely formed would have made this area productive for hunter-gatherers traveling through the basin. With lakeshore decline, previously expansive wetlands would likely become unvegetated due to lack of moisture and poor soil leaching qualities. Later Haiwee and Marana times experienced more rapid elevation fluctuation, yet edaphic and phreatic qualities in the western area allowed wetlands to migrate successfully. This includes much of the freshwater and northern brackish habitats. Obsidian hydration data (Table 6.9:C) generally supports the movement of people's activities along with shoreline fluctuations. The elevation of highly significant hydration frequencies appear to fluctuate in relation to the lake curve (Figure 2.3).

Discussion

Together, the t-test analysis of obsidian hydration readings, hydration values converted to temporal components, and the distribution of artifacts compared by wetland class, quadrant, and elevation establish a pattern of dynamic changes in prehistoric land-use relative to the near-shore wetlands of Mono Lake. Initial occupation during the

TP/EH is ephemeral, but then focuses in the northwest sector at lower elevations during the PN-IV. Artifacts in the northern brackish wetlands are flaked stone tools manufactured from non-local obsidian. The small sample suggests short-term use; however, the items are all tools and may reflect to small group size along with tool use, but relatively little tool production. Exploitation of this area appears to have coincided with a rapid decrease in lake level, as identified through the lake fluctuation curves documented here and in other regional basins.

When the lake stabilized at its low stand (ca. 6000 B.P.), use shifted to saline habitats, mainly in the northeast. During this time of low but stable, then rising lakeshore, it appears that wetlands had time to establish due to artesian spring seepage at places such as Warm Springs and Simon's Spring (as seen in quadrat B35). This seepage created a productive and relatively expansive marsh wetland. As the lake began to rise to its high stand during the PN-II/PN-I interval, land-use shifted to upper elevations as groundwater percolation during these wetter times allowed the eastern wetlands to migrate upward with the lakeshore.

This focus of activity in the northeast is also supported by the t-tests comparing wetlands and basin quadrants. Debitage is significantly older than tools deposited in the saline wetlands and the eastern half of the basin, pointing out different patterns of land-use. The intensity of tool discard clearly shows major unevenness over time. In the pre-Newberry era, important tools appear to have been projectile points and bifaces. Probably curated, such artifacts may have been part of a highly mobile toolkit and used for hunting and butchering waterfowl, antelope and other animals found in the local environment.

Debitage is primarily biface reduction debris, which also supports the prevalent use of bifaces. There is greater mobility indicated in the saline wetland and northeastern quadrant because they contain the greatest toolstone diversity of the sample (Table 4.3). Tools found more commonly at higher elevations than in other wetlands also supports artifacts being associated with the lakeshore fluctuation. Millingstones and handstones found in slightly elevated amounts suggest that plant processing played a role in subsistence through the use of hard seed resources. Further importance of these habitats for plant processing is seen in a flaked-to-ground stone tool ratio (1.28:1) that is the lowest of the three wetland groups.

The lake receded during pre-Newberry I and Newberry II times, culminating in the Marina Low Stand (1941 m) at ca. 1850 B.P. During this time of less effective moisture, the saline wetland would have difficulty migrating onto the newly exposed lakebed due to high soil alkalinity and poor leaching capabilities. The emphasis of use during NW-II and NW-I times shifted from the northeast to the southwest quadrant as toolstone procurement became an important activity in the southern brackish habitats. This is manifested in large quantities of assayed cobbles and obsidian debitage that emphasize decortication and percussion debris in the southwest quadrant. Emphasis on raw material acquisition is demonstrated by temporal use focused above 2000 m in the southwest sector during the NW-I. During this time, the lake reached a low stand at 1941 m (the Marina Low Stand).

The lake underwent several relatively rapid fluctuations from the low stand attained toward the end of the Newberry period and into Marana times. These would have made it difficult for wetlands to migrate onto newly exposed lands, especially in the more arid eastern basin. Exceptions would be where there was a relatively large amount of flowing freshwater along with conditions that allowed for leaching lake-deposited minerals from newly exposed shores. Areas that fit this description correlate to places where occupation was most intensive. During the Haiwee interval, land-use shifted from the southwest quadrant and brackish habitat into the southwest freshwater zone. During this time, quadrats which also contain ground stone were used with greater frequency into the Marana period, suggesting an intensification on plant processing (Table 5.22).

Geography and geomorphology affect the distribution of economically important resources within the basin, thereby also directing the arrangement of certain artifact types. This is seen in the prevalence of millingstones and handstones in the northern area with bedrock mortars more common in the southwestern quadrant. The divergence happened because different habitats promote the growth of plants which may be more easily processed using one technology rather than another. For example, millingstones are most often believed to have been used to process hard seeds, but may also have been applied certain root crops (cf. Delacorte 2002). In contrast, bedrock mortars were commonly used to process other wetland plants such as berries, roots, tubers, as well as acorns traded from the western Sierra Nevada. That temporal use of the areas where these technologies were found is different suggests that millingstones and handstones were more exclusively used in Haiwee and earlier times. During the Marana period people included the use of bedrock mortars more often.

During Marana times, land-use focused in the southwestern freshwater habitat where one also finds the greatest tool densities along with bedrock mortar and pestle technology. Cores and flake tools are important items with debitage and flake tools predominantly made through percussion-based technology. The large quantities of tools and debitage suggest more long-term or recurrent use of the southwestern area than seen in earlier times.

Use-intensity by elevation mostly fluctuates below 2000 m, reflecting how people positioned themselves relative to changing lake levels. Areas exploited with the greatest intensity at different locations around the lake vary due to habitat productivity that changes as a result of lake fluctuations. Other factors relate to changes in resource focus as well as duration and season of occupation. In addition, the higher incidence of hydration readings corrected for time in quadrats that contain ground stone suggests that these technologies became much more important in Haiwee and Marana periods than they had been previously because greater residential stability required an expansion of the diet breadth.

Changes in technology and land-use patterns have been identified within wetland areas around Mono Lake. To understand the mobility range that may have been practiced during these times and how they may have influenced these patterns provide another facet to understanding the role that the wetlands played for people in the past. Following is a discussion of stone material diversity found around Mono Lake and its relationship to prehistoric use of wetland habitats.

Obsidian Distribution

Artifact distributions changed through time in many wetland contexts at Mono Lake. There were differences in activities undertaken within the basin, and differing mobility strategies practiced throughout the Holocene. Stone tool material variability in conjunction with changes in artifact dispersion offers a useful indicator of prehistoric mobility patterns and prehistoric lifeways.

Temporal Distinctions

While t-test evaluations identified Mono Craters debitage as being more temporally sensitive than tools made from the same glass, small samples made it difficult to evaluate the five remaining sources in this manner. Furthermore, t-tests suggest that saline habitats exhibit the highest level of use early on, followed by the brackish, with freshwater habitats having the most intensive occupation in more recent times. Correcting for variable hydration rates and placing each item into one of nine temporal components roughly duplicated t-test results. One difference was found in that the brackish habitat actually demonstrates greater early use (>6000 B.P.) in the northwest sector. From here, land-use shifted to saline contexts, then back to brackish wetlands before being more intensively focused in the southwest freshwater region for the most recent two temporal intervals.

As far as obsidian source distribution and diversity is concerned, two patterns have been argued to be evident in the Inyo-Mono region and surrounding areas. The first more general one is for decreasing obsidian source diversity through time (cf. Basgall

1989). This pattern has been frequently encountered in the Owens Valley in excavated assemblages (Basgall and McGuire 1988; Basgall et al. 2003; Delacorte 1999; Zeanah and Leigh 2002), although it may not hold true in near-quarry contexts, where locally available material appears to dominate assemblages throughout time (Basgall 1983; King et al. 2001). Differences in source diversity by temporal component are argued to represent varied patterns of mobility with the earlier, diverse materials representing a more wide-ranging settlement pattern where people often used whatever material was locally available, be it obsidian, basalt, cryptocrystalline, or other stone types. The Newberry period is found to exhibit more standardized source distributions with fewer unknown obsidian sources or a variety of non-obsidian material being present. More recent times demonstrate decreased source diversity with emphasis on more local materials implying a reduction in residential mobility. Contrarily, in the southern Owens Valley some late period sites exhibit source diversity that mirrors that of earlier deposits (Delacorte 1999; Delacorte et al. 1995). This appears to be due not to wide-ranging mobility, but rather the result of scavenging earlier archaeological deposits, which present greater source diversity.

A second pattern of source distribution that is thought to be prevalent in the region is one of decreasing source presence the further away from a source one is. It is often termed the linear distance-decay model (cf. Gilreath 2001). The model describes the relative presence of a particular source to decrease the further away one moves from it and has been identified in several central-eastern California contexts (Basgall 1983; Bieling 1992; Fredrickson 1991; Gilreath and Hildebrandt 1997; Goldberg et al. 1990;

Halford 1998; Overly 2002, 2004). In the Mono Basin, Richman and Basgall (1998) found Mono Craters/Mono Glass Mountain obsidian to be most common south of the lake along Highway 120, followed by Casa Diablo. Along Hwy 167 to the north, Bodie Hills was the most common source.

Other studies in the Mono Basin have shown that source distributions shift from the prevalence of Casa Diablo in older (Newberry) components, with more recent ones dominated by Mono Craters/Mono Glass Mountain obsidian (Bettinger 1981; McGuire 1994; Wickstrom and Jackson 1993). These latter two sources are grouped because initial non-destructive sourcing studies were unable to distinguish the two, but this problem has been overcome (Hughes 1989). Additionally, Hull (2002a, b) identified a similar pattern of changing source use in Yosemite Valley, west of the Mono Basin.

Returning to the present sample, previous arguments suggest that in the Mono Basin, one may expect to find the greatest source diversity among older artifacts, with more recent hydration values being predominantly from Mono Craters obsidian. Likewise, source distributions should vary around the basin with Mono Craters or Casa Diablo being prevalent in the southwest (possibly varying by time), Bodie Hills in the northwest, Mt. Hicks in the northeast, and Truman Queen/Mono Glass Mountain in the southeast, along with Mono Craters obsidian.

To assess temporal patterns of obsidian procurement and use in the total sample, the six obsidian sources were compared by their temporal distributions as seen by the hydration values converted to temporal components (Table 6.11). These data made it apparent that the sources do not pattern out as neatly as expected, with non-local sources being common earlier and the local glass assuming prominence in recent times. Rather, it appears that Mono Craters glass was used with greatest prevalence through most of the Holocene, from PN-III, along with more limited use of the remaining obsidian sources.

Table 6.11. Temporal Distribution of Obsidian Sources and Tools.

	Hydration Frequencies								
	MR	**HW**	**NW-I**	**NW-II**	**PN-I**	**PN-II**	**PN-III**	**PN-IV**	**TP/EH**
A. Toolstone Distribution									
Casa Diablo	2	3	2	2	-	-	-	1	1
Mono Craters	46	36	51	29	27	14	7	-	1
Bodie Hills	3	4	2	1	2	1	-	1	-
Mt. Hicks	3	3	3	-	1	1	-	1	1
MGM	-	1	-	3	-	-	-	-	-
Truman-Queen	1	2	-	-	-	-	-	-	-
Total	**55**	**49**	**58**	**35**	**30**	**16**	**7**	**3**	**3**
B. Tool Distribution									
Projectile Point	-	5	-	1	-	1	-	-	-
Biface	1	5	5	1	1	-	1	1	1
Flake Tool	20	11	11	5	3	2	1	2	1
Core	3	3	2	-	1	-	-	-	-
Total	**24**	**24**	**18**	**7**	**5**	**3**	**2**	**3**	**2**

MR = Marana (100-650 B.P.); HW = Haiwee (650-1350 B.P.); NW-I = Newberry I (1350-2275B.P.); NW-II = Newberry II (2275-3200 B.P.); PN-I = pre-Newberry I (3200-4000 B.P.); PN-II = pre-Newberry II (4000-5000 B.P.); PN-III = pre-Newberry III (5000-6000B.P.); PN-IV = pre-Newberry IV (6000-7500 B.P.); TP/EH = Terminal Pleistocene/Early Holocene (7500-12,500 B.P.).

To better understand the use of local vs. extra-local materials, non-Mono Craters obsidians were grouped and compared against the local source (Table 6.12). These were corrected for time span, with a Chi-square statistic and adjusted residuals outlining differences within the sample (X^2=19.24; df=8; p<.025). It is now apparent that extra-local sources are more common before 6000 B.P., with MC being more commonly used in the Mono Basin thereafter.

Table 6.12. Temporal Distribution of Mono Craters vs. non-Mono Craters Obsidian.

	Hydration Frequencies								
	MR	HW	NW-I	NW-II	PN-I	PN-II	PN-III	PN-IV	TP/EH
A. Toolstone Distribution									
Mono Craters	46	36	51	29	27	14	7	-	1
non-Mono Craters	9	13	7	6	3	2	0	3	2
Total	**55**	**49**	**58**	**35**	**30**	**16**	**7**	**3**	**3**
B. Toolstone Distribution Corrected for Time by Period*									
Mono Craters	708	514	551	314	338	140	70	-	2
non-Mono Craters	138	186	76	65	38	20	-	20	4
Total	**846**	**700**	**627**	**379**	**376**	**160**	**70**	**20**	**6**
C. Adjusted Residuals of Hydration Values Corrected for Time									
Mono Craters	0.78	-7.46	3.75	0.02	3.87	1.61	3.85	-9.85	-3.22
non-Mono Craters	-0.78	7.46	-3.75	-0.02	-3.87	-1.61	-3.85	9.85	3.22

* Count corrected for 1000 years. MR = Marana (100-650 B.P.); HW = Haiwee (650-1350 B.P.); NW-I = Newberry I (1350-2275B.P.); NW-II = Newberry II (2275-3200 B.P.); PN-I = pre-Newberry I (3200-4000 B.P.); PN-II = pre-Newberry II (4000-5000 B.P.); PN-III = pre-Newberry III (5000-6000B.P.); PN-IV = pre-Newberry IV (6000-7500 B.P.); TP/EH = Terminal Pleistocene/Early Holocene (7500-12500 B.P.).

One outlier of this pattern is present in the Haiwee interval where the residuals suggest a significant presence of non-local obsidian relative to the sample. While Mono Craters is still more common than the other sources, there is a relative increase in the presence of non-local sources. This may be explained through artifact scavenging from earlier deposits. Quadrats that contained this "fluorescence" of Haiwee usage in the northwest (B112, B134) also contained diverse obsidian toolstone spanning the Holocene epoch. Since these are surface deposits, items could be easily scavenged by people reusing the area, which is suggested by the incidence of multiple hydration bands on some of these items. Moreover, increased presence of non-local material in the HW interval may also be due to the fact that five of the seven projectile points in the present sample date to this period, and none are manufactured from Mono Craters obsidian. That the MR period appears to represent equal use of local and non-local obsidian relates to a continuation of the scavenging patterns from varied deposits around the basin.

Spatial Distinctions

Toolstone diversity found across tool types is rather even, with projectile points, bifaces, and flake tools manufactured from five distinct obsidian sources and an additional four flake tools fabricated on non-obsidian material (Table 4.3). Cores are restricted to the local Mono Craters obsidian and debitage is present in all six sources along with cryptocrystalline and basalt materials; however, the bulk of debitage is from Mono Craters.

Grouping toolstone materials by source (Table 4.3), the freshwater region has the most restricted source diversity containing mostly Mono Craters obsidian along with one Truman-Queen and non-obsidian specimen each. In contrast, the saline wetlands have the greatest source diversity with all six sources and non-obsidian materials represented. The brackish habitat is similar, lacking only Mono Glass Mountain obsidian. This distribution, when compared to the rough age ranges ascribed to the wetland habitats, supports a notion of decreasing source diversity through time, with the most intensively oldest (saline) being the most diverse, and the youngest (freshwater) the least diverse.

If one turns to the adjusted residuals (X^2=41.39; df=12; p< .001), a pattern contrary to common notions of a distance-decay model for obsidian distributions is apparent. For example, Casa Diablo is closest to the southern sections of the basin but is entirely absent there. Instead, it achieves a high representation in the saline units, which are furthest away. Likewise, Mt. Hicks obsidian, whose source is found northeast of the Mono Basin, should be prevalent in the saline habitat under a distance-decay model. It is actually better represented in the brackish wetlands.

Looking at the data by quadrant, there is a stronger pattern. Casa Diablo obsidian only occurs in the northern half of the basin, where it is significantly over-represented in the northeast sector. Moreover, Mt. Hicks along with Bodie Hills is significantly over-represented in the northwest. This latter, along with Mono Craters, and Mono Glass Mountain better conform with expectations of the distance-decay model. Truman-Queen distribution occur in all but the southeast quadrant, which is the closest to its source location; however, the sample is small.

Looking at the distribution of obsidian sources across space and time indicates that temporal use of an area (or archaeological deposit) affects the distribution of stone materials present rather than simple geography. Proximity of an obsidian source does not necessitate that it assumes prominence in an archaeological assemblage. It may occur with a source at closest proximity or most prominant within the local geography; however, others that are nearby may or may not be present in an assemblage. Obsidian sources present in an archaeological context appear to be related to factors other than strictly linear distance. Among these include the antiquity of activities related to artifact deposition, as well as more recent scavenging of the deposits.

Given the assumption that stone tool diversity is an indicator of mobility range, predictions were confirmed with the earliest use of brackish and saline habitats exhibiting the greatest stone diversity. Following this, the brackish habitat shows recurrent occupation and hydration measurements are from items whose source diversity mirrors that of the earlier samples. Freshwater wetlands demonstrate the most intensive recent temporal use and exhibit the least source diversity of the sample, suggesting that at this time people were not as residentially or logistically mobile as they had been previously.

CHAPTER 7

CONCLUSIONS

The results of the present study lead to several conclusions, some expected and others unexpected. In the greater Inyo-Mono region a pattern of resource intensification has been identified. This is most well documented in Owens and Deep Springs valleys to the south, where people had initially focused on lowland resources but later began to more intensively use upland resources, such as pinyon, to supplement foodstuffs acquired in the lowlands. The current study sought to identify changing patterns of land-use in a single macro-environmental context, the near-shore wetland habitats around Mono Lake. At a more fine-grained level, this habitat was segregated into three different types, freshwater, brackish, and saline. Wetland classes were derived from biological and geomorphological studies.

Expectations were that the freshwater habitats would be the focus of initial use in the region, followed by the brackish, and lastly the saline habitats. This was expected because current vegetation distributions were most diverse and dense in the freshwater, and least so in the saline habitats. The number of animal species varied in the same manner across wetland class as well. If resource intensification occurred through a widening of the diet breadth, saline habitats would be expected to be the last exploited, because they contain mainly low-ranked seed resources, although seasonally abundant resources (e.g., brine fly pupae, waterfowl, and eggs) may have made them periodically lucrative habitats. Additional expectations were that earlier use of the basin would have a more restricted artifact assemblage due to less intensive and more short-term use of the study area. By contrast, recent assemblages would be more diverse, indicative of more extended occupation and potentially even year-round residency.

Data were collected through stratified surface survey of 10 km^2. All flaked stone artifacts were collected and analyzed including a debitage sample. Studies of artifact morphology and use-wear provided information about differences in use of wetland habitats, although some characteristics were more evenly distributed. For example, flake tools were found to be made using different techniques in each of the three wetland classes, yet use-wear attributes exhibited little variance. Likewise, millingstones were found in all quadrants of the basin, and use-wear attributes appeared to be relatively similar across space.

Chronological control across the study area was attained through the use of obsidian hydration analysis. All 214 collected cultural items fabricated from obsidian (aside from one assayed cobble) underwent obsidian source analysis using visual methods in conjunction with geochemical sourcing as a check on the visual ascriptions. Following this, all items underwent obsidian hydration analysis. Using t-tests to identify patterns of hydration variability, as well as source-specific hydration rates to place the items into chronological components, the temporal structure of wetland use in the Mono Basin was achieved.

T-tests identified Mono Craters debitage as being the most temporally sensitive across wetland classes, geographic area, and elevation. Correcting for variable hydration rates and placing the items into temporal components allowed for more standardized comparison across regions with variable toolstone diversity. In a general sense, earliest intensive use of wetland habitats was found in the northwest brackish area (PN-IV) with focus shifting to the saline habitats during the pre-Newberry III, II, I, and Newberry II. From the Newberry II to the Newberry I periods, land-use shifted to the southwest brackish units. The most intensive use of freshwater habitats was seen in the Haiwee and Marana times.

Spatial distributions of the artifacts provide more insight into the different uses of near-shore wetland habitats. Of note, bifaces and bifacial flaking debris were more common in saline habitats relative to others. This observation demonstrates the importance of this technology in earlier times. Likewise, millingstones and handstones are common in the northern half of the basin but notably under-represented in the southern half. This appears related to environmental variability as well as temporal use of these grinding tools. Comparison of quadrats with ground stone to those containing only flaked stone show an increase in the association of Haiwee and Marana hydration readings with ground stone artifacts. In contrast, quadrats containing only flaked stone experienced the heaviest use during earlier times. The slight over-representation of grinding tools in saline contexts, which exhibit heaviest use in PN-III through NW-II times, may be related to the same periods of use, or, alternatively, the milling equipment may have been brought in during later intervals. Bedrock mortars were identified in the southwest portion of the basin, whereas they were absent from the other regions surveyed. The intensive use seen in the southwest freshwater habitat during the Marana period suggests that bedrock mortars may not have been commonly used until this time.

Additionally, grouping artifacts by elevation demonstrates that flaked stone tools are most prevalent below 1960 m, closer to the current lakeshore, while groundstone is more evenly distributed across elevation. Artifacts are notably sparse above 2000 m in the entire survey universe, other than the residues of obsidian raw material procurement.

This land-use pattern conforms to expectations derived from the lake fluctuation curve developed by Stine (1987; 1990), and others (cf. Bacon et al. 2006; Benson et al. 1990) for the Mono and other closed-lake basins. From the late Pleistocene/Holocene transition the lake elevation steadily dropped to a level likely below the current lake elevation, reaching a low stand sometime during the PN-IV or PN-III. This coincides with earliest use focused on the northwest brackish wetlands. As discussed earlier, it seems that this area would have had seasonally abundant wet meadow habitat that would migrate downslope as the lake receded due to the reliable water source of the Sierra Nevada mountains along with favorable soil leaching capabilities. The sample of items is small, yet appears to represent a high diversity of toolstone, as well as tools, rather than unmodified debitage. This suggests that small groups of people may have stayed for periods of time to acquire resources before moving on.

From the PN-III to NW-II interval (ca. 6000-2275 B.P.), land-use shifted mainly to the saline wetlands, where there is a significant presence of bifaces and bifacial flaking debris. That most of the older residues dating to this era are debitage, continues to reinforce the short-term use of the habitat characterized by brief occupation that probably targeted specific resources. The gradual increase in tool discard rates and the presence of milling equipment may be associated with this era as family groups spent longer periods of time in the basin. Much of this more ancient debris is located near or above 1981 m, which would have been in the vicinity of the lakeshore sometime around ca. 3800 B.P. Low slope gradient and artesian springs may have made this an extensive, productive wetland habitat for both plants and animals. Once established during the mid-Holocene low stand (ca. 6,000 B.P.), it is possible that the wetlands migrated upward as the lake transgressed to its high stand at 1981 m where it remained for some time. Wetlands here likely remained productive and relatively expansive during this era. As the lake began receding, the newly exposed lakebed would not quickly become revegetated because of the high mineral content in the soil and poor soil leaching capabilities that result from low freshwater inflow along with small sediment size. As discussed by Stine (1987:226), this led to the formation of the dune fields that exist there today.

The Newberry I era experienced a shift in use from saline to predominantly brackish and occasionally freshwater habitats. However, the significant increase in hydration readings from the southwestern brackish area appears to relate more to the importance of raw material acquisition than to residential activity. This pattern has been identified in other regional contexts in proximity to obsidian sources during this interval (Basgall 1983; Goldberg et al. 1990; Ramos 2000; Singer and Ericson 1977).

Haiwee and Marana times witnessed an increase in the use of freshwater wetlands. These contexts are marked by the greatest density of tool discard along with bedrock mortars, both implying more long-term use. Moreover, a prevalence of obsidian hydration readings associated with quadrats containing ground stone artifacts during this time suggests an increased importance of plant procurement in the diet. Additionally, extended occupation likely places greater importance on reliable sources of water which are most abundant in the southwestern area. In arid lands of the Western Desert in Australia, there is a noted pattern of decreased residential mobility being associated with more permanent sources of water, whereas earlier more mobile groups often utilized more ephemeral or seasonal water sources (Veth 2005). This appears to fit shifting patterns of land-use and occupation observed in the Mono Basin - one, a move from less to more reliable sources of freshwater; two, an increase in tool discard rates; three, the use of more expedient implements; and four, investment in permanent processing features. These lines of evidence suggest more intensive occupation in late prehistoric use of the near-shore wetland habitats at Mono Lake; however, lacking rock ring features, residential occupation presented by the sample appears less intensive than that observed at more shallow wetlands in the Great Basin (cf. Kelly 2001; Livingston 1986). This may be due in part to the area sampled being so restricted toward the lakeshore or to geomorphic processes obscuring the features.

It is interesting that the smallest micron value obtained on obsidian artifacts on the project is 1.4μ. Using the hydration rate for Mono Craters obsidian, this would put the last use of the near-shore area at ca. 133 years B.P., shortly after Europeans arrived in the Mono Basin. Protohistoric structures and animal drive corrals have been described further east of the project area (Arkush 1987, 1995), and it is possible that European disruption to the traditional native lifeway may have caused the *Kutzadika'a* to change certain aspects of their subsistence and settlement patterns; ethnographies assembled in the 1960s still note the use of the wetlands by native populations.

Finally, data derived from the current project appear to portray a pattern of resource intensification whereby prehistoric populations in the Mono Basin practiced changing patterns of land-use. Early in the Holocene, people traveled through the basin for short periods of time. This may have been to target seasonally abundant resources, such as waterfowl, eggs, antelope, or brine flies. By the middle Holocene (PN-III through PN-I) people spent more time in the saline habitats procuring animal and plant resources as well. As time progressed, local obsidian acquisition became important, with people spending more time in the vicinity of Mono Lake's wetlands. Intensive local obsidian procurement (NW-I) appears to pre-date the formation of Panum Crater (ca. 605 B.P.) (Sieh and Bursik 1986). Later, a broad suite of activities is represented, including those related to the procurement and processing of both plants and animals, as well as the production and discard of greater quantities of tools. The variety and density of activities represented depicts a people spending additional time around the lake. By the latest prehistoric times, different technologies were adopted and people were practicing a wider array of activities. They had an expanded diet breadth compared to earlier times. So from the earliest times people used the Mono Lake basin on logistical forays or short-term residential visits, while residues from later occupants appear to represent more prolonged use of the area by family groups.

These changes appear to be related to both environmental and demographic factors and are not consistent with a model of cultural stasis such as the "Desert Culture." Changing intensity of use around the basin, as well as differential rates of artifact discard, depict the varied strategies used by people to make a living in the Mono Lake basin.

Tools and debitage recovered on the project show that different settlement strategies were used to exploit Mono Lake wetlands throughout the Holocene. The effects of shifting strategies caused by environmental fluctuation as well as demographic increase in the region together created more competition over important resources. These factors encouraged successful hunter-gatherers in the Mono Lake basin to change the manner in which they lived throughout the past.

Appendix A. Sample Quadrats and Location.

Appendix A. Sample Quadrats and Location.*

Freshwater Unit Location

Unit #	Quad Sheet	mE:	mN:
F3	Negit Island	316050	4212700
F4	Negit Island	316050	4213200
F50	Lee Vining	316900	4201700
F58	Lee Vining	318400	4200700
F62	Lee Vining	318900	4201200
F64	Lee Vining	318900	4202200

Brackish Unit Locations

Unit #	Quad Sheet	mE:	mN:
B2	Lee Vining	321350	4200650
B3	Lee Vining	321850	4199650
B12	Lee Vining	322850	4200150
B21	Mono Mills	328550	4202200
B35	Mono Mills	330050	4204200
B36	Mono Mills	330550	4203200
B44	Mono Mills	331550	4204200
B66	Sulphur Pond	324550	4218200
B101	Negit Island	322050	4215700
B104	Negit Island	322050	4217200
B112	Negit Island	321550	4217700
B115	Negit Island	321050	4215700
B130	Negit Island	320050	4216200
B134	Negit Island	319550	4215200
B143	Negit Island	319050	4216700

Saline Unit Locations

Unit #	Quad Sheet	mE:	mN:
S7	Mono Mills	332550	4205700
S27	Alameda Well	337050	4213200
S42	Alameda Well	335550	4213200
S44	Alameda Well	335550	4214200
S49	Alameda Well	335050	4214200
S63	Sulphur Pond	333550	4210700
S88	Sulphur Pond	331050	4212700
S96	Sulphur Pond	330550	4215200
S102	Sulphur Pond	330550	4218200
S115	Sulphur Pond	330050	4217200
S116	Sulphur Pond	330050	4217700
S144	Sulphur Pond	329050	4217700
S165	Sulphur Pond	328050	4215200
S166	Sulphur Pond	328050	4215700
S171	Sulphur Pond	328050	4218200
S173	Sulphur Pond	328050	4219200
S180	Sulphur Pond	327550	4216700
S183	Sulphur Pond	327550	4218200
S208	Sulphur Pond	326550	4219700

*UTM coordinate system is NAD 27 zone 11 N.

Appendix B. Vegetation/Geomorphology Form.

Mono Lake Wetland Land-Use Study
Landform and Vegetation Data

Quadrat Designation:________ **UTM Coordinates:** Zone 11 mE:________ mN:_________
Archaeological Components: Prehistoric: _______ Historic: _______
Disturbances: Vehicle Tracks ______ Human Tracks______ Modern Trash_____
Description:

Geomorphology

Primary Landform:
- Exposed Lakebed_____
- Sandsheet_____
- Dune_____
- Wetland_____
- Lake____
- Other__________________

Secondary Landform:
- Exposed Lakebed_____
- Sandsheet_____
- Dune_____
- Wetland_____
- Lake____
- Other__________________________

Depressions/Old Lagoon: Yes No **Slope:** ____°
Description:____

____

____

Vegetation

Ground Cover: % barren____ % grasses____ % shrubs____ % trees____

Nearest water: Lake Stream Spring Marsh

Location:____

____

Primary Vegetation: Sagebrush Bitterbrush Rabbitbrush Saltgrass Greasewood
Willow Tule (Scirpus/Typha) Pinyon Juniper

Other:____

Secondary Vegetation: Sagebrush Bitterbrush Rabbitbrush Saltgrass Greasewood
Willow Sedge Tule (Scirpus/Typha) Desert Peach Pinyon
Juniper Foxtail Barley Ricegrass Wood Rose Grasses Herbs

Other:____

Vegetation Sample taken?____________

Description:____

____

____

____

Presence of Water: Lake Stream Spring Dry Creek
Description:____

____

Appendix C. Artifact Analytical Data.

Appendix C. Projectile Point Attribute Data.

ID	Unit	Mtrl.	XRF	Cond.	Wt.	Type	ML	AL	SL	MW	BW	NW	MTH	DSA	PSA	NOA	Use Wear	Stat.	Imp. Frac.	Comment
3577	B66	OBS	TQ*	WHL	0.8	DSN	32.1	29.4	7.0	12.1	12.1	6.2	3.0	215	999	35	0	0	0	
3584	B104	OBS	BH*	NC	1.0	RS	-20.7	-20.7	5.4	14.8	9.5	6.2	3.6	205	130	25	0	0	1	DST
3855	S63	OBS	BH*	WHL	1.1	DSN	29.4	24.5	9.5	15.4	15.4	8.0	3.1	205	170	25	0	0	0	
3907	B115	OBS	MH	NC	2.7	Elko-E	38.6	35.6	8.7	-20.7	16.0	9.8	4.9	210	155	50	0	1	0	
3920	B115	OBS	BH*	NC	0.6	DSN	16.2	13.9	8.9	-12.3	-12.3	8.4	3.3	200	140	60	0	0	0	
3975	S165	OBS	CD*	WHL	2.1	RS	36.4	36.4	4.4	15.0	8.3	7.5	4.3	215	120	85	0	1	0	Weathered
3981	S165	OBS	MGM	PRX	3.9	Elko C-N	-25.2	-24.2	8.7	25.1	-12.4	11.6	5.4	170	115	55	0	2	0	Weathered

Mtrl. = material (OBS = obsidian); XRF = source based on X-ray florescence (BH = Bodie Hills, CD = Casa Diablo, MGM = Mono Glass Mountain, MH = Mt. Hicks, TQ = Truman-Queen); Cond. = condition (NC = nearly complete, PRX = proximal end fragment, WHL = whole); Wt. = weight in grams; Type = point type (DSN = Desert Side-notched, Elko C-N = Elko Corner-notched, Elko-E = Elko Eared, RS = Rose spring); ML = maximum length; AL = axial length; SL = stem length; MW = maximum width; BW = basal width; NW = neck width; MTH = maximum thickness; DSA = distal shoulder angle; PSA = proximal shoulder angle; NOA = notch opening angle; Use Wear (0 = no evidence); Stat. = evidence of weathering and patina (0 = no evidence, 1 = slight, does not affect specific observation, 2 = yes, impedes observation); Imp. Frac. = evidence of impact fracturing (0 = no evidence, 1 = slight evidence). All measurements are in mm, negative values denote incomplete measurements.

Appendix C. Biface Attribute Data.

ID	Unit	Mtrl.	XRF	Cond.	Wt.	ML	MW	MTH	Stage	No. of Arrises	SPA	Shape	Size	Use Wear	Form	Comment
2208	F62	OBS	MC	END	12.5	-39.9	-30.6	-8.8	4	3	55	2,8	3	5E	9	
513	F62	OBS	MC	NC	21.7	-49.7	40.1	11.5	2	1	30	1,8	2	5E	2	
3643	B115	OBS	BH	WHL	28.0	71.3	38.8	9.5	2	2	30	3,2	3	1M,4M	2	
3644	B115	OBS	CD	END	7.1	-42.7	-30.7	-7.9	4	3	30	3,8	9	3E	2	reworked along break
4175	B134	OBS	CD	END	5.7	-45.5	-21.8	-6.1	4	3	45	2,8	2	3,5E	9	
3857	S63	OBS	BH	WHL	8.6	-38.9	-31.5	-7.3	2	4	45	2,3	1	3,5M	2	
4077	S63	OBS	MGM	MED	3.8	-29.9	-23.4	-7.1	3	3	40	9,8	9	9	2	
3691	S102	OBS	MH	NC	30.9	-81.8	38.9	7.6	4	4	35	1,8	3	4,5M	2	poss.haft
3983	S165	OBS	CD	PRX	11.6	-38.3	34.5	6.2	4	2	30	1,8	3	5E	9	
4000	S165	OBS	MH	NC	1.4	-22.7	-12.2	-3.2	4	3	25	8,8	2	9	9	RS?

Mtrl = material (OBS = obsidian); XRF = source based on X-ray florescence (BH = Bodie Hills, CD = Casa Diablo, MC = Mono Craters, MGM = Mono Glass Mountain, MH = Mt. Hicks); Cond. = condition (END = indeterminate end fragment, MED = medial fragment, NC = nearly complete, PRX = proximal end fragment, WHL = whole); Wt. = weight in grams; ML = maximum length; MW = maximum width; MTH = maximum thickness; Stage = reduction stage; No. of Arrises = number of arrises per cm; SPA = spine plane angle; Shape = end shape (1 = rectangular, 2 = convex pointed, 3 = convex rounded, 8 = unworked or snapped, 9 = indeterminate); Size (1 = arrow size, 2 = dart size, 3 = knife/blade size, 9 = indeterminate); Use Wear (1 = unifacial edge flaked, 3 = unifacial micro-chipped, 4 = bifacial micro-chipped, 5 = edge ground, 9 = indeterminate, E = end, M = margin); Form = original form (2 = flake base, 9 = indeterminate). All measurements are in mm, negative values denote incomplete measurements.

Appendix C. Flake Tool Attribute Data.

ID	Unit	Mtrl.	XRF	Cond.	Wt.	ML	MW	MTH	Flake Type	No. of Edges	Size	Edge Shape	Edge Modif.	Edge Angle
53	F58	OBS	MC	WHL	4.9	33.8	24.3	7.5	7	1	4	2A	1	35
286	F62	OBS	MC	PRX	89.1	-49.4	103.9	15.9	5	2	5	1A/1A	2/3	90//80
512	F62	OBS	MC	WHL	83.1	79.4	62.2	18.0	4	2	5	2B/2B	2,3,5/2,3,5	35/35
1158	F62	OBS	MC	NC	50.5	-61.3	-63.8	16.9	4	1	5	2B	2	45
1334	F62	OBS	MC	NC	29.2	-72.8	47.5	10.7	4	3	5	1A/1A/3A	1,3/1,3/1	75/80/40
1866	F62	OBS	MC	NC	22.8	-52.6	-40.5	-13.8	14	1	5	2A	1	35
1867	F62	OBS	MC	WHL	24.4	48.6	51.9	19.0	4	2	5	3B/2B	1,3,7/2,7	30/35
2478	F62	OBS	MC	WHL	3.6	34.8	20.5	5.6	7	2	4	3B/3A	1/1	25/55
2493	F62	OBS	MC	NC	205.6	111.7	89.8	23.6	2	1	5	1A	1	70
2592	F62	OBS	MC	NC	20.3	-66.5	28.9	12.3	6	2	5	3A/3A	1,3/1,3	50/60
2603	F62	OBS	MC	WHL	23.4	59.6	32.3	12.9	4	2	5	2B/2B	2,3/1,3	60/30
2605	F62	OBS	MC	PRX	36.9	-58.9	-48.3	13.3	5	1	5	2A	4,7	40
2633	F64	OBS	MC	WHL	6.2	32.2	29.4	7.0	5	2	4	3B/2A	2/2	40/20
3276	B2	OBS	MC	WHL	5.6	53.9	18.4	6.7	8	1	5	3B	1,3	35
3538	B36	OBS	MC	MRG	7.6	-35.0	-30.6	-5.9	4	1	4	2A	1,6	25
3596	B112	OBS	MH	WHL	7.5	45.0	26.8	8.4	8	2	4	2B/3A	1,3/1,3	25/25
3625	B112	OBS	BH	PRX	9.9	-39.4	-49.0	-7.9	4	1	5	2A	1,3	35
3641	B112	OBS	MC	NC	5.1	-35.0	47.8	4.6	8	2	4	3A/1A	1,2/2	25/20
3655	B115	OBS	MC	PRX	3.1	-23.3	22.6	6.1	8	1	3	3A	4	45
3660	B115	OBS	BH	NC	6.6	-38.2	27.4	6.8	8	2	4	3A/2A	2,4/2	45/40
3744	S165	CCR	-	WHL	12.5	60.6	30.5	6.6	8	2	5	3B/1A	2/1,2	25/40
3753	S165	CCR	-	DST	3.8	-16.2	-32.8	7.4	5	1	4	2A	2	70
3759	S165	OBS	MH	PRX	9.5	-35.6	33.6	7.8	1	1	4	2A	1,3	40
3776	S173	CCR	-	PRX	2.7	-30.4	-29.3	3.1	8	2	4	2,1A/3A	1/2	25/20
3888	B134	OBS	MH	WHL	3.3	38.8	25.4	3.2	8	1	4	3B	1	25
3889	B134	CCR	-	NC	0.7	26.2	15.5	2.1	8	3	3	2A/2A/3A	1/1,6	55/55/20
3901	B134	OBS	MC	WHL	2.2	33.1	25.8	4.0	7	2	4	1,2A/1A	2/2	25/30
3905	B134	OBS	MC	MRG	3.9	-43.0	-19.2	-4.8	14	3	4	2B/3A/3A	1,3/1	70/90/30
3919	B115	OBS	MH	WHL	11.2	48.8	28.3	7.5	5	2	5	3B/2B	4/3	35/35
4020	S27	OBS	MC	PRX	1.8	19.1	19.1	4.6	4	2	3	3A/3A	2/1	45/30
4067	S63	OBS	MC	NC	1.8	14.9	24.1	4.3	1	1	3	2A	2	60
4071	S63	OBS	TQ	NC	4.0	-38.7	-24.1	-4.9	1	1	4	2B	1	40
4095	S63	OBS	CD	MRG	4.1	-22.0	-31.3	-4.6	14	1	4	2B	2	25
4105	S63	OBS	MC	DST	3.7	-23.2	-29.7	-4.6	14	1	4	2B	2,5	20
4110	S63	OBS	MC	WHL	11.4	60.4	29.2	7.4	8	3	5	3,4B/2,4B/3B	2/1,2/1	30/30/25
4183	B21	OBS	MC	WHL	18.7	53.6	45.7	9.7	4	1	5	3A	1,6	30

Appendix C. Flake Tool Attribute Data (continued).

ID	Unit	Mtrl.	XRF	Cond.	Wt.	ML	MW	MTH	Flake Type	No. of Edges	Size	Edge Shape	Edge Modif.	Edge Angle
4188	B21	OBS	MH	WHL	8.3	43.7	26.2	8.8	4	3	4	3A/1,2A/2A	2/2,3/3	35/45/40
4283	F62	OBS	MC	NC	54.5	59.8	-56.5	15.2	2	1	5	2B	1,3	65
4291.1	B115	OBS	MH	NC	18.2	50.0	43.0	11.4	8	1	5	1A	1,3	20
4292.1	B134	OBS	CD	MRG	2.8	26.1	23.9	5.4	14	1	4	2B	1	20

Mtrl. = material (CCR = cryptocrystalline silicate, OBS = obsidian); XRF = source based on X-ray florescence (BH = Bodie Hills, CD = Casa Diablo, MC = Mono Craters, MGM = Mono Glass Mountain, MH = Mt. Hicks, TQ = Truman-Queen); Cond. = condition (DST =distal end fragment , MRG = margin fragment, NC = nearly complete, PRX = proximal end fragment, WHL = whole); Wt. = weight in grams; ML = maximum length; MW = maximum width; MTH = maximum thickness; Flake Type (1 = primary decortication, 2 = secondary decortication, 4 = simple interior percussion, 5 = complex interior percussion, 6 = linear interior percussion, 7 = early biface thinning, 8 = late biface thinning, 14 = indeterminate); No. of Edges = number of worked edges; Size (3 [2.0-3.0 cm in diameter], 4 [3.0-5.0 cm in diameter], 5 [>5.0 cm in diameter]); Edge Shape - shape of each worked edge (1 = concave, 2 = convex, 3 = straight, A = even, B = jagged irregular); Modification noted on each worked edge (1 = unifacial micro-chipped, 2 = bifacial micro-chipped, 3 = rounded, 4 = extreme battering/dullung, 5 = unifacial edge flaked, 6 = bifacial edge flaked, 7 = step fractured). All measurements are in mm, negative values denote incomplete measurements.

Appendix C. Core Attribute Data.

ID	Unit	Mtrl.	VIS	Cond.	Wt.	ML	MW	MTH	Core Form	Core Type	No. of Plats.	Platform Conf.	Platform Type	Flake Length
865	F62	OBS	MC	WHL	90.9	70.2	36.5	36.4	5	1	1	1	4	30.2
1329	F62	OBS	MC	WHL	420.0	92.7	85.5	51.3	5	1	1	1	2	65.2
1870	F62	OBS	MC	NC	31.2	-40.1	32.9	23.4	10	4	1	4	2	18.1
2495	F62	OBS	MC	WHL	102.8	62.6	56.5	31.2	5	1	1	1	2	44.2
2594	F62	OBS	MC	END	63.6	-64.4	-53.2	-24.4	1	4	1	4	2	47.4
3529	B3	OBS	MC	WHL	966.0	115.9	94.6	77.4	5	1	1	1	23	79.7

Mtrl. = material (OBS = obsidian); VIS = visual sourcing determination (MC = Mono Craters); Cond. = condition (END = end fragment, NC = nearly complete, WHL = whole); Wt. = weight in grams; ML = maximum length; MW = maximum width; MTH = maximum thickness; Core Form (1 = tabular cobble, 5 = split cobble, 10 = globular cobble); Core Type (1 = unidirectional, 4 = bifacial); No. of Plats = number of platforms; Platform Conf. = platform configuration (1 = unidirectional, 4 = bifacial); Platform Type (2 = interior, 3 = prepared, 4 = cortical and interior); Flake length = length of maximum flake removal scar. All measurements are in mm, negative values denote incomplete measurements.

Appendix C. Core Tool Attribute Data.

ID	Unit	Mtrl.	Cond.	Collected	Comment	ML	MW	MTH	Loc. Dam.	Wear Type
2929	B12	IGN	-	+	#4;NO					
4079	S63	IGN	WHL	-	Recorded	95	80	70	E	Step Fractured

Mtrl. = material (IGN - igneous); Cond. = condition (WHL - whole); Collected (-/+ = no/yes); ML - maximum length; MW - maximum width; MTH = maximum thickness; Loc. Dam. - location of damage (E = end). All measurements are in mm.

Appendix C. Assayed Cobble Attribute Data.

ID	Unit	Mtrl.	VIS	Cond.	Wt.	ML	MW	MTH	No. of Flakes
2838	B2	OBS	MC	WHL	353.4	90.1	79.1	64.9	4

Mtrl. = material (OBS = obsidian); VIS = visual sourcing determination (MC = Mono Craters); Cond. = condition (WHL = whole); Wt. = weight in grams; ML = maximum length; MW = maximum width; MTH = maximum thickness. All measurements are in mm.

Appendix C. Debitage Attribute Data.

ID	Subcat	Unit	Mtrl.	Source	Wt.	Grams	No.	Size	Type
54		F58	OBS	MC	14.9		1	4	5
1044		F62	OBS	MC	100.6		1	5	14
1506		F62	OBS	MC	44.7		1	5	7
1868		F62	OBS	MC	4.0		1	3	10
1871		F62	OBS	MC	19.2		1	4	10
1872		F62	OBS	MC	3.5		1	3	14
1873		F62	OBS	MC	2.5		1	3	10
2207		F62	OBS	MC	1.9		1	3	7
2209		F62	OBS	MC	227.7		1	5	2
2632		F64	OBS	MC	5.6		1	5	14
2917		B3	OBS	MC	30.8		1	5	5
2924		B12	OBS	MC	2.6		1	4	14
2925		B12	OBS	MC	4.9		1	4	7
2926		B12	OBS	MC	0.7		1	3	7
3351		B2	OBS	MC	19.8		1	5	7
3681		B143	OBS	MC	0.8		1	3	8
3709		S102	OBS	MC	1.0		1	3	7
3754		S165	OBS	MH	9.0		1	4	7
3756		S165	CCR		4.9		1	4	8
3757		S165	CCR		3.3		1	4	8
3758		S165	OBS	CD	3.8		1	5	7
3761		S165	CCR		1.9		1	4	8
3782		S173	OBS	CD	11.4		1	5	8
3811		S44	OBS	MC	1.0		1	2	14
3821		S44	OBS	MC	0.5		1	2	14
3882		S96	BAS		0.7		1	3	8
3883		B134	OBS	MC	4.8		1	3	14
3922		B115	BAS		3.6		1	4	5
3970		S165	OBS	MH	3.5		1	4	8
3972		S165	CCR		1.0		1	3	8
4002		S165	OBS		0.3				
4002	1	S165	OBS	BH	-0.3	0.1	1	2	8
4002	2	S165	OBS	MC	-0.3	0.1	1	2	8
4109		S63	OBS	MC	0.8		1	2	14
4127		S7	OBS	MC	0.7		1	2	4
4151		S7	OBS	MC	0.7		1	3	10
4174		B134	OBS	MC	0.1		1	2	4
4176		B134	OBS	MC	0.3		1	2	8
4209		B44	OBS	MC	0.9		1	3	4
4285		F58	OBS	MC	3.1		1	4	7
4286		F58	OBS		58.3				
4286	1	F58	OBS	TQ	-58.3	4.3	1	4	7
4286	2	F58	OBS	MC	-58.3	4.2	1	3	1
4286	3	F58	OBS	MC	-58.3	1.9	1	3	10
4286	4	F58	OBS	MC	-58.3	0.9	1	3	10
4286	5	F58	OBS	MC	-58.3	2.8	1	3	10

Appendix C. Debitage Attribute Data (continued).

ID	Subcat	Unit	Mtrl.	Source	Wt.	Grams	No.	Size	Type
4286	6	F58	OBS	MC	-58.3	3.4	1	4	1
4286	7	F58	OBS	MC	-58.3	6.8	1	4	2
4286	8	F58	OBS	MC	-58.3	19.1	1	4	4
4286	9	F58	OBS	MC	-58.3	4.7	1	4	7
4286	10	F58	OBS	MC	-58.3	10.2	1	4	7
4287		F62	OBS		422.1				
4287	1	F62	OBS	MC	-422.1	2.0	1	4	7
4287	2	F62	OBS	MC	-422.1	80.3	1	5	2
4287	3	F62	OBS	MC	-422.1	99.4	1	5	2
4287	4	F62	OBS	MC	-422.1	53.6	1	5	5
4287	5	F62	OBS	MC	-422.1	29.0	1	5	7
4287	6	F62	OBS	MC	-422.1	27.6	1	5	7
4287	7	F62	OBS	MC	-422.1	22.1	1	5	7
4287	8	F62	OBS	MC	-422.1	50.6	1	5	14
4287	9	F62	OBS	MC	-422.1	7.7	1	4	14
4287	10	F62	OBS	MC	-422.1	2.3	1	4	10
4287	11	F62	OBS	MC	-422.1	19.6	1	4	5
4287	12	F62	OBS	MC	-422.1	5.7	1	4	5
4287	13	F62	OBS	MC	-422.1	9.1	1	4	7
4287	14	F62	OBS	MC	-422.1	3.8	1	4	7
4287	15	F62	OBS	MC	-422.1	3.3	1	4	7
4287	16	F62	OBS	MC	-422.1	1.3	1	3	14
4287	17	F62	OBS	MC	-422.1	2.7	1	3	14
4287	18	F62	OBS	MC	-422.1	0.2	1	2	10
4287	19	F62	OBS	MC	-422.1	0.1	1	2	14
4287	20	F62	OBS	MC	-422.1	0.5	1	2	14
4287	21	F62	OBS	MC	-422.1	0.1	1	2	14
4288		F64	OBS		26.5				
4288	1	F64	OBS	MC	-26.5	5.0	1	4	4
4288	2	F64	OBS	MC	-26.5	1.5	1	3	7
4288	3	F64	OBS	MC	-26.5	9.5	1	4	4
4288	4	F64	OBS	MC	-26.5	5.7	1	4	7
4288	5	F64	OBS	MC	-26.5	2.4	1	4	7
4288	6	F64	OBS	MC	-26.5	0.8	1	3	4
4288	7	F64	OBS	MC	-26.5	0.8	1	3	4
4288	8	F64	OBS	MC	-26.5	0.5	1	2	7
4288	9	F64	OBS	MC	-26.5	0.1	1	2	10
4289		B2	OBS		431.9				
4289	1	B2	OBS	MC	-431.9	13.2	1	5	8
4289	2	B2	OBS	MC	-431.9	19.5	1	5	7
4289	3	B2	OBS	MC	-431.9	9.2	1	5	7
4289	4	B2	OBS	MC	-431.9	5.9	1	5	8
4289	5	B2	OBS	MC	-431.9	12.7	1	5	8
4289	6	B2	OBS	MC	-431.9	40.9	1	5	8
4289	7	B2	OBS	MC	-431.9	20.2	1	5	8
4289	8	B2	OBS	MC	-431.9	15.6	1	5	8
4289	9	B2	OBS	MC	-431.9	219.7	1	5	2
4289	10	B2	OBS	MC	-431.9	11.3	1	5	14
4289	11	B2	OBS	MC	-431.9	11.4	1	4	2
4289	12	B2	OBS	MC	-431.9	11.1	1	4	4
4289	13	B2	OBS	MC	-431.9	4.6	1	4	4
4289	14	B2	OBS	MC	-431.9	4.4	1	4	5
4289	15	B2	OBS	MC	-431.9	3.4	1	4	5
4289	16	B2	OBS	MC	-431.9	6.7	1	4	5
4289	17	B2	OBS	MC	-431.9	2.2	1	4	14
4289	18	B2	OBS	MC	-431.9	2.4	1	4	14
4289	19	B2	OBS	MC	-431.9	1.8	1	3	2
4289	20	B2	OBS	MC	-431.9	1.6	1	3	2
4289	21	B2	OBS	MC	-431.9	2.9	1	3	5

Appendix C. Debitage Attribute Data (continued).

ID	Subcat	Unit	Mtrl.	Source	Wt.	Grams	No.	Size	Type
4289	22	B2	OBS	MC	-431.9	2.1	1	3	7
4289	23	B2	OBS	MC	-431.9	1.3	1	3	8
4289	24	B2	OBS	MC	-431.9	3.0	1	3	14
4289	25	B2	OBS	MC	-431.9	2.3	1	3	14
4289	26	B2	OBS	MC	-431.9	1.3	1	3	14
4289	27	B2	OBS	MC	-431.9	0.4	1	2	8
4289	28	B2	OBS	MC	-431.9	0.7	1	2	14
4290		B3	OBS		55.0				
4290	1	B3	OBS	MC	-55.0	12.5	1	5	4
4290	2	B3	OBS	MC	-55.0	17.0	1	5	7
4290	3	B3	OBS	MC	-55.0	8.6	1	4	7
4290	4	B3	OBS	MC	-55.0.	4.7	1	4	7
4290	5	B3	OBS	MC	-55.0	4.8	1	4	7
4290	6	B3	OBS	MC	-55.0	3.3	1	4	8
4290	7	B3	OBS	MC	-55.0	3.6	1	3	14
4291		B115	OBS	BH	1.2	1.2	1	3	4
4292		B134	OBS		40.1				
4292	1	B134	OBS	MC	-40.1	11.6	1	4	7
4292	2	B134	OBS	MC	-40.1	2.3	1	4	8
4292	3	B134	OBS	MC	-40.1	0.2	1	2	14
4292	4	B134	OBS	MC	-40.1	1.6	1	3	5
4292	5	B134	OBS	MH	-40.1	4.3	1	3	10
4292	6	B134	OBS	MC	-40.1	8.4	1	4	8
4292	7	B134	OBS	MC	-40.1	6.0	1	4	8
4292	8	B134	OBS	MC	-40.1	5.2	1	4	5
4292	9	B134	OBS	MC	-40.1	0.3	1	2	8
4293		S7	OBS		1.6				
4293	1	S7	OBS	MC	-1.6	0.5	1	2	7
4293	2	S7	OBS	MC	-1.6	0.6	1	2	7
4293	3	S7	OBS	MGM	-1.6	16.7	1	3	7
4294		S27	OBS		4.7				
4294	1	S27	OBS	MC	-4.7	0.4	1	2	14
4294	2	S27	OBS	MC	-4.7	0.9	1	2	7
4294	3	S27	OBS	MC	-4.7	0.5	1	2	8
4294	4	S27	OBS	MC	-4.7	0.7	1	2	8
4294	5	S27	OBS	MC	-4.7	1.0	1	2	14
4294	6	S27	OBS	MC	-4.7	0.3	1	2	7
4295		S42	OBS		1.5				
4295	1	S42	OBS	MC	-1.5	1.2	1	2	8
4295	2	S42	OBS	MC	-1.5	0.3	1	2	8
4295	3	S42	OBS	MC	-1.5	0.4	1	2	8
4296		S44	OBS		3.6				
4296	1	S44	OBS	MC	-3.6	1.5	1	3	8
4296	2	S44	OBS	MC	-3.6	1.5	1	3	14
4296	3	S44	OBS	MC	-3.6	0.2	1	2	14
4296	4	S44	OBS	MC	-3.6	0.2	1	2	14
4297		S63	OBS		13.0				
4297	1	S63	OBS	BH	-13.0	1.3	1	3	14
4297	2	S63	OBS	MC	-13.0	0.5	1	2	5
4297	3	S63	OBS	MC	-13.0	0.7	1	2	7
4297	4	S63	OBS	MC	-13.0	0.1	1	2	8
4297	5	S63	OBS	MC	-13.0	0.8	1	2	14
4297	6	S63	OBS	MC	-13.0	0.4	1	2	14
4297	7	S63	OBS	MC	-13.0	1.6	1	3	14
4297	8	S63	OBS	MC	-13.0	6.3	1	4	8
4297	9	S63	OBS	MC	-13.0.	0.8	1	2	8
4297	10	S63	OBS	MC	-13.0	0.4	1	2	14
4298		S96	OBS		0.9				
4298	1	S96	OBS	MC	-0.9	0.6	1	2	14
4298	2	S96	OBS	MC	-0.9	0.2	1	2	14

Appendix C. Debitage Attribute Data (continued).

ID	Subcat	Unit	Mtrl.	Source	Wt.	Grams	No.	Size	Type
4299		S115	OBS		0.2				
4299	1	S115	OBS	MC	-0.2	0.1	1	1	14
4299	2	S115	OBS	MC	-0.2	0.2	1	2	14
4300		S116	OBS		0.7				
4300	1	S116	OBS	MC	-0.7	0.1	1	1	10
4300	2	S116	OBS	MC	-0.7	0.2	1	2	8
4300	3	S116	OBS	MC	-0.7	0.1	1	2	8
4300	4	S116	OBS	MC	-0.7	0.2	1	2	14
4301		S166	OBS		19.0				
4301	1	S166	OBS	MGM	-19.0	1.8	1	3	14
4301	2	S166	OBS	MC	-19.0	0.7	1	5	7
4301	3	S166	OBS	MC	-19.0	0.6	1	2	14

Mtrl. = material (BAS = basalt, CCR = cryptocrystalline; OBS = obsidian); Source = obsidian source (BH = Bodie Hills, CD = Casa Diable, MC = Mono Craters, MGM = Mono Glass Mountain, MH = Mt. Hicks, TQ = Truman-Queen); Wt. - weight of total sample in grams; Grams = weight of analyzed flake; Size (1 [<1.0 cm in diameter], 2 [1.0-2.0 cm in diameter], 3 [2.0-3.0 cm in diameter], 4 [3.0-5.0 cm in diameter], 5 [>5.0 cm in diameter]); Type = flake type (1 = primary decortication, 2 = secondary decortication, 4 = simple interior percussion, 5 = complex interior percussion, 7 = early biface thinning, 8 = late biface thinning, 10 = percussion fragment, 14 = indeterminate percussion).

Appendix C. Handstone Attribute Data.

ID	Unit	Mtrl.	Cond.	ML	MW	MTH	Edge Shaped	No. of Surfs.	Surf. Shape	Surf. Text	Pol.	Peck.	Sec. Mod.	Fire Affect.	Comment
14	F50	GRN	WHL	128	87	38	+	2	3/1	S/S	+/+	+/+	+	-	battered on 2 ends
1328	F62	BAS	NC	-73	52	24	+	2	1/2	S/S	+/+	+/+	+	-	battered
3571	B66	IGN	NC	130	-100	20	-	1	3	IRR	+	-	-	+	
3572	B66	VBL	WHL	105	100	65	-	1	3	S	+	-	-	+	
3581	B66	BAS	FRG	-102	-60	999	-	1	1	S	+	-	+	-	
3582	B66	IGN	FRG	-40	-40	-40	IND	1	2	S	+	+	-	-	
3696	S102	PUM	FRG	80	97	999	-	2	1/1	S/S	+/+	-/IND	-	-	
3710	S115	META	WHL	120	110	34	+	2	1/1	S/S	+/+	+/+	+	-	ground & battered
3741	S165	PUM	WHL	98	75	57	-	1	2	S	+	-	-	-	
3783	S180	GRN	FRG	-65	-80	-35	IND	1	2	S	+	+	-	-	weathered
4066	S63	PUM	NC	-80	100	65	+	1	1	S	+	-	-	-	
4206	B44	SCH	NC	98	78	18	+	2	1/4	S/S	+/+	+/+	+	-	poss.recycled slab

Mtrl. = material (BAS = basalt, GRN = granitic, IGN = igneous, META = metamorphic, PUM = pumice, SCH = schist, VBL = vesicular basalt); Cond. = condition (FRG = fragment, NC = nearly complete, WHL = whole); ML - maximum length; MW = maximum width; MTH = maximum thickness; Edge Shaped = evidence of edge shaping (+/- = present/absent, IND = indeterminate); No. of Surfs. = number of ground surfaces; Surface Shape (1 = slightly convex, 2 = convex, 3 = flat, 4 = slightly concave); Surface Text. - surface texture (IRR = irregular, S = smooth); Pol. = polish (+/- = present/absent); Peck. = pecking (+/- = present/absent, IND = indeterminate); Sec. Mod. = secondary modification (+/- = present/absent); Fire Affect. = All measurements are in mm, negative values denote incomplete measurements.

Appendix C. Pestle Attribute Data.

ID	Unit	Mtrl.	Cond.	ML	MW	MTH	End Shaped	No. of Ends	End Shape	Sec. Mod.	Fire Affect.	Wear Loc.	Comment
511	F62	IGN	WHL	194	148	65	-	1	CONV	+	-	E	Battered

Mtrl. = material (IGN = igneous); Cond. - condition (WHL = whole); ML - maximum length; MW = maximum width; MTH = maximum thickness; End Shaped = evidence of end shaping (+/- = present/absent); No. of Ends = number of ground ends; End Shape (CONV = convex); Sec. Mod. = secondary modification (+/- = present/absent); Fire Affect. = evidence of being fire affected (+/- = present/absent); Wear Loc. = location of wear (E = end). All measurements are in mm.

Appendix C. Millingslab Attribute Data.

ID	Unit	Mtrl.	Cond.	ML	MW	MTH	Edge Shaped	No. of Surfs.	Surf. Shape	Surf. Text.	Pol.	Peck.	Sec. Mod.	Fire Affect.	Comment
797	F62	IGN	MRG	-190	-120	-30	+	2	5/3	S/S	+/+	+/+	-	-	
3551	B36	SCH	FRG	-145	-70	-35	IND	1	3	S	+	+	-	-	
3637	B112	SED	FRG	-150	-120	-20	IND	1	4	S	+	-	-	-	
3841.1	S63	SST	FRG	200	-100	65	IND	1	5	S	+	+	-	-	
3841.2	S63	SST	MRG	-125	-70	-45	-	1	3	S	+	IND	IND	-	
3841.3	S63	SST	FRG	-185	-95	-45	-	1	3	S	+	IND	IND	-	weathered
3845	S63	SCH	FRG	-75	-55	-30	IND	2	3/3	S/S	+	+/+	IND	-	
3867	S88	GRN	NC	350	275	100	-	1	3	IRR	+	IND	-	-	weathered
3895	B134	SCH	MRG	-170	-120	45	+	2	3/4	S/S	+/+	+/+	-	-	
3910	B115	VBL	FRG	-115	-95	-24	IND	2	4/4	S/S	+/+	-/-	-	-	
3957	S115	IGN	MRG	-240	230	40	+	1	4	S	+	+	+	-	bottom ground
4107	S63	SST	FRG	-145	-18	-11	IND	1	3	S	+	+	IND	-	
4169	B134	GRN	MRG	-220	-180	100	+	1	5	S	+	+	+	-	margin ground ML=420mm
4170	B134	GRN	MRG	-130	-120	-90	+	1	5	S	+	+	+	-	margin ground ML=420mm
4171	B134	GRN	MRG	-110	-150	100	+	1	5	S	+	+	+	-	margin ground ML=420mm

Mtrl. = material (GRN = granitic, IGN = igneous, SCH = schist, SED = sedimentary, SST = sandstone, VBL = vesicular basalt); Cond. = condition (FRG = indeterminate fragment, MRG = margin fragment, NC = nearly complete); ML = maximum length; MW = maximum width; MTH = maximum thickness; Edge Shaped = evidence of edge shaping (+/- = present/absent, IND - indeterminate); No. of Surfs. = number of ground surfaces; Surface Shape (3 = flat, 4 = slightly concave, 5 = concave); Surface Text. - surface texture (IRR - irregular, S = smooth); Pol. = polish (+/- = present/absent); Peck. = pecking (+/- = present/absent); Sec. Mod. = secondary modification (+/- = present/absent, IND = indeterminate); Fire Affect. = evidence of being fire affected (+/- = present/absent); Wear Loc. = location of wear (E = end). All measurements are in mm.

Appendix C. Miscellaneous Ground Stone Attribute Data.

ID	Unit	Field #	Cat #	Mtrl.	Analysis	Collected	Site ID	Aggregate/ Comment
3789	S180	12-2	7	PUM	-	-		
3844	S63	4-3	4	PUM	-	-	SITE 6	Handstone?
3894	B134	9-1	12		-	-		
4102	S63	1-1	55	PUM	-	-	SITE 6	
4189	B21	10-2	7	PUM	-	-		

Mtrl. = material (PUM = pumice).

Appendix C. Bedrock Mortar Attribute Data.

ID	Unit	Feat.	Mtrl.	ML	MW	No. of Cups	Comment
509	F62	1	IGN	100	65	1	recorded
510	F62	2	IGN	279	192	16	recorded
2579	F62	3	IGN	350	250	5	recorded
2583	F62	4	IGN	450	250	7	recorded
2606	F62		IGN				
2607	F62		IGN				
2608	F62		IGN				
2579	F62	3	IGN	100	65	1	recorded

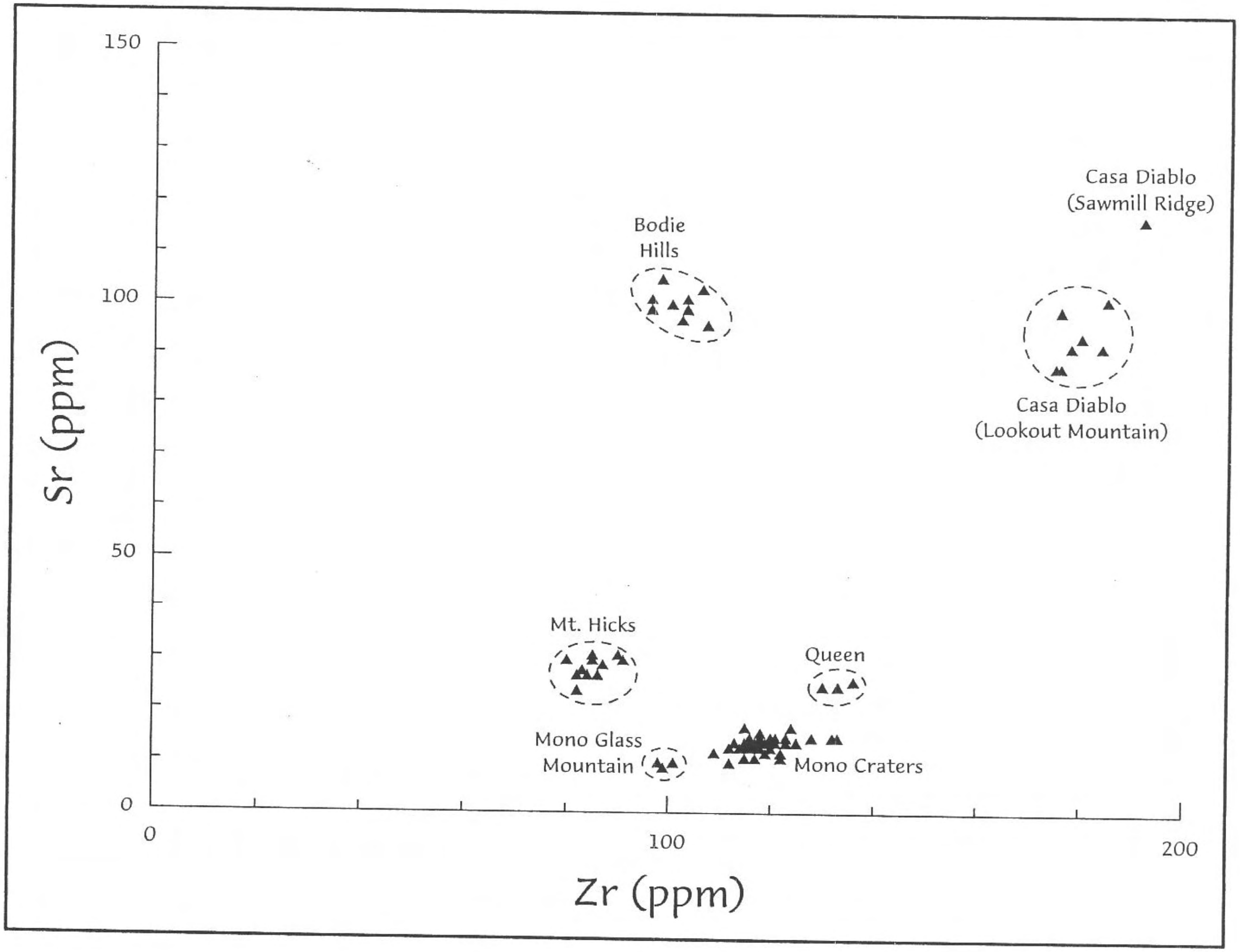
Feat. - feature designation; Mtrl. = material (IGN = igneous); ML = maximum length; MW = maximum wedth; No. of Cups = number of mortar cups present. All measurements are in mm.

Appendix C. Bead Attribute Data.

ID	Unit	Mtrl.	Cond.	Wt.	ML	MW	MTH	Hole Diameter	Comment
3980	S165	STE	WHL	0.6	17	16.3	1.6	2.7	unifacially bevelled

Mtrl. = material (STE = steatite); Cond. - condition (WHL = whole); Wt. - weight in grams; ML = maximum length; MW = maximum width; MTH = maximum thickness. All measurements are in mm.

Appendix D. XRF Sourcing Results.


150
100
50
0
Sr (ppm)
0
100
200
Zr (ppm)
Casa Diablo
(Sawmill Ridge)
Bodie
Hills
Casa Diablo
(Lookout Mountain)
Mt. Hicks
Queen
Mono Glass
Mountain
Mono Craters

Northwest Research Obsidian Studies Laboratory

Table A-1. Results of XRF Studies: Mono Basin Artifacts, Mono County, California

Site	Specimen No.	Catalog No.	Trace Element Concentrations											Ratios		Geochemical Source
			Zn	Pb	Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	Fe^2O^{3T}	Fe:Mn	Fe:Ti	
Mono Basin Survey	1	53	53	26	188	17	29	115	20	486	444	20	1.12	21.7	75.8	Mono Craters
			± 10	5	5	9	3	10	2	88	28	31	0.11			
Mono Basin Survey	2	513	39	33	191	14	29	118	20	402	457	NM	1.14	21.3	91.6	Mono Craters
			± 10	4	5	9	3	10	2	88	28	NM	0.11			
Mono Basin Survey	3	1334	45	25	196	15	33	121	20	395	323	NM	1.08	28.9	88.7	Mono Craters
			± 10	4	5	9	3	10	2	88	27	NM	0.11			
Mono Basin Survey	4	1506	45	23	204	15	29	118	21	351	342	NM	1.12	28.1	102.1	Mono Craters
			± 10	4	5	9	3	10	2	88	28	NM	0.11			
Mono Basin Survey	5	2207	50	33	215	14	30	125	22	NM	NM	NM	NM	30.6	66.5	Mono Craters *
			± 9	4	5	9	3	10	2	NM	NM	NM	NM			
Mono Basin Survey	6	2208	37	27	195	12	29	119	19	336	417	NM	1.11	22.8	105.4	Mono Craters
			± 10	4	5	9	3	10	2	88	28	NM	0.11			
Mono Basin Survey	7	2478	50	32	214	14	32	125	20	325	355	NM	0.96	23.5	95.1	Mono Craters
			± 9	4	5	9	3	10	2	88	28	NM	0.11			
Mono Basin Survey	8	2592	36	25	182	14	29	118	21	339	272	NM	0.93	30.0	89.1	Mono Craters
			± 10	4	5	9	3	10	2	88	27	NM	0.11			
Mono Basin Survey	9	2633	40	35	197	14	28	123	24	327	305	NM	1.06	30.1	103.8	Mono Craters
			± 10	4	5	9	3	10	2	88	28	NM	0.11			
Mono Basin Survey	10	2924	53	29	196	15	32	128	20	NM	NM	NM	NM	20.5	94.3	Mono Craters *
			± 9	4	5	9	3	10	2	NM	NM	NM	NM			
Mono Basin Survey	11	2925	52	30	198	14	29	119	19	350	310	18	1.08	30.1	99.3	Mono Craters
			± 9	4	5	9	3	10	2	88	27	31	0.11			
Mono Basin Survey	12	2926	54	29	206	15	32	118	19	NM	NM	NM	NM	21.6	103.8	Mono Craters *
			± 9	4	5	9	3	10	2	NM	NM	NM	NM			
Mono Basin Survey	13	3276	45	37	188	13	31	117	22	255	263	NM	0.65	22.3	82.5	Mono Craters
			± 10	4	5	9	3	10	2	88	27	NM	0.11			
Mono Basin Survey	14	3351	61	28	197	15	29	118	22	389	453	NM	1.15	21.8	95.8	Mono Craters
			± 9	4	5	9	3	10	2	88	28	NM	0.11			
Mono Basin Survey	15	3538	38	30	182	13	31	115	21	370	301	NM	1.11	31.9	97.1	Mono Craters
			± 10	4	5	9	3	10	2	88	28	NM	0.11			

All trace element values reported in parts per million; ± = analytical uncertainty estimate (in ppm). Iron content reported as weight percent oxide.
NA = Not available; ND = Not detected; NM = Not measured.; * = Small sample.

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Table A-1. Results of XRF Studies: Mono Basin Artifacts, Mono County, California

Site	Specimen No.	Catalog No.	Trace Element Concentrations											Ratios		Geochemical Source
			Zn	Pb	Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	Fe^{2}O^{3T}	Fe:Mn	Fe:Ti	
Mono Basin Survey	16	3577	66	39	185	25	25	133	31	NM	NM	NM	NM	8.8	38.6	Queen *
			± 10	5	5	9	3	10	2	NM	NM	NM	NM			
Mono Basin Survey	17	3584	45	24	188	105	13	98	15	NM	NM	NM	NM	15.7	38.1	Bodie Hills *
			± 10	5	5	9	3	10	2	NM	NM	NM	NM			
Mono Basin Survey	18	3625	25	34	187	101	14	103	15	648	412	577	0.68	14.6	36.2	Bodie Hills
			± 11	4	5	9	3	10	2	89	28	32	0.11			
Mono Basin Survey	19	3643	19	34	183	96	12	107	15	541	482	NM	0.60	11.3	38.8	Bodie Hills
			± 12	4	5	9	3	10	2	89	28	NM	0.11			
Mono Basin Survey	20	3644	50	31	163	101	19	185	12	922	255	979	1.19	40.2	43.6	Casa Diablo (Lookout Mountain)
			± 10	5	4	9	3	10	1	90	27	32	0.11			
Mono Basin Survey	21	3681	38	29	184	14	30	116	20	NM	NM	NM	NM	31.8	87.3	Mono Craters *
			± 10	4	5	9	3	10	2	NM	NM	NM	NM			
Mono Basin Survey	22	3701	55	34	187	14	30	115	21	NM	NM	NM	NM	31.3	89.0	Mono Craters *
			± 10	4	5	9	3	10	2	NM	NM	NM	NM			
Mono Basin Survey	23	3759	41	30	149	30	13	80	21	558	321	51	0.50	14.5	32.1	Mt. Hicks
			± 10	4	4	9	3	10	2	88	27	33	0.11			
Mono Basin Survey	24	3782	43	26	147	99	17	176	11	673	311	992	1.06	29.6	53.1	Casa Diablo (Lookout Mountain)
			± 10	5	4	9	3	10	2	89	27	32	0.11			
Mono Basin Survey	25	3855	43	36	179	100	14	100	14	NM	NM	NM	NM	10.6	30.7	Bodie Hills *
			± 10	4	5	9	3	10	2	NM	NM	NM	NM			
Mono Basin Survey	26	3857	26	30	182	101	14	96	15	573	374	607	0.58	14.2	35.7	Bodie Hills
			± 10	4	5	9	3	10	2	89	28	32	0.11			
Mono Basin Survey	27	3883	40	26	192	15	29	120	21	325	289	NM	0.97	29.2	96.0	Mono Craters
			± 10	4	5	9	3	10	2	88	27	NM	0.11			
Mono Basin Survey	28	3905	44	28	195	15	31	133	22	NM	NM	NM	NM	25.8	36.6	Mono Craters *
			± 10	4	5	9	3	10	2	NM	NM	NM	NM			
Mono Basin Survey	29	3907	28	32	152	29	15	87	19	524	330	44	0.55	15.2	36.8	Mt. Hicks
			± 10	4	4	9	3	10	2	88	27	33	0.11			
Mono Basin Survey	30	3920	29	37	184	99	10	103	14	NM	NM	NM	NM	16.7	35.3	Bodie Hills *
			± 11	4	5	9	3	10	2	NM	NM	NM	NM			

All trace element values reported in parts per million; ± = analytical uncertainty estimate (in ppm). Iron content reported as weight percent oxide.
NA = Not available; ND = Not detected; NM = Not measured.; * = Small sample.

Northwest Research Obsidian Studies Laboratory

Table A-1. Results of XRF Studies: Mono Basin Artifacts, Mono County, California

Site	Specimen No.	Catalog No.	Trace Element Concentrations											Ratios		Geochemical Source
			Zn	Pb	Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	$Fe^{2}O^{3T}$	Fe:Mn	Fe:Ti	
Mono Basin Survey	31	3970	43	43	172	30	14	91	21	582	427	41	0.56	11.9	33.9	Mt. Hicks
			± 9	4	4	9	3	10	1	88	28	34	0.11			
Mono Basin Survey	32	3975	38	39	150	94	19	180	13	NM	NM	NM	NM	35.5	52.2	Casa Diablo (Lookout Mountain) *
			± 10	4	4	9	3	10	2	NM	NM	NM	NM			
Mono Basin Survey	33	3981	29	35	187	9	26	99	23	403	263	0	0.73	24.9	61.0	Mono Glass Mountain
			± 10	4	5	10	3	10	2	88	27	31	0.11			
Mono Basin Survey	34	4020	52	26	215	15	29	121	22	NM	NM	NM	NM	27.3	84.9	Mono Craters *
			± 9	4	5	9	3	10	2	NM	NM	NM	NM			
Mono Basin Survey	35	4071	57	28	181	26	27	136	37	683	639	73	0.81	11.1	40.7	Queen
			± 9	4	5	9	3	10	2	89	28	32	0.11			
Mono Basin Survey	36	4077	25	35	199	10	24	101	24	366	249	0	0.74	26.7	67.5	Mono Glass Mountain
			± 11	4	4	10	3	10	1	88	27	31	0.11			
Mono Basin Survey	37	4105	67	30	202	14	28	113	24	376	408	NM	1.12	23.6	96.1	Mono Craters
			± 9	4	5	9	3	10	2	88	28	NM	0.11			
Mono Basin Survey	38	4151	47	31	192	14	29	117	22	NM	NM	NM	NM	31.0	94.8	Mono Craters *
			± 10	4	5	9	3	10	2	NM	NM	NM	NM			
Mono Basin Survey	39	4175	42	28	155	92	15	178	11	803	241	947	1.21	43.3	50.6	Casa Diablo (Lookout Mountain)
			± 10	4	4	9	3	10	2	90	27	32	0.11			
Mono Basin Survey	40	4209	49	33	196	13	29	116	22	NM	NM	NM	NM	23.7	82.4	Mono Craters *
			± 10	4	5	9	3	10	2	NM	NM	NM	NM			
Mono Basin Survey	41	4285	45	24	184	12	30	122	20	256	240	NM	0.81	29.8	100.3	Mono Craters
			± 10	4	5	9	3	10	2	88	27	NM	0.11			
Mono Basin Survey	42	4288	37	29	192	14	30	118	19	NM	NM	NM	NM	26.9	85.3	Mono Craters *
			± 10	5	5	9	3	10	2	NM	NM	NM	NM			
Mono Basin Survey	43	4289	47	29	192	11	28	122	22	330	308	NM	1.04	29.2	100.6	Mono Craters
			± 10	4	5	10	3	10	2	88	27	NM	0.11			
Mono Basin Survey	44	4290	38	24	184	13	30	114	22	350	360	NM	1.18	28.3	108.3	Mono Craters
			± 10	5	5	9	3	10	2	88	28	NM	0.11			
Mono Basin Survey	45	4291.1	33	36	158	31	14	85	20	593	346	73	0.58	15.3	34.4	Mt. Hicks
			± 10	4	4	9	3	10	2	88	27	32	0.11			

All trace element values reported in parts per million; ± = analytical uncertainty estimate (in ppm). Iron content reported as weight percent oxide.
NA = Not available; ND = Not detected; NM = Not measured.; * = Small sample.

Table A-1. Results of XRF Studies: Mono Basin Artifacts, Mono County, California

Site	Specimen No.	Catalog No.	Trace Element Concentrations											Ratios		Geochemical Source
			Zn	Pb	Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	Fe^{2}O^{3T}	Fe:Mn	Fe:Ti	
Mono Basin Survey	46	4292	44	26	204	14	30	116	24	249	385	NM	0.79	18.1	100.5	Mono Craters
			± 10	5	5	9	3	10	2	88	28	NM	0.11			
Mono Basin Survey	47	4293	52	38	200	10	29	98	23	439	449	0	0.75	14.8	57.5	Mono Glass Mountain
			± 9	4	5	10	3	10	2	88	28	31	0.11			
Mono Basin Survey	48	4294	62	27	198	13	33	120	21	NM	NM	NM	NM	30.3	108.0	Mono Craters *
			± 10	5	5	9	3	10	2	NM	NM	NM	NM			
Mono Basin Survey	49	4295	44	26	195	11	33	117	22	305	260	NM	0.94	31.6	98.5	Mono Craters
			± 10	5	5	10	3	10	2	88	27	NM	0.11			
Mono Basin Survey	50	4301	47	27	200	14	30	116	22	NM	NM	NM	NM	30.2	107.5	Mono Craters *
			± 10	4	5	9	3	10	2	NM	NM	NM	NM			
Mono Basin Survey	1	54	41	29	180	11	30	115	21	350	339	17	1.12	28.4	102.4	Mono Craters
			± 10	5	5	10	3	10	2	88	28	31	0.11			
Mono Basin Survey	2	512	52	33	189	13	29	116	23	371	447	42	1.08	20.9	94.4	Mono Craters
			± 9	4	5	9	3	10	2	88	28	33	0.11			
Mono Basin Survey	3	1158	59	29	184	10	30	112	20	363	317	5	1.09	29.8	97.3	Mono Craters
			± 10	4	5	10	3	10	2	88	27	31	0.11			
Mono Basin Survey	4	2603	40	27	186	13	29	112	23	357	375	2	1.08	24.9	97.6	Mono Craters
			± 10	4	5	9	3	10	2	88	28	31	0.11			
Mono Basin Survey	5	2632	50	33	192	12	28	109	22	303	350	9	1.08	26.6	113.0	Mono Craters
			± 10	4	5	10	3	10	2	88	28	31	0.11			
Mono Basin Survey	6	3596	15	30	151	27	19	86	21	616	371	25	0.62	15.1	35.2	Mt. Hicks
			± 14	5	4	9	3	10	2	88	28	86	0.11			
Mono Basin Survey	7	3655	53	26	200	14	33	120	25	741	437	13	0.85	17.1	39.5	Mono Craters
			± 9	4	5	9	3	10	1	89	28	31	0.11			
Mono Basin Survey	8	3660	43	33	182	97	14	102	16	623	381	540	0.65	15.2	36.1	Bodie Hills
			± 10	4	5	9	3	10	2	89	28	32	0.11			
Mono Basin Survey	9	3691	38	37	158	27	17	84	20	526	352	12	0.57	14.7	37.8	Mt. Hicks
			± 10	4	4	9	3	10	2	88	27	31	0.11			
Mono Basin Survey	10	3754	20	27	153	31	15	90	19	639	434	64	0.60	12.6	33.2	Mt. Hicks
			± 12	4	4	9	3	10	2	89	28	32	0.11			

All trace element values reported in parts per million; ± = analytical uncertainty estimate (in ppm). Iron content reported as weight percent oxide.
NA = Not available; ND = Not detected; NM = Not measured.; * = Small sample.

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Table A-1. Results of XRF Studies: Mono Basin Artifacts, Mono County, California

Site	Specimen No.	Catalog No.	Trace Element Concentrations Zn	Pb	Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	Fe^{2}O^{3T}	Ratios Fe:Mn	Fe:Ti	Geochemical Source
Mono Basin Survey	11	3758	51	24	150	88	15	176	11	855	403	954	1.23	26.2	48.5	Casa Diablo (Lookout Mountain)
			± 10	4	5	9	3	10	2	90	28	33	0.11			
Mono Basin Survey	12	3888	33	41	160	27	15	82	22	636	418	17	0.60	13.0	33.2	Mt. Hicks
			± 10	4	5	9	3	10	2	88	28	31	0.11			
Mono Basin Survey	13	3919	27	32	147	24	15	82	20	552	380	8	0.54	13.1	34.6	Mt. Hicks
			± 11	5	4	9	3	10	2	88	28	31	0.11			
Mono Basin Survey	14	3983	35	28	153	117	19	192	12	1148	251	1105	1.30	44.6	38.3	Casa Diablo (Sawmill Ridge)
			± 10	5	5	9	3	10	2	91	27	32	0.11			
Mono Basin Survey	15	4000	18	33	157	30	17	85	21	NM	NM	38	NM	14.0	19.0	Mt. Hicks *
			± 13	5	5	9	3	10	2	NM	NM	35	NM			
Mono Basin Survey	16	4067	45	34	205	17	32	124	22	788	268	24	0.92	30.1	39.9	Mono Craters
			± 10	4	5	9	3	10	2	89	27	31	0.11			
Mono Basin Survey	17	4095	43	34	154	92	18	184	14	849	433	958	1.26	24.8	49.7	Casa Diablo (Lookout Mountain)
			± 10	4	4	9	3	10	2	90	28	32	0.11			
Mono Basin Survey	18	4110	46	25	210	15	30	123	20	284	305	0	1.04	29.4	115.5	Mono Craters
			± 10	4	5	9	3	10	2	88	27	31	0.11			
Mono Basin Survey	19	4183	40	26	193	14	32	121	21	247	302	19	1.02	29.3	129.0	Mono Craters
			± 10	4	5	9	3	10	2	88	27	31	0.11			
Mono Basin Survey	20	4188	47	33	153	28	16	83	21	619	374	40	0.60	14.6	34.2	Mt. Hicks
			± 9	4	5	9	3	10	2	88	28	34	0.11			
Mono Basin Survey	21	4286.1	41	36	170	25	23	130	33	600	646	38	0.77	10.4	43.6	Queen
			± 10	5	5	9	3	10	2	89	28	34	0.11			
Mono Basin Survey	22	4287.1	58	28	190	13	31	118	21	359	303	11	1.11	31.6	99.1	Mono Craters
			± 9	4	5	9	3	10	2	88	27	31	0.11			
Mono Basin Survey	23	4287.12	38	29	185	15	28	116	21	343	362	20	1.15	27.2	106.7	Mono Craters
			± 10	4	5	9	3	10	2	88	28	31	0.11			
Mono Basin Survey	24	4287.17	36	31	197	14	27	117	19	372	324	20	1.12	29.9	97.4	Mono Craters
			± 10	4	5	9	3	10	2	88	28	31	0.11			
Mono Basin Survey	25	4289.1	69	34	229	15	31	132	25	355	378	43	1.00	22.9	91.3	Mono Craters
			± 9	4	5	9	3	10	1	88	28	33	0.11			

All trace element values reported in parts per million; ± = analytical uncertainty estimate (in ppm). Iron content reported as weight percent oxide.
NA = Not available; ND = Not detected; NM = Not measured.; * = Small sample.

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Table A-1. Results of XRF Studies: Mono Basin Artifacts, Mono County, California

Site	Specimen No.	Catalog No.	Trace Element Concentrations Zn	Pb	Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	Fe^2O^{3T}	Ratios Fe:Mn	Fe:Ti	Geochemical Source
Mono Basin Survey	26	4290.1	39	31	186	14	27	113	21	331	292	32	0.99	29.5	96.4	Mono Craters
			± 10	4	5	9	3	10	2	88	27	38	0.11			
Mono Basin Survey	27	4291	51	38	191	103	12	106	13	883	408	541	0.52	11.6	21.1	Bodie Hills
			± 9	4	5	9	3	10	2	89	28	33	0.11			
Mono Basin Survey	28	4291.1	32	30	147	88	19	175	14	725	219	1018	1.06	42.0	49.0	Casa Diablo (Lookout Mountain)
			± 11	5	5	9	3	10	2	90	27	32	0.11			
Mono Basin Survey	29	4292.8	35	35	196	16	27	118	24	370	304	3	1.09	30.8	94.8	Mono Craters
			± 10	4	5	9	3	10	2	88	27	31	0.11			
Mono Basin Survey	30	4297.1	28	38	188	99	16	96	15	983	352	513	0.57	14.7	20.7	Bodie Hills
			± 11	4	5	9	3	10	2	90	28	32	0.11			
NA	RGM-1	RGM-1	24	28	157	108	24	223	11	1690	280	789	1.91	57.6	37.9	RGM-1 Reference Standard
			± 12	5	5	9	3	10	2	92	28	32	0.11			

All trace element values reported in parts per million; ± = analytical uncertainty estimate (in ppm). Iron content reported as weight percent oxide.
NA = Not available; ND = Not detected; NM = Not measured.; * = Small sample.

Appendix E. Obsidian Hydration Data.

Appendix E. Obsidian Hydration Readings and Temporal Components.

Temporal units[+]:	Marana	Haiwee	NW-I	NW-II	PN-I	PN-II	PN-III	PN-IV	TP/EH
Casa Diablo (Hall and Jackson 1989) yBP=129.656$x^{1.826}$	0.9-2.5μ	2.6-3.6μ	3.7-4.7μ	4.8-5.7μ	5.8-6.5μ	6.6-7.4μ	7.4-8.1μ	8.2-9.2μ	9.2-12.2μ
*Bodie Hills and Mt. Hicks also used this rate.									
Mono Craters (Onken 1991 in Carpenter 2001) yBP=1000(x^2/14.7)	1.2-3.1μ	3.1-4.5μ	4.5-5.7μ	5.8-6.8μ	6.9-7.6μ	7.7-8.5μ	8.6-9.3μ	9.4-10.5	10.6-13.5μ
Mono Glass Mtn. (Overly 2003) yBP=129.656$(0.8x)^{1.826}$ *Correction factor using CD rate.	1.1-3.0μ	3.0-4.5μ	4.6-6.0μ	6.1-7.2μ	7.3-8.2μ	8.3-9.2μ	9.3-10.2μ	10.2-11.5	11.6-15.2μ
Truman-Queen (Basgall and Giambastiani 1995) yBP=82.74$x^{2.06}$	1.1-2.7μ	2.8-3.8μ	3.9-5.0μ	5.1-5.9μ	6.0-6.5μ	6.6-7.3μ	7.4-8.0μ	8.1-8.9μ	9.0-11.4μ

[+] Marana (Historic-650 B.P); Haiwee (650-1350 B.P.); NWI= Newberry I (1350-2275 B.P.); NWII= Newberry II (2275-3200 B.P.); PNI= pre-Newberry I (3200-4000 B.P.); PNII= pre-Newberry II (4000-5000 B.P.); PNIII= pre-Newberry III (5000-6000 B.P.); PNIV= pre-Newberry IV (6000-7500); TP/EH= Terminal Pleistocene/Early Holocene (7500-12,500 B.P.).

Appendix E. Obsidian Hydration Measurements from Project Quadrats by Source.

Unit	Description	Num	Measurements	Mean	StDev	CV	MR	HW	NWI	NWII	PNI	PNII	PNIII	PNIV	TP/EH
Casa Diablo															
B115	Biface	2	3.4/11.5	7.4	5.8	78%	-	1	-	-	-	-	-	-	1
B134	Biface	1	8.8	8.8	-	-	-	-	-	-	-	-	-	1	-
	Flake Tool	2	1.6/3.3	2.5	1.2	48%	1	1	-	-	-	-	-	-	-
Subtotal Brackish							**1**	**2**	-	-	-	-	-	**1**	**1**
S63	Flake Tool	1	2.3	2.3	-	-	1	-	-	-	-	-	-	-	-
S165	Projectile Point (RS)	1	3.1	3.1	-	-	-	1	-	-	-	-	-	-	-
	Biface	2	3.9/5.0	4.5	0.78	17%	-	-	1	1	-	-	-	-	-
	Debitage	1	4.3	4.3	-	-	-	-	1	-	-	-	-	-	-
S173	Debitage	1	5.4	5.4	-	-	-	-	-	1	-	-	-	-	-
Subtotal Saline							**1**	**1**	**2**	**2**	-	-	-	-	-
Casa Diablo Total							**2**	**3**	**2**	**2**	-	-	-	**1**	**1**
Mono Craters															
F58	Flake Tool	1	5.8	5.8	-	-	-	-	-	1	-	-	-	-	-
	Debitage	13	2.0/4.1, 2.0/4.4, 4.0, 4.2, 4.4, 4.8, 5.0, 5.2, 5.4, 5.4, 5.9	4.4	1.2	27%	2	5	5	1	-	-	-	-	-
F62	Biface	3	3.8, 6.5/8.6	6.3	2.4	38%	-	1	1	-	-	-	1	-	-
	Flake Tool	23	1.5, 1.7/3.5/5.8, 1.9/4.5/6.9, 2.1/4.0/6.0, 2.3/5.0/5.9, 2.5, 4.1, 4.2/5.6, 4.7, 3.1/5.0/5.9, 3.6, 5.0	4.1	1.6	39%	7	6	5	4	1	-	-	-	-
	Core	8	1.9/3.3, 2.0/7.2, 2.2/4.1, 4.8, 5.1	3.8	1.9	50%	3	2	2	-	1	-	-	-	-
	Debitage	32	1.7, 1.7/5.9, 1.7, 1.7, 1.8, 1.9/5.3, 1.9, 2.0, 2.1, 2.1, 2.3, 2.4, 3.1, 3.7, 3.8, 4.0, 4.1, 4.9, 5.1/6.1, 5.2, 5.5, 5.5, 5.7, 5.8, 6.4, 6.0, 6.7, 7.0, UNR	4.0	1.8	45%	13	4	7	6	1	-	-	-	-
F64	Flake Tool	1	3.1	3.1	-	-	1	-	-	-	-	-	-	-	-
	Debitage	15	2.7/5.6, 2.9, 3.0/6.7, 4.0/5.0, 4.2, 4.4, 4.4, 4.5, 4.5, 7.6	4.6	1.4	30%	3	6	4	1	1	-	-	-	-
Subtotal Freshwater							**29**	**24**	**24**	**13**	**4**	-	**1**	-	-

Appendix E. Obsidian Hydration Measurements from Project Quadrats by Source (continued).

Unit	Description	Num	Measurements	Mean	StDev	CV	MR	HW	NWI	NWII	PNI	PNII	PNIII	PNIV	TP/EH
Mono Craters (continued)															
B2	Flake Tool	3	1.7/3.2/4.7	3.2	1.5	47%	1	1	1	-	-	-	-	-	-
	Debitage	34	1.9, 2.3/6.5, 2.5/4.8, 2.7/5.5, 3.0/3.9, 3.0, 3.8/6.9, 4.2, 4.4, 4.7, 4.7, 4.8, 4.9, 5.0, 5.1, 5.3, 5.3, 5.4, 5.7, 5.7, 6.0, 6.2, 6.4, 6.4, 6.5, 7.0, 7.8, 7.8, 8.1	5.1	1.6	31%	6	4	13	7	1	3	-	-	-
B3	Core	1	4.0	4.0	-	-	-	1	-	-	-	-	-	-	-
	Debitage	9	4.0, 4.0, 4.3, 5.0, 5.1, 5.3, 6.4/7.6, 6.7	5.4	1.3	24%	-	3	3	2	1	-	-	-	-
B12	Debitage	3	2.6, 2.8, 6.1	3.8	2.0	53%	2	-	-	1	-	-	-	-	-
B21	Flake Tool	1	3.5	3.5	-	-	-	1	-	-	-	-	-	-	-
B36	Flake Tool	2	1.4/3.6	2.5	1.6	64%	1	1	-	-	-	-	-	-	-
B44	Debitage	1	5.4	5.4	-	-	-	-	1	-	-	-	-	-	-
B112	Flake Tool	1	5.0	5.0	-	-	-	-	1	-	-	-	-	-	-
B115	Flake Tool	1	4.2	4.2	-	-	-	1	-	-	-	-	-	-	-
B134	Flake Tool	3	1.6/8.6, 3.3	4.5	3.6	80%	1	1	-	-	-	-	1	-	-
	Debitage	11	3.0, 3.0, 3.1, 3.7, 4.5, 5.0, 6.9, 7.2, 7.5, 7.6, 7.7	5.4	2.0	37%	3	2	2	1	4	1	-	-	-
B143	Debitage	1	7.5	7.5	-	-	-	-	-	-	1	-	-	-	-
Subtotal Brackish							**14**	**15**	**20**	**11**	**7**	**4**	**1**	-	-
S7	Debitage	4	4.1, 4.7, 7.8, 8.3	6.2	2.2	35%	-	1	1	-	-	2	-	-	-
S27	Flake Tool	2	2.1/8.4	5.2	4.4	85%	1	-	-	-	-	1	-	-	-
	Debitage	7	7.0, 7.2, 7.2, 7.4/8.9, 8.0, 8.5	7.7	0.7	10%	-	-	-	-	4	2	1	-	-
S42	Debitage	3	6.7, 6.7, 6.9	6.7	0.1	1%	-	-	-	2	1	-	-	-	-
S44	Debitage	6	6.5, 6.6, 7.0, 7.1, 8.7, UNR	7.2	0.9	13%	-	-	-	2	2	1	-	-	-
S63	Flake Tool	4	2.9, 4.0/5.5, 7.8	5.0	2.1	42%	1	1	1	-	-	1	-	-	-
	Debitage	11	5.6, 6.7/7.8, 6.7, 6.9, 7.0, 7.0, 7.1, 7.1, 8.3, 13.5	7.6	2.1	28%	-	-	1	2	5	2	-	-	1
S96	Debitage	2	UNR, UNR	-	-	-	-	-	-	-	-	-	-	-	-
S102	Debitage	1	7.5	7.5	-	-	-	-	-	-	1	-	-	-	-
S115	Debitage	3	7.8/9.1, 8.7	8.5	0.6	7%	-	-	-	-	-	1	2	-	-

Appendix E. Obsidian Hydration Measurements from Project Quadrats by Source (continued).

Unit	Description	Num	Measurements	Mean	StDev	CV	MR	HW	NWI	NWII	PNI	PNII	PNIII	PNIV	TP/EH
Mono Craters (continued)															
S116	Debitage	4	5.7, 6.9, 7.1, 9.0	7.2	1.3	18%	-	-	1	-	2	-	1	-	-
S165	Debitage	1	5.1	5.1	-	-	-	-	1	-	-	-	-	-	-
S166	Debitage	2	5.1, 7.7	6.4	1.8	28%	-	-	1	-	-	1	-	-	-
Subtotal Saline							**2**	**2**	**6**	**6**	**14**	**10**	**5**	-	**1**
Total Mono Craters							**46**	**35**	**51**	**29**	**27**	**14**	**7**	-	**1**
Bodie Hills															
B104	Projectile Point (RS)	1	3.2	3.2	-	-	-	1	-	-	-	-	-	-	-
B112	Flake Tool	2	1.9/8.3	5.1	4.6	90%	1	-	-	-	-	-	-	1	-
B115	Projectile Point	1	3.1	3.1	-	-	-	1	-	-	-	-	-	-	-
	Biface	2	3.7/4.7	4.2	0.7	16%	-	-	1	1	-	-	-	-	-
	Flake Tool	1	6.5	6.5	-	-	-	-	-	-	1	-	-	-	-
	Debitage	1	7.2	7.2	-	-	-	-	-	-	-	1	-	-	-
Subtotal Brackish							**1**	**2**	**1**	**1**	**1**	**1**	-	**1**	-
S63	Projectile Point	1	3.2	3.2	-	-	-	1	-	-	-	-	-	-	-
	Biface	3	1.6/3.0/6.1	3.6	2.3	63%	1	1	-	-	1	-	-	-	-
	Debitage	1	2.1	2.1	-	-	1	-	-	-	-	-	-	-	-
S165	Debitage	1	4.4	4.4	-	-	-	-	1	-	-	-	-	-	-
Subtotal Saline							**2**	**2**	**1**	-	**1**	-	-	-	-
Bodie Hills Total							**3**	**4**	**2**	**1**	**2**	**1**	-	**1**	-
Mt. Hicks															
B21	Flake Tool	1	1.8	1.8	-	-	1	-	-	-	-	-	-	-	-
B112	Flake Tool	2	2.2/3.9	3.0	1.2	40%	1	-	1	-	-	-	-	-	-
B115	Projectile Point (ELK)	1	6.8	6.8	-	-	-	-	-	-	-	1	-	-	-
	Flake Tool	2	4.5, 8.8	6.6	3.1	47%	-	-	1	-	-	-	-	1	-
B134	Flake Tool	1	10.1	10.1	-	-	-	-	-	-	-	-	-	-	1
	Debitage	1	3.6	3.6	-	-	-	1	-	-	-	-	-	-	-
Subtotal Brackish							2	1	2	-	-	1	-	1	1

Appendix E. Obsidian Hydration Measurements from Project Quadrats by Source (continued).

Unit	Description	Num	Measurements	Mean	StDev	CV	MR	HW	NWI	NWII	PNI	PNII	PNIII	PNIV	TP/EH
Mt. Hicks (continued)															
S102	Biface	1	4.6	4.6	-	-	-	-	1	-	-	-	-	-	-
S165	Biface	1	3.1	3.1	-	-	-	1	-	-	-	-	-	-	-
	Flake Tool	1	6.1	6.1	-	-	-	-	-	-	1	-	-	-	-
	Debitage	2	1.4, 3.6	2.5	1.6	64%	1	1	-	-	-	-	-	-	-
Subtotal Saline							**1**	**2**	**1**	-	**1**	-	-	-	-
Mt. Hicks Total							**3**	**3**	**3**	-	**1**	**1**	-	**1**	**1**
Mono Glass Mountain															
S7	Debitage	1	6.8	6.8	-	-	-	-	-	1	-	-	-	-	-
S63	Biface	1	3.4	3.4	-	-	-	1	-	-	-	-	-	-	-
S165	Projectile Point (ELK)	1	6.7	6.7	-	-	-	-	-	1	-	-	-	-	-
S166	Debitage	1	6.4	6.4	-	-	-	-	-	1	-	-	-	-	-
Mono Glass Mtn. Total							-	1	-	3	-	-	-	-	-
Truman-Queen															
F58	Debitage	1	3.2	3.2	-	-	-	1	-	-	-	-	-	-	-
B66	Projectile Point (DSN)	1	3.5	3.5	-	-	-	1	-	-	-	-	-	-	-
S63	Flake Tool	1	2.4	2.4	-	-	1	-	-	-	-	-	-	-	-
Truman-Queen Total							**1**	**2**	-	-	-	-	-	-	-

DSN = desesrt side-notched; ELK = Elko series; RS = Rose Springs; MR = Marana (Historic-650 B.P); HW = Haiwee (650-1350 B.P.); NWI = Newberry I (1350-2275 B.P.); NWII = Newberry II (2275-3200 B.P.); PNI = pre-Newberry I (3200-4000 B.P.); PNII = pre-Newberry II (4000-5000 B.P.); PNIII = pre-Newberry III (5000-6000 B.P.); PNIV = pre-Newberry IV (6000-7500); TP/EH = Terminal Pleistocene/Early Holocene (7500-12,500 B.P.); UNR = unreadable.

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