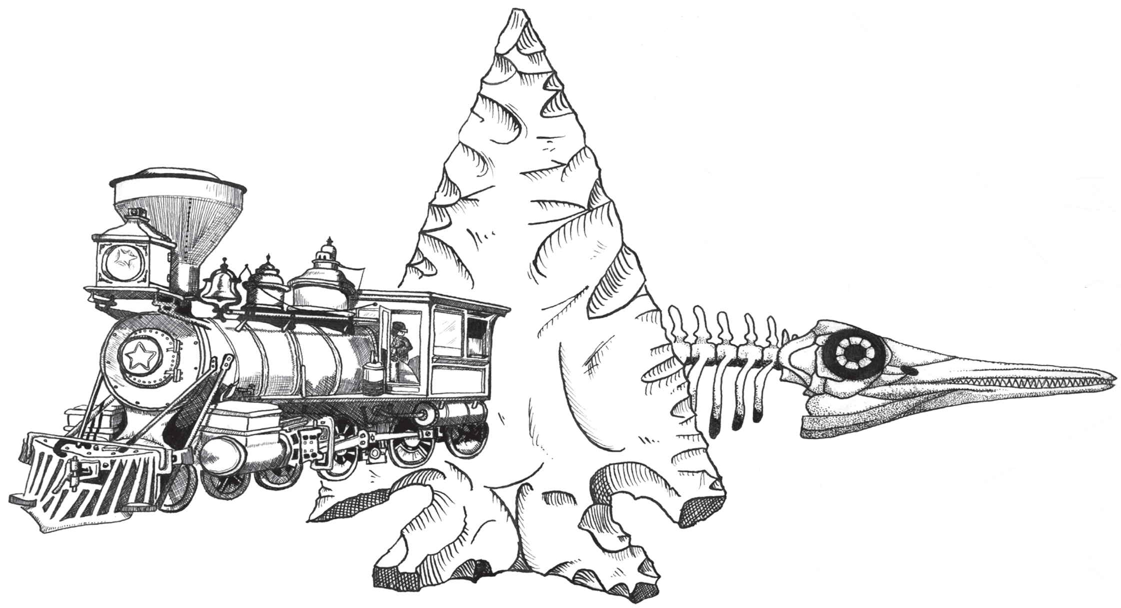
U.S. DEPARTMENT OF THE INTERIOR
Bureau of Land Management
NEVADA



Mustang Shelter:
Test Excavation of a Rockshelter in the Stillwater Mountains, Western Nevada

By Robert L. Kelly

Cultural Resource Series No. 18
2007

UNIVERSITY OF WYOMING

Mustang Shelter: Test Excavation of a Rockshelter in the Stillwater Mountains, Western Nevada

With a report on test excavations at Dixie Shelter, 26CH1077, Foxtail No. 1, and Mad Bird Shelter

Robert L. Kelly
University of Wyoming

With contributions by
Daniel R. Bach, Shannon Gilbert, Steven Grantham, and Judith Polanich

Contributors

Daniel R. Bach
High Plains Macrobotanical Services
Casper, WY

Steven Grantham
Associate State Archeologist
California Department of Forestry and Fire Protection
Fortuna, CA

Shannon Gilbert
Research Associate
Philip L. Wright Zoological Museum
University of Montana
Missoula, MT

Judith Polanich
Museum Curator
Sierra District, California State Parks
Tahoma, CA

Table of Contents

List of Illustrations

List of Tables

Acknowledgments

I begin by thanking my contributors who, once again, have waited too long to see their work come to fruition. If there is one thing I have learned in over 30 years of archaeology, it is to cherish colleagues who have both skills *and* patience. Thanks, everybody.

This short monograph was initially submitted in early 2004 to the University of Utah Anthropological Papers. For various reasons, the review process took a long while, but by November of 2005 two reviews had been secured. However, by that time, the University of Utah Press was uncertain if the venerable Anthropological Papers would continue, and so no decision could be made. Looking around for another publication outlet, I became aware that the Nevada Bureau of Land Management could publish the monograph digitally at no charge on their website. I decided to go that route.

We "discovered" Mustang Shelter in 1980, when surveying a mountain to the south of the shelter. An eagle-eyed crew member pointed out a dark spot far away in the side of a stone outcrop. Its approximate location was marked on the topographic sheet with the words "shelter?" scrawled in the margin. It was not until 1986 that I was able to return to the site, this time with Lin Poyer, who assisted in the initial test. Walking up the canyon where the map indicated the shelter lay, our attention was drawn away by a herd of wild horses, stampeding away over a ridge. Watching them disappear, we walked right by the shelter, and did not notice it until we turned in disappointment to begin the long walk back home. The shelter was named on the spot.

We excavated only a small test unit in 1986, but it nonetheless suggested promise and, in 1990, I returned with a small crew to expand the test excavation. Research in 1986 and 1990 was conducted under BLM Cultural Resource Use Permits N-43868 and N-52741, and Nevada State Antiquities Permits 274 and 329.

I deeply appreciate Lin Poyer's assistance in testing rockshelters in the summer of 1986. She remained cheerful despite the heat, long hikes, an incident with a bull on Table Mountain, and the discovery of mountain lion feces outside our tent one morning. She has remained cheerful for more than 20 years now, something else that I appreciate. I acknowledge the financial assistance provided by the University of Louisville that made the 1990 excavation season possible. I was assisted that summer by Philip Carr, Bobby Conard, and Jeff Campbell. I appreciate their willingness to live in a dry camp for three weeks, and for putting up with a terrible tick infestation (that claimed both Carr and myself as fever victims).

Mustang Shelter is in a remote location that cannot be reached by vehicle and where there is little water. Work there was made possible by the encouragement and efforts of Brian Hatoff, then of the Bureau of Land Management, Carson City District. I am grateful for the helicopter assistance provided to us by Captain Marion Rackowitz, then Commander of the Fallon Naval Air Station.

I appreciate Peter Wigand's assistance with the sediment samples and Rick Weathermon's help with lithic raw material identifications. Mary Walter Hughes and David Byers provided the artifact illustrations. Data on the debitage sample was collected by Philip Carr and Christopher Hall when both were undergraduates at the University of Louisville. Data on the debitage from the other rockshelters tested in the summer of 1986 were collected by Meegan Sanderson (Cox) and Brian Andrews, then at the University of Wyoming. David Byers, Frederica Kaestle, Edward Jolie, and Shannon Gilbert read the final chapter.

Lastly, I wish to thank Charlie and Hazel Gomes. As he has done before, Charlie provided an airplane and his piloting skills to take aerial photos of Mustang Shelter. He and Hazel also hiked up to the site one hot afternoon with a back pack full of ice cream packed in dry ice. I thought that trick would be hard to beat. But one day the following week, while I was making coffee over the fire at 5 AM, a plane flew low overhead. On its first pass, I recognized it as Charlie's. On its second pass, the door opened, two large boxes tumbled out, and gently floated down on parachutes. We chased them through the piñon and sagebrush and enjoyed all sorts of edible treats in the final days of the excavation. Thanks, Charlie.

R.L.K.
Laramie, Wyoming

Chapter 1: Introduction

This report describes the results of a test excavation of Mustang Shelter, a modest rockshelter with deeply stratified deposits located in the Stillwater Mountains, near the northeast corner of the Carson Desert (figure 1). We undertook this excavation as part of a research program aimed at understanding the role of wetland resources in Great Basin aboriginal settlement and subsistence.

The role of wetlands in Great Basin subsistence and settlement has concerned archaeologists for many years (Heizer and Napton 1970; Heizer 1967; Janetski 1986; Janetski and Madsen 1990; Kelly 1985, 1988, 1990, 1995, 1997, 2001; Larsen and Kelly 1995; Loud and Harrington 1929; Livingston 1986, 1988; Napton 1969; Raven 1990; Raven and Elston 1988, 1989, 1992; Rhode 1990; Thomas 1985; Zeanah 1996, 2004; Zeanah et al. 1995). Past debate over how prehistoric peoples used these areas focused on whether wetlands provided (a) high quality resources exploited by a sedentary population, or (b) low quality resources used as secondary foods or in conjunction with other foods by nomadic foragers (Bettinger 1993; Janetski and Madsen 1990; Kelly 1988, 1990, 1995, 2001). The consensus arose that both positions are over-simplified. Wetlands are not easily pigeon-holed into “good” and “bad” categories; they contain many resources, some providing good returns and others not so good returns. Equally important is the fact that we cannot understand their use without considering the other options that the surrounding region offered to foragers. Therefore, a regional context and research program is crucial.

One of the Great Basin’s major wetlands, the Stillwater Marsh, lies in the Carson Desert. The Stillwater Marsh receives much of its water from the Carson River and occasionally from the Humboldt River. Today, water diverted from the Truckee River also enters the Carson Desert (as did water from the Walker River in the pre-contact past), but the wetland today is substantially reduced from its prehistoric size due to use of the water for irrigation and municipal purposes. The wetland offered a variety of food resources to ancient foragers, such as bulrush, cattail, waterbirds, small mammals, and minnows. Detailed descriptions of the Stillwater wetlands appear elsewhere (Kelly 2001; Larsen and Kelly 1995; Raven and Elston 1988, 1989; Raven 1990; Zeanah 1996).

The Stillwater Mountains form the eastern border of the Carson Desert. This range is relatively low, its highest point being only 8700 feet (2652 meters) above sea level (a more complete description is in Kelly [2001]). It is a rugged range, with few springs and only one inconsequential stream in our study area (in Mississippi Canyon). In the mountains are a

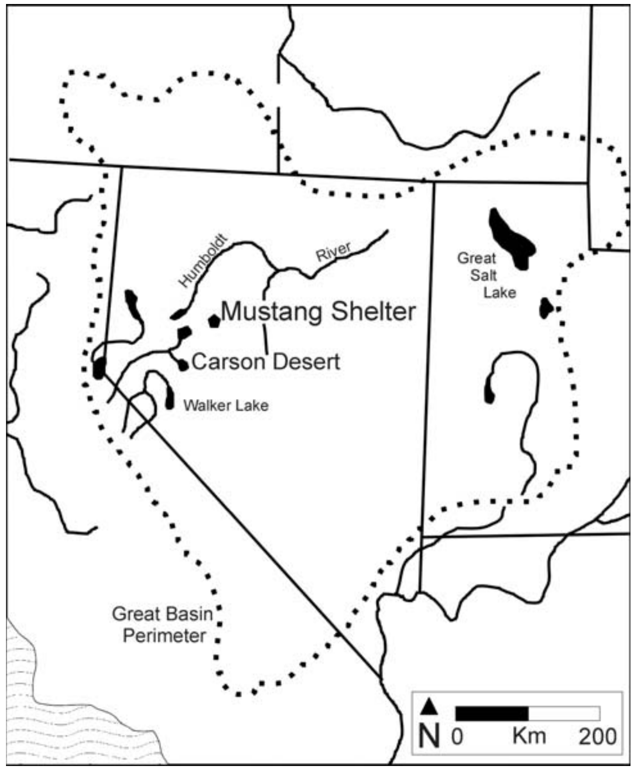


Figure 1. Location of Mustang Shelter.

variety of seeds, roots, small game, bighorn sheep, and piñon. Piñon, however, may not have been present in the range until sometime after circa 1500 uncal. BP (see discussion in Kelly 2001).

In the past 30 years, the Carson Desert has seen several research efforts. First, Hidden Cave, located at the southern end of the Stillwater Mountains, was excavated for the third time in 1979 and 1980 (Thomas 1985). Associated with this excavation, I conducted a sample survey of the Stillwater Mountains and the Carson Desert in 1980-81 (Kelly 1985, 2001). After completion of the survey, dramatic flooding in the Stillwater Marsh in 1985-1986 revealed numerous archaeological sites as well as human burials (Brooks et al. 1988; Brooks and Brooks 1990; Kelly 2001; Larsen and Kelly 1995; Raven and Elston 1988, 1989; Raven 1990; Raymond and Parks 1989; Tuohy et al. 1987). Finally, David Zeanah (Zeanah et al. 1995; Zeanah 1996, 2004) used a GIS to develop a foraging model to predict variation in food resource use over both space and time in the Carson Desert.

Zeanah’s model agrees in many respects with one I developed (Kelly 1995, 2001). Both models predict that the Stillwater Marsh should have been the focus of women's foraging, while men might have traveled further, targeting bighorn sheep in the mountains. According to the models, residential occupation of the mountains should have been rare. The models also predicted that piñon, even when it was present, was not important to the diet, except possibly when the wetlands were nearly dry (Kelly 2001). Interestingly, Schoeninger's (1995) stable isotope analysis of the human remains recovered from the marsh suggests that the marsh's inhabitants did not eat piñon. And piñon hulls were non-existent in the marsh's macrobotanical remains (Rhode 2001; Budy 1988).

This prediction also receives support in the near complete lack of groundstone implements in the Stillwater Mountains (Kelly 1990, 1995, 2001); metates were especially rare. And, dominated by debitage from the resharpening of bifacial implements, the lithic assemblage in the modern piñon-juniper zone suggest that small hunting parties, rather than entire residential groups (Kelly 2001) probably used this area. These hunting parties were likely to have been composed primarily of men. Analysis of the Stillwater human skeletal remains shows a significantly higher frequency of osteoarthritis on men's as compared to women's hips and ankles, and significant sex differences in femora shape. These osteological data suggest that men did considerably more walking than did women in this population (Larsen et al. 1995).

Nonetheless, research in the Stillwater Marsh pointed to a major transition in the settlement-subsistence system soon after 1500 uncal. BP, the late Reveille/early Underdown Phase (Kelly 2001; see also Kelly 1997). This transition was postulated to be linked to a decline in effective moisture that would have reduced the foraging potential of the uplands and desert environment relative to that of the wetlands. However, the migration of the Numa into the region, as suggested by Bettinger (Bettinger and Baumhoff 1982, Bettinger 1994, 1999a, 1999b) is another possible explanation for the transition. Yet a third possibility is that lake levels rose, flooded the current marsh, and moved settlements to the new lake shores, away from the modern marsh, where we have not yet detected them. We return to some of these issues in the concluding chapter.

I postulated that the transition soon after 1500 uncal. BP entailed greater use of wetland resources and a reduction in residential mobility (sensu Binford 1980) that resulted in the tethering of settlements to the marsh. Upland resources would have been taken through logistical mobility. A corollary to this argument is that the uplands would have been used through residential mobility prior to about 1500 uncal. BP (although piñon would, obviously, not have been important since it was not present). If people did use the mountains residentially, then they would not have had a settlement system that was not permanently tethered to the wetlands. *If* this reconstruction is correct, then hunting *and* gathering through logistical and residential mobility would have been the focus of activities in the mountains prior to 1500 uncal. BP. After

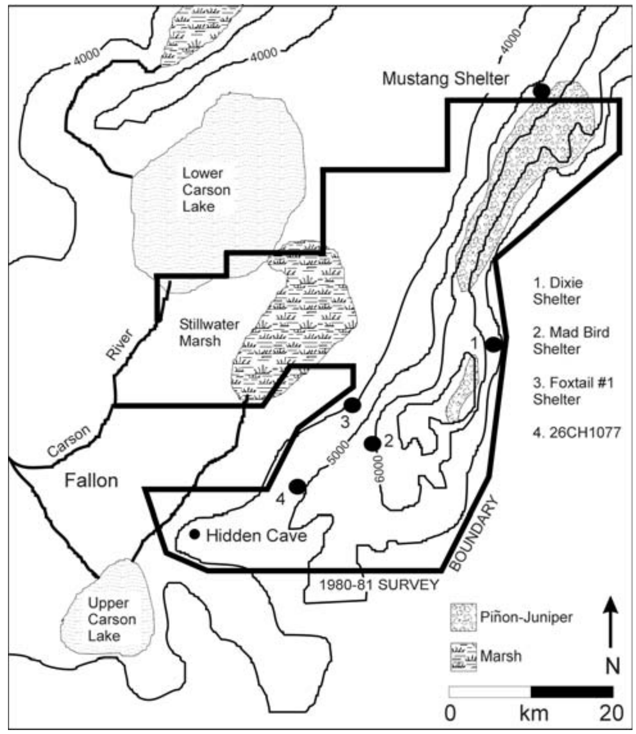


Figure 2. Approximate locations of shelters tested in 1986 in the Stillwater Mountains. Also shown is the 1980-81 survey

1500 uncal. BP, the mountains would have been used primarily by hunting expeditions from wetland base camps, with bighorn sheep as the primary target, and perhaps small mammals as secondary resources. Piñon might have ranked a distant third in importance later in time.

Excavations undertaken in the Stillwater Marsh in 1987 have expanded our knowledge of the use of wetland resources there (Kelly 2001; Raven and Elston 1988, 1989; Raven 1990; Raymond and Parks 1989). But the 1980-81 regional survey found few sites in the Stillwater Mountains with potential for stratigraphic excavation. Hidden Cave was the only excavated site above the valley floor; while this site contributed enormously to our understanding of the region's prehistory, it is located at the southern end of the Stillwater Mountains, well outside the modern piñon-juniper zone and the best hunting localities. Even more importantly, its deposits primarily predate 1500 uncal. BP and thus cannot shed light on the hypothesized transition.

Figuring that rockshelters would provide the best stratified deposits, we conducted a rockshelter survey in 1986, during which we located and tested five shelters, including Mustang Shelter (figure 2). Four of these shelters are described in chapter six. Showing promise of stratified deposits, Mustang Shelter was tested more extensively in the summer of 1990 with a crew of four for 21 days. All artifacts and samples from all

Figure 3. Aerial photo of Mustang Shelter, facing north (shelter indicated by arrow).

stove parts (figure 9). (We piled this material in the northeast corner of the site during the 1990 excavation; it was not collected.) After excavation was complete, we lined the west wall of the test trench with plastic, covered the bottom with rock, and backfilled the entire excavation.

Excavation Strategy

The 1986 test excavation consisted of a single 1 x 1 m unit with a small extension in the southwest corner to remove a bundle of basketry splints (Ch1082/7); altogether we removed about .34 m^3 of sediments (figures 7 and 9 show the location of the 1986 test; this test is also shown in figure 6). In 1990, the test consisted of a half-meter wide trench that extended the western half of the 1986 test 50 cm to the south (encompassing the 1986 test unit extension) and 2.5 m to the north. We labeled excavation units according to the grid coordinates of a unit's southwest corner. We expanded the original 1 x 1m test

sites are curated at the Nevada State Museum under accession number 1-83 We discuss the other sites tested below, but devote most of this monograph to Mustang Shelter.

Mustang Shelter

Mustang Shelter is located in an outcrop of tuft at about 6200 feet (1890 m) at the base of the piñon-juniper zone of the northern Stillwater Mountains (figures 3 and 4). (To protect the site, its exact location is not given here; it can be obtained by qualified researchers from the Nevada State Museum site files.) It is located some 45 km as the crow flies from the center of the Stillwater Marsh, and is near a place identified by the Paiute woman, Wuzzie George, as *Wudumi*, or "tall mountain," said to be a good deer and bighorn sheep hunting area (Fowler 1992: 40). A spring is located a few hundred meters to the SE that does not provide a flow sufficient to fill the wash in front of the shelter, but that did produce a modicum of water in the summers of 1986 and 1990.

Opening to the SSW, the shelter's current surface sits about 12 m above the dry wash (figure 5). The interior of the shelter is relatively level, and receives sediments from two small talus cones at either side of the entrance, eolian dust, and spall from the shelter's sides and roof (figures 6 and 7). The roof of the shelter dips, forming an outer shelter and an inner, more protected recess (figure 8).There is a cavity above the shelter (see cover photo), but it contains no sediments.

The surface of the site in 1986 was covered with historic debris; a local informant believed that it looked like the remnants of a sheep-herding or line camp. It included a partially buried tarp (left in place), coyote trap weight stones, a suspended pole, a bucket, frying pan, shovel blade, firewood, and

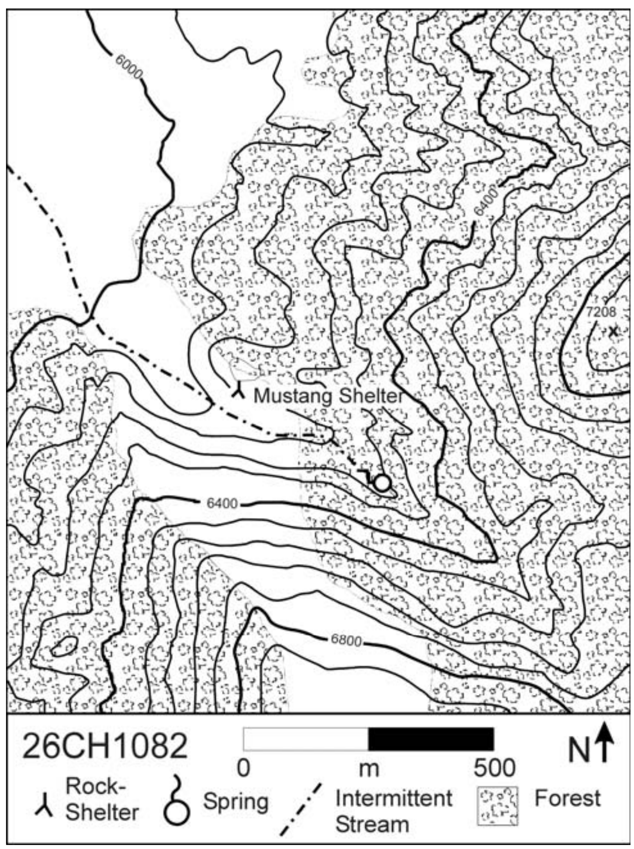


Figure 4. Topographic map showing location of Mustang Shelter.

Figure 5. Photo of Mustang Shelter, indicated by red arrow, in 1990. Screening area marked by tripod screen support.

Figure 6. Mustang Shelter, after completion of initial test in 1986.

unit with another .5 x .5 m unit, N 12-E 5.5. We excavated part of the 1986 test unit to about 2 meters below the surface, but did not reach the base of the deposits. In total, we removed about 3.6 m^3 of sediments in 1986 and 1990, and screened them through 1/8 inch mesh. We screened all deposits at the base of the slope outside the shelter, just east of a large boulder (see figure 5). In 1990, we established a datum on the NW wall of the cave, about 2 m above the ground surface. However, this was not permanently marked. In 1990, we piece-plotted every artifact and bone found *in situ* that was larger than 3 cm in its maximum dimension using a stadia rod and builder's level to obtain depth. Figure 10 shows the excavation at the end of the 1990 fieldwork.

Excavation followed natural stratigraphy where possible, never removing levels more than 10 cm in thickness. For strata 9, 10, and 11, which presented no natural stratigraphy, 10 cm excavation levels were used. Obvious rodent burrows and other areas of disturbance were removed as separate levels. Material from these levels is not included in estimates of, for example, strata debitage or bone density, or strata artifact counts.

Expectations

What did we expect to find in Mustang Shelter? In brief, if the shelter contained deposits that spanned the time period of interest, and it does, we expected to see a transition at approximately 1500 uncal. BP in the way the shelter was used. Drawn from the survey data and from the excavation data on marsh sites, we hypothesized that there should be a shift from primarily residential use of the shelter for the purposes of both hunting and gathering before 1500 uncal. BP (but the gathered component would not include piñon), to a logistical use for the purpose of hunting large game after 1500 uncal. BP.

How might this transition be marked in archaeological terms? Obviously, the faunal assemblage should, if the hypothesis is correct, indicate a decrease in the range of game taken, with more attention devoted to large species, bighorn in particular, after 1500 uncal. BP The way game are butchered could also point to differences in the way the shelter was used. In brief, we would expect to see more evidence of game processing for transport after, rather than before 1500 uncal. BP

Another line of evidence comes from the stone tools and

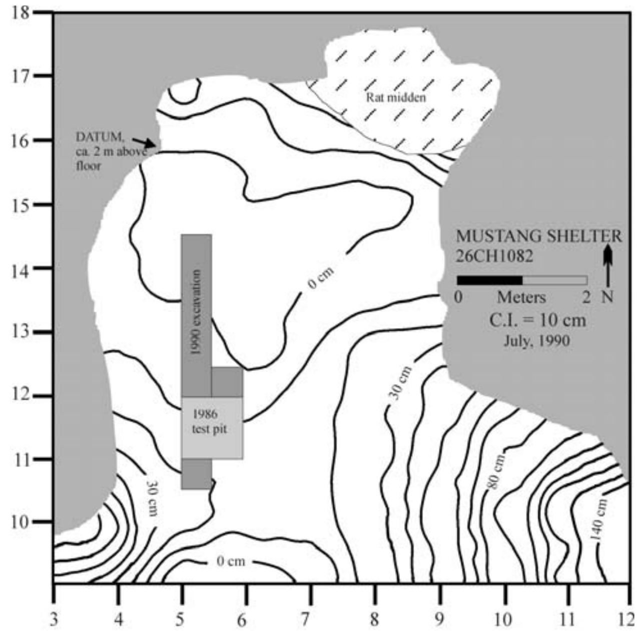


Figure 7. Map of Mustang Shelter showing elevation contours (10 cm interval) and locations of 1986 and 1990 excavations.

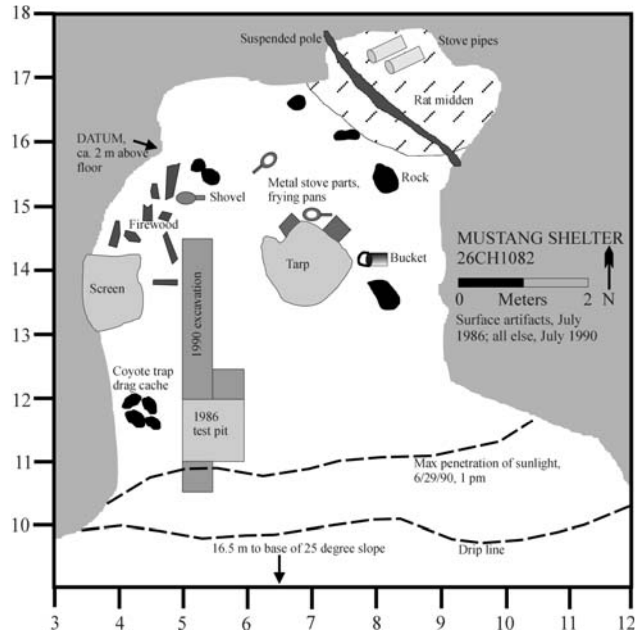


Figure 9. Map of historic artifacts found on surface of Mustang Shelter; these materials were not collected.

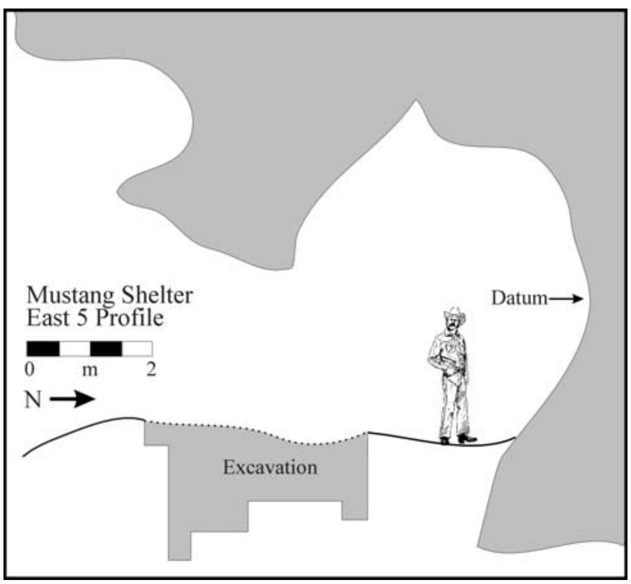


Figure 8. Profile of Mustang Shelter showing location of 1990 test excavation and datum; six-foot tall "Gatecliff Man" for scale.

Chert is fairly abundant in the Stillwater Mountains, although we know of no major sources of material in the northern Stillwaters where cryptocrystalline raw material is available in large amounts and good quality. There is a chert source a few kilometers to the west-northwest at "Spring Q" (Kelly 2001), but this material is of very low quality; this same material appears as small nodules in the walls and ceiling of Mustang Shelter. As noted below, this material was not an important toolstone for the people who used the site. Other potential toolstone is available in colluvium in the surrounding region. We were not able to conduct a thorough surface survey to document the "lithic landscape."

We postulate then, that people who used the shelter primarily through residential mobility prior to 1500 years ago would have used a mixture of bifacial and expedient flake debitage, the waste flakes from the manufacture and maintenance of tools. In the previous analysis of the material recovered from the regional surface survey and excavations in the Stillwater Marsh, I developed an argument that related stone tool manufacture and maintenance to mobility (Kelly 1985, 1988, 1990). Based on that argument, we make some predictions here about how the hypothesized change in the shelter's use might be reflected in stone tools.

Figure 10. Interior of Mustang Shelter showing completed 1990 test excavation.

tools. After 1500 years ago, if the shelter were used more frequently by logistical hunting parties, we would expect to see more evidence of those hunters having “geared up” from the valley floor, with bifacial hunting implements and/or prepared cores.

As with the faunal data, the stone tool assemblage from the test excavation is limited. The sample of waste flakes is considerably larger than the stone tool assemblage, but it too has its biases. The conclusions that derive from the report that follows, then, are quite preliminary. We have not returned to the site since 1990, but it merits further attention. In particular, the site has promise of deeper and older deposits.

Chapter 2: Stratigraphy

Mustang Shelter's stratigraphy is presented in figure 11 and described in table 1; this stratigraphy is from the west wall of the 1990 excavation trench, the so-called East 5 wall. We have not conducted any formal analyses of the sediments. Uncalibrated radiocarbon dates run from 730 BP near the surface to 3020 BP at the bottom of the excavation (table 2). The lack of a late component suggested by the radiocarbon dates is reflected in the dearth of Desert series (Desert Side-notched and Cottonwood triangular) projectile points.

Table 1. Field description of stratigraphy.

Stratum	Description
1	Surface to a few cm below surface, a date of 730 uncal. BP lies at the contact between 1 and 2; loose, powdery windblown dust; some historic debris on surface, slopes gently from front to rear of shelter; cow dung restricted to the upper 5-10 cm.
2	Similar to 1 but with high density of organics, more so towards the front of the shelter; contains several packed lenses of organic material, including piñon branches, cones, and cone parts.
3	Another organic layer, especially so near the front of the shelter, separated from stratum 2 at the shelter's front by layer of ash and charcoal that slopes downward from the shelter's inside to the outside; found primarily between N 11 and N 12; contains a date of 1070 uncal. BP near top.
4	An organic-rich rubble unit, sloping from front to rear of shelter; similar to stratum 9, 10, and 11 but contains more organic material, although less than in strata 1-3; no bedding of organics as in 1-3.
5	Organic-poor rubble at front of shelter; lies at and outside of the dripline; probably the same unit as stratum 4, but with poorer organic preservation due to location outside the dripline.
6	Layer of packed and in places burned bighorn sheep feces, 750 uncal. BP; the feces were identified as sheep but assignation to bighorn is based on the radiocarbon date; stratum confined to rear of the shelter, behind where shelter roof dips; in places extremely compact; in units N13.5 and N 14 it is overlain by a layer of ash and burnt sediment; just below the dung layer is an ashy layer containing many small flakes. A depression located beneath a tarp on the shelter's surface shows that this dung layer extends to the east.
7	Grey, ashy, loose powdery layer than contains few clear organic lenses. Associated with date of 990 uncal. BP.
8	Thick layer, internally undifferentiated, of dust, ash, small "mulched" organics, but few lenses as in strata 1-3; less organic material towards the rear of the shelter; associated with a date of 1030 uncal. BP.
9-11	Strata 9-11 are arbitrary units; below stratum 4 in the front of the shelter and stratum 8 in the rear the deposits contain considerably fewer organic remains. No internal stratigraphy was visible in 9-11 and the divisions are based on the available radiocarbon dates. Stratum 9 contains two hearths: 1350 and 1610 uncal. BP. Strata 10 and 11 were only exposed in the front of the shelter where the test pit was excavated deepest; a date of 2160 uncal BP on scattered carbon notes the division between 10 and 11; stratum 11 has a date of 3020 uncal. BP at its, and the excavation's, base.

Strata 1 through 8, dating from 730 uncal. BP to sometime after 1350 uncal. BP (the age of feature 4 in stratum 9) contained copious amounts of botanical material (figure 12), much of it probably the result of packrat activity; strata 1-4 contained especially large amounts of plant material. However, the presence of cut, split, and in one instance, bundled serviceberry splints shows that some of the plant material is the result of human activity. Stratum 6 is a compact layer of bighorn sheep feces. Below stratum 8 it was not possible to discern any obvious natural stratigraphy in the narrow test unit. In stratum 9, one hearth (feature 4) was dated to 1350 uncal. BP, and another (feature 3), a small, stone-lined hearth that lay slightly deeper, dated to 1610 uncal. BP (see below). Other radiocarbon dates were obtained from scattered carbon below these hearths. Consequently, strata 9, 10 and 11 are arbitrary stratigraphic units whose boundaries were defined on the basis of the available radiocarbon dates. They were excavated in 10 cm levels.

As noted, the strata above stratum 9 contained many plant remains, including various fragments of piñon pine (cones, twigs, etc.). Since the appearance of piñon in the region is an important issue, and since other data suggest that piñon did not appear in the vicinity of the Carson Desert until after 1500 uncal. BP, we submitted two soil samples from stratum 10 and one from stratum 11 to Peter Wigand for microscopic analysis. Wigand (personal communication, 1994) used flotation, heavy liquids and fine screening to produce a residue from each sample that was rich in microscopic carbonized plant material. These were compared to a collection of piñon material, but Wigand could not find any organic remains that compared with the piñon reference material. As other research with pollen and packrat midden analysis suggests (Kelly 2001:36; Wigand 1990; Wigand et al. 1995; Wigand and Rhode 2003), the Mustang data suggest that piñon pine was not present in the Stillwater Mountains until sometime after ~1500 uncal. BP

RATES OF DEPOSITION

During excavation we kept rough track of the volume of rock removed from each excavation layer by pouring rock from screened deposit back into a marked bucket. These data provide a rough measure of the changing percentages of rock in the strata (figure 13). Unmodified rock is introduced to the shelter primarily through roof spall and secondarily through talus accumulation, but we did not differentiate between pieces that might have accumulated from one mechanism rather than the other.

The highest percentage of rock is recorded in stratum 1; all other strata had similar rock volumes, with the exception of strata 2 and 8, both of which had low rock volumes. Assuming a more or less constant rate of roof spall and talus activity, these differences may reflect changes in the rate of accumula-

Table 2. Radiocarbon dates from Mustang Shelter.

Beta Analytic	Location	Material	Age (BP)	Corrected (2 sigma)
33002	N11 E5, top of stratum 2	grass	730 ± 70	AD 1163-1332
39025	N12 E5, top of stratum3	grass	1070 ± 60	AD 806-1046
45504	N14 E5, stratum 6	feces	740 ± 50*	AD 1205-1312
39024	N14 E5, base of stratum 7	carbon	1030 ± 60	AD 890-1155
39026	N13 E5, stratum 7	carbon (from sediment sample)	990 ± 50	AD 968-1168
39022	N11 E5, stratum 9	carbon (from hearth, feature 4)	1350 ± 60	AD 569-782
39021	N12.5 E5, stratum 9	wood (burnt, from feature 3)	1610 ± 50	AD 335-566
39020	N11 E5, stratum 10	carbon (scattered)	2160 ± 50	366-88 BC
39023	N11 E5, stratum 11	carbon (scattered)	3020 ± 50	1409-1125 BC

* $^{13}C/^{12}C$ ratio = -25.7 0/00; unadjusted ^{13}C age is 750 BP.
Calibration based on CALIB 5.0.2.

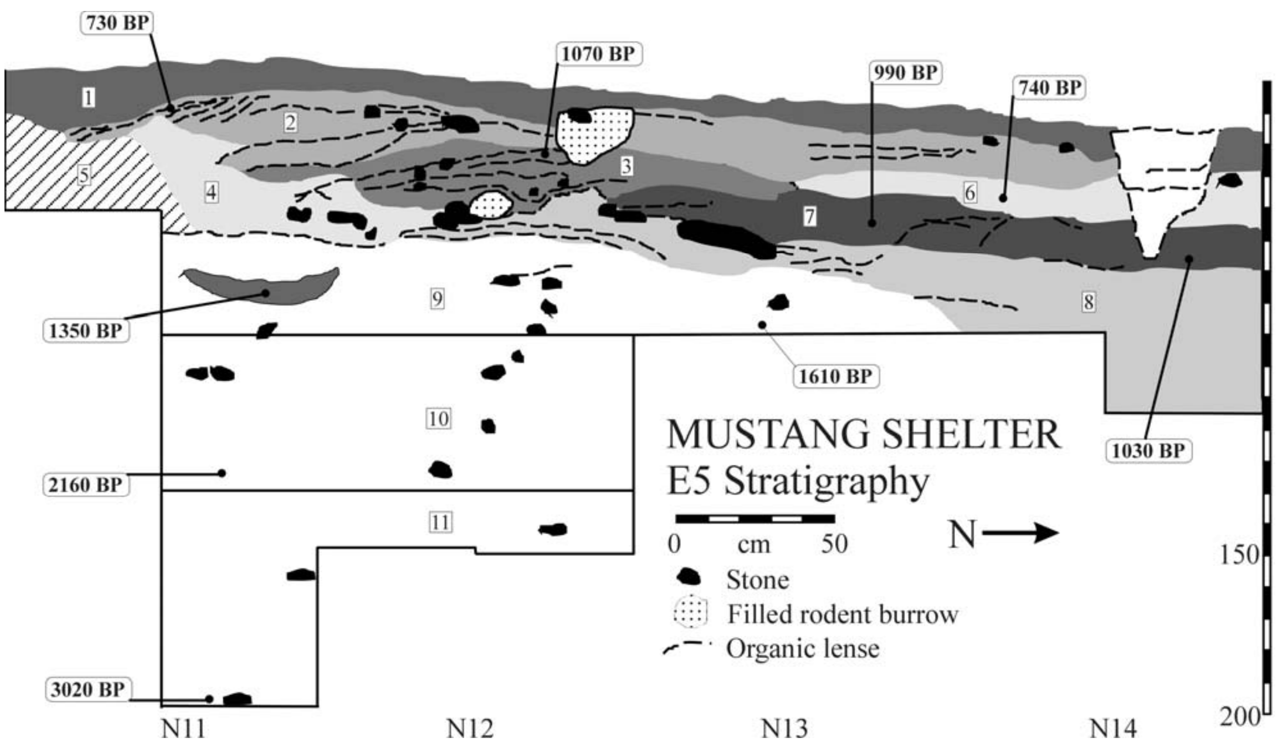


Figure 11. Mustang Shelter stratigraphy, with locations of uncalibrated radiocarbon dates.

tion of deposits from eolian dust and introduced organic materials. Where eolian deposits accumulate rapidly, there is less time for roof spall and talus accumulation to add rock to the deposit. Thus, high densities of rock may indicate slow rates of accumulation. Through this reasoning, stratum 1 represents a period of very slow deposition (see below). A radiocarbon date near the base of stratum 1 suggests that this decrease in the rate of deposition began by 730 uncal. BP.

Stratum 2 contains a high volume of organic material, especially near the shelter's front, some of which may have been brought into the shelter by humans (this stratum contained the basketry raw material mentioned above and de-

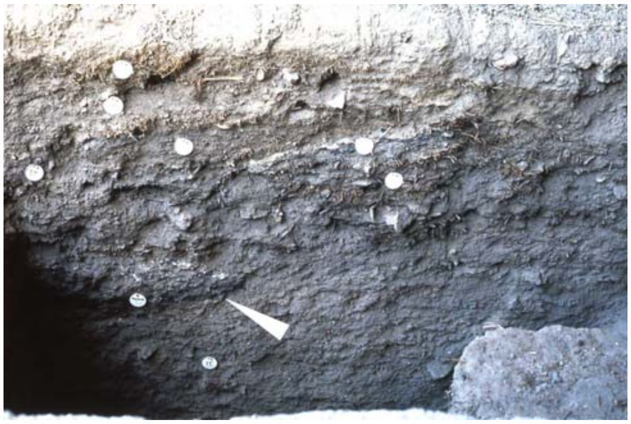


Figure 12. Photo of upper strata in Mustang Shelter, N11, E5 unit; tags are radiocarbon samples; the white arrow points to feature 4.

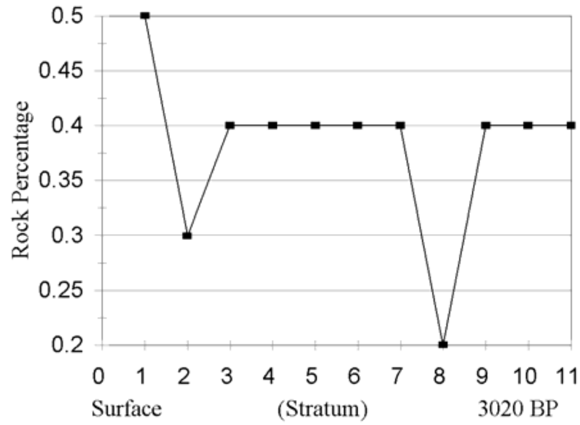


Figure 13. Graph showing the changing density of unmodified rock in the various strata.

scribed below but much of it may be wood rat accumulation). This suggests rapid accumulation, perhaps in only a few days time, if humans were the primary accumulating agent.

However, there is nothing in stratum 8 that suggests it accumulated rapidly. This could suggest that climatic activity during the time stratum 8 accumulated was such that the rate of roof spall and talus formation was lower relative to other time periods. However, note that stratum 8 is thicker to the rear of the shelter (see figure 11). Talus contributions would been greatest at the front of the shelter. Thus, stratum 8 may have a lower rock percentage because it was only receiving rock from one of the two depositional agents, roof spall.

Evidence against this argument, however, comes from the horizontal distribution of rock in the test trench. We can only look at the distribution of rock in strata 1 and 2 since these are the only strata which sample the front, middle and rear of the shelter within the test trench

Combining these two strata (figure 14) we see that there is a peak of rock density near the front of the shelter, as we might expect since this would receive both roof spall and talus. There is then a decline in rock abundance, but then a gradual increase until rock density reaches it highest level at 14 north, nearer to the back of the shelter. It is possible that this distribution of rock is anthropogenic and somehow related to the historic use of the shelter as a sheep camp. It could also reflect a greater spalling rate at the rear of the shelter — a higher rate that could have produced the roof's present configuration. Alternatively, it could be produced by large animals, who might kick stones to the sides of a shelter. At present, these are just guesses. If, however, the horizontal distribution of rock in strata 1 and 2 is representative of the horizontal distribution of rock in all other levels (a fact that we cannot presently confirm) then it would suggest that stratum 8 formed rapidly, too rapidly for the incorporation of much rock from either roof spall or talus.

But this would not explain why stratum 6 contain an average amount of rock. Stratum 6 is a dense layer of bighorn sheep feces that, like stratum 8, is confined to the rear of the shelter. Since sheep like to gather in shelters during inclement weather, we had presumed that stratum 6 would have formed during a single instance of use. But since the layer contains an average amount of rock, it is possible that this strata accumulated over time, indicating a greater frequency of use of the shelter by sheep about 700 uncal. BP than at other times (although identifiable bighorn sheep remains occur in all strata except 7 and 8). However, stratum 6 also has a low density of archaeological remains (see below) and this, too, may point to a more rapid accumulation than that of other strata. It is possible that some of the rock from this stratum was brought up from the underlying stratum 7 by the sheep's hooves, and that more factors than can be accounted for in this limited test trench affect the abundance of rock in the shelter's strata. In sum, we suspect that stratum 6 formed relatively quickly.

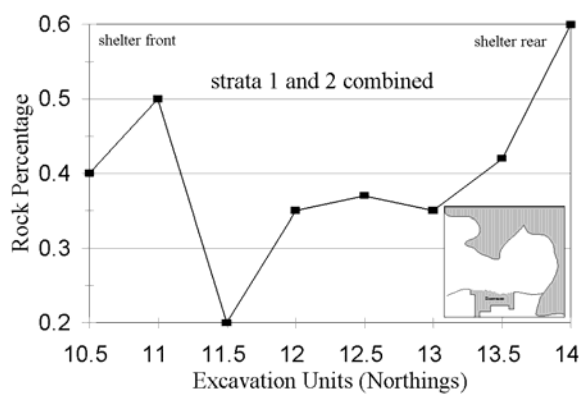


Figure 14. Graph showing the changing density of rock from the front to the rear of the shelter in strata 1 and 2 combined.

The rate of sediment deposition in the shelter has remained the same throughout most of the time material has accumulated. Using the radiocarbon dates and their associated proveniences, the rate of deposition of stratum 11 is about .07 cm/yr. For stratum 9 and 10 it is about .06 cm/year (recall that these are arbitrary stratigraphic divisions). For stratum 2 through 8, it is between .09 and .1 cm/year. As noted above, the inclusion of large amounts of organic material are responsible for this apparent increase. However, none of these figures account for compaction of the lower sediments. We are unsure how to take compaction into account, but doing so would move the sedimentation rates of strata 9 through 11 closer to the rates of strata 2 through 8.

However, stratum 1, which accumulated over the past 730 years, has a rate of deposition of only .01 cm/year. This might be a function of a decrease in the rate of accumulation of organic material. However, note that this rate is even below that of stratum 11, and since we have not taken post-depositional compaction into account in calculating the sedimentation rate of stratum 11, the low depositional rate of strata 1 is probably not simply a function of the lack of organic material being brought into the shelter. Stratum 1's low rate of sedimentation is also attested to by the stratum's high percentage of rock (that, or the rate of roof spall dramatically increased over the past 700 years).

All the radiocarbon dates appear to be in order with the exception of the 1070 uncal. BP date in stratum 3. Based on radiocarbon dates and superposition, the chronological order of the strata from oldest to youngest are: 11, 10, 9, 8, 7, 3/6(?), 2 and 1. The chronological positions of strata 4 and 5 near the mouth of the shelter are more difficult to determine, since they lack radiocarbon dates. They either post-date stratum 8 or are of the same age. Stratum 5 predates 1; and stratum 4 predates 7. Thus, stratum 4 must predate 1000 uncal. BP, but is later than the underlying feature 4, dated to 1350 uncal. BP

Figure 15 shows the relationship between the corrected radiocarbon dates (mid-points) and the strata. These dates suggest that strata 1 through 7 fall within the Underdown Phase while 9 through 11 fall in the Reveille Phase (with 8 probably falling into the Underdown Phase, but this is not certain).

The sample of radiocarbon dates is too small to determine periodicities in the shelter's use, however, the densities of debitage in the various strata may suggest that the shelter was used more at some times that at others in the past. Figure 16 shows the density of debitage and bone by strata. There is no significant change in the density of bone over time. This is expected since the bone density is based on count and since small mammals that would have been present naturally in the

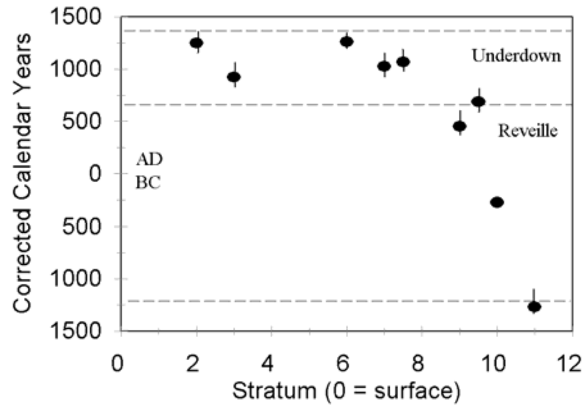


Figure 15. Graph showing the age of the strata using calibrated radiocarbon dates.

shelter comprise the majority of the faunal sample (see chapter 4). The lowest density is found in stratum 6, the sheep feces layer, which is also expected if that layer formed in the short span of time in which we think it formed.

Debitage, on the other hand, shows some significant differences among the strata. Again, the lowest density is found in stratum 6, as we might expect; there are two obvious peaks in strata 8 and 9 on the one hand, and strata 3 and 4 on the other. The difference between these two may be greater than this diagram suggests if we take into account rates of deposition that allow for compaction. If we could take compaction of the lower deposits into account, this would increase the volume measurement and lower the density of the debitage. Thus, the later peak of strata 3-4 is perhaps somewhat stronger than the earlier peak in strata 8-9.

A backplot of piece-plotted debitage against the stratigraphy adds additional light to this picture (figure 17). There is a high density of material in stratum 3. And there is an extremely low number of piece-plotted items in strata 1 and 2. The lack of piece-plotted items in these strata between N11 and N12 is a function of the fact that those deposits were removed in the 1986 test pit when debitage was not piece-plotted. However, the dearth of piece-plotted items from N12 to N14.5 in strata 1 and 2 does reflect a low density of finds.

No clear layers of debitage appear in strata 9-11. Unlike the other strata, however, we can examine vertical changes in the density of debitage within these strata. To do so, we have averaged the debitage densities of equivalent 10-centimeter excavation levels that encompassed strata 9, 10, and 11 in units N11-E5, N11-E5.5, N11.5-E5, N11.5-E 5.5, N12-E5, and N12-E5.5. Shown in figure 18, the debitage densities suggest a period of occupation near the base of the excavation, another near the transition between stratum 11 and 10, another in the middle of stratum 10, and one near the base of stratum 9.

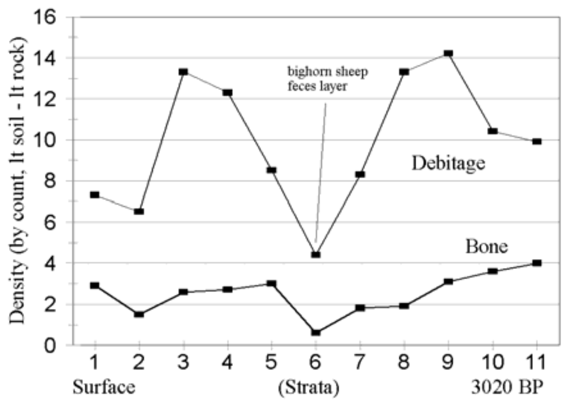


Figure 16. Graph showing the densities of debitage and bone by count in the various strata.

We do not know when the shelter was first used (since we did not reach the record's bottom), but these data and figures suggest that there have been pulses in the intensity of use of the shelter since at least 3020 uncal. BP. Taking the density of debitage as a proxy indicator of the periodicity of use of the shelter, there were three to four pulses in the shelter's use before it reached a peak during the formation of stratum 9, about 1350 uncal. BP. There is then a decline in the use of the shelter, although this is reflected primarily by stratum 7 as stratum 6 is affected by the high density of feces (and the density of material in stratum 5 may be affected by the fact that stratum 5 sits close to the dripline, where activity might have been less frequent). Use of the shelter picks up again around 950 uncal. BP (or perhaps slightly later; as we noted above the radiocarbon date from stratum 3 is slightly out of order), then quickly declines after about 700 uncal. BP. There was apparently very little use of the shelter in the past 700 years until it was used as a sheepherding camp in the late nineteenth or early twentieth centuries.

Features

Several features were uncovered in the course of excavation.

Feature 1

This feature straddled N13.5-E5 and N14-E5, at the north

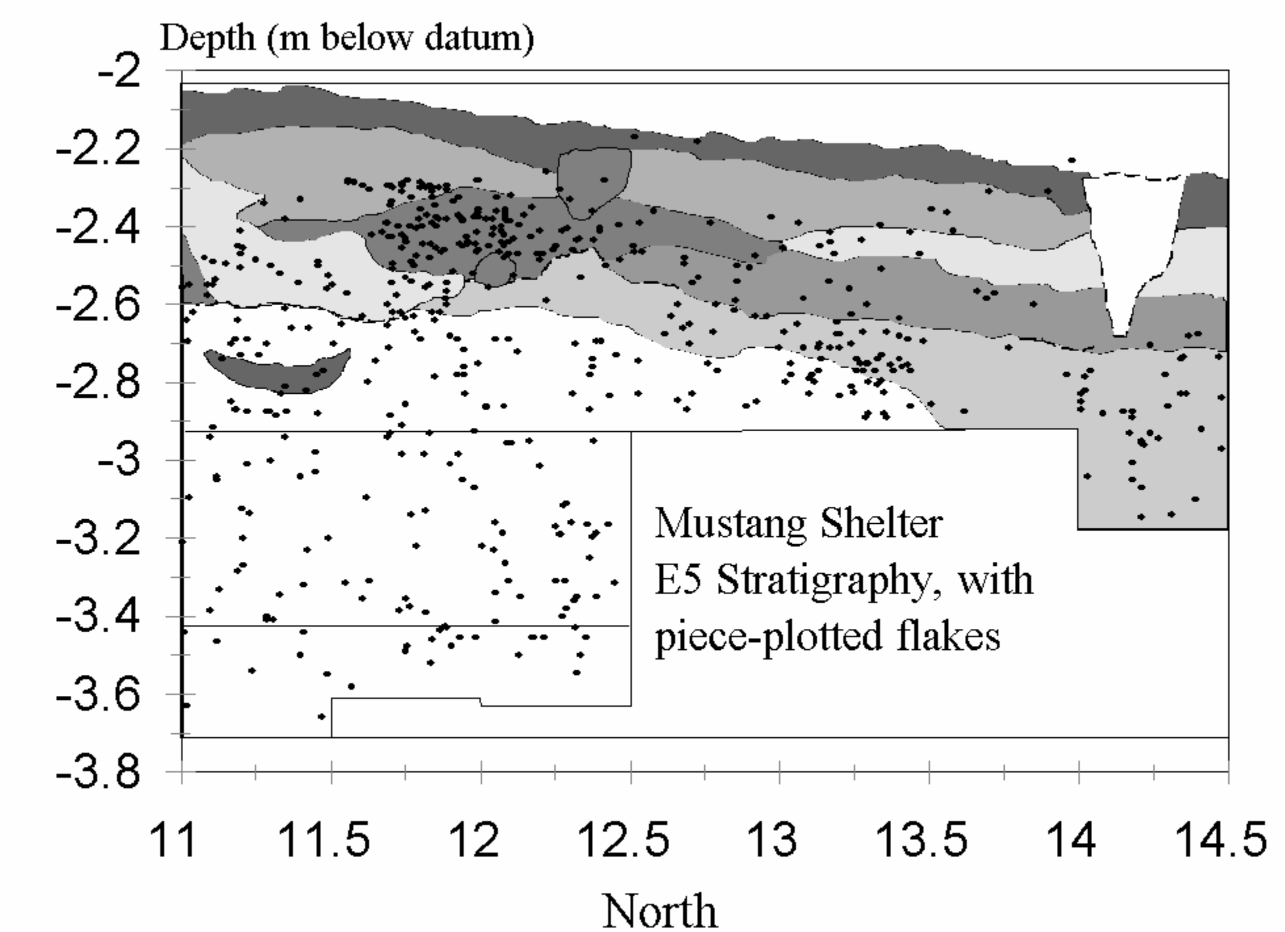


Figure 17. Backplot of piece-plotted artifacts superimposed on the Mustang Shelter stratigraphy.

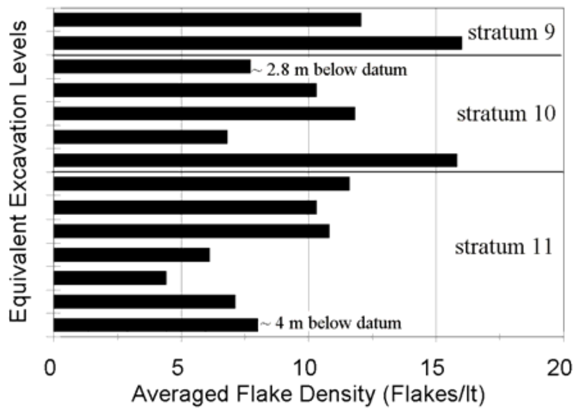


Figure 18. Debitage density in the lower three strata, by arbitrary 10-cm level.

end of the test trench, although it only appears distinctly in the west profile of N14-E5 (see the stratigraphic profile, figure 11). The feature is at least 50 cm wide and nearly as deep, and is filled with a white to grey ash; in unit 13.5-E5 it graded into a dark, carbon-laden deposit. In places, it is clear that this darker material was the burned remnants of existing strata; this was especially evident where it was stratum 6 that burned. The feature probably extends even further to the north into unexcavated deposits. It encompassed the first five excavation levels of N13.5-E5 and an odd deep, narrow portion intrudes down through strata 1, 2, 6, and into 7. Its surface of origin is clearly the surface of the site or very near to the surface of the site, and it may be historic. Prior to excavation we noticed that there was a shallow depression in this area and feature 1 conformed to the contours of that depression. Its edges were hard to distinguish from the loose, ashy, organic material that comprised strata 1 and 2 and the overall effect may be that some debitage, bone and artifacts were added to those strata in units N13.5-E5 and N14-E5 (this would only mean that the low debitage density of strata 1 and 2 noted above might be even lower). The feature itself contained two organic lenses running across its middle. This suggests that the feature filled gradually, perhaps with post-fill rodent disturbance. The feature may represent a large, most likely anthropogenic, fire in the rear of the shelter; how it came to form such a relatively deep, narrow pit is unclear.

Feature 2

This was a very shallow basin filled with charcoal and ash. It lay in the east half of N13.5-E 5 (level 8) in stratum 8. It extended into the east profile into an unexcavated unit. The entire exposed portion of the hearth was removed as a soil sample but remains unanalyzed.

Feature 3

This hearth straddles N12.5-E5 and N13-E5 and is located in stratum 9. The hearth is stone-lined on its edges and bottom, approximately 36 x 36 x 8 cm deep (figure 19). Very little charcoal and ash was present; a partially burnt piece of wood provided a date of 1610 uncal. BP (Beta 39021). There is an area of red, oxidized sediment just to the north of the hearth; the stones are slightly fire-cracked. Although the wood was taken for a radiocarbon sample, the hearth was otherwise not removed. Excavation in the two units ceased at the hearth's level. It remains *in situ*.

Feature 4

Located in the west wall of N11-E5 (level 3), stratum 9, feature 4 is a 50 cm wide shallow basin hearth; it appears as a tagged feature in the lower left of figure 12. A layer of white ash lies at the bottom; above this is a layer of oxidized earth followed by a dark carbon-filled layer. This is, in turn, covered by a thicker layer of grey ash and topped by a layer of white ash. This feature provided a radiocarbon date of 1350 uncal. BP (Beta 39022). Originally, we thought there were two features here, and the hearth may have witnessed two episodes of use separated by a relatively short period of time.

Features 5, 6, and 7

Features 5, 6, and 7 were not noticed until they were seen in the north profile of Unit N 11.5-E 5.5 (figure 20). Features 5 and 6 were removed as part of N11.5-E5.5 Level 9 (stratum 9) and Level 11 (stratum 10). Parts of feature 7 were removed as parts of levels in units N12-E5 and N11.5-E5.5. Unit N12-E5.5 was eventually excavated, but only deep enough to recover Feature 7 (as Level 1 of that unit). The feature, a 50 cm wide shallow basin filled with ash was removed in its entirely but remains unstudied.

Analytical Units and the Stratigraphy

Mustang Shelter is not especially rich in artifacts. However, its dry deposits preserve a greater range of artifact types than is seen in many other sites, including basketry fragments and artifacts of reed and other organic materials. Table 3 shows the distribution of the 229 artifacts recovered from the excavation (not including debitage) and their stratigraphic associations. As is true for many test excavations that encounter a stratigraphy blindly, the stratigraphic associations of some artifacts are not clear.

In the analyses described in the following chapters, we use only those artifacts from secure stratigraphic contexts and those contexts that can be placed in stratigraphic order. For this second reason, stratum 5 is often left aside (and it accounts

Figure 19. Photo of feature 3, rock-lined hearth; trowel points to north.

for only two of the 229 artifacts). In addition, in most analyses we will lump strata 1-4 together. The reason is that our primary interest is in whether a change in the use of the shelter took place approximately 1500 years ago. Strata 1-4 probably represent a post-1000 uncal. BP (and certainly a post 1350 uncal. BP) occupation of the shelter. We have no date from stratum 4, but we have a 1070 uncal. BP date from stratum 3, and a 1030 uncal. BP date from stratum 7 which either is as old as or somewhat younger than stratum 4. A hearth dated to 1350 uncal. BP lies near the top of stratum 9. Stratum 6-8 predate strata 1-4, and strata 9, 10 and 11 obviously predate strata 6-8 and are stratigraphically in temporal order with associated radiocarbon dates. The age of strata 6-8 is more problematic, so the key division, given the research question, is between strata 1-4, 9, and 10 and 11. We comment on this division more below.

The debitage analysis consists of a sample of material from the 1986 test unit and the 1990 .5 x .5 m unit N11-E5, which lies below the 1986 test. These units do not contain material from strata 6-8, which are located closer to the rear of the shelter. We chose this particular sample for the debitage because we wanted to look at change from the earliest to the latest occupation of the shelter and yet we wished also to look at debitage from one location in the shelter to hold depositional and post-depositional factors constant.

Why? Obviously, differences in the frequency of different artifact types among the strata could point to changes in the way the shelter was used over time. But a significant problem with a test excavation is that it could represent a biased sample of a site given that different classes of materials can be systematically deposited in particular places in a site. Artifact size is perhaps especially important. At Gatecliff Shelter, for example, Thomas (1983) found that there was significant size-sorting on some of the living floors such that larger items occur near the back or sides of the cave, or, alternatively near the

Figure 20. Photo of the stratigraphy of north wall of N11.5-E5.5; red arrows, from bottom, point to features 6, 5, and 7.

dripline. This could result from intentional discard (people toss large things outside the dripline or against shelter walls where they are out of the way) or post-depositional processes (small items are trampled into the deposit while larger items are kicked by animals or people until they move to the shelter's mouth or to its walls). It was for this reason that we placed the test trench from the dripline toward the back of the shelter. However, time did not permit us to reach the back of the shelter, and the excavation was placed away from the shelter's sides. Thus, our sample may be somewhat biased against those larger items that may have found their way to the walls of the shelter (this may be why we found relatively few cores, hammerstones, and groundstone artifacts). Taken from the front of the shelter, our debitage sample could be biased towards larger flakes. However, there is reason to think not.

Figure 21 shows the density of bone and debitage across the test trench for strata 1 and 2 combined (as above, we consider these strata since they were the only ones that extended across the entire trench). This figure shows a peak in debitage density near the front of the shelter. Flintknapping requires

Table 3. Distribution of Artifact classes by stratum in Mustang Shelter.

Stratum	Cordage & Basketry	Ornaments	Bifaces	Reed & Wood	Cores	Projectile Points	Hair	Coprolite	Feathers	Ground-Stone	Flake Tools	Historic	Hammer-Stone	Total
Unknown	0	1	7	0	1	1	1	0	0	0	0	0	0	11
1	2	1	5	1	0	2	0	0	0	0	0	2	0	13
2	4	3	7	5	1	4	1	0	1	0	6	2	0	34
3	2	0	14	5	1	5	0	6	1	0	2	1	0	37
4	0	0	8	0	2	0	0	0	0	0	0	0	1	11
5	0	0	2	0	0	0	0	0	0	0	0	0	0	2
6	0	0	2	1	0	2	0	0	2	2	0	0	0	9
7	0	0	3	2	0	0	1	0	1	0	1	0	0	8
8	0	0	9	0	0	2	0	0	0	0	0	0	0	11
9	0	1	20	1	0	1	0	0	1	1	3	0	0	28
10	0	2	13	0	2	3	0	0	0	0	0	0	0	20
11	0	0	5	0	1	3	0	0	0	0	0	0	0	9
1/2	0	0	2	0	2	0	0	0	0	0	0	0	0	4
2/3	0	0	0	0	0	2	0	0	0	0	0	1	0	3
2/4	1	2	0	0	0	1	0	0	0	0	0	0	0	4
3/4	0	0	9	0	1	1	0	0	0	0	1	0	0	12
3/8	0	0	2	0	0	0	0	1	0	0	0	0	0	3
4/8	0	0	4	0	0	0	0	0	0	0	0	0	0	4
4/9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7/8	0	0	3	1	0	0	0	0	0	0	0	0	0	4
8/9	0	0	0	0	0	0	0	0	0	0	2	0	0	2
Totals	9	10	115	16	11	27	3	7	6	3	15	6	1	229

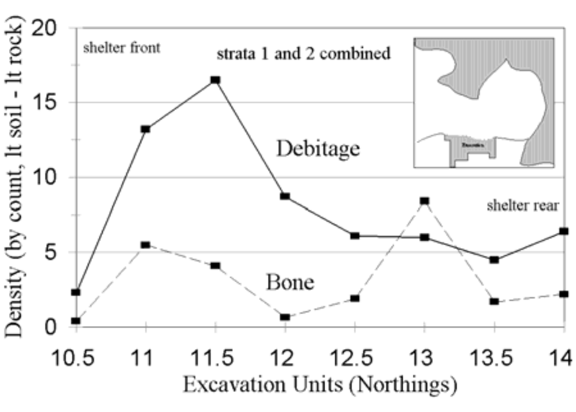


Figure 21. Graph showing the densities of debitage and bone from the front to the rear of the shelter, strata 1 and 2 combined.

good light, and the front of a shelter provides it better than its rear. In addition, flintknapping is a messy activity that produces many small, sharp objects. Thus it would probably have been done away from those parts of the shelter, the rear and side walls, that were more likely to serve as sleeping places. Thus, if a sample must be limited, it is best to limit it to the front of a shelter where more of all flintknapping debris produced is likely to be present.

In sum, in order to look at the entire stratigraphy, and yet hold depositional and post-depositional factors as constant as possible, the debitage analysis includes only material from the deep excavation units near the front of the shelter.

Sample size issues result if we break down strata 1-4 into the individual strata and, for the debitage analysis, the stratigraphic associations of material recovered in the initial 1986 test is less certain than for materials recovered in 1990. Additionally, stratum 9 bridges the time period of interest, containing one hearth dating to 1350 uncal. BP and another to uncal. 1610 BP. Thus, the major expected difference lies between strata 1-4 and strata 10-11, with stratum 9 being a possible transition. As a result of initial analysis, we thought it best to present stratum 10 separately from 11 here in order to see with greater clarity whether the pre-stratum 9 assemblages differed from one another. However, in a few places, where sample size is a consideration, we will combine strata 10 and 11.

Chapter 3: Lithic Assemblage

In this chapter, we first describe the major classes of stone artifacts recovered and analyze their distribution.[1] Special attention is then given to the debitage from the site.

Projectile Points (N=27)

Twenty-seven points were recovered from Mustang Shelter. Twenty-four could be assigned to types using Thomas' (1981) key. Projectile point data are presented in table 4 and the points are illustrated in figure 22. Comments on some of the specimens are given below.

Desert Series (N=2)

Specimen Ch1082/645 is a basal fragment and its assignment to the Desert series, as a Desert Side-notched point, is tentative, based on the fact that there appears to be the remnant of a notch on one side of the point. Specimen Ch1082/657 falls into Thomas' Cottonwood Leaf-shaped type. Both specimens were recovered from stratum 6, dating to 740 uncal. BP These points are the only indication of a Yankee Blade Phase occupation at the site.

Rosegate Series (N=14)

Specimen Ch1082/3 is on the large side for a Rosegate series projectile point. One side of the base may have broken in use or manufacture, and the maker may have intended the base to be somewhat larger than it is. Thus, this point could actually fall within the Elko series. Specimen Ch1082/12 appears burnt and may have broken as a result of burning. Specimen Ch1082/97, an obsidian point fragment, is heavily resharpened; its base is broken but a sufficient amount remains to assign it to the Rosegate series. A small amount of cortex is present on one face. Measurements on specimen Ch1082/143 were estimated as the base has an unidentified organic fiber wrapped around it, fiber that was used to haft the point to a shaft. Specimen Ch1082/338, fashioned from a white chert, bears an impact fracture on its tip. Specimen Ch1082/818 is complete but was found *in situ* in two pieces (both were given the same catalog number). Specimen Ch1082/922 bears a fracture that suggests it was broken during the flaking of the second notch. The point's other edges are pristine and suggest the point was never used.

Elko Series (N=8)

Six points fall into the Elko Corner-notched type, and two (Ch1082/658, 965) into the Elko Eared type. Specimen Ch1082/417 is small, resharpened and battered. Its basal width would have been larger but both ears have been broken. The point also appears to be burned. Specimen Ch1082/565 is fashioned from a chert that may have come from the southern Stillwater mountains. Its edges do not bear much evidence of use. Specimen Ch1082/612 is just a fragment of the base; its typo-

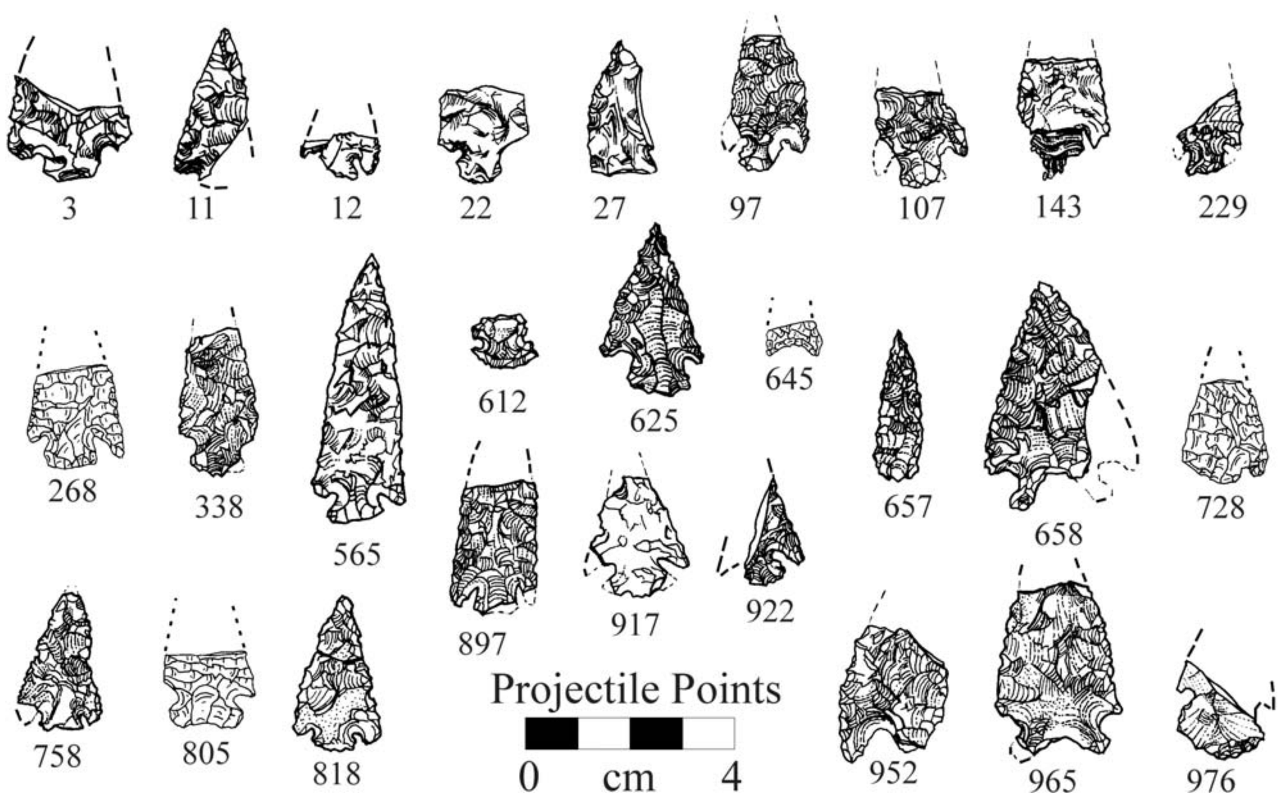


Figure 22. Projectile points from Mustang Shelter.

Table 4. Data on projectile points from Mustang Shelter.

Ch1082/	Stratum	Max Len mm	Max Wid mm	Max Th mm	Wt gm	Portion	Material	Axial Len mm	Len to Max Wid. mm	Basal Wid mm	Neck Wid mm	Notch Open. deg.	DSA deg.	PSA deg.	Axial L/ Total L	Resharp.	Type
3	2		23.0	5.2	2.0	base	moss agate		7.0	>9.8	10.4	65	160	90	1	?	Rosegate
11	2			3.1	1.0	frag	chert						150		1	no	Unknown
12	2		14.6	3.2	0.3	base	chert		5.8	6.8	6.5	40	130	110		?	Rosegate
22	2/3		18.1	4.7	1.2	base	chert?		7.1	9.4	7.2	50	160	140	1	?	Rosegate
27	3/4			3.8	1.2	frag	chert									?	Unknown
97	1		16.6	4.2	1.3	miss tip	obsidian		4.6	8.2	6.2	60	130	120	1	yes	Rosegate
107	2/4			3.3	1.1	base	chert		4.7	7.8	7.5	70	140	90	1	?	Rosegate
143	3			3.9	1.5	base	chert									no	Rosegate?
224	2/3		14.4	3.5	0.5	base	chert		4.6	7.8	6.1	45	130	110	1	?	Rosegate
268	surface		18.4	3.8	1.4	base	chert		2.1	9.8	8.2	10	105	100	1	?	Rosegate
338	3		14.5	3.9	1.8	miss tip	chert		7.8	9.0	8.1	85	185	110	1	no	Rosegate
417	2	22.3	19.4	3.8	1.3	miss tip	chert	22.3	4.9	10.8	7.7	40	160	150	1	yes	Elko Corner-notched
565	-	50.7	17.9	3.7	2.9	whole	chert	49.8	3.5	11.3	7.5	35	160	120	0.98	no	Elko Corner-notched
612	8				0.3	base	chert			10.8	7.9	40	180	140	0.98	?	Elko Corner-notched
625	10	32.2	19.8	4.0	1.8	whole	obsidian	32.2	6.5	11.6	8.9	65	160	125	1	yes?	Elko Corner-notched?
645	6					base	obsidian									?	Desert Side-notched?
657	6	28.5	8.6	2.8	0.8	whole	chert	28.5	4.7	8.0					1	no	Cottonwood Leaf-shaped?
658	10	42.9	25.4	4.5	3.5	whole	chert	36.3	7.0	15.9	14.7	55	160	140	0.84	no	Elko Eared
728	3		16.3	3.0	1.1	miss tip	chert		2.3	5.9	6.7	10	115	95	1	no	Rosegate
758	9	26.4	15.8	3.0	1.0	whole	chert	25.9	3.0	7.7	7.6	30	130	115	0.98	yes	Rosegate
805	10		18.3	3.5	1.0	base	chert		5.9	13.5	10.5	50	170	130	<1	no	Elko Corner-notched
818	8	28.3	16.2	3.2	1.3	whole	chert?	28.3	1.7	7.8	7.4	35	130	110	1	no	Rosegate
897	3		17.8	3.9	1.9	base	chert		2.0	8.1	7.4	25	115	110	1	no	Rosegate
922	3			2.6	0.5	base	chal		2.0	7.7	6.0	25	120	120	1	?	Rosegate
952	11			5.7	3.1	base	chert			16.6	17.4			90	<.97	yes?	Unknown, Humboldt?
965	11		23.4	5.6	4.6	miss tip	chert		7.7	18.8	14.5	60	160	130	0.91	no	Elko Eared
976	11			2.8	0.7	base	chert			16.0	12.0	55	160	130	1	?	Elko Corner-notched?

logical assignment is based only on the basal width and the proximal shoulder angle. Specimen Ch1082/625, fashioned from obsidian, appears to have been made from an earlier tool based on several odd flake scars on one side that are cross-cut by small pressure flake scars. The point may have been made from a scavenged tool, but the long flake scars are not weathered, hence it was perhaps recycled from a recently broken tool. Specimen Ch1082/805 may have been made from the same raw material as Ch1082/268. The type assignation of Ch1082/976 is difficult. The point was made on a thin flake; the ventral surface of the original flake is still visible, and the break suggests that the point snapped in making the second notch. Specimens Ch1082/658 and 965 are assigned to the Elko Eared type. Most of the points in the collection have snapped tips, or are broken just above where the hafting would have ended, but specimen Ch1082/658 has one tang and a lower corner broken, reflecting a different kind of breaking action.

Unknown (N=3)

Specimen Ch1082/11 is perhaps a Rosegate point, but it too appears to have broken during the manufacture of one of the corner notches and nothing remains of the base, making a type assignation impossible. Specimen Ch1082/27 is resharpened and its base is broken. The neck width, as evidenced by the scar left when the base snapped off, suggests a narrow neck width and this suggests a Rosegate assignment, but a definitive type assignment is not possible. Specimen Ch1082/952 may be a large Humboldt point, but it is possible that it is a resharpened Elko Corner-notched. It is not possible to say with certainty, however, whether the notch is a basal or corner notch.

Table 5. Projectile point distribution by stratum.

Stratum	Desert Series	Rosegate Series	Elko Series
surface	0	1	0
1	0	1	0
2	0	1	1
2/4	0	1	0
2/3	0	2	0
3	0	5	0
6	2?	0	0
8	0	1	1
9	0	1	0
10	0	0	3
11	0	0	2

Are Projectile Point Types Associated with Particular Strata?

The distribution of the typeable projectile points is shown in table 5. The two possible Desert series points occur in stratum 6, the layer of sheep feces, but we have noted that the assignment of these point fragments to the Desert series is somewhat tentative. Rosegate series points appear in stratum 9 and above, although the majority is in strata 2 and 3. One Elko series point appears in stratum 2 and another in stratum 8, but most occur in strata 10 and 11. Thus the major stratigraphic break between Rosegate and Elko series points is at stratum 9.

Comparing this pattern to the distribution of radiocarbon dates (figure 15), we see that this distribution conforms to the temporal distribution of Rosegate and Elko series points at other sites in the central Great Basin (Thomas 1981, 1983).

BIFACES (N=115)

Table 6 lists data on bifacial artifacts other than projectile points. Most of the bifaces are fragmented; only one complete specimen was recovered (Ch1082/424). The bifaces were classified as to whether they were thought to be projectile point preforms, roughouts (very early stage bifaces; Thomas [1988]), other kinds of biface portions (bases, tips, midsections, or other fragments), or projectile point tips, midsections, and bases. The decision as to whether a biface fragment is specifically a piece of a projectile point is somewhat subjective, and we took a conservative approach. If we could not assuredly assign a piece to the projectile point category, it was assigned to the general biface category. Figure 23 shows a sample of the bifaces; figure 24 shows projectile point fragments and preforms.

Is There a Difference in the Stratigraphic Distribution of Projectile Point Fragments and other Biface Fragments?

Bifaces can be used for many purposes, including tasks related to hunting, but projectile points are clearly associated with hunting. We tried to separate projectile points from bifaces in order to see if there were any significant changes in the frequency of hunting-related equipment through the shelter's stratigraphy. Table 7a tabulates the frequency of projectile point fragments and preforms against the frequency of other biface fragments (including "roughouts"). Fifteen items from mixed stratigraphic contexts are excluded and two items from stratum five are not included since the temporal position of that stratum is uncertain. The samples from most strata are too small for analysis so we have combined material from strata 1-4 and 6-8, leaving strata 9, 10, and 11 to stand alone. Comparing these five samples to one another, we see no significant difference in the distribution of projectile point fragments versus other biface fragments ($\chi^2 = 6.1$, df = 4, $p < .25$).

Table 6. Data on bifaces other than projectile points from Mustang Shelter.

		Unit			Length	Width	Thick.	Wt.		
Ch1082/	North	East	Level	Stratum	mm	Mm	mm	gm	Material	Comments
2	11	5	1	1	-	-	2.2	0.1	chalcedony	projectile point fragment
4	11	5	2	2	-	-	3.7	1.9	chert	tip, burnt
5	11	5	2	2	-	20.1	4.6	2.2	chert	midsection
13	11	5	3	2	-	-	-	-	obsidian	projectile point tip
14	11	5	3	2	-	25	5.7	3.7	chert	fragment, burnt
25	11	5	5	3/4	-	-	2.5	0.5	chert	projectile point tip
26	11	5	5	3/4	-	-	2.5	0.3	chal	projectile point tip
30	10.5	5	2	1/2	-	-	2.6	0.6	chalcedony	projectile point midsection
94	11	5	1	4	-	27.9	6.8	5.8	chert	fragment
109	12	5	4	-	-	-	3.8	1.2	chalcedony	projectile point tip
131	11	5.5	4	4	-	-	3.4	1.3	chert	fragment
134	11	5.5	4	4	-	-	2	0.2	obsidian	projectile point base
141	11	5.5	5	4	-	31.2	10	12.4	chert	roughout
142	12	5	6	3	-	-	2.7	0.7	obsidian	projectile point tip
156	11	5.5	5	4	-		3.4	0.6	chert	projectile point midsection
174	12	5	8	3	-	23.2	5.8	4	chert	midsection, battered
175	11	5.5	5	4	-	-	-	0.7	chert	fragment
179	11	5.5	5	4	-	-	12.3	3.8	chert	edge
195	11	5.5	6	9	-	-	3	1.2	chert	projectile point tip
204	11	5.5	6	9	-	-	2.4	0.2	chert	projectile point tip
207	11.5	5	1	3/4	-	21.7	4.5	0.6	burnt?	projectile point midsection
215	12.5	5	4	2	-		2.5	0.3	chert	fragment
227	12.5	5	7	-	-	16.7	4.7	1.4	chert	projectile point midsection
238	11.5	5	5	9	-	-	4	1.3	chert	projectile point tip
259	13	5	3	2	-	-	4.4	2	chert?	midsection
281	13	5	4	2	-	-	3.7	1.5	chert	preform?
304	11.5	5.5	4	3	-	34.6	6.2	7	chert	base
306	13	5	5	6	-	20.2	3.2	1.9	chert	preform
316	12	5	9	3/8	-	-	4.9	3.2	chalcedony	fragment
328	12	5	9	3/8	-	-	-	0.1	chert	projectile point base
352	11.5	5.5	5	3	-	-	5.3	3.1	chert	fragment
378	13.5	5	1	1	-	16.6	5.3	2.6	chert	fragment
379	11.5	5.5	6	3	-	-	3.2	1.3	chert	projectile point tip
380	13.5	5	1	1	-	-	6.4	2.3	chert	fragment
394	11.5	5.5	6	3	-	24.6	5.8	3.9	chert	base
400	11.5	5.5	6	3	-	21	3.8	1.8	chert	preform
404	11.5	5.5	6	3	-	30	7.2	8.5	chert	tip
424	11.5	5.5	7	4	77.5	38	5.7	18.9	chert	whole
425	12	5	12	9	-	-	5.6	4.3	chert	fragment
426	11.5	5.5	8	4/8	-	-	10.5	2.8	chert	tip
431	11.5	5.5	8	4/8	-	30.6	4.9	4.9	chert	base
436	11.5	5.5	8	4/8	-	-	8.3	1.1	silt.	fragment
438	12	5	12	9	-	-	4.5	1.8	chert	tip
439	11.5	5.5	8	4/8	-	23.6	5	3.1	chert	fragment
457	11.5	5.5	9	9	-	-	7.6	10.3	chert	burnt fragment
476	13.5	5	7	7	-	22.3	6.4	4.7	chert	tip, smashed
496	11	5	5	10	-	28.2	7.7	9	chal	base
503	13	5	8	7/8	-	-	8.4	7.8	chert	fragment
538	13	5	8	7/8	-	-	6.6	3.2	chert	tip

Table 6 (continued).

Ch1082/	North	Unit East	Level	Stratum	Length mm	Width Mm	Thick. mm	Wt. gm	Material	Comments
547	11	5.5	8	10	-	24.1	6.1	3.9	chert	base
548	12.5	5	8	7	-	23.1	5.1	3.3	chert	base
552	12.5	5	8	7	-	-	4.2	1.3	chert	burnt fragment
555	12.5	5	9	-	-	21	5	3.1	chert	fragment
559	13	5	8	7/8	-	-	1.7	0.1	chert	projectile point base
569	12.5	5	10	-	-	-	4.3	2.4	chert	fits 577, preform?
577	12.5	5	10	-	-	-	4.7	3.8	chert	fits 569
588	12.5	5	10	-	-	13.7	3.6	1	chert	projectile point midsection
599	13.5	5	8	8	-	-	6.8	7.4	chert	fragment, burnt
601	13.5	5	8	8	-	-	9.1	5.9	chert	fragment
603	13.5	5	8	8	-	-	2.5	0.2	chert	projectile point base
611	13.5	5	8	8	-	-	4.5	1.1	chert	fragment
614	11.5	5.5	11	10	-	-	2.7	0.5	chert	projectile point tip
619	13.5	5	9	8	-	-	5	1.9	chert	tip, burnt
620	11.5	5.5	12	10	-	-	7.6	3	chert	fragment
638	11.5	5.5	13	10	-	-	3.9	1.5	chert	base
644	11	5.5	11	10	-	32.6	7.1	8.3	chert	midsection of large biface
653	14	5	5	6	-	-	-	0.6	chert	fragment
681	14	5	7	8	-	-	5.2	2.4	chert	base
684	14	5	7	8	-	33.2	8.3	8.5	chert	base
690	11.5	5	11	10	-	-	6.4	2.7	chal	tip
691	11.5	5	11	10	-	-	6.8	1.2	chert	midsection
729	-	-	-	-	-	-	6.1	5.3	chalcedony	tip
732	12	5	13	9	-	-	3.1	0.6	obsidian	projectile point tip
742	12	5	13	9	-	-	2.8	0.4	chert	projectile point base
751	13	5	10	9	-	-	2.6	0.2	chert	projectile point base
753	12	5	13	9	-	25.3	4.1	2.1	obsidian	base
754	12	5	13	9	27.3	14.9	2.3	1.1	chert	preform
759	12	5	14	9	-	-	2.5	0.4	obsidian	projectile point tip
765	12.5	5	12	9	-	-	3.3	0.7	chert	projectile point tip
774	12	5	14	9	-	-	2.9	0.6	chert	projectile point tip
776	12.5	5	12	9	-	23.9	4.2	1.3	chert	midsection
777	12.5	5	12	9	-	-	3.6	1.3	chert	projectile point tip
778	12.5	5	13	9	-	-	2.7	0.5	obsidian	projectile point midsection
781	12	5	14	9	-	-	6.4	6	chert	base
782	12	5	15	10	-	-	-	2.1	chert	fragment
784	12	5	15	10	-	-	2.7	0.6	chert	projectile point tip
814	12	5	17	10	-	-	5.4	3.4	chert	tip
823	14	5	8	8	-	-	2.7	0.4	chert	projectile point tip
836	14	5	8	8	-	-	3.2	0.9	obsidian	projectile point tip
880	12	5.5	2	3	-	-	-	0.7	chert, heated	tip
881	12	5.5	2	3	-	-	-	0.7	chert	fragment
889	10.5	5	2	1/2	-	27.8	9	7.6	chert	base, roughout
893	10.5	5	1	1	-	-	2.1	0.2	chert	projectile point base
894	10.5	5	1	1	-	-	-	0.3	chal.	fragment
899	12	5.5	3	3	-	13.2	3.6	1.2	chert	projectile point midsection
900	10.5	5	3	5	-	-	4.1	1.6	chert	fragment
904	10.5	5	4	5	-	-	5.3	3	chert	fragment, burnt
919	12	5.5	4	3	-	18.3	5	2	chert	midsection

Table 6 (continued).

Ch1082/	North	Unit East	Level	Stratum	Length mm	Width Mm	Thick. mm	Wt. gm	Material	Comments
945	12	5.5	4	3	-	-	5.9	4.6	chert	base
950	12	5.5	4	3	-	24.4	6.7	6.8	chert	base?
951	11	5	12	11	-	27.9	7.4	5.2	siltstone?	base
953	11.5	5.5	15	10	-	-	5.3	3.4	chert	tip
960	11.5	5.5	16	11	-	-	9.7	6	chert	fragment, burnt
964	11.5	5.5	16	11	-	-	7.9	6.2	siltstone?	base
981	11	5.5	13	10	-	-	6.4	3.4	chert	tip
998	11	5.5	15	11	-	-	4.4	1.2	chert	midsection
1006	11	5.5	16	11	-	-	3	0.4	chert	projectile point base
1011	11.5	5.5	9	9	-	-	3.9	1.1	chert	fragment, burnt
1012	11.5	5.5	9	9	-	-	-	0.2	chert	fragment
3101	11	5	5	3/4	-	-	5.8	3.6	chert	fragment
3102	11	5	5	3/4	-	-	5.1	1.9	chert	fragment
3103	11	5	5	3/4	-	32.4	5.6	8.7	chert	tip, caliche adhering to one surface
3104	11	5	5	3/4	-	-	6.4	2.2	chert	fragment
3105	11	5	5	3/4	-	-	4.8	3.6	chert	base
3106	11	5	5	3/4	64.4	44.7	10.74	47.5	chert	Roughout; cortex present

Table 7. Distribution of biface fragments and non-typeable projectile point fragments.

7a Stratum	Projectile Point Fragments	Biface Fragments	Total
1-4	11	29	40
6-8	4	10	14
9	13	11	24
10	4	11	15
11	1	4	5
Total	33	65	98
7b	Projectile Point Fragments and whole	Biface Fragments	
1-4	23	29	52
6-8	8	10	18
9	14	11	25
10	7	11	18
11	3	4	7
Total	53	65	118
7c	Projectile Point Fragments	Biface Fragments	
1-4	11	29	40
9	13	11	24
10-11	5	15	20
Total	29	55	84
7d	Projectile Points Fragments and whole	Biface Fragments	
1-4	23	29	52
9	14	11	25
10-11	10	15	25
Total	47	55	102

Table 7b adds the projectile point tallies from table 5 to the projectile point fragment and preform frequencies. However, there is still no significant difference in the distribution of projectile points (whole, fragments, and preforms) versus other bifaces ($\chi^2 = 1.48$, df = 4, $p < .90$). Since our primary concern is with the difference between the pre- and post-1500 uncal. BP occupation, and since stratum 9 bridges that time period, the Tables 7c and 7d remove strata 6-8 and collapse 10-11. Again, however, there is no significant difference between these strata in terms of biface versus projectile point fragments whether we leave the projectile points out (df = 2, $\chi^2 = 5.77$, $p < .10$) or not (df = 2, $\chi^2 = 1.43$, $p < 1.0$). In sum, we see no difference in the stratigraphic distribution of projectile point fragments versus other biface fragments.

Bifaces and Remaining Utility

Another useful way to look at bifaces is in terms of what Bettinger (1989) calls "remaining utility." We used this concept previously to analyze bifaces from sites in the Stillwater Marsh (Kelly 2001). The method uses the idea that the smaller a biface fragment, the less utility that remains in that piece (in terms of its ability to be used as is or resharpened into a useful tool). Weight is the easiest way to look at size, but weight is not entirely satisfactory because it is a biface's dimensions and not its overall mass that determines whether it can be resharpened or reused — a very small complete biface might contain more utility than a fragment of similar weight of an originally larger biface. Therefore, to determine remaining utility Bettinger looks at bifaces in terms of whether or not they can provide original measurements for length, width, and thickness.

Generally, if a biface suffers a slight break, it might lose its original length, but will still be useful. A more severe break

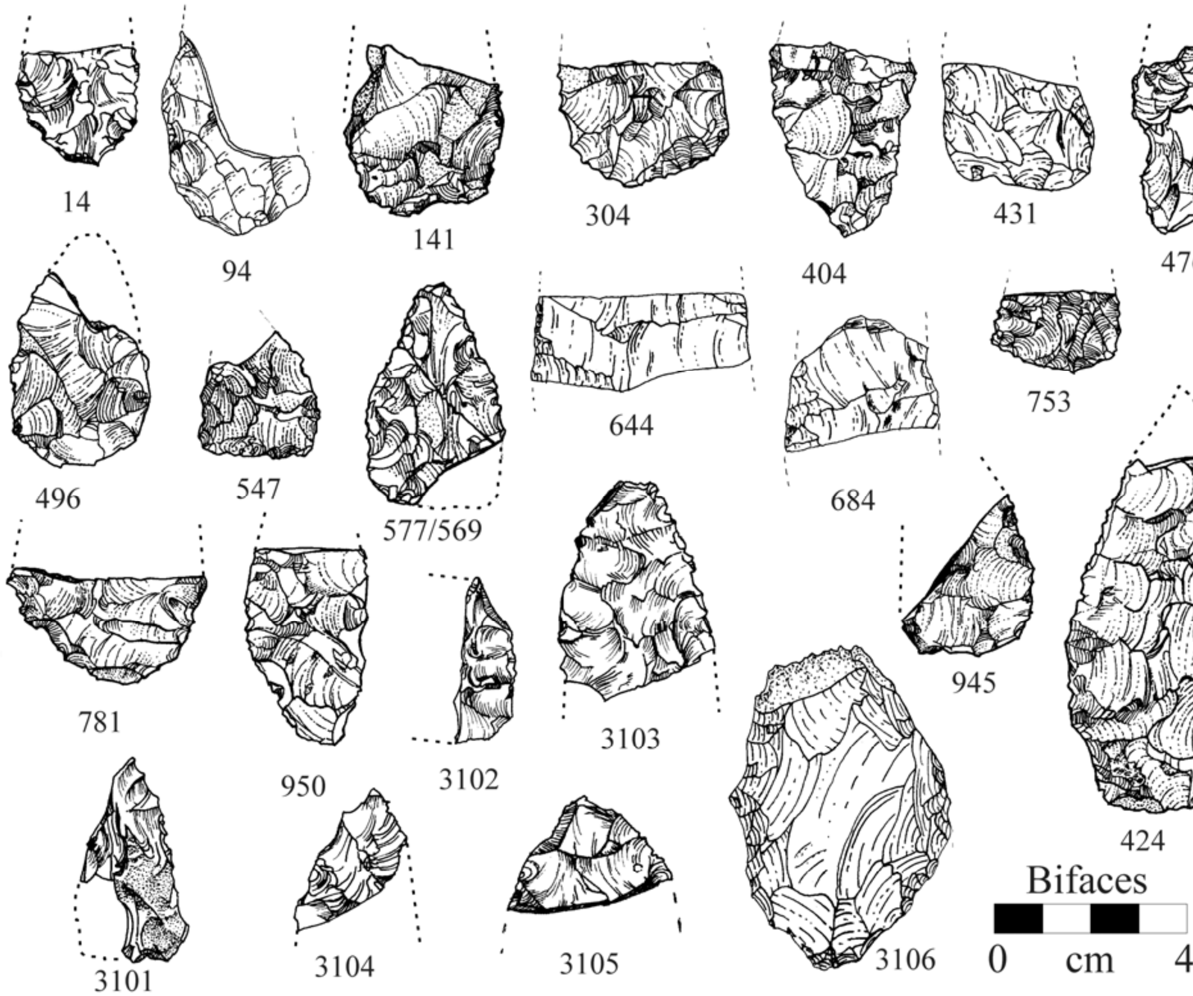


Figure 23. A selection of bifacial artifacts from Mustang Shelter.

might result in the lost of the tool's original length and width, but probably not thickness. Bifaces or biface fragments that can provide all three original measurements probably have high remaining utility. Biface fragments that can only provide two of their original size measures probably have more remaining utility than bifaces than can only provide one (thickness). A biface fragment that cannot be measured for original length, width or thickness is probably a small, fingernail-sized fragment that is useless as a tool. This means that the overall remaining utility of an assemblage of bifaces can be presented as a cumulative curve using the frequencies of bifaces that can provide all three of their original dimensions, those that can only provide two original dimenions (width and thickness), those that only provide original thickness, and those that provide no original measurements. Assemblages that contain a high percentage of bifaces that can be measured for all three variables have high remaining utility. Those assemblages that provide no maximum measurements have low remaining utility.

The concept of remaining utility provides a way to measure the intensity of use of a site. Little remaining utility suggests that the site has seen a long term or repeated occupations (with subsequent scavenging of materials already on a site). High remaining utility suggests a site where tools were abandoned (or cached) with perhaps the expectation of a return, or a site where there was no concern for extracting maximum utility from tools, e.g., where people expected to return to a base camp soon. Such interpretations would have to be made in light of the local availability of raw materials, since the lack of local toolstone alone will force people to make more intense use of tools.

As is obvious from table 8, only three of the bifaces provide all three measurements. (For tips we measured the thickness of the whole projectile points in 1 mm increments from the tip to the base. This showed that maximum projectile point thickness is obtained only about six mm back from the tip.

Table 8. Counts of bifaces for assessing remaining utility.

Stratum	Length, Width, Thick.	Width and Thick.	Thick.	None	Total
Total	3	48	55	9	115
1-4	2	14	20	4	40
9	1	4	17	2	24
10-11	0	4	15	1	20

Note: Columns show how many bifaces can be measured for all attributes listed; "total" includes bifaces from strata 6-8.

Thus, if a tip fragment was more than 6 mm long, it was measured for maximum thickness.)

Cumulative curves are used to characterize an assemblage graphically; Kolmogorov-Smirnov tests permit us to determine if differences between curves are significant. Table 8 shows how many bifaces (not including projectile points) in the assemblage provide original dimension measurements. Strata 6-8 have been left out since the sample size in those units was too small (they are included, however, in the "total" counts in table 8). Figure 25 shows the distribution of the overall profile with hypothetical curves showing the appearance of cumulative curves of assemblages with high and low remaining utility. This figure suggests that the non-projectile point biface assemblage at Mustang Shelter contains a moderate amount of remaining utility.

The concept of remaining utility is best used to make comparisons between strata or sites than to hypothetical situations. There are no significant differences among the strata in Mustang shelter (between 1-4 and 9: $D_{0.05}$=.35, D_{max} = .19; between 9 and 10-11, $D_{0.05}$=.41, D_{max}=.04; there are also no significant differences between the overall profile and individual strata.) Hence, the overall profile was compared to site 26Ch1062 in the Stillwater Marsh, as well as to sites analyzed by Bettinger: three sites in Owens Valley (Two Eagles, Crater Middens, and Pinyon House) and the composite profile of Gatecliff Shelter (see Kelly 2001, Bettinger 1989). This comparison is portrayed in figure 26. A series of K-S tests between the Mustang overall profile and each of the other sites showed a significant difference between Mustang and Crater Middens ($D_{0.05}$=.14, D_{max}=.82), Pinyon House ($D_{0.05}$=.16, D_{max}=.30), and Two Eagles ($D_{0.05}$=.2, D_{max}=.81). The difference between Mustang and 26Ch1062 is not significant ($D_{0.05}$=.20, D_{max}=.19), nor is there any difference between the Mustang profile and that of Gatecliff Shelter ($D_{0.05}$=.5, D_{max}=.13).

Crater Middens and Two Eagles are more long-term residential camps, while Pinyon House is (primarily) a historic era upland seasonal piñon camp. Gatecliff is a short term residential camp and logistical hunting location. These comparisons

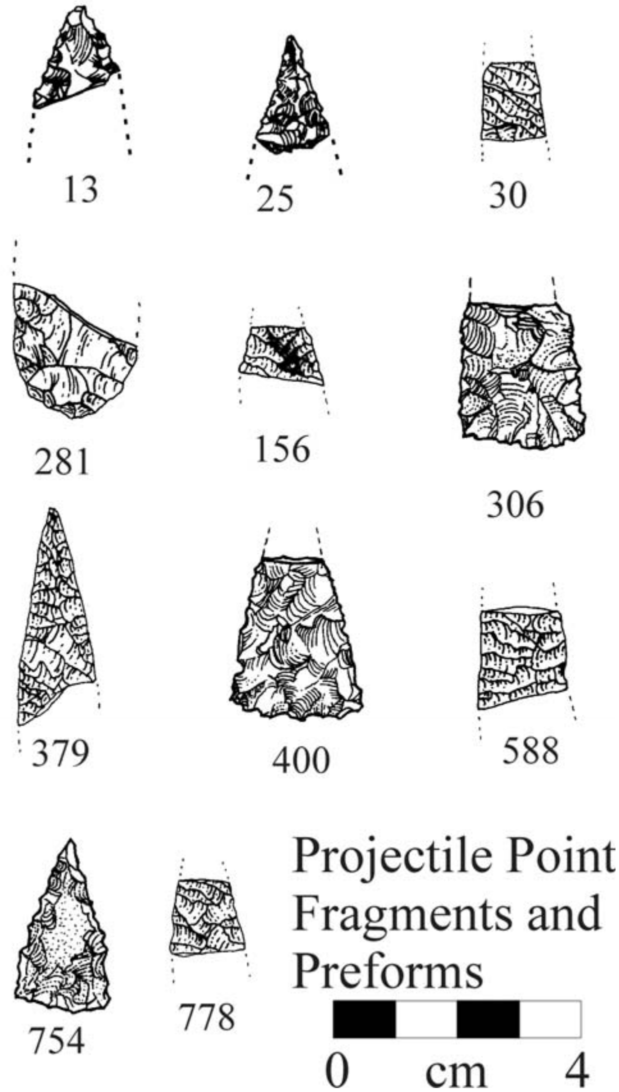


Figure 24. Projectile point fragments and performs from Mustang Shelter.

suggest that the overall Mustang profile fits the pattern of a short term hunting camp, where still useable tools are lost, or scuttled (perhaps because the occupants are on their way home) rather than that of a longer-term residence. Given that there is no stone tool raw material in the Stillwater Marsh where 26Ch1062 is located, and since the debitage assemblage at that site otherwise suggests a high degree of tool scavenging (Kelly 2001), it is surprising that it is closer to Mustang Shelter than to the residential sites in Owens Valley. In an area as devoid of stone tool raw material as the Stillwater Marsh, one would expect tools to be intensively used. The relatively high remaining utility at 26Ch1062 is therefore surprising; it might simply point to the fact that bifaces were not an essential part of the tool kit when foragers were living in the marsh. And, in fact, evidence of biface knapping is rare on the valley floor

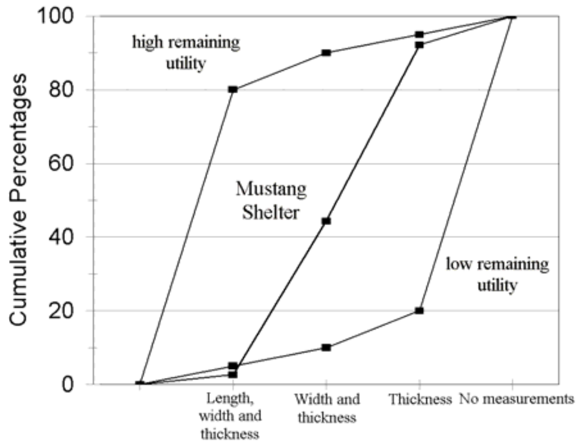


Figure 25. Cumulative curve showing overall biface completeness compared to hypothetical curves showing high and low remaining utility.

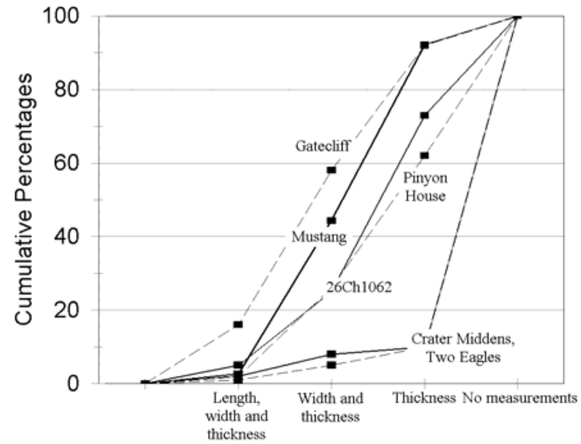


Figure 26. Cumulative curves showing the relationship between Mustang Shelter's overall biface completeness curve and those of other selected sites.

(Kelly 2001).

FLAKE TOOLS (N=15)

Very few flake tools were recovered from the test excavation. In part, and perhaps in large part, this is a product of the fact that only tools with edge retouch or definite macroscopic evidence of use wear are included in this category. However, the debitage analysis (see below) only found 10 flakes (out of 2461) with definite macroscopic signs of use-wear. Macroscopic examination of flake edges is, of course, not sufficient for a complete analysis of flake use-wear, but along with the small number of flake tools recorded here, it suggests that flakes were produced primarily through tool manufacture and maintenance, and not for use as tools.

Data on the flake tools are presented in table 9 and a selection of specimens are shown in figure 27. Five of the flake tools (Ch1082/9, 102, 505, 660, and 694) appear to be concave scrapers, or spokeshaves. These are made on a range of flake sizes and chert types. The other flakes, also made on a range of flake size and chert types, bear evidence of expedient use. Specimen Ch1082/886 could be a projectile point preform. The wear on specimens Ch1082/10, 594, 595, and 695 suggests that they were used as cutting tools while the other flake tools served as scraping tools. In no case is there extensive retouching or evidence of heavy use-wear.

CORES (N=11)

Those items labeled here as cores are any large chunks of stone that are not shaped tools and yet from which one or more flakes were removed. Data on cores are also presented in table 9 and some specimens are shown in figure 28. Five of these (Ch1082/114, 121, 137, 650, and 676) appear to be of the chert that appears in small nodules in the shelter walls. Thus, there is some doubt as to whether these are actually cores. However, these pieces appear to be larger than the fragments commonly found in the deposits, and hence they may have been brought to the shelter from another exposure of the tuft in which the shelter is found, perhaps from a source located nearby during the surface survey in the 1980s and labeled Spring Q (Kelly 2001). At least one of these (Ch1082/137, not illustrated) bears macroscopic traces of use as a concave scraper or spokeshave.

Another of the possible cores (Ch1082/31) is of a very coarse-grained rhyolite with only a few flake scars. This raw material would have been a poor source of material for anything but a few flake tools that did not require sharp edges.

The remaining chert pieces are primarily core fragments. One, Ch1082/876 bears macroscopic evidence of use (again, as a concave scraper). Specimens Ch1082/29 and 596 retain some cortex. Ch1082/697 is a green chert with brecciated dolomite; this raw material does not appear in the debitage sample.

Given the evidence for flake tool production at the site, it is odd that more cores were not found. It is possible that these were discarded elsewhere in the cave, perhaps near the rear or sides of the shelter that we did not sample.

GROUNDSTONE (N=3)

There were only three fragments of groundstone tools recovered (see table 9). One of these, Ch1082/721, is extremely small and a definite identification is not possible. A best guess is that it is a piece of a mano. Specimens Ch1082/494 and 506 are fragments of metates.

Table 9. Data on flake tools, cores and other stone artifacts from Mustang Shelter.

Ch1082/	North	East	Level	Stratum	Length mm	Width mm	Thick. mm	Wt. gm	Material	Comments
Flake Tools										
9	11	5	3	2	40.5	23.4	7.6	7.8	chert	spokeshave
10	11	5	3	2	-	37.7	5.9	13.8	chert	
15	11	5	3	2	30.9	24.4	8	6.8	chert	scraper
16	11	5	3	2	22.9	18.1	8	2.9	chert	
102	12	5	2	2	23.7	17.4	4.6	1.9	chert	spokeshave
113	11	5.5	3	2	29.7	32.4	10.2	10.8	chert	scraper
155	12	5	7	3	-	32.4	9	11.3	chert	retouched flake
505	11.5	5	6	9	53.8	42.6	21.2	41	chert	spokeshave
594	11.5	5.5	10	9	44.3	23.9	5.9	5.6	chert	
595	11.5	5.5	10	9	52.9	18	5.5	4.3	chert	
660	14	5	6	7	22.6	18	6.1	2.4	chert	spokeshave
694	13	5	9	8/9	-	24.6	3.7	2.4	chert	spokeshave
695	13	5	9	8/9	43	30.1	4.6	5.1	chert	
886	12	5.5	2	3	29.6	19.3	5.1	3.1	chert	preform?
3107	11	5	5	3/4	-	32.6	6.5	7.8	chert	
Groundstone tools										
494	13.5	5	6	6	-	-	-	423		metate frag
506	13	5	6	6	-	-	-			metate frag (large)
721	12.5	5	12	9	-	-	-	11.1		mano frag?
Hammerstone										
95	11	5	1	4	87	59.6	26.1	186	chert	
Cores										
29	11	5	5	3/4	-	-	-	32	chert	
31	10.5	5	2	1/2	-	-	-	86	Tuft?	
114	11	5.5	3	2	-	-	-	86	chert, cave wall spall?	cortex
121	11	5.5	4	4	-	-	-	189	chert, cave wall spall?	2 pieces, cortex
137	11	5.5	5	4	-	-	-	28	chert, cave wall spall?	fragment w/ cortex
596	12.5	5	10	-	-	-	-	30	chert	fragment w/ cortex
650	11	5	6	10	-	-	-	38	chert w/ cortex	burnt?
676	11	5.5	12	10	-	-	-	43	chert, cave wall spall?	cortex
697	11	5	9	11	-	-	-	56	rhyolite?	weathered surface present
875	12	5.5	1	1/2	-	-	-	61	chert	fragment w/ cortex
876	12	5.5	2	3	-	-	-	62	silicified siltstone?	

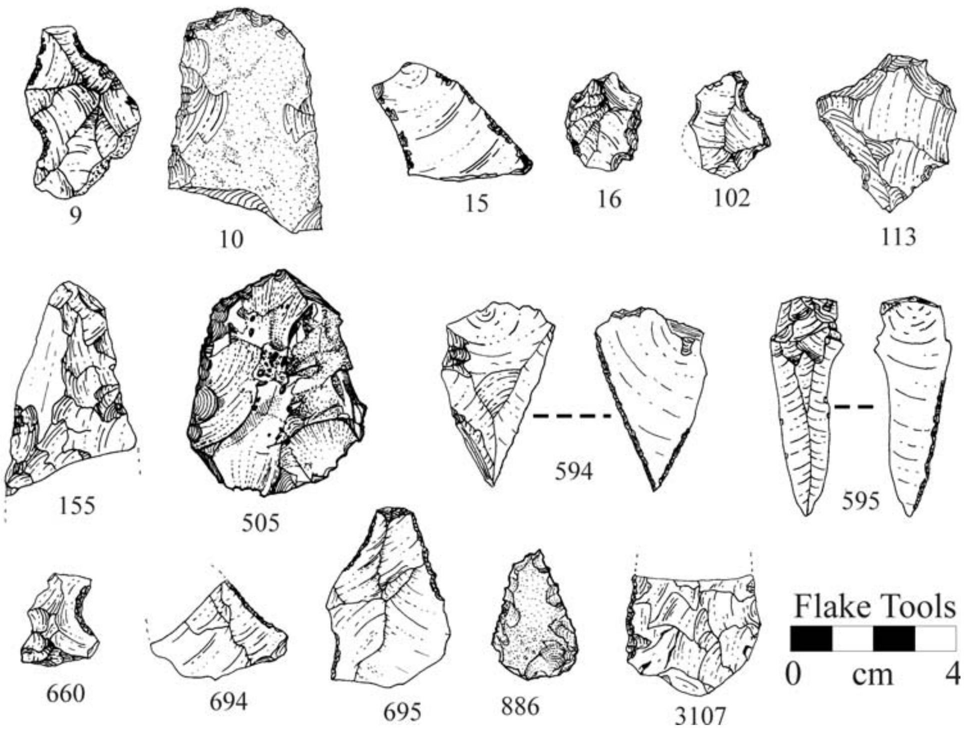


Figure 27. Flake tools from Mustang Shelter.

Hammerstone (N=1)

Only one possible hammerstone, specimen Ch1082/95, was recovered (see table 9). The specimen is a red chert, and was probably split in the past, but it bears evidence of light battering at one end suggestive of at least expedient use as a hammerstone.

Is There a Difference in the Distribution of Stone Artifacts Among the Strata?

Table 10 summarizes the distribution of the major lithic artifact classes. Those artifact classes represented by only a few items are not included, nor are those few items from mixed stratigraphic contexts that might compromise analysis: 3/8, 4/8, 4/9, and 8/9. Finally, stratum 1 includes surface artifacts.

Additionally, material from strata 1-4 are combined, as is the material from strata 6-8; stratum 5 is not included for reasons given above. Material from strata 9, 10 and 11 again stand alone.

A series of chi-square tests were conducted examining the distribution of bifaces, cores, projectile points, and flake tools across the strata as defined above. The distribution of each category was examined relative to the distribution of all other categories (that is, with 2 x 5 tables, e.g., bifaces versus all other artifacts against the five stratigraphic units, 1-4, 6-8, 9, 10, and 11; thus df = 4 for all cases). No significant differences ($p < .05$) were detected (bifaces, χ^2=6.26; cores χ^2=4.84; projectile points, χ^2=4.70; flake tools, χ^2=3.67). This artifact sample shows no change in use of the shelter over time. We also tested to see if there were differences between strata 1-4, 9 and 10-11. We left out groundstone and hammerstones since they were so few in number. A 3x4 chi-square table (lower portion of table 10) shows no difference (χ^2 = 10.33, $p < .20$) among strata 1-4, 9 and 10-11 in terms of the most common lithic artifact categories (bifaces, cores, projectile points, and flake tools).

Debitage

Artifacts, however, are not the only indicator of how a shelter was used. Debitage, the waste flakes remaining from the manufacture and maintenance of stone tools is another. In some ways, it is a superior indicator of use. Artifacts can be manufactured in one place, transported, used in several places and finally discarded elsewhere. Waste flakes are generally left where they were produced and thus are a more direct indicator of on-site activities involving stone tool manufacture and maintenance. They are also more abundant that tools and thus less susceptible to sample size issues.

The sample used here is a 25% sample of the materials recovered in the 1986 test pit and 100% of the material recovered from the .5 x .5 m unit N11 E5. We choose a 25% sample of the 1986 material since the 1986 test pit was 1 x 1 m in size and the 1990 unit was only one quarter that size. The reasons for choosing this particular area of the excavation were given above. This sample means, however, that we did not sample debitage from strata 6-8. This is not a problem for, as noted above, the relevant comparison here is between four stratigraphic units: the combined strata 1-4 and strata 9, 10, and 11.

Field counts suggest that a total of 18,333 flakes were recovered in the 1986 and 1990 excavations. The sample we drew contains 2461 flakes, a 13.4% sample of the current excavated material.

The approach to data collection taken here is similar to that used previously on material from 26Ch1062, in the Stillwater Marsh and material from a surface survey in the Carson Desert and Stillwater Mountains (Kelly 2001). We recorded the material type (e.g., obsidian, basalt, rhyolite, chert) and sorted material into different types of chert based on color, inclusions, and texture. After data collection was complete, we felt that several of the raw material categories could be combined.

Following Sullivan and Rozen (1985) we recorded the portion of the flake: whole, proximal (bearing a platform), midsection/distal (no platform present, but ventral and dorsal surfaces discernible) and shatter (no platform present and dorsal and ventral surfaces not discernible). We noted the presence of utilization, but this is based on macroscopic examination only, or at 10x. As noted above, only 10 pieces were classified as "used" and so we do not use these data in the analysis that follows.

Platforms were characterized as: single (or plain) facet, ≤3 facets, >3 facets, split, crushed, lipped, snapped, and indeterminate (see Kelly 2001 for definitions).

Some of these platform types are not mutually exclusive. In particular, the "lipped" platform category could also, and usually does, have a platform with > 3 facets. However, lipped platforms appear to be fairly distinctive of soft hammer, late-stage biface knapping (Bradbury and Carr 1995, 1999); although soft hammer knapping does not always produce lipped platforms, lipped platforms are usually produced by soft hammer knapping late in the biface reduction sequence. For this reason, the characteristic of "lipping" superceded faceting.

The presence or absence of cortex was recorded; other researchers have quantified the amount of cortex present, but this appears to be an unreliable measure and difficult to interpret (see Bradbury and Carr 1995, 1999). Each flake was weighed to the nearest .1 gram. The exterior platform angle (the angle formed by the platform and the flake's dorsal surface) was measured to the nearest degree with a goniometer, and platform width and depth (the latter being the distance across the platform from the ventral to the dorsal face) was measured with a digital caliper. The number of dorsal scars (> 2 mm in length not including edge grinding flakes emanating from the platform) was recorded. On whole flakes maximum length was recorded (normally, but not always along the strik-

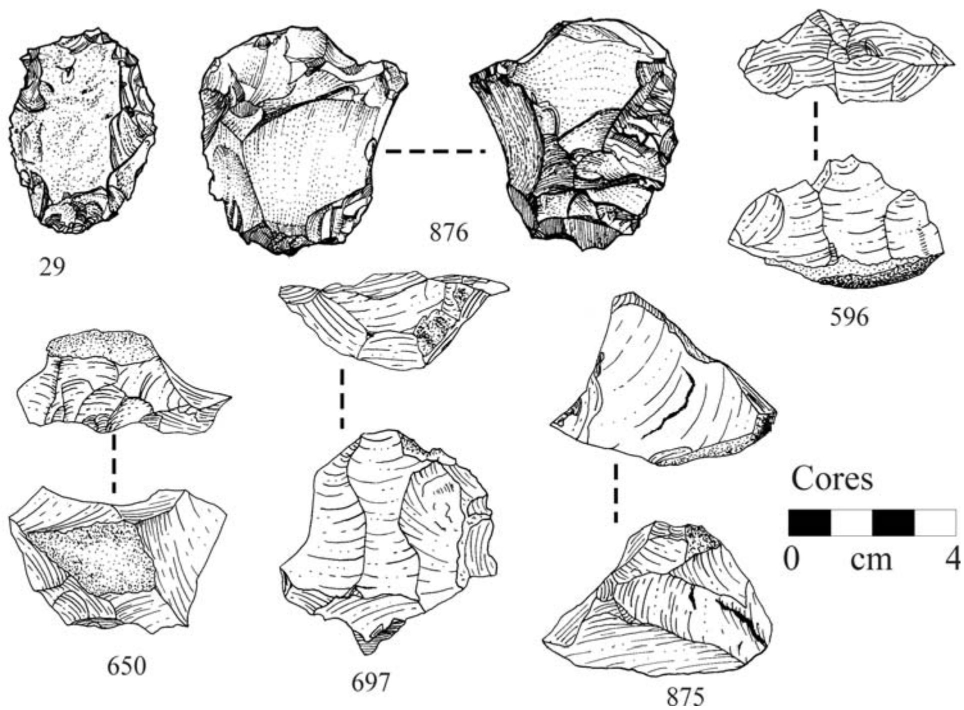


Figure 28. Cores from Mustang Shelter.

Table 10. Distribution of major lithic artifact classes in Mustang Shelter by stratum.

Stratum	Bif.	Cores	Proj. Points	Ground-stone	Flake Tools	Ham-stones	Total
?	7	1	1	0	0	0	9
1	5	0	2	0	0	0	7
2	7	1	4	0	6	0	18
3	14	1	5	0	2	0	22
4	8	2	0	0	0	1	11
1/2	2	2	0	0	0	0	4
2/3	0	0	2	0	0	0	2
2/4	0	0	1	0	0	0	1
3/4	9	1	1	0	1	0	12
5	2	0	0	0	0	0	2
6	2	0	2	2	0	0	6
7	3	0	0	0	1	0	4
7/8	3	0	0	0	0	0	3
8	9	0	2	0	0	0	11
9	20	0	1	1	3	0	25
10	13	2	3	0	0	0	18
11	5	1	3	0	0	0	9
Totals	109	11	27	3	13	1	164
1-4	45	7	15	-	9	-	76
9	20	0	1	-	3	-	24
10-11	18	3	6	-	0	-	27
Totals	83	10	22	-	12	-	127

ing axis) as well as maximum width; the primary purpose of these two measurements was to obtain a rough measure of dorsal surface area to calculate the density of dorsal scars. Thickness was taken at the intersection of the length and width measurements. The termination was also characterized as feather, hinge, step, or indeterminate. These data were recorded in the late 1980s and early 1990s by two undergraduate students at two different times (one working with the 1986 material, the other with the 1990 material). We could not make a specific effort to determine that their data collections were comparable, but both collected data under my direction and their work was periodically checked by myself. Thus, we assume comparability in the data collection.

Table 11 shows the abundance of different raw materials in the shelter by simple count in terms of flake portion. The Sullivan and Rozen method has been extensively critiqued, and their original interpretations of assemblages containing different frequencies of the various flake portions does not seem very useful (reviewed in Odell 2000). However, it is useful to look at the raw materials in terms of the abundance of shatter. In particular, raw material five and the less abundant six are primarily represented in the sample as shatter. Eventually, we decided that these two raw materials were the same. As noted above, the bed of tuft in which the shelter formed contains chert nodules. Near Spring Q, one of the 1981 survey units (Kelly 2001) only a few kilometers away from Mustang, our survey had located an area where these nodules are large and where they were quarried. Thus, people did make use of this particular toolstone in the past (although its flaking properties do not make it a choice raw material). The formation exposed at Spring Q is the same formation that contains the shelter. And Mustang Shelter's walls and ceilings contain small, generally unusable nodules of this chert. The fact that raw materials 5 and 6 are largely represented by shatter leads us to suspect that this material is largely if not entirely present in the shelter as a product of spalling. For this reason, we removed these two raw materials from the sample. This left a sample of 1664 pieces of debitage. If raw materials 5 and 6 are present throughout the shelter's deposits in the same frequencies as in this sample (combined, about 32%), then the total number of flakes recovered from the excavations would be reduced to 12,467 (the sample fraction remains the same, however).

(Incidentally, the discussion in chapter one of stratigraphic and horizontal differences in debitage density, used in part to discuss temporal changes in intensity of use of the shelter did not take the effects of raw material 5 and 6 into account. Assuming that the material is present equally throughout the deposit would not change the relative differences noted above in flake densities. However, from the present debitage sample it appears that raw material 5 (6 is present in relatively small amounts) is not present in the same frequency in all strata. It only appears in strata 2, 4, 9, 10, and 11, where it is present in the following respective frequencies: 15%, 39%, 37%, 42% and 24% (there are too few flakes in stratum 1 to make a meaningful calculation). Applying these correction factors to figure 16, however, does not alter the apparent peaks and valleys significantly.)

Table 12 shows the distribution of the raw materials across the stratigraphic units (not including raw materials 5 and 6). After data collection was completed we decided that cherts 10 and 14 were the same and the latter's code was changed to the former's; likewise, chert 16 was added to chert 7 (we burden the reader with these observations only because the excel data tables contain the original assignations). Table 12 shows that Chert 10, a clear to smoky gray chert occasionally with brown patches, is the major constituent of the assemblage, followed by chert 7 (a gray chert with white inclusions and streaks), the "Other" category (which includes a variety of generally coarser-grained material) and, in strata 1-4, "other cryptocrystalline": this last includes a variety of poorly represented sources.

In the following analyses, we use several measures to ask if there are differences in the form of stone tool reduction in the four stratigraphic units. Essentially this means whether we are looking at flakes that result from early episodes in the reduction of stone, or flakes that result from efforts that are late in the tool producing sequence. In such analyses, it would be best to hold the raw material constant since some raw material types are more amenable to flintknapping than others. Obsidian, for example, can be worked more profitably at smaller size than silicified siltstone. However, holding raw material constant would drastically cut the sample size and render some of these tests invalid. In addition, the vast majority of the assemblage is comprised of different kinds of chert; finer stone such as obsidian and coarser stone types make up a small percentage of the assemblage. Thus, we hold raw material constant only where the particular question and sampling considerations make it both necessary and/or feasible.

In these analyses, a "significant difference" is taken to mean "at the .05 level of confidence."

Is There a Difference in the Distribution of Flake Portions Among the Strata?

The first task is to determine if there are fundamental differences in the frequencies of flake portions across the strata. As noted above, such differences may not have the interpretive potential that was originally assumed because the frequencies

Table 11. Flake portions represented in different raw materials in debitage sample.

Raw material	Flake Portion Counts: Whole	Proximal	Distal	Shatter	Total	Row-wise %: Whole	Proximal	Distal	Shatter
Obsidian	8	3	13	4	28	0.29	0.11	0.46	0.14
Other Crypto.	6	3	29	19	57	0.11	0.05	0.51	0.33
Other	20	15	43	92	170	0.12	0.09	0.25	0.54
Chert 5	8	4	68	661	741	0.01	0.01	0.09	0.89
Chert 6	3	0	7	44	54	0.06	0.00	0.13	0.81
Chert 7	22	32	75	54	183	0.12	0.17	0.41	0.30
Chert 8	3	5	15	5	28	0.11	0.18	0.54	0.18
Chert 9	18	6	32	15	71	0.25	0.08	0.45	0.21
Chert 10	168	106	401	185	860	0.20	0.12	0.47	0.22
Rhyolite	3	2	4	27	36	0.08	0.06	0.11	0.75
Chert 12	12	3	27	16	58	0.21	0.05	0.47	0.28
Chert 13	7	3	18	5	33	0.21	0.09	0.55	0.15
Chert 14	8	7	27	21	63	0.13	0.11	0.43	0.33
Chert 15	8	7	8	12	35	0.23	0.20	0.23	0.34
Chert 16	6	5	7	23	41	0.15	0.12	0.17	0.56
Totals	300	201	774	1183	2458				

Table 12. Frequencies of different raw materials in the combined stratigraphic units.

Raw Material	Stratigraphic Units: 1-4	9	10	11	Total	Column-Wise %: 1-4	9	10	11
Obsidian	6	0	7	16	29	1	0	2	2
Other Crypto.	54	1	0	2	57	12	1	0	0
Other	27	7	42	94	170	6	4	13	12
Chert 7	29	59	46	90	224	6	32	15	12
Chert 8	7	5	6	10	28	2	3	2	1
Chert 9	24	6	14	27	71	6	3	5	4
Chert 10	263	81	136	443	923	61	43	46	58
Rhyolite	7	18	7	4	36	2	10	2	1
Chert 12	3	7	14	34	58	1	4	5	4
Chert 13	3	0	6	24	33	1	0	2	3
Chert 15	3	0	12	20	35	1	0	4	3
Totals	426	184	290	764	1664	100	100	100	100
Percent	26	11	07	46	100				

of those flake portions are affected by different amounts of post-depositional trampling as well as raw material characteristics. If we hold raw material constant, then, some patterning in the distribution of flake portions may, in fact, be monitoring changes in the amount of trampling that the site has seen over time, which may, in turn, have something to say about the intensity of site use. For this reason, we look at Chert 10 only, the most abundant material in the shelter.

Table 13 shows the distribution of flake portions for Chert 10 across the stratigraphic units. A series of 2x4 chi-square tests were run comparing the distribution of each flake portion across the four stratigraphic units relative to the distribution of all the other portions (thus df = 3 for all tests). These tests found no significant difference in the distribution of whole flakes (χ^2=6.51, p<.10), proximal flakes (χ^2=2.03, p<.75), or distal/midsections (χ^2=6.97, p<.10). There was, however, a significant difference in the distribution of shatter (χ^2=23.3, p<.001). The adjusted standardized residuals showed a significantly *higher* than expected frequency of shatter in stratum 10 and a *lower* than expected frequency in strata 1-4.

What can produce large amounts of shatter relative to other flake portions? One possibility is trampling since flakes will break as people walk on them. However, experimental data suggest that trampling primarily produces proximal, distal and midsection fragments out of initially intact flakes, rather than shatter (Prentiss and Romanski 1989). For this reason, we rule out trampling as the cause of the high amounts of shatter in stratum 10; conversely, the low amounts of shatter in strata 1-4 do not necessarily mean that the shelter saw less intensive use during their formation.

Shatter can also result from burning, either from heat treatment gone awry or a post-depositional fire. Evidence of burning was extremely rare, although many of the flake fragments, and shatter in particular, were too small (<.1 g) to reliably determine if they had experienced burning. Nonetheless, we do not think that burning is responsible for the shatter.

High amounts of shatter can also result from bipolar or more expedient (or inexperienced) core reduction. This would suggest that there was more expedient tool production in stratum 10 and less expedient tool production in strata 1-4.

Is There a Difference in the Distribution of Cortical Flakes Among the Strata?

A high frequency of flakes bearing evidence of cortex may reflect an early phase in the reduction of a core. Table 14 shows the distribution of whole flakes (all raw materials) across the four stratigraphic units in terms of the presence/absence of cortex on their dorsal surface. As is evident, cortical flakes are rare in the shelter, and there is no significant difference in the distribution of cortical versus non-cortical flakes (χ^2=4.08, df=3, p<.20). Since we suspect that there is no quality raw material within easy distance of the shelter (the Spring Q material is poor quality), the lack of flakes bearing some cortex is not unexpected.

Is There a Difference in the Frequency of Platform Types Among the Stratigraphic Units?

Table 15 shows the distribution of different platforms (from whole flakes and proximal flake fragments). This table does not include the snapped, split, and indeterminate categories as instances of these flakes are rare (and in the analysis the snapped category presented some problems as it was difficult to say in many cases whether a flake should be classified as whole with a snapped platform or as a non-platform-bearing piece).

Table 13. Distribution of flake portions across the stratigraphic units; raw material 10 only, one flake not coded.

Stratum	Whole	Proximal	Distal	Shatter	Total
1-4	62	37	123	41	263
9	17	11	36	17	81
10	19	17	50	50	136
11	78	47	219	98	442
Total	176	112	428	206	922

Table 14. Frequency of whole flakes bearing evidence of cortex across the stratigraphic units.

Stratum	Absent	Present	Total
1-4	84	5	89
9	28	2	30
10	47	8	55
11	117	9	126
Total	276	24	300

Table 15. Distribution of platform types across the four stratigraphic units.

	Facets					
Stratum	Single	2-3	>3	Crushed	Lipped	Total
1-4	25	17	39	27	7	115
9	5	3	4	10	6	28
10	13	8	12	18	15	66
11	32	23	34	34	22	145
Total	75	51	89	89	50	354

Again, we look at the distribution of each platform type across the four stratigraphic units relative to the distribution of all other platform types (thus df=3 in all cases).

Doing so, we find no significant difference in the distribution of single-facet-platform flakes (χ^2= .36), platforms with ≤ 3 facets (χ^2= ,85), or crushed platforms (χ^2= 2.21).

There is, however, a significance difference in the distribution of platforms with >3 facets (χ^2= 8.37, p<.05), with the adjusted standardized residuals indicating a higher than expected frequency in strata 1-4 and a lower than expected frequency in stratum 9. There is also a significant difference in the distribution of lipped platform flakes (χ^2 = 11.51, p<.01) with the adjusted standardized residuals pointing to a lower than expected frequency in strata 1-4 and a higher than expected frequency in stratum 10.

These results seem contradictory. Lipped-platform flakes and flake platforms with > 3 facets both suggest later stages in tool production, and yet here we see that while platforms with >3 facets are more frequent in strata 1-4, lipped-platform flakes are less so. This is true even if we remove stratum 9 and compare strata 1-4 to the combined assemblages of strata 10 and 11 (χ^2=17.22, p<.01). Lipped-platform flakes tend to be much smaller than other whole flakes in stratum 10 (lipped platform whole flake mean wt. =.36g, n=8; other whole flakes mean wt. =.81g, n=26; t=1.37, df=32, p=.089), which also suggests late stage tool reduction. As we pointed out above, lipped-platform flakes generally form when using a soft-hammer in the final stages of biface knapping (Bradbury and Carr 1995, 1999), although they form at a very low frequency in doing so. It may be that a soft hammer happened to be used in stratum 10 but not in strata 1-4 or that our small sample has over-represented a relatively rare event in the stratum 10 sample. However, this is unlikely since the stratum 10 lipped-platform flakes are spread across six raw material types, indicating that they are not the result of a single tool-making instance.

Is There a Difference in Mean Whole Flake Weight Among the Stratigraphic Units?

Another way to look at differences in reduction is through the weight of whole flakes. This is a bit tricky because flakes of various sizes can be produced at different stages of tool manufacture. However, while one can produce small flakes from a large stone, one cannot produce large flakes from a small stone. Cores and tools become smaller as they are reduced and so the flakes removed from them also, on average, become smaller.

Table 16 shows the average whole flake size (all raw materials included) for the four stratigraphic units. An initial table showed that variances were too large to accommodate analysis of variance (the largest variance was more than three times the size of the smallest) and so a five percent trimmed mean was used in this table (following Drennan 1996). This reduced the variance to an acceptable range. There is a significant difference in the means (F=25.82, p<.0005), produced primarily by the fact that flakes in strata 10 and 11 are skewed toward larger sizes. Using trimmed means still, a series of t-tests shows no significant difference between strata 1-4 and 9 (t= -.35, df=92) and between strata 10 and 11 (t= -.33, df=136; equal variance test). There is a difference, however, between strata 9 and 10 (t= -2.24, one-tailed p=.014, df=62, unequal variance test). The shift to smaller flakes occurred after the formation of strata 10.

Table 16. Mean flake size across the four stratigraphic units.

Stratum	N	Mean (grams)	Variance
1-4	69	.26	.14
9	25	.29	.11
10	39	.58	.48
11	99	.62	.44

Note: includes all raw materials.

Is there a Difference Among the Strata in Whole Flake Dorsal Scar Density?

Yet another way to look at the degree of stone reduction is by examining the number of dorsal scars on flakes. As stone is reduced, there should be more evidence of previous flake removals left on the dorsal surface of flakes. However, as stone is reduced, flakes tend to become smaller, leaving less room for those dorsal scars. One way around this is to look at the dorsal scar *density*. This is calculated most simply by dividing the number of flake removal scars on the dorsal surface of whole flakes and dividing by a rough measure of the flake's surface area, length x width. [2]

Table 17 shows the mean dorsal scar density of whole flakes (all raw materials) and variance across the four stratigraphic units. As this table shows, there is a small increase in the dorsal scar density in strata 1-4 and 9 over strata 10 and 11. Using five percent trimmed means again, there is a significant difference among the means (F=9.77, p<.005, df=363). However, the range of the variances in this case is large and the test may be invalid.

A series of one-tailed t-tests using five percent trimmed means shows a significant difference between strata 9 and 10 (t=3.77, p<.005, df=17) even if unequal variance is assumed

Table 17. Distribution of mean whole flake dorsal scar density across the four stratigraphic units.

Stratum	N	Mean Scars/cm^2	Variance
1-4	55	.05	.0013
9	16	.06	.0022
10	32	.03	.0032
11	86	.02	.00001

Note: includes all raw materials.

(t=2.89, p<.005). There is no significant difference between strata 1-4 and 9, but there is a difference between strata 10 and 11 (t=2.83, p<.003, df=38, unequal variance test). In general, dorsal scar density increases from the bottom of the site up to strata 9, with the largest jump occurring between strata 10 and 9.

Is There a Difference Among the Strata in the Predicted Flake Removal Number of Whole Flakes?

A final way to look at the degree of stone reduction is through the predicted flake removal number. This is a more ambiguous measure than those discussed above. Sets of experimental tools and core reductions suggest that a flake's removal number can be predicted, sometimes with fairly high accuracy from a set of variables. Several such experiments have been conducted in recent years (e.g., Bradbury and Carr 1999; Shott 1996; and Ingbar et al. 1989). At the time the data collection for this sample occurred, only work by Ingbar et al (1989) had been conducted; the other regression formulae require variables that were not measured on these flakes. There is no consensus yet on which formula, if any, works best for a given situation; in addition, the formulae have been developed for biface reduction and may not be applicable to core reduction sequences (Larson and Finley 2004). Thus, we offer conclusions from the predicted flake removal numbers cautiously.

Ingbar et al.'s Regression Model 4 often predicts negative numbers but this is a function of the particular equation. It is the relative differences between mean predicted removal numbers that matter. Looking at table 18, stratum 11 has the lowest flake removal numbers, indicating flakes removed early in the sequence, while stratum 9 has the highest, indicating flakes removed at a later stage of reduction. An ANOVA shows a significant difference among the strata (F=102.29, p<.0005, df=383). A series of one-tailed t-tests shows no significant difference between strata 1-4 and 9 (t=-1.23), and significant differences between strata 9 and 10 (t=2.26, p=.013) and between strata 10 and 11 (t=3.04, p<.001). Flakes are removed earlier in the sequence in stratum 10 than 9, and earlier still in stratum 11 compared to stratum 10.

Table 18. Distribution of mean whole flake predicted removal numbers across the four stratigraphic units.

Stratum	N	Mean	Variance
1-4	61	-15.3	49.5
9	18	-12.9	61.1
10	36	-17.7	51.7
11	96	-21.5	34.8

Note: Using Ingbar et al. (1987) model 4, all raw materials included.

Summary of Debitage Analysis

Table 19 summarizes the patterns discerned by the debitage analysis. Looking just at raw materials we see that all strata are dominated by various cherts, but the assemblages of strata 10 and 11 also contain >10% each of coarse-grained materials. This suggests a greater use of expedient tool manufacture. Such expedient tool use is also suggested by the high frequency of shatter in stratum 10, and the lower amounts in stratum 1-4, especially stratum 1. Flake weight and flake removal number also point to earlier reduction stages in stratum 10 and 11 than in stratum 9 and 1-4. This is somewhat corroborated by the increase in the dorsal scar density, although here a break lies between stratum 10 and 11 and between strata

Table 19. Summary of differences in debitage between the four stratigraphic units.

Stratum	Raw Material	Flake Portion	Flake Platform	Dorsal Scar Count Density	Flake Weight	Flake Removal Number
1-4	Various Cherts	less shatter	more platforms with >3 facets, but fewer lipped-platform flakes	--------	--------	--------
9	Various Cherts	--------	fewer platforms with >3 facets	increase in density over Stratum 10	--------	--------
10	Cherts, Other	more shatter	more lipped-platform flakes	increase in density over Stratum 11	larger flakes than in strata 9 and 1-4	Flakes removed earlier in sequence than in stratum 9
11	Cherts, Other	--------	--------	--------	larger flakes than in strata 9 and 1-4	Flakes removed earlier in sequence than in stratum 10

9 and 10, as patterns in the flake weight and removal number would have suggested.

Flake platforms, on the other hand, produce contradictory evidence. The higher frequency of platforms with >3 facets agrees with other data pointing to late stage reduction in strata 1-4, but the low frequency of lipped-platform flakes does not. In addition, and conversely, the high frequency of lipped-platform flakes in stratum 10 is suggestive of late-stage biface reduction and is counter to other indicators, as is the low frequency of platforms with >3 facets in Stratum 9.

How should we interpret these patterns? First, recall that the division between strata 9, 10, and 11 was based only on the location of radiocarbon dates. Had we selected different radiocarbon samples we would have had different strata and the results might have been different. However, the lipped-platform flakes occur throughout stratum 10, and in fact, nearly half occur in the lowest excavation level of the stratum (on the other hand, there are only 15 lipped-platform flakes from the stratum so they do not constitute much evidence to overturn other indicators). Given that lipped platform flakes form at a very low rate in experimental assemblages it is perhaps unwise to rely heavily on them as indicators of late stage biface knapping.

What can we infer at this point? Although the stone artifacts showed no significant change over time (looking at material from throughout the test excavation) the debitage data, coming from only one unit in the front of the shelter point to some changes in the way stone was reduced in the shelter and hence to changes in the way the shelter was used. Most obvious, perhaps, is that the data point to early stage reduction in stratum 11, with no counter indicators. Second, stratum 10 may contain some late stage biface rejuvenation flakes, but it too is largely characterized by early stage reduction, earlier than that indicated by the debitage in strata 9 and 1-4. With stratum 9, we see a change in the dorsal scar count density, flake weight and predicted removal number that suggest a jump from early to later stage reduction. Flake weight and predicted removal number show no difference between strata 9 and 1-4, while the flake platforms suggest, if anything, somewhat later stage reduction. The major change, therefore, appears to be between strata 10 and 11 on the one hand, and strata 9 and 1-4 on the other.

We will return to these interpretations in the concluding chapter and suggest what they may tell us about change over time in the way people used Mustang Shelter.

[1] Future researchers who may wish to analyze material collected in 1986 from the rockshelter test excavations, including that of Mustang Shelter, were originally catalogued using a system borrowed from the Mimbres Valley (New Mexico) Project. This system used numbers in the format: 3-11,5-4-118, where "3" was the site number (Mustang in this case), 11,5 was the test excavations SW corner coordinates, 4 was the level, and 118 was a consecutive number within the level. This system was later abandoned in favor of the standard "Ch1082/xxxx" for various reasons, but some artifacts from the 1986 test excavations of Mustang, 26CH1077, Foxtail, Dixie, and Mad Bird Shelters still retain these initial catalog numbers.

[2] Using L x W to calculate area assumes flakes are rectangles and thus overestimates area. After the analysis described here, we calculated area with a sample of debitage using length and width; we then calculated actual area using Sigma Scan. We found that a flake's actual area was nearly perfectly predicted by the simple equation (Length x width)/2. However, this calibration was not used here. In any case, while the actual density measures used here are not accurate, the relative differences are.

Chapter 4: Faunal Assemblage

By Shannon Gilbert

This chapter provides a description of the faunal materials from Mustang Shelter as well as a brief discussion of the patterns observed in the assemblage. The faunal assemblage is comprised of 4,640 bones of which 762 (16.4%) are identifiable to a specific species or genus (Tables 20, 21, and 22). The majority of the assemblage consists of small unidentifiable fragments. Element, portion, size, side, age, percentage present, degree of burning, and cut marks were recorded for each specimen; fragment length was also recorded for small mammal elements. The zooarchaeology comparative collection at California State University, Chico was used to identify the mammal and bird bones in the collection. Virginia Butler identified the fish specimens in the assemblage. The Number of Identifiable Specimens, or NISP (Grayson 1984), was used to quantify the taxa and Minimum Number of Individuals, or MNI, were calculated for small mammals identifiable to genus based on the greater number of right or left mandibles.

Several different species of mammals are represented including bighorn sheep (*Ovis canadensis*), bobcat (*Lynx rufus*), cottontail rabbit (*Sylvilagus nuttallii* and *Sylvilagus* sp.), yellow-bellied marmot (*Marmota flaviventris*), golden-mantled ground squirrel (*Spermophilus lateralis*), chipmunk (*Tamias* sp.), white-tail antelope squirrel (*Ammospermophilus leucurus*), gopher (*Thomomys* sp.), pocket mice (*Perognathus* sp.), canyon mice (*Peromyscus crinitus*), other New World mice (*Peromyscus* sp.), woodrat (*Neotoma cinerea* and *Neotoma lepida*) and long-tailed vole (*Microtus longicaudus*). The majority of the identifiable mammal remains consist of small mammals (N=697, 15%). Cottontails comprise the majority (68%, N=525, MNI=11) of the identifiable assemblage, followed by woodrats (12%, N=90, MNI=7) and bighorn sheep (7%, N=52, MNI=1). Tui chub (*Gila bicolor*), other minnows (Cyprinidae), small birds (Emberizidae and Passeriformes), reptiles (Iguanidae, Colubridae, and Viperidae), and Jerusalem crickets (*Stenopelmatus* sp.) were also identified in the assemblage but in very small numbers.

Small mammals, consisting of cottontail rabbits, woodrats, squirrels, mice, gophers, and voles, comprise the largest portion of the assemblage. Some of the small mammal specimens show evidence of natural modification, such as digestive attrition, or cultural modification, such as burning, indicating that small mammals were brought to the shelter by both humans and non-human predators. Thirty-five percent of the specimens show evidence of digestive attrition, in the form of pitting, staining, and/or rounding of fracture edges; some elements also have pellet or scat material attached to fossae or crevices. Only five percent show evidence of burning. There are almost twice as many juveniles (MNI=7) as adults (MNI=4) for the species identified most frequently in the assemblage, cottontail rabbit. Age determinations were based on the distal femur, proximal tibia, and proximal humerus (Hale 1949).

Several studies examine the patterns of small mammal deposition by humans and other agents, such as owls and coyotes, in the Great Basin (Hockett 1989, 1991, 1993; Schmitt and Juell 1994; Schmitt and Lupo 1995). Although determining the depositional origin of small mammal remains in rockshelter and cave faunal assemblages can be difficult, researchers have identified some methods and patterns that can tease out the primary depositional agent. These methods, including skeletal element frequencies and proportions (Hockett 1993), breakage patterns (Schmitt and Juell 1994), and fragmentation ratios (Lyman 1994), were applied to the Mustang small mammal remains to determine the primary depositional agent.

NISP, Minimum Number of Elements (MNE), and MAU (Minimum Animal Unit) were calculated for three subsets of the small mammal assemblage — cottontail rabbits, rat-size mammals, and mouse-size mammals — to compare the Mustang small mammal remains to those of raptor and coyote assemblages (table 23). Skeletal element frequencies were calculated as %MAU and were determined by taking the element with the greatest MAU value and giving it a value of one; all remaining MAU values were then divided by the greatest MAU value so that %MAU values were scaled from zero to one (Hockett 1993, see also Binford 1978).

Table 24 presents a summary of skeletal element frequencies. The mandible is the element with the greatest frequency in all three small mammal subsets. The tibia is the most frequent cottontail rabbit element, followed by the ulna and radius. The astragulus, calcaneus and innominate are the least represented cottontail elements. Rat-size mammals are represented primarily by the femur, followed by the humerus; the least represented elements are again the astragulus, calcaneus and innominate. Mouse-size mammals are represented primarily by the femur and tibia; the least represented elements are the maxilla, astragulus, and calcaneus.

The ratio of postcranial to cranial elements, the ratio of forelimb to hindlimb elements, and the ratio of axial to appendicular elements were calculated for the three small mammal subsets. For cottontail rabbits, forelimbs outnumber hindlimbs two-to-one; the ratio of postcranial to cranial remains is three-to-one, and there are considerably more appendicular elements than axial elements, by nearly two-to-one. For rat-size mammals, there is a three-to-one ratio of forelimb to hindlimb

Table 20. Number of identified specimens for large mammals, fish, birds, and other animals, Strata 1-11.

Taxa	1	2	3	4	5	6	7	8	9	10	11	Total
Ovis canadensis	1	6	3	5	2	1	0	0	3	24	7	52
Artiodactyl	0	8	12	7	7	0	0	0	0	0	10	44
Lynx rufus	0	0	0	0	0	0	0	1	0	0	0	1
Canidae	0	0	0	1	0	0	0	0	0	0	0	1
Carnivora	0	0	0	0	0	0	0	0	0	0	1	1
Emberizidae	0	0	0	0	0	0	0	0	0	1	0	1
Passeriformes	0	0	0	0	0	0	0	0	2	1	2	5
Small reptile	0	0	0	0	0	0	0	0	2	1	6	9
Sauria	0	0	0	0	0	0	0	0	0	5	1	6
Iguanidae	0	0	0	0	0	0	0	0	0	1	0	1
Colubridae	0	1	0	0	0	0	0	0	0	2	0	3
Viperidae	0	0	0	0	0	0	0	0	0	0	1	1
Gila bicolor	0	0	0	0	0	0	0	0	0	3	2	5
Cyprinformes	0	0	0	0	0	0	0	0	0	0	2	2
Cyprinidae	0	0	0	0	0	0	0	0	0	0	1	1
Small fish	0	0	0	0	0	0	0	0	0	0	1	1
Stenopelmatus sp. (Jerusalem cricket)	0	2	0	0	0	0	0	0	0	0	0	2
Class I Mammal	1	0	0	0	0	0	0	0	0	11	77	89
Class II Mammal	43	28	0	0	12	2	8	25	1	164	230	513
Class II/III Mammal	0	10	3	0	0	0	34	39	95	60	6	247
Class III Mammal	52	40	23	44	8	17	28	48	19	141	189	609
Class IV Mammal	1	1	1	8	0	0	1	2	79	3	14	110
Class IV/V Mammal	11	79	45	6	2	1	22	24	25	117	127	459
Class V Mammal	0	48	82	0	16	1	6	16	29	62	22	282
Uniden. Mammal	16	34	51	54	17	3	0	26	141	267	104	713
Total	125	257	220	125	64	25	99	181	396	863	803	3158

bones, a one-to-one ratio of cranial to postcranial remains, and only slightly more appendicular than axial elements. There was a slightly greater proportion of hindlimb to forelimb bones for the mouse-size mammals, a one-to-four ratio of cranial to post-cranial remains, and a three-to-one ratio of appendicular to axial elements.

Skeletal element portions, calculated as the NISP per element portion (complete, proximal/anterior, distal/posterior, and incomplete) and displayed as percentage of the NISP for the total element were used to examine breakage patterns. A tabulation of breakage patterns for cottontail rabbits (Table 25) shows that the proximal ulna, distal femur, and shaft fragments of the humerus and tibia are the most represented portions of long bone elements. Elements of the cranium, maxilla, and mandible are almost always fragmented. The innominate, vertebrae, rib, and scapula are not well represented in the as-

Table 21. Number of identified specimens for small mammals, Strata 1-11.

Taxa	1	2	3	4	5	6	7	8	9	10	11	Total
Sylvilagus nuttalli	0	0	1	0	0	0	0	1	11	14	8	35
Sylvilagus sp.	33	23	20	29	6	8	7	61	87	116	39	429
Rodentia-mouse size	7	3	8	4	3	2	1	6	25	27	13	99
Rodentia - rat size	1	0	0	9	12	1	8	25	16	81	53	206
Sciuridae	0	0	0	1	0	1	1	2	3	7	3	18
Ammospermophilus leucurus	0	0	0	0	0	0	0	0	0	12	1	13
Tamias sp.	0	0	0	0	0	0	1	1	0	0	1	3
Spermophilus cf. lateralis	0	1	2	1	0	0	4	0	0	3	2	13
Marmota flaviventris	0	0	0	0	0	0	0	0	0	1	0	1
Thomomys sp.	0	0	1	1	0	0	0	3	4	4	4	17
Perognathus sp.	0	0	0	0	1	1	0	0	1	10	1	14
Cricetidae	0	0	0	0	0	0	0	1	0	1	0	2
Neotoma cinerea	0	0	1	0	0	0	0	0	0	3	0	4
Neotoma lepida	0	0	1	2	0	0	0	0	3	4	9	19
Neotoma sp.	2	4	1	0	1	2	1	3	8	30	15	67
Peromyscus sp.	0	0	0	0	0	0	0	0	2	3	1	6
Microtus cf. longicaudus	1	1	2	0	0	0	0	0	0	0	1	5
Microtus sp.	0	1	0	0	0	0	0	1	2	3	0	7
Total	44	33	37	47	23	15	23	104	162	319	151	958

semblage and those that are present are incomplete. Patellas, metapodials, phalanges, carpals/tarsals, astraguli and calcanea, although encountered rarely in the assemblage, are largely complete.

Using skeletal element frequencies, proportions, and breakage patterns, a comparison of the Mustang small mammal assemblage to those of owls, coyotes, and other human contexts indicates that the Mustang small mammal assemblage displays characteristics of both naturally and culturally deposited assemblages. For example, an assemblage of cottontail rabbits generated by raptors should contain a large quantity of tibia shafts, a greater quantity of immature individuals than adults, pellet material adhered to the bone, and a greater quantity of forelimbs than hindlimbs (Hockett 1991, 1993). The Mustang cottontail rabbit assemblage demonstrates all of these traits of a naturally produced assemblage. However, the cottontail assemblage also displays characteristics of a culturally produced assemblage, including a lower frequency of axial elements, excluding the cranium and mandible, and a large proportion of unidentifiable small mammal fragments (Hockett 1991, 1993; Jung 1997).

Likewise, the Mustang rat and mouse-size mammals are both similar and dissimilar to assemblages produced by owls and raptors (Hockett 1991, 1993). As in owl and raptor assemblages, the Mustang assemblage contains a large quantity of mandibles and tibiae, equal proportions of astraguli and calcanea, and a small quantity of scapulas and innominates. However, the humerus is poorly represented in the Mustang assemblage, though it is usually well represented in owl and raptor assemblages (Hockett 1991, 1993).

Additionally, there are some similarities and differences between the Mustang small mammal assemblage and assemblages found in coyote scats (Schmitt and Juell 1994). For instance, proximal and distal portions of elements are repre-

Table 22. Number of identified specimens for large and small mammals, fish, birds, and other animals; mixed strata and unprovenienced finds.

Taxa	1 & 2	2 & 3	2 & 4	3 & 4	3 & 8	7 & 8	4 & 8	4 & 9	Unknown	Total
Sylvilagus nuttalli	0	0	2	0	0	0	1	2	2	7
Sylvilagus sp.	0	3	6	9	5	5	5	6	15	54
Rodentia - mouse size	0	0	0	2	0	0	0	1	6	9
Rodentia - rat size	0	0	0	0	2	0	0	0	24	26
Sciuridae	0	0	0	0	1	0	0	0	1	2
Spermophilus cf. *lateralis*	0	0	0	0	1	0	1	0	0	2
Marmota flaviventris	0	0	0	0	0	0	0	0	1	1
Ovis canadensis	0	0	0	5	1	0	0	0	0	6
Artiodactyl	0	2	2	4	0	0	1	0	0	9
Stenopelmatus sp.	0	0	0	0	1	0	0	0	0	1
Class 1 Mammal	0	0	0	1	0	1	0	0	0	2
Class 2 Mammal	4	6	3	6	0	2	4	5	9	39
Class 2/3 Mammal	0	0	0	3	0	0	0	0	9	12
Class 3 Mammal	4	4	0	10	0	14	8	4	21	65
Class 4 Mammal	0	0	0	1	0	0	1	1	22	25
Class 4/5 Mammal	6	0	0	23	0	32	1	1	17	80
Class 5 Mammal	4	20	12	0	3	3	3	1	25	71
Unident. Mammal	0	7	13	44	15	0	15	4	15	113
Total	18	42	38	108	29	57	40	25	167	524

sented in similar quantities between the Mustang cottontail rabbit assemblage and the coyote scat assemblage, but the quantities of complete and incomplete elements are dissimilar between the two, as elements in the coyote scat assemblage are more fragmented and incomplete than in the Mustang assemblage.

A pattern that emerged in the Mustang small mammal assemblage is that the degree of fragmentation increases with the body size of the small mammal. Using the ratio of NISP to MNE to measure fragmentation (Lyman1994), the mouse-size mammal elements are more complete than rat-size mammal elements, which are more complete than the cottontail rabbit elements (Table 26). The NISP:MNE ratios for Mustang compare favorably with owl—and coyote—generated small mammal assemblages (Lyman 1994; Jung 1997). Increased fragmentation correlates with increased prey size since the bones must be broken down into smaller, digestible fragments. Additionally, the Mustang small mammal remains are not as intensely fragmented as would be expected if the assemblage were the result of cultural processes, such as grease extraction. The overall qualitative and quantitative patterns observed in the assemblage indicate that owls and coyotes were the primary depositional agents of the Mustang small mammal assemblage. Qualitative characteristics indicative of a human role in the formation of the small mammal assemblage, such as burning and cut marks, indicate that humans were responsible for only a small portion of the small mammal remains.

Large Mammal Remains

Two percent (NISP=111) of the faunal assemblage was identifiable to bighorn sheep or artiodactyl. The remains identified to artiodactyl are likely bighorn sheep as no other species of artiodactyl was identified in the assemblage. Twenty percent of the bighorn and artiodactyl remains display cut marks. These cut marks are similar to the types of cuts used for dis-

Table 23. NISP, MNE, MAU for all cottontail rabbits, rat-size mammals, and mouse-size mammals.

Element	Cottontail rabbits (*Sylvilagus* sp.)			Rat-size mammals			Mouse-size mammals		
	NISP	MNE	MAU	NISP	MNE	MAU	NISP	MNE	MAU
Cranium	115	10	0	29	3	0	29	3	0
Mandible	49	21	10.5	32	22	11	32	22	11
Maxilla	23	11	5.5	15	1	.5	15	1	.5
Teeth	95	70	0	22	7	0	22	7	0
Vertebrae	7	3	.17	19	9	.5	19	9	.5
Ribs	15	1	.07	0	0	0	0	0	0
Scapula	23	13	6.5	7	6	3	7	6	3
Innominate	10	3	3	8	5	5	8	5	5
Humerus	26	14	7	8	5	2.5	8	5	2.5
Radius	18	18	8	1	1	.5	1	1	.5
Ulna	19	15	7.5	1	1	.5	1	1	.5
Femur	12	9	4.5	29	19	8	29	19	8
Tibia	49	26	13	19	15	7.5	19	15	7.5
Metapodials	23	17	.85	2	9	0	2	9	0
Carpals/Tarsals	10	7	.35	7	7	.4	7	7	.4
Astragulus	3	3	1.5	3	3	.12	3	3	.12
Calcaneus	3	2	1	4	3	.15	4	3	.15
Phalanges	26	23	.58	3	4	.05	3	4	.05

Table 24. Skeletal element frequencies for small mammals.

Element	*Sylvilagus*[a]	Rat-size mammal[b]	Mouse-size mammal[c]
Maxilla	.42	.33	.05
Mandible	.80	1.00	1.00
Scapula	.50	.14	.30
Innominate	.23	.19	.50
Humerus	.53	.45	.20
Radius	.62	.12	.50
Ulna	.57	.26	.50
Femur	.34	.50	.70
Tibia	1.00	.29	.70
Astragulus	.11	.09	.12
Calcaneus	.07	.11	.15

[a] includes all cottontail remains; [b] includes rat-size rodents, Class 2/3 mammals, Sciurids, and the genus *Thomomys* and *Neotoma*; [c] includes mouse-size rodents, Class 1 mammals, *Peromyscus, Perognathus,* and *Microtus*.

Table 25. Skeletal element portions for Sylvilagus.

Element	Complete %	Proximal or Anterior %	Distal or Posterior %	Incomplete %
Cranium	1.0	9.7	4.3	84.7
Maxilla	13.0	34.7	0.0	52.1
Mandible	8.1	28.5	28.5	34.6
Incisor	75.7	18.1	18.1	0.0
Molar	56.4	3.2	3.2	19.3
Vertebrae	42.8	0.0	0.0	57.1
Ribs	0.0	0.0	0.0	93.0
Scapula	8.6	47.8	47.8	26.0
Innominate	100.0	0.0	0.0	0.0
Ilium	0.0	0.0	0.0	100.0
Ischium	0.0	0.0	0.0	100.0
Acetabulum	0.0	0.0	0.0	100.0
Humerus	3.8	30.7	30.7	50.0
Radius	18.0	27.7	27.7	27.7
Ulna	0.0	5.2	5.2	15.7
Femur	0.0	75.0	75.0	0.0
Tibia	0.0	34.6	34.6	53.0
Patella	100.0	0.0	0.0	0.0
Carpals/ tarsals	75.0	0.0	0.0	0.0
Astragulus	66.0	0.0	33.0	0.0
Calcaneus	0.0	66.0	0.0	33.0
Metapodials	39.1	34.7	21.7	4.3
Phalanges	69.2	11.5	19.2	0.0

memberment and filleting (Binford 1981:105-142) and suggest that Mustang shelter was used as a temporary hunting camp and/or butchering site. However, 22 percent of the artiodactyl assemblage shows evidence of severe carnivore modification in the form of tooth marks, scoring, denticulate bone edges, channeling, polishing, and chipped back edges (Haynes 1980; Binford 1981:35-81). Nine percent (NISP=10) of the elements display both cut marks and carnivore modification. The presence of cut marks on many of the elements identified as bighorn sheep or artiodactyl indicates that humans are at least partly responsible for the accumulation of those remains.

Binford's (1978) Modified General Utility Index (MGUI) provides another avenue for assessing the role of humans in producing a faunal assemblage. The MGUI assigns economic importance to skeletal elements based on the nutritional value associated with those elements. Binford (1978) argued that people should utilize elements in accordance with their respective economic utility and that such usage should be reflected in the faunal assemblage. For example, people are expected to consume and transport skeletal elements high in economic utility (e.g. femora) rather than skeletal elements lower in economic utility (e.g., the radius/ulna). In order to examine this relationship, Binford (1978) used the MGUI along with another measure, the Minimum Animal Unit (MAU, expressed as a percentage). The %MAU is the measure of NISP per anatomical unit divided by the number of times that anatomical unit occurs in the skeleton. The highest %MAU is fixed at 100 and all the remaining values are scaled accordingly. A positive relationship between the MGUI and %MAU, known as a *gourmet strategy*, signals a strategy in which high utility elements are kept and transported, while low utility elements are discarded. On the other hand, a negative relationship between the MGUI and %MAU, known as a *bulk strategy*, signals a strategy in which low utility elements are kept, while high utility elements are discarded. These two strategies should be reflected in the faunal remains from different types of archaeological sites. For example, a gourmet strategy should characterize residential base camps and a bulk strategy should characterize butchering sites.

If the model proposed in Kelly (2001) is correct, that is, if the aboriginal inhabitants generally exploited the mountains as part of a logistical strategy for the procurement of bighorn sheep, then we would expect the Mustang bighorn and artiodactyl assemblage to reflect the "bulk strategy" since high utility elements should be transported to the residential base camp on the valley floor, while low utility elements should be discarded at Mustang (Binford 1980; O'Connell et al. 1988). However, there is no statistically significant relationship ($r = -.012$, $p>.25$) between %MAU and MGUI (Figure 29) and as a result the assemblage does not reflect either a gourmet or bulk strategy as high, medium, and low utility elements were recovered from Mustang.

Ethnoarchaeological studies suggest that transport patterns vary by time, place, and sample, depending on such factors as the number of prey killed, prey size, the number of carriers available, and the distance from the kill site to the base camp (O'Connell 1993:171-172, also see O'Connell et al. 1988, 1990, 1992). Hypothetically, if small numbers of bighorn were hunted in relation to the number of carriers, and/or, if the distance from the kill site to the base camp was relatively short, then the entire animal(s) could have been brought back to a residential camp. The small quantity of bighorn and artiodactyls remains may suggest that the base camp was sufficiently close to Mustang that entire carcasses were easily trans-

Table 26. NISP:MNE ratios for small mammal remains.

Element	*Sylvilagus*	Rat-size mammal	Mouse-size mammal
Mandible	2.64	2.22	1.76
Scapula	1.75	1.16	1.25
Innominate	1.92	1.68	0.00
Humerus	1.00	3.00	0.00
Radius	1.26	1.00	0.00
Ulna	0.00	0.00	0.00
Femur	1.33	1.81	1.83
Tibia	1.88	2.80	1.00
Average	1.47	1.81	0.73

ported. The Stillwater marsh sites contain very few bighorn and artiodactyl remains (Schmitt and Sharp 1990; Kelly 2001); those that are present are phalanges and cervical vertebrae, low utility elements indicating that either few sheep were hunted from the marsh, or that sheep were usually butchered thoroughly in the mountains and only meat returned to the marsh villages.

The lack of a relationship between the %MAU and MGUI and the presence of carnivore modification on many of the bones prompted examination of other potential taphonomic processes. As Lyman (1994:234-263) has documented, assemblages in which the frequency of skeletal parts increases as their respective bone density increases typically indicates a taphonomic process that is mediated by the structural density of skeletal parts. Bone mineral density is positively correlated with %MAU (figure 30). Although not statistically significant (r = .19, p = .25), it suggests that carnivore attrition played some role in producing patterning in the assemblage. Marean and Spencer (1991) argue that carnivore-ravaged assemblages should exhibit (1) low long bone end to long bone shaft ratios, (2) carnivore gnawing marks, and (3) a correlation between the frequencies of long bone ends and bone density. The Mustang assemblage exhibits all three characteristics. First, the ratio of long bone ends to long bone shaft ratios is 1:14. Second, almost one quarter of the assemblage displays evidence of carnivore gnawing. Third, the frequencies of long bone ends correlate with the structural density of those bones. Consequently, the data suggest that the skeletal element portions exhibited in the bighorn and artiodactyl assemblage are the result of carnivores, rather than humans transporting nutritionally valuable skeletal parts and discarding lower value parts.

In conclusion, although the majority of the Mustang faunal assemblage appears to have been deposited by non-human agents, particularly owls and coyotes, the presence of cut

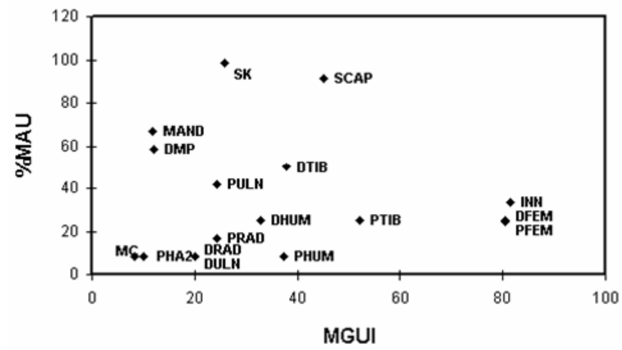


Figure 29. Bighorn sheep and artiodactyls %MAU vs. MGUI.

marks and burning on some of the bighorn, artiodactyl, and cottontail rabbits indicates that humans were at least partly responsible for the accumulation of the Mustang faunal assemblage. Sample size prevents an examination of the data by stratigraphic unit. Nonetheless, the small quantity of remains that show cultural modification suggest that human occupation of the shelter was transient.

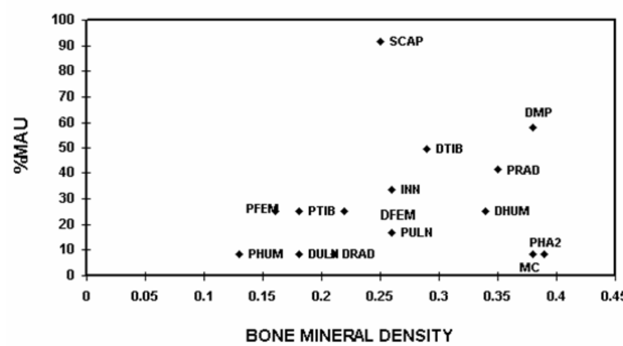


Figure 30. Bighorn sheep and artiodactyls %MAU vs. bone mineral density.

Chapter 5: Basketry, Organic and Historical Artifacts

This chapter describes the organic artifacts recovered at Mustang Shelter; it also briefly describes historic artifacts recovered from the excavation (not including those historic artifacts mapped but not collected from the site's surface).

BASKETRY

By Judith Polanich

Mustang Shelter yielded a number of perishable materials, including several fragments of a coiled basketry tray, one edge of a twined basketry tray, twined weft, a short length of cordage, and debris from basketry making or repair. All the basketry fragments are discards, broken from baskets through use, and are not cached remains of complete and useful baskets. Coarse twining remains and weaving debris deposited post-1000 uncal BP were succeeded by close coiled fragments, probably from a single broken basket 730-1000 uncal. BP Finally, a unique fragment of twined basketry was recovered from the surface.

Despite their small size and fragmentary nature, these materials present an interesting case for reconstruction of the region's cultural history. Two tray fragments, totally different in construction technique, served the same essential function: winnowing seeds. Separated by half a millennium, they are undoubtedly the product of two different populations. While the coiled tray is common in pre-Numic assemblages, the parallel-twined tray fragment may be a unique specimen. Found on the surface, the tray fragment (1082/1) is typical of Numic work excepting one essential feature: the fragment is plain-twined rather than twill-twined. In addition to this puzzle, two basketry techniques common in archaeological remains in the immediate area were not found at Mustang Shelter: Lovelock wicker and Catlow twining.

In this chapter, we will first describe the materials, then compare them to archaeological specimens for the region, and finally assess their contributions to our understanding of site function and cultural history at Mustang Shelter.

Coiled Basketry (N=5)

Coiling is sewing, accomplished with an active vertical element, the stitch, which moves around and/or through a passive horizontal element, the foundation (Weltfish 1930:455). Using an awl, the weaver punches an opening into previously completed work and pushes the pointed end of the sewing strand through the hole. California and Great Basin coiling was simple coiling: one active sewing strand drawing the coils tightly together to form a solid fabric (cf. Morris and Burgh 1941).

Five fragments of coiled basketry, four of them demonstrably broken from a single basket, were recovered from Mustang Shelter (see table 27). All fragments were coiled in a leftward work direction on a three-rod bunched foundation of peeled shoot material (probably willow), with the slightly larger apex rod split by the sewing stitch of the subsequent course. (Adovasio [1970: 27] tabulated the distribution of western Nevada textile wall techniques by site. In his analysis, he has replaced the misleading "rod-bundle foundation" of the Heizer and Krieger [1956] taxonomy with "three-rod bunched foundation and two rod and welt" as appropriate. In explanation, he remarks that "frequent splitting of the apex rod does produce the appearance of "half or quarter" twigs or even "bar-like slats" in cross section" [Adovasio 1970:8]).

The stitching in these fragments of coiled basketry was mixed, interlocking and non-interlocking, with many split stitches on the non-work face. Expansion to accommodate the increasing basket radius was accomplished by splitting the stitch in the course below or by sewing two successive stitches through the same hole. Work face, the surface facing the weaver during manufacture, could not be positively determined but was probably the concave surface, which is now charred; organic material fills some of the crevices. The sewing strand is split and peeled shoot (probably willow). Splices

Table 27. Mustang Shelter coiled basketry.

Ch1082/	Stratum	Length Cm	Width Cm	Thick Cm	Stitch Width Mm	Coil Depth Mm	Per Inch Stitch/Coil	Piece joins	Evidence of use?
274	2	3	1.3	.5	3	6.5	10/5	101	Yes
101	2/4	9.8	2.5	.7	2+	5	9/5	274, 283	Yes
283	2	6	2	.6	2-3	6.5	10/5	101, 315	Yes
315	3	4.7	1.7	.6	2-3	5	10/5	283	Yes
374	3	5	1	.7	3	6	~10/~5	None	None

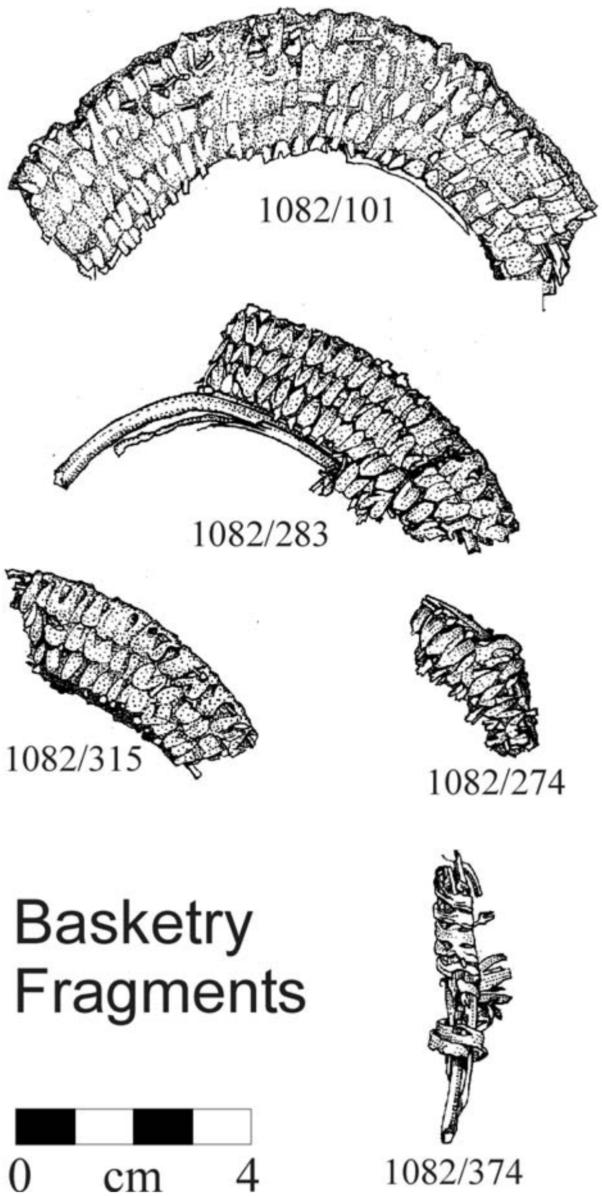


Figure 31. Basketry fragments from Mustang Shelter.

were not visible.

Despite lack of direct evidence, it is quite likely that Ch1082/374 is a part of the same basket as the other four fragments (figure 31). The stitching type and measurements fall well within their range. The fragment curvature is double: it matches the arch of the other fragments but seems to have come from an in-curved portion of a basket, where the basket wall turns upward. Ch1082/374 may be from the outer diameter of the same basket, the up-curving tray margin where charred deposits were less likely to be found, or it may come from another basket altogether, an unknown basket bowl or tray.

Twined Basketry (N=2)

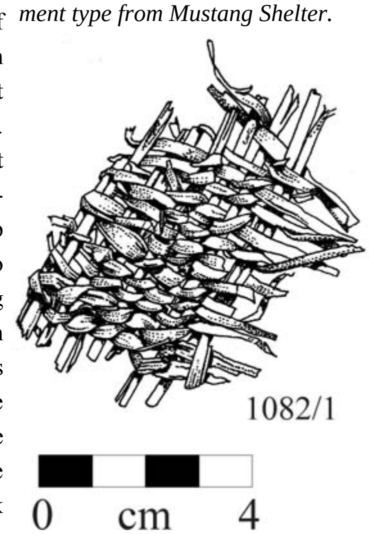
The term twining was first used by Mason (1885:292) to describe a method of manufacture "by means of twining two woof strands around a series of warp strands." The term bears three connotations: "twin," recalling the use of two strands; "twine" or cordage, which is produced with the same twisting motion; and the "twining" activity of strands themselves, twisting or "twining" about each other as they enclose the warp.

Two-strand twining produces a double helix identical to that of two-strand cordage; warp strands are caught in each twist and serve to join successive twined weft elements into a coherent fabric (Emery 1966:196). The weft pair is at right angles to the warp elements but actually crosses them at the slightly oblique angle of the helix. The slant thus produced, up-to-the-right (S) or down-to-the-right (Z), is the only visually distinctive characteristic of twining (Emery 1966:196).

Two fragments of twining were recovered from Mustang Shelter (table 28). Although both fragments are plain twined of willow with up-to-the-right (S) slant of turns, they vary in weft type and probably in warp arrangement as well.

Specimen Ch1082/21 (see figure 34) was first thought to be cordage, as no warp is present. However, this specimen was also examined by Daniel Bach, who writes that it "is two pieces of willow (*Salix* sp) twined together…. Length of the twine unraveled would be approximately 185 mm. Bark is present and there is no evidence of burning. The crimp from engagement with the warp is clearly evident, and it represents nine turns of unpeeled, whole shoot weft, probably from a roughly constructed trap or fence rather than a basket. They could also have served as the twining to hold sagebrush clothing together, as illustrated in Fowler (1992:140). Although willow is not mentioned as being used for this purpose, it would have been present in the region and gathered for many other purposes."

Figure 32. Unknown basketry fragment type from Mustang Shelter.



Specimen Ch1082/1 is a unique fragment of close plain twining with up-to-the-right (S) slant of weft turn (figure 32). It comes from a basket with parallel warp arrangement, each warp stick aligned parallel to the next as the weaving proceeded back and forth across the fabric. This is clearly evidenced by the edge selvage where the weft was crossed over the last warp and the work

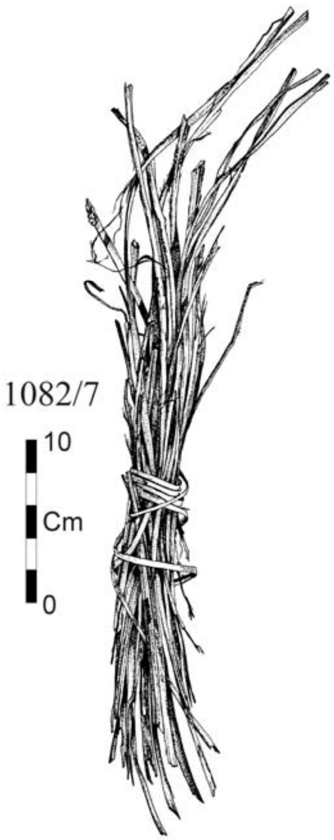


Figure 33. Bundle of split serviceberry, probably basketry raw material, from Mustang Shelter.

was turned over, like a book page, to continue on the other side. Thus, both faces were, alternately, work faces.

New warps were inserted by trimming the shoot to a diagonal point and pairing it with an additional warp for several courses, then separating them. Weft splices are not apparent. There is no evidence of charring but small reddish seed darts are caught in the weave. Despite the plain twine weave, these seed darts confirm the identification of the original basket as a parallel warp winnowing tray, like those commonly made in close twill twining and used by Numic peoples. This rare and provocative fragment was left at Mustang Shelter sometime after 730 uncal. BP

Weaving Debris (N=2)

Weft for twining and sewing strands for coiled basketry must be flexible and strong, requirements met by Great Basin willow (*Salix* sp.) and serviceberry (*Amelanchier* sp.). Preparation for use normally included splitting, peeling, and trimming to size. These activities are usually assumed, not discussed, in archaeological reports unless the pattern on the basket was made with unpeeled willow (Heizer and Krieger 1956:47). Scattered through the fill in stratum 2 near the front of the shelter are weaving by-products: some 60 "culls" from the production of flexible weavers or sewing strands. A bundle of the material (1082/7), split serviceberry (*Amelanchier* sp.), is shown in figure 33. Ch1082/8 is a sample of scattered pieces of the same material.

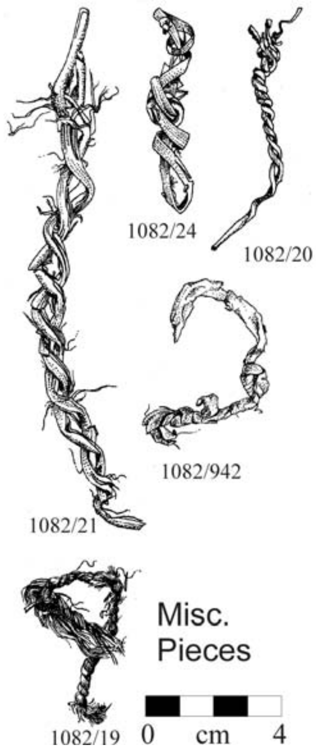


Figure 34. Miscellaneous organic pieces from Mustang Shelter.

When weaving or sewing strands are made from the split shoots, these must be thinned to optimize pliancy before weaving can begin. The shoots are first cut from the main plant, then split into two or three parts. Each length is further split lengthwise to separate the flat length of outer sapwood and inner bark used for weaving from the soft pith and extraneous inner sapwood, the culls (Wheat 1967:93). The same process is used whether the final weaver is used as twining weft or coiling strand. The presence of this weaving debris probably indicates that occasional weaving or repair of damaged baskets was accomplished at Mustang Shelter. Sixty relatively short culls (maximum 52 cm) would produce only about 30-45 weavers, as each finished weaving strand requires one or more thinning operations. Extensive gathering and preparation of the year's supply of willow would produce far more debris than these few culls.

Cordage (N=1)

Cordage may be characterized by plant fiber type and composition; twist of preliminary strand; number of strands (or plys) which are combined into the final yarn (either "string" or "rope"); twist of the finished yarn; and the size and degree of twist of all constituent elements (Osborne and Osborne 1954). Ordinary California and Great Basin cordage was 2-ply, composed of two strands twisted to form either a Z or S helix (when viewed vertically), and then plied or twisted together to produce a yarn helix twisted in the opposite direction.

A single 10 cm length of cordage (Ch1082/20) was recov-

Table 28. Mustang Shelter twining.

Ch1082/	Stratum	Len. cm	Wid. cm	Thi. cm	Warp Arrange	Warp Width	Weft Width	Weft Type	Per Inch Turns	Courses	Use
21	2	16	1	.5	Unknown	~3mm	<3mm	Whole	~2	Unknown	Unknown
1	Surface	7	4.5	.25	//	2	2	Split	6-7	7	Seeds

Table 29. Two-ply Z-S Apocynum cordage in western Nevada.

Site	No. pc.	Type	Diameter (cm)	Use
Mustang Shelter	1	Z-S	.3	net?
Lovelock Cave*	914	Right twist	.6-6	net?, woof for garments/mats
Lovelock Cave **	1016	Right twist	.4-.6	nets
Hanging Rock Cave	5	S-twist	.8	nets (sheet bend knots)
Hidden Cave	637	Z-spun, S-twist	N/A	many knots present
Hidden Cave?	2 nets	S-twist	.7-1.8/.6-1.9	fish net
Granite Point Cave	14	S-twist	<2	

* "probably either dogbane, flax, or nettle" (Loud and Harrington 1929: 78)
** material not specified, assumed to be as above
Based on Roust 1966: 53; Ambro 1966; Loud and Harrington 1929: 78; Heizer and Kreiger 1956:62; Goodman 1985: 277-278; Tuohy 1969:42-43.

ered from Stratum 2 at Mustang Shelter (figure 34). Two dogbane (Indian hemp, *Apocynum* sp.) strands were Z-spun and combined at a 35 degree angle to form a 3mm thick Z-S two ply cord. This cord is typical of the most common fine cordage found in western Nevada archaeological context, where it was often used for nets.

In general, archaeological cordage recovered from the western Great Basin may be divided into S-Z rope and Z-S string (Tuohy 1969:43; Fowler 1994:105-106). Ethnographically, the Toedökadö Paiute of Stillwater Marsh made *Apocynum* (Dogbane) cordage with a downward spin and upward twist which would produce 2-ply, S-spun Z-twist cordage (Wheat 1967:58; Fowler 1992:115), but the examples of fine netting illustrated in Wheat and those collected at Stillwater in 1924 by Harrington appear to be S-twist instead (Wheat 1967:55; Fowler 1992:116).

Historically, the analytical terminology used to describe cordage has suffered from confusion of terms (Osborne and Osborne 1954:1094). Yarn produced by two Z-spun strands combined into S-ply cordage is properly designated as Z-S twist (Wendrich 1994:30-32) but the literature often omits the initial spin and describes only the final twist. Thus, Z-S cordage might appear as "S-twist" or "clockwise" or "right-twist." In table 29, the original designations are retained, although all specimens appear to be Z-spun, S-twist, 2-ply cordage.

Table 30. Distribution of close coiling wall types in western Nevada.

Site	One-rod Split Stitch	One-rod Interlock Stitch	One-rod and welt	Two-rod stacked	Two-rod & welt	Three-rod Split Stitch	Three-rod Interlocking Stitch
Mustang Shelter	-	-	-	-	-	5	-
Lovelock Cave	P	P	P	-	30	240	14
Humboldt Cave	12	P	P	-	50	360	15
Leonard Rockshelter	-	-	-	-	-	P	P
Horse Cave	-	1	1	-	1	39	P
Fishbone Cave	-	-	-	-	-	2	1
Stick Cave	-	-	-	-	P	22	-
Chimney Cave	-	-	-	1	-	9	2
Guano Cave	-	-	-	-	-	1	-
Crypt Cave	-	-	-	-	-	11	1
Cowbone Cave	-	-	-	-	-	1	-
Ocala Cave	-	-	-	-	-	20	P
Falcon Hill	-	-	-	--		P	P
Total	12	1	1	1	81	710	33

P = present; based on Adovasio 1970:27; Grosscup 1960; Hattori 1982; Rozaire 1969, 1974; Tuohy 1974; Tuohy and Hattori 1996.

Table 31. Radiocarbon dates for close coiling on three-rods with split stitch in western Nevada.

Site	^{14}C dates	Probable range for close-coiled 3-rod split stitch
Mustang Shelter	AD 800-1333	AD 880 - 1220
Humboldt Cave	AD 2 ± 175	
Lovelock Cave		500 BC – AD 1000
Falcon Hill Cave	490 ± 100 BC	490 BC – AD 800
Lovelock Cave	1218 ± 260 BC	1000 -2000 BC
Leonard Rock-shelter	3786 ± 400 BC	Dubious association
Cowbone Cave	4015 BC	No association

Based on Adovasio 1970: 27; Heizer and Kreiger 1956; Grosscup 1960; Rozaire 1969; E.A. Jolie, personal communication, 2004.

Basketry Comparisons

Comparison of the Mustang Shelter specimens to those reported in the archaeological literature is hampered by three factors: the fragmentary nature of many archaeological remains; the lack of detail in older published reports; and inaccurate application of technical terminology. Nonetheless, some comparisons can be made.

The coiled fragments recovered from Mustang Shelter are similar in wall type to the flat circular trays best known from Humboldt Cave (Heizer and Krieger 1956:45) and found throughout western Nevada (see table 30). The fragments of coiled basketry found at Mustang Shelter were scattered in several levels dated between 730 - 1070 uncal. BP. These dates barely overlap Adovasio's Western Basin Stage 4, 2000 – 1000 uncal. BP(Adovasio 1986a:200), and so the Mustang Shelter basketry is clearly a very late manifestation of this type (see table 31).

Within the seeming uniformity of "close coiled three-rod basketry," however, is a diversity which belies its secure assignment to a unitary and unchanging tradition. Basket starts, work direction, stitch type, splice types, and rim finish display a variety which is seldom assessed. Typological analysis that allows discrimination only by wall type has thus reduced the potential of 6000 years of temporal and geographic variation within close coiled basketry to a static phenomenon. Although basket technology may be extraordinarily long lived due to the nature of the learning context, the intermittent co-occurrence of plain flexible warp twining, Catlow twining, and Lovelock wickerware in the region suggest that re-analysis of close coiling technical features might reveal greater variation than previously realized. These features are discussed below in order to clarify the place of the Mustang Shelter assemblage in the regional context.

Starts

The need to produce a tiny spiral at the start of a coiled basket and the rigid nature of many foundation materials may dictate that different foundation material and sewing technique be used to start the basket than are used in the main wall. Unfortunately, starts are seldom reported. Heizer and Krieger characterize Humbolt Cave starts as "a tiny ring" (Heizer and Krieger 1956). Lawrence Dawson, who had many opportunities to study western Great Basin coiling during his 38 years at the Lowie Museum, noted two types of Lovelock coiled starts. One is a "clock spring" of foundation wrapped with stitching material; the other is a "pigtail" of foundation bent to leave an open hole (Dawson n.d.). As the Mustang Shelter fragments did not include a start, no comparisons may be made.

Work Direction and Work Face

Although the terms "clockwise" and "counterclockwise" are frequently found in basketry literature to describe the foundation spiral, they confound three separate analytical attributes which are seldom defined: work direction, work surface, and position of viewer (table 32).

When the hole is punched and the sewing strand inserted

Table 32. Various meanings of "clockwise, counterclockwise" in basketry literature.

Actual Attributes	Group A	Group B	Group C	Group D
Work Face	concave	convex	concave	convex
Work Direction	rightward	leftward	rightward	leftward
Viewer Position	concave	concave	convex	convex
Erroneous Description	"Clockwise"	"Clockwise"	"Counterclockwise"	"Counterclockwise"

Table 33. Work direction and work face on trays.

Site	N	Work Direction Recorded	Actual Work Direction	Work Face
Mustang Shelter	1	Leftward	Leftward	Concave?
Humboldt Cave	136	Leftward and rightward	Leftward	
Lovelock Cave	264	//// (except for one \\\\)	Leftward (one exception)	
Leonard Rockshelter		"identical to Humboldt and Lovelock cave"		
Falcon Hill		Leftward	Leftward	
Stick Cave		<<<<<	Leftward	
Horse Cave		>>>>>	Rightward?	
Chimney Cave		<<<<<	Leftward	Concave
Gatecliff Shelter	2	Leftward	Leftward	Concave
Hidden Cave	6	Leftward	Leftward	Concave

Based on Adovasio 1970:27; Adovasio and Andrews 1983:282; Goodman 1985:268; Grosscup 1960; Heizer and Kreiger 1956; Rozaire 1969, 1974.

by the weaver, the stitch may be placed either to the right or the left of the previous stitch (Wissler 1914:49). This is "work direction." This behavioral pattern is both stable and uniform within ethnic groups (Elsasser 1978:633). Among California and Great Basin basket makers, the face of the basket into which the hole is punched is the face towards the weaver. This is the "work face" and may be either concave or the convex face of the finished basket. Within a weaving tradition, work face may vary with basket type: open baskets may be worked on the concave face and closed forms may be worked on the convex face. From the weaver's view, the work direction is unchanged but the choice of work surface is dictated by ease of working or the use of the finished product.

Ignoring the weaver's intentions, the position of the analyst relative to the finished basket surface compounds the possibility of error, and identical weaver behaviors may be variously and erroneously typed. Thus, the terms "clockwise" and "counterclockwise" have no analytical integrity while work face and work direction have discrete referents and may be compared across traditions (Weltfish 1930:460).

The weaver's actions may be recovered from the work itself (Baumhoff, in Balfet 1957:2). As the weaving strand moves up, over, down, and through the foundation the helix slant of the strand records the direction of the progress of work. Sewing which progresses to the left will produce stitches that lean "down-to-the-left" while sewing to the right will leave a "down-to-the-right" slant (Loud and Harrington 1929:66). The resulting work direction should be characterized as leftward or rightward. Although the literature is riddled with inaccuracies, it is usually possible to determine the work direction of a coiled basket from illustrations in archaeological reports as the slant of stitch remains the same no matter the work surface or viewer position (contra Heizer and Krieger 1956:57). Work surface is more difficult to recover from illustrations unless the entire basket is intact and the terminal course is present (see table 33). Leftward work direction predominated in prehistoric western Nevada and is evidenced at Mustang Shelter.

Table 34. Stitch count on close coiled baskets.

Site	Courses per 10 cm*	Stitches per 10 cm*	Stitches /100 cm^2
Mustang Shelter	20	36-40	700-800
Humboldt Cave (split both faces)	22-27	25-29	550-783
Humboldt Cave (split one face)	22-27	25-29	550-783
Lovelock Cave	20-30	20-40	400-1200
Falcon Hill	12-30	12-60	144-1800
Seven Caves	20-25	24-27	480-657
Monitor Valley	20-25	24-27	480-657
Grimes Point	20	30	600
Hidden Cave (3-rod)	20-30	30-40	600-1200
Hidden Cave (2-rod and welt)	17.5-30	20-40	350-1200
Granite Point (split both faces)	23-25	30-35	690-875
Granite Point (split one face)	23	19	437

* Reported in a variety of measures that are here standardized to courses or stitches per 10 cm.

Sewing stitch

A number of archaeological typologies have relied entirely on stitch type (Morris and Burgh 1941:6). California and Great Basin ethnographic examples, stitch type varies principally by whether the stitch forms a fabric with the stitching on the course below. If it does so (and removing the foundation would leave a net-like structure), the stitch is "interlocked." If it does not (and removing the foundation would result in complete disintegration) then it is "non-interlocked." If the awl and the stitch pass through the stitch in the course below, the stitch is split, whether on the work or non-work surface or both.

As suggested in table 30, the most common stitch type in western Great Basin coiled basketry was split stitch. At Humboldt Cave, 12 of 136 trays have stitches split on only one face, while the remaining 124 trays have stitches split on both faces (Heizer and Krieger 1956:45, 53). At Lovelock Cave, 91 percent of the coiled basket fragments had stitches split on one or both faces and nearly all of these were thought to represent trays (Loud and Harrington 1929:65-66). The Mustang Shelter coiled fragments, with stitches split on the non-use surface, fit neatly into this pattern.

Stitches may be tightly packed together or may be spaced far apart so that the foundation shows between them. The resulting gap may be measured for comparison to other work. In ethnographic California, stitching gap often varied with basket function. The ratio of width of sewing strand to thickness of foundation (actually measured as length of stitch), on the other hand, seems to vary by ethnicity rather than function and results in a characteristic "look" to the basket fabric (Loud and Harrington 1929:63).

Stitch count, which documents the number of stitches but not the size of gaps between them, varies by basket function and is frequently reported for close coiled archaeological specimens. The relative construction effort may be compared by multiplying the number of courses per inch by the relative number of stitches per inch. The Mustang Shelter coiled basket(s) fall in mid-range (table 34).

Sewing strands are not infinitely long and must be periodically replaced but the treatment of the resulting ends is usually an aesthetic problem rather than a structural one (Barrett 1908:160). Compression between courses will keep the coiled basket from unraveling, however the smooth surface will be spoiled by lumpy or ragged ends. Splices are difficult to detect in archaeological specimens due to the maker's desire to hide them and the subsequent wear and deterioration of the surface in use and deposition. Dawson notes that the most common pattern on Lovelock Cave close coiling is for the fag end of the new strand to be concealed between the foundation courses and the moving end of the exhausted strand to be cut off flush on the non-work surface. The other, possibly earlier, pattern is identical in treatment of the fag ends but the moving ends are longer and bound under the next stitches on the non-work surface (Dawson n.d.). Splices were not observable on the Mustang Shelter fragments.

Although there is little variation in stitch between the start and the termination of a coiled basket, rims may be finished in a variety of ways. The coiled end may be tapered smoothly to join with the course below or may end abruptly and the last few stitches may be secured by several means. Unusual finishes are often reported, while self rims, where the stitch does not change, may be ignored.

Close coiled trays in this region are reported with both self rims and herringbone rim finishes. The second pattern is not represented at Humboldt Cave but is documented for Lovelock Cave (Heizer and Krieger 1956:46; Loud and Harrington 1929:67). Dawson's notes also mention the presence of diagonal overstitching and distinguish two types of herringbone rim finishes: the "Havasupai type," which has a separate foundation under the herringbone stitch, and the "Miwok type," which is stitched directly over the last regular course (Dawson n.d.). Unfortunately, no rim finish is present in the Mustang Shelter fragments.

Twined Basketry

Archaeological twining typologies are usually based on the primary construction weave, or wall type (Weltfish 1930:473). Twined wall types vary along two independent dimensions: the grouping of warp elements in successive courses and the number of weft elements (Emery 1966:202-203). In plain or simple twining, the same warp or group of warps is engaged on every course. In twill twining (diagonal, alternate pair, split pair twining) a different or alternate pair of warps is engaged in each successive round. Normal or two-strand twining requires only two strands but three or more weft strands can be used to produce three-strand twining.

Simple typologies, however, tell only part of the story. Twined basketry has a number of diagnostic attributes that can provide the analyst with rich information about weaving practices and basket function. The time lost in analysis of these additional attributes will be repaid in greater accuracy of identification.

Weft twist and spacing of weft rows are attributes often reported by analysts of archaeological basket fragments. The slightly oblique angle at which the wefts cross the warp is a product of the helix turn of the wefts. The angle may be characterized as S-twist or Z-twist (Adovasio 1977:20) when the weft twist is analyzed like a cord, in a vertical position. However, I prefer to analyze the twist from the weaver's point of view, where the horizontal position of basket weft and normal rightward progress of work result in slant of twist best characterized as up-to-the-right and down-to-the-right slant of turn (Barrett 1908:147).

Spacing of weft rows may be described as "close or open twine" (Adovasio 1977:25) or "compact or spaced twine" (Emery 1966:201). The description depends on the size of the gap between the weft rows, which may be measured (Morris and Burgh 1941:24). Open twined baskets serve very

Table 35. Distribution of plain twined wall types in western Nevada.

Site	Close plain \\\	Close plain ///	Open plain \\\	Open plain///
Mustang Shelter	-	1	-	1
Lovelock Cave	26	P	36	-
Humboldt Cave	16	P	26	-
Leonard Rockshelter	-	80	10	-
Horse Cave	25	1	21	-
Fishbone Cave	8	1	2	-
Stick Cave	15	-	11	-
Chimney Cave	9	-	2	-
Guano Cave	12	-	2	-
Crypt Cave	14	6	31	1
Falcon Hill	P	P	P	P

P = present; /// = up-to-the-right slant of weft turn; \\\ = down-to-the-right slant of weft turn.

Table 36. Open plain twined //// basketry in western Nevada (based on Hattori 1982).

Site	No.	Warp	Weft
Mustang Shelter	1	Unknown	Unpeeled shoot
Crypt Cave	1	Peeled twigs	Grass bunches
Falcon Hill	1	Unknown	Unknown

different functions from those that are close twined (table 35).

Mustang Shelter is an oddity in western Nevada, where plain twining found in archaeological context is characterized by down-to-the-right slant of weft twist. As weft twist is determined by learning context rather than functional necessity, it may be an important ethnic marker, identifying the makers of Mustang Shelter twining.

Although open plain twining is commonly found in archaeological context, open plain twining with up-to-the-right slant of turn is not. Once twining materials are considered, there are few specimens similar to the Mustang Shelter fragment (table 36).

Table 37. Close plain twined //// basketry in western Nevada.

Site	No.	Warp	Weft	Form Represented
Mustang Shelter	1	peeled *Salix*	*Salix*, split	tray
Crypt Cave	6	peeled twigs	soft	
Falcon Hill	P	stiff rod	unknown	bowl, cap
Lovelock Cave	P	flexible	Tule, cat-tail	bags, trays
Humboldt Cave	1	unknown	one course in \\\ tray	tray
Leonard Rockshelter	80	*Salix*, peeled	*Salix*, split	unknown with burial
Horse Cave	1	peeled twigs	soft	
Fishbone Cave	1	peeled twigs	soft	
Guano Cave	P	peeled twigs	soft	
Hidden Cave	18	whole rods	sedge?	circular tray?
Gatecliff	1	*Salix*, unpeeled	*Salix*, split	circular tray?
Hanging Rock	P	flexible		

Other archaeological examples of up-to-the-right open plain twining are found at some distance from Mustang Shelter: three fragments at Hogup Cave (Aikens 1970) to the east and some late fragments at Colville Rockshelter to the south (Meighan 1953:177, pl. 27b). The latter are undoubtedly Numic. Open plain twining was not, apparently, commonly made with up-to-the-right slant of turns in western Nevada until the advent of Numic peoples (Fowler 1994:122).

Close plain twined basketry is far more abundant in the western Nevada archaeological record than is open twining, however, examination of the data reveals that only a very few fragments are rigid, made with shoot warp and weft (table 37).

All the weaving materials found at Mustang Shelter were shoots and split shoots. Warp and weft of twined basketry, foundation and sewing strands of coiled basketry, and remains of prepared materials were all of shoots, probably willow (*Salix exigua*). No flexible warp basketry, neither plain flexible twining nor Catlow twining on cordage warp, was evidenced.

Materials play an important role in the intended use of a basket and may also profoundly affect other technical attributes. The choice of material class is more fundamental than the composition or exact species of material. Thus shoot warps of all species may be grouped together as a class, distinct from the class of cordage warp. Shoot preparation is usually simple: the shoot may be used as it was cut, or the bark may be peeled and/or scraped, but the working characteristics remain the same (table 38).

Identification of the Mustang Shelter fragment as a tray depends on two attributes: parallel warp arrangement and alternate work face. In twining, the passive or warp elements are arranged in a stable position relative to one another, either circular (radial), parallel or roughly fan-shaped. All three arrangements are found in the Great Basin: radial for spherical containers, parallel for shallow trays and fan shaped for elliptical containers.

Work face, the surface towards the weaver, may be concave, convex, or both (turning the work to both faces alternately). The work face can be found by tracing the weft. In western Nevada, most parallel warp baskets are worked on both faces alternately, the weaver turn-

Table 38. Radiocarbon dates for up-to-the-right weft slant close plain twined basketry.

Site	^{14}C Dates	Basket wall type	Materials Class
Mustang Shelter	A.D. 800-1333	Close twined Tray	*Salix* warp and weft
Falcon Hill	1375 $\pm$ 90 B.C.	Close twined (cap)	Unknown
Falcon Hill	1810 $\pm$ 80 B.C.	Close twined	Unknown
Falcon Hill	1900 $\pm$ 100 B.C.	Close stiff twining	Shoot?
Falcon Hill	1950 $\pm$ 100B.C.	Close stiff twining	Shoot?
Leonard Rockshelter	3786 $\pm$ 325 B.C.	Close stiff twining	*Salix* warp and weft

ing the basket from concave face to convex face, with the warps always facing away, as the work proceeds.

None of the comparative archaeological specimens is from a parallel twined tray, thus the Mustang Shelter specimen may be unique in the archaeological record of western Nevada.

Discussion

The technical comparisons above and the functional analysis below suggest that both the coiled basketry fragments and the close-twined fragments found at Mustang Shelter belong to baskets used for seed gathering or processing. The coiled fragments are covered with charred deposits typical of seed parching. The close-twined fragment has small reddish seed darts caught in the weave. These small fragments testify both to the use of two different seed processing strategies and possibly to the presence of two different ethnic groups. The coiled remains dated prior to 730 uncal. BP (figure 31) indicate that Mustang Shelter was used by non-Numic peoples. The four fragments described above (Ch1082/101, 274, 283, 315) were part of a flat, coiled circular tray used for parching seeds, a process which may have produced the heavy accumulation of charred material on the coiled parching trays. As the pre-Numic populations of the Great Basin apparently lacked the twined seed beater and scoop-shaped tray so essential to Numic hard seed gathering, gathering strategies using relatively flat coiled trays are identified with pre-Numic users. The coiled parching tray fragments from Mustang Shelter undoubtedly belonged to non-Numic peoples.

The use of twined seed beaters and trays for winnowing and parching was one of the hallmarks of Numic basketry (Fowler 1994). However, neither twined fragments from Mustang Shelter are typical of Numic twining.

The whole-shoot weft, open-twined specimen (1062/21) from Mustang Shelter does not resemble ethnographic examples of Northern Paiute work. Although the Northern Paiute, including the Toedökadö, used plain twined openwork in trays and piñon gathering baskets (Fowler 1992:130), "work with the whole rod wefts, common in Washoe plain twining, is very rare in Northern Paiute work" (Fowler and Dawson 1986:708). Washoe work, however, "always had to be down-to-the-right twining turns" (Fowler and Dawson 1986:705).

The close-twined fragment found on the surface of Mustang Shelter (1082/1) is not typical of a wall type used by the Numic, either. In fact, if it represents the technique used for an entire basket, the split-shoot weft, close-weave, parallel-warp tray fragment would be unique in the cultural record of western Nevada. It is unknown in the literature, in my experience of Numic museum collections, and in the recollection of other museum analysts (Dawson, personal communication, 1988). There are several possible explanations.

First, the fragment might represent a greater variance in pre-contact Western Numic parallel twined trays than ethnographers recorded, although its total absence from the archaeological and ethnographic record is hard to explain. It is possible that the 80 fragments from a burial at nearby Leonard Rockshelter are from a similar basket but no edge pieces, which would cinch the parallel warp identification, are reported (Heizer 1951).

However, once auxiliary weaves, and not just main wall construction types are considered, the Mustang Shelter fragment may be more successfully compared to Numic trays. Unlike coiled basketry, where one stitch type is normally used to stitch the foundation together from start to finish, twined basketry often requires several twining techniques to spread, bend, or secure the warps into a coherent fabric. Twining begins with a "start" which serves to align the warps with one another. The general type of start is dependent on the warp arrangement planned -- radial, fan or parallel -- but within these constraints the weave is so great as to yield only to description, not classification.

In parallel warp twining, shaping the flat fan into a scoop-shaped bowl requires a combination of warp additions and subtractions held in pace with auxiliary weaves which secure them. The method by which the terminal warps ends are secured is the basket selvage. Sometimes there is a course or two of alternate weave before the selvage which brings the warps closer together. This is known as the underselvege. In twining, especially in parallel twining, auxiliary weaves are essential to shaping the finished basket and often vary considerably from the wall weave. Western Numic weavers preferred to use plain twining over two paired warps as auxiliary weaves on close twill-twined trays (Fowler and Dawson 1986:708-711). Several rows of closer plain twining are illustrated on two open twined examples from Stillwater Marsh (Fowler 1994: 133, figs. 86 and 87). In both cases, these auxiliary weaves appear at the basket start, where the heavy butt ends of the warp were secured. The 2mm thick warps of the Mustang Shelter fragment are too thin for the butt end of any sturdy tray.

It is possible that the fragment represents an auxiliary part of a small tray-like construction rather than an actual tray. Parallel-warp plain open-twined construction was used for cradle boards, seed beaters, and piñon scoops. The presence of small reddish seed darts in the weave argue against a cradle board, a conclusion confirmed by the thin warps on the Mustang Shelter fragment, warps which are far too fragile for the sturdy cradle board start, which typically average 4.5 mm at mid warp. The Panamint made a close twined version of the seed beater, with a tubular handle (Fowler and Dawson 1986:718). It is conceivable, though not attested that plain twining was used as an auxiliary weave in shaping these.

However, it is most probable that the fragments come from "foreign" sources. Central Numic weavers from Panamint and Western Shoshone communities sometimes used close plain twining over one warp, especially on the tip of the close twined tray (Fowler and Dawson 1986:716) where the warps are thinnest. This would allow for the relatively fragile 2 mm warp of the Mustang Shelter example. It is possible that the specimen was part of a "foreign" tray, transported to Mustang Shelter by Western Shoshone peoples in late proto-contact or post-contact times. This is certainly possible given that the artifact appeared on a site's surface that was littered with historic debris.

FEATHERS, HAIR, AND COPROLITES

By Robert L. Kelly

Six feathers were recovered. Only two of these show signs of modification by having been split down their stem, Ch1082/3108, from a red-tailed hawk (*Buteo jamicensis*) in stratum 2, and Ch1082/563, from an unidentified bird in stratum 7. These were probably part of arrow or dart fletching (although red-tailed hawk is not mentioned as fletching by Fowler [1992: 105]). Several pieces of hair (N=3) and coprolites (N=7) were also recovered, but these have not been studied.

WORKED WOOD AND CANE

By Daniel Bach

Data on 16 artifacts fashioned from wood and reed are presented in table 39; some of these are illustrated in figure 35. These are primarily from the upper deposits (above stratum 9) where preservation of organic material was excellent. Most were found near the front of the shelter where non-artifactual organic material was common. This may be a packrat nest area and the artifact's location may reflect activity by wood rats rather than humans. A total of five genera of wood were identified: cedar (*Juniperus* sp.), sagebrush (*Artemisia* sp.), serviceberry (*Amelanchie*r sp.), willow (*Salix* sp.) and a type of reedgrass (*Calamagrostis* sp.?). The wood specimens/artifacts ranged from simple twisted or cut sticks to pegs, trap trigger, the tip of a fire starter, and split basketry material (already mentioned above, figures 33 and 34).

Wood specimens were identified using a wood and charcoal collection and reference manuals (Core et al. 1979; Esau 1977) and a SWIFT SM80 stereo widefield microscope (10-40X). Key characteristics used to identify wood genera included bark characteristics and the presence or absence of rings or pores in both the early and late wood.

Specimen Ch1082/7, mentioned in Polanich's basketry description, is a bundle of split serviceberry (*Amelanchier* sp.) wood. The average length of the bundle is 430 mm with an average width of 5 mm. All of the wood appears to have been cut. Some of the wood was cut perpendicular to the plant while other strips were cut at angles ranging from 30° to 60°. The thickness of the split serviceberry wood ranged from .87 mm to 3.47 mm. Specimen Ch1082/8 consists of about 20 additional fragments that were found loose in the same level and area as Ch1082/7. Although willow was favored for basketry manufacture by the Stillwater Paiute, serviceberry, obtained in the Stillwater Mountains, was also used, especially for rims (Fowler 1992:128; Moerman 1998:68-69). These were normally gathered in the fall or winter and thus the presence of this artifact may suggest a season of occupation for the shelter, at least for the uppermost deposits.

Specimen Ch1082/18 is a small serviceberry (*Amelanchier* sp.) branch which has been looped and tied to itself. The uncoiled length is estimated at 175 mm. The maximum thickness is 2.75 mm with a minimum thickness of 1.23 mm. Bark is present and there is no evidence of burning. Its function is unknown.

Specimen Ch1082/32 is fashioned from greasewood (*Sarcobatus* sp.); greasewood is not found in the immediate vicinity of the shelter today and would not have been there in the past. Thus, this object was transported to the shelter from the valley floor. One half displays heavy use wear/polishing while the other half displays none. Both ends have been modified and charred. The charring on the proximal end starts at the tip and proceeds towards the distal end and measures 37.3 mm. The overall length of the notch is 30.9 mm. Angle of the

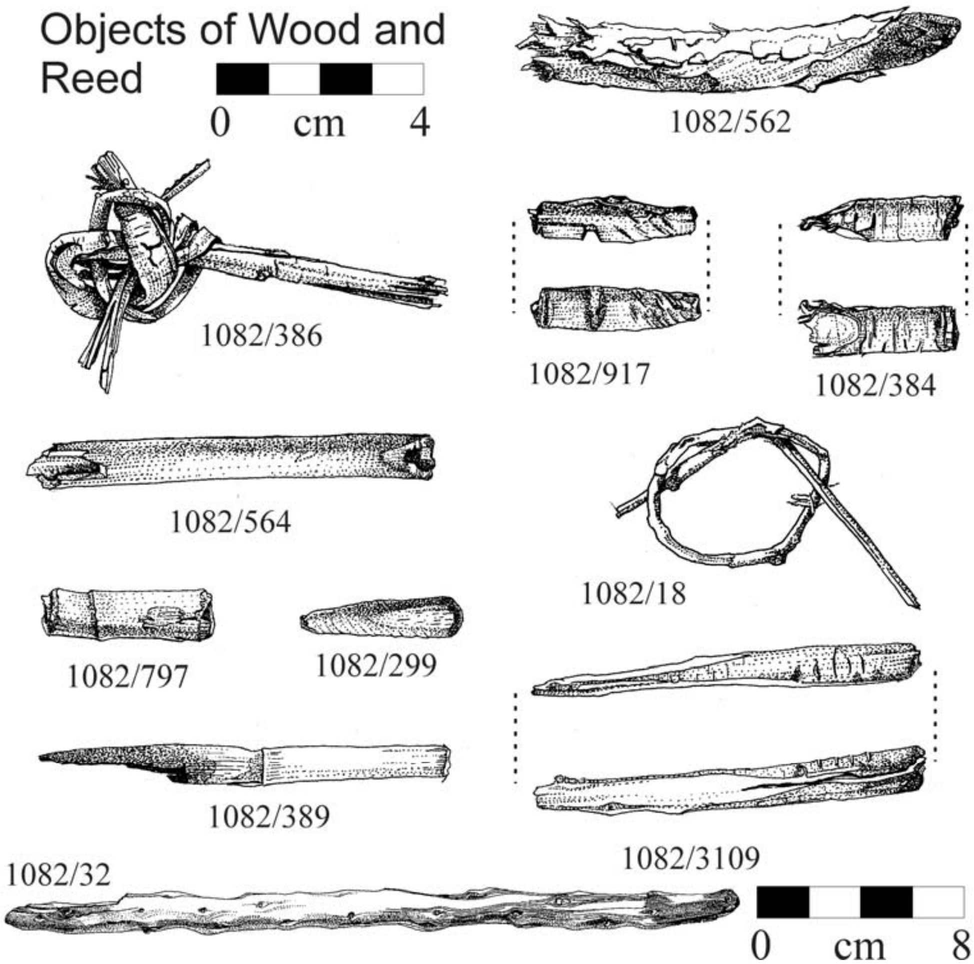


Figure 35. Objects of wood and reed from Mustang Shelter; lower scale for Ch1082/32 only.

notch is 15°. Located near the tip of the proximal end are four cut marks. The distal end of this tool has also been notched. Length of the notch is 45.5 mm and displays light charring. Length of the charring is 37.7 mm. The end was split starting at the heartwood creating a parallel split. All of the bark has been stripped off. It is possible that the tool was a hand drill, the polishing resulting from rubbing between the palms. It may have been part of a fire-starter kit. However, ethnographically, Paiute fire-starters normally had a female end into which a sagebrush or greasewood tip could be fitted. This specimen appears to have had something hafted with cordage onto one end, possibly a stone drill tip.

Specimen Ch1082/273 is a notched willow (*Salix* sp.) peg. Angle of the notch is approximately 10°. This artifact appears to have been snapped off at both ends versus being cut. Bark is present and there is no evidence that the wood was burned.

Specimen Ch1082/299 is a tip of a sagebrush (*Artemisia* sp.) fire starter. The end that was used to start a fire contained two cuts (probably the result of stripping away unwanted wood or knots). The first cut had a maximum length of 9.3 mm. The second cut had a maximum length of 10.5 mm. The other end of the fire starter contains what appears to be a female receptacle. The depth of this receptacle is 1.9 mm. The maximum width at this end is 3.5 mm; the minimum width is 3.3 mm. There are numerous cuts which were used to peel away the wood layers thereby tapering the fire drill. No bark was present and the entire drill has been smoothed. Some charring is present on the end used to start a fire. This artifact is very similar to those used by the Paiute in Stillwater Marsh and illustrated by Fowler (1992:113); these ethnographic fire drill tips were also sometimes made of sagebrush (Fowler 1992:112; Moerman 1998:103).

Specimen Ch1082/310 (not illustrated) is a greasewood (*Sarcobatus* sp.) twig that has seven cut marks on one end and a notch on the other. Depth of the notch on the "ventral" side is 10.5 mm while the depth of the notch on the "dorsal" side is 2.5 mm. The proximal end has also been notched by splitting the wood down the heartwood. The length of the notch on the "dorsal" side is 13.3 mm. Bark is present and the wood was not burned. Its function is unknown.

Specimen Ch1082/384 is a willow (*Salix* sp.) peg. No observable orientation was present. The flat end of the peg contains five cuts. The peg end contains four cuts. The minimum thickness of the peg end is .3 mm. Angles of the peg end are 18° and 22° respectively. Both ends show evidence that they were broken off of the main plant versus being cut off.

Specimen Ch1082/386 is two serviceberry (*Amelanchier* sp.) bark wrapped twigs. If untied, the total approximate length would be 160 mm. Both ends indicate that the twigs were snapped off versus being cut off. Bark is present and the twig has not been burned. Its function is unknown.

Table 39. Wood and reed artifacts from Mustang Shelter.

Ch1082/	Stratum	Material	Length mm	Max. Dia./ Thickness mm	Comments
18	2	serviceberry	40	1.23-2.75	knotted stick
21	2	willow	145	3.0	piece of rough basket, trap, fence?
32	2	greasewood	284	14	burnt at both ends, smoothed shaft
273	2	willow	65.8	3.64-7.0	split twig
299	3	sagebrush	30.3	7.3	Tip of fire-starter
310	6	greasewood	121.9	5-6.9	cut marks on one end
384	2	willow	27.7	8.2	small “peg” cut at one end, two whittle slices to form adze-
386	1	serviceberry	75.7	7.4	knotted stick (two pieces “tied” together)
389	3	reedgrass?	79.3	6.7	reed segment, possibly same species as 797; arrow shaft
522	7/8	willow	184.0	4.0	long thin twig, possibly cut at one end
562	7	juniper	81.1	11.3	broken, worn or whittled to dull point at one end; digging
564	7	serviceberry	77.5	8.2	reed segment (different species than 797 or 389); arrow
797	9	reedgrass?	32.5	9.8	reed segment, wear or intentional grinding at one end;
917	3	willow	32.2	8.6	small notched peg, cut at one end, whitted to dull point at
938	3	willow	66.1	5.9	cut at one end, whittled to point at other; unfinished peg or
3109	3	willow	75.4	7.9	cut and burnt at one end with 4 surface cut marks, whittled

Specimen Ch1082/389 is tentatively identified as reedgrass (*Calamagrostis* sp.?). The proximal end was cut and the distal end was burned. Maximum length of the burn is 33.7 mm. Given the shelter's location it is unlikely that reed would have entered the shelter through natural processes and therefore this artifact was probably deposited through human agency. It may be a piece of an arrow shaft as cane was commonly used for this purpose ethnographically (Fowler 1992:105).

Specimen Ch1082/522 (not illustrated) is a willow (*Salix* sp.) stick. The proximal end contains one complete wrap of willow fibers. These fibers measure 55 mm in length. Both ends have been snapped off versus being cut. There are no cut marks or evidence of burning.

Specimen Ch1082/562 (not illustrated) is a cedar (*Juniperus* sp.) stick, pointed at one end. The proximal end has been rounded to a point and is burned. The distal end has been snapped off. The tip has an oval cross-section, with diameters of 5.2 and 2.9 mm. Bark has been removed from the tip of the artifact and it is charred. Bark is present at 11.5mm on one side and at 21.9 mm on the other.

Specimen Ch1082/564 is a piece of a serviceberry (*Amelanchier* sp.) branch. No observable orientation was present. One end was broken off and then cut, the other was simply cut but shows some characteristics similar to those of a spiral fracture. Like specimens Ch1082/389 and Ch1082/797, this artifact, too, may be an arrow shaft fragment.

Specimen Ch1082/797 is tentatively identified as a type of reedgrass (*Calamagrostis* sp.?). Both ends are cut and there is no indication of charring. It too may be a portion of an arrow shaft.

Specimen Ch1082/917 is made of willow (*Salix* sp.) and is probably a trap trigger. The proximal end contains three cuts. This end is cut and snapped off, as opposed to being cut completely through. The "dorsal" cut measured 2 mm while the "ventral" side measured 1.1 mm. There is a groove present that has a maximum width of 2.5 mm. The depth of this cut is 2.5 mm. The groove has two angles of 20° and 30°. The former represents the upper portion of the trap trigger while the latter represents its lower portion. The distal end is cut and then "ground;" this end is also slightly charred. Cuts are present which allowed the maker to peel the wood layers away thereby tapering the artifact.

Specimen Ch1082/938 (not illustrated) is a willow (*Salix* sp.) peg. No orientation was present. Maximum width at the cut end is 3.5 mm while the minimum width is 2.2 mm. There are two cuts observed on the peg end. One cut has a minimum length of 22.8 mm while a second has a maximum length of 3.5 mm. Angle of the peg end could not be calculated because the wood is warped. The bark was stripped off and there is no evidence of charring.

Specimen Ch1082/3109 is also a willow (*Salix* sp.) peg. The proximal end (left, as illustrated) was used as the peg end. The distal end contains three cuts and is slightly charred. There is a split in the wood which originates at the tip of the distal end and travels towards the proximal end and towards the heartwood. This split measures 31.8 mm and is probably the result of the wood drying out. The tip shows signs of heavy polishing while the rest of the wood shows minor polishing. The proximal end contains three cuts: one with a maximum length of 52.5 mm and an angle of 5°, a second 39.4 mm long with an angle of 5°, and a third has a maximum length of 38.1 mm and an angle of 8°. The minimum tip thickness is 1.9 mm. The proximal end displays minor charring. Bark is present.

Ornaments

By Steve Grantham and Robert L. Kelly

Data on ornaments made of various materials are included in table 40; some of the items are illustrated in figure 36. This assemblage includes four shell beads (Ch1082/111, 112, 240, and 800), a notched piece of gypsum (Ch1982/115), a tooth (Ch1082/284), a stone bead (Ch1082/28), two bone beads (Ch1082/98, 286; the latter not illustated) and one bone bead "blank" (Ch1082/567). Using the Bennyhoff and Hughes (1987) classification system the shell beads are G1, Tiny Saucer types (Ch1082/111, 112), F3a, Square Saddle (Ch1082/112), and cCC2j (Ch1082/800). Unfortunately, Type

Table 40. Ornaments from Mustang Shelter.

Stratum	Ch1082/	Len. mm	Thick. mm	Wt. gm	Dia. mm	Inside Dia. mm	Material	Comments
10	28	4.5	1.3	0.1	4.4	1.6	stone	
2/4	98	22.9	0.8	0.3	3.8	2.1	bone, bird?	
2/4	111	-	0.7	0.1	4.5	1.5	*Olivella* sp.	curvature=1.0 mm, ground edges, conical perforation, Type G1, Tiny Saucer
-	112	7.2	0.4	0.1	7.2	1.5	*Olivella* sp.	curvature=1.1 mm, diagonal=7.3 mm, width=6.0 mm, ground edges, conical perforation, Type F3a, Square Saddle
2	115	-	1.6	0.1			gypsum	4 cut marks along edge
1	240	-	1.1	0.1	4.9	1.5	*Olivella* sp.	curvature=1.0 mm, burned, ground edges, conical perforation, Type G1, Tiny Saucer
2	284	22.3	5.0	0.5			tooth	cordage wrapped around root
2	286	5	0.9	0.1			bone	split in half
10	567	25.8	0.7	0.4	4.5	2.6	bone, bird?	cut marks on bone are 3.3 mm apart
9	800		0.8	0.1	5.5	1.8	*Haliotis rufescens*	Type cCC2j, Simple Ring

G1 is not temporally diagnostic, occurring throughout the archaeological sequence and the *Haliotis* specimen has no known temporal range. The F3a Square Saddle is a Middle Period Marker in central California; at Mustang it was found in a rodent burrow between strata 2 and 3 so its depositional provenience is uncertain but probably falls within the age range of the Middle Period.

Specimen Ch1082/115 is a very small triangular-shaped, flat piece of gypsum that has 4 small grooves cut along one edge; the other edges are breaks. Specimen Ch1082/284 is a tooth with cordage wrapped around the base. These artifacts are too few in number to analyze, but it is worth noting that they are present nearly throughout the site's temporal range. There was no evidence for any burials in the shelter and these ornaments probably are lost items.

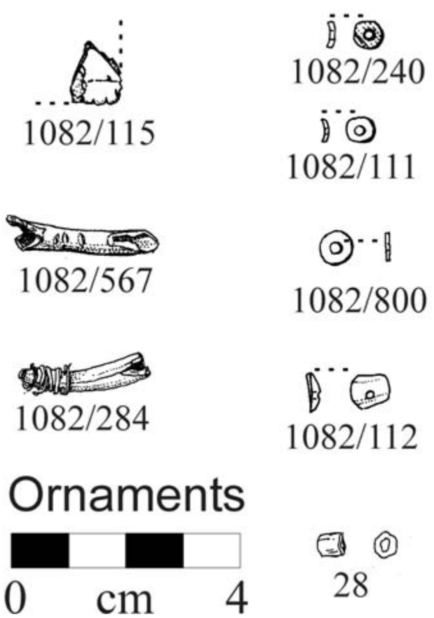


Figure 36. Ornaments from Mustang Shelter.

HISTORIC ARTIFACTS

By Robert L. Kelly

Leaving aside the material scattered on the surface of the shelter, only six artifacts that are clearly associated with the historic time period were recovered from the shelter's deposits. These include two uncataloged pieces of metal--one a piece of bent wire, the other a manufactured piece of, perhaps, a harness or belt. Additionally, there were several pieces of string (Ch1082/19, 23), a leather strip (Ch1082/942), and a bit of cloth fabric (1082/6) (refer to figure 34). All of these items came from strata 1-3.

Chapter 6: Comparison to Other Stillwater Mountains Rockshelters

In 1986 several other rockshelters were located and tested along with Mustang Shelter. As in the 1986 Mustang test, this was done with a test pit excavated in 10 cm levels by trowel with all deposit dry-screened through 1/8 inch mesh. Figure 2 (in chapter 1) shows the approximate location of the shelters. As with Mustang, the exact location of the shelters is not given but is available in the Nevada State Museum site files.

Although the quick nature of the tests and the lack of dates prohibit extensive analysis, the debitage recovered from these sites does permit us to answer, if only partially, the question of whether Mustang Shelter is typical or atypical of rockshelters in the Stillwater Mountains. In this chapter, we present a brief description of each shelter, followed by a comparison of each to Mustang Shelter. The faunal remains from these test units have not been analyzed.

Foxtail Shelter Number 1 (26Ch1079)

Foxtail Shelter Number 1 is the largest of several small shelters formed in the conglomerate deposits along the eastern edge of the Carson Sink at about 1280 m above sea level (figure 37). The site has only about .75 m of clearance at the mouth and inside, but extends back at most about 5 m from the dripline, and is about 6 m wide at the mouth (figures 38, 39). The surface is level. The shelter faces WNW, looking out onto the Stillwater Marsh and Foxtail Lake. A pile of rock near the northern edge of the mouth might be the remnants of a wall. Behind this feature, on the ceiling, is some possible red rock art (figure 40). There is a large rodent midden at the north end of the shelter. The site does not provide much shade after noon in the summer.

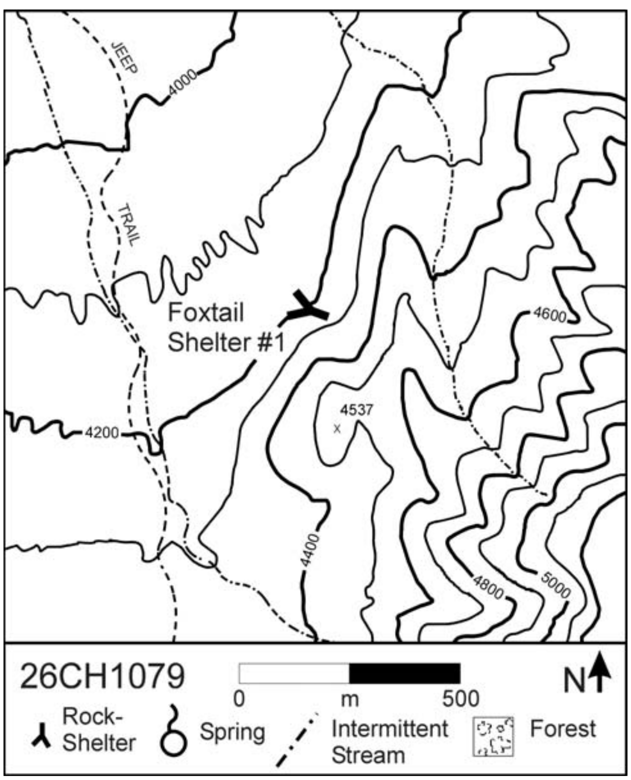


Figure 37. Location of Foxtail Shelter No. 1.

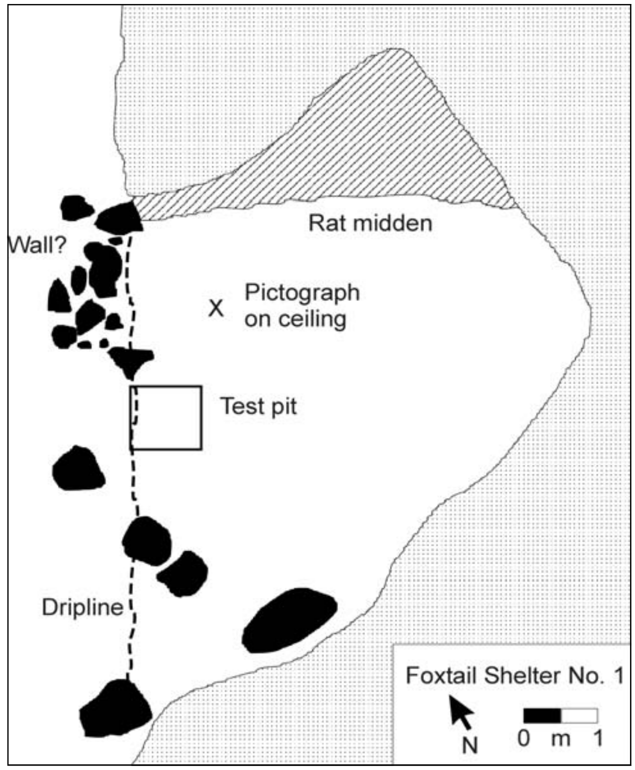


Figure 38. Map of Foxtail Shelter No. 1 showing location of the 1986 test unit.

A 1 x 1 m test pit was placed just behind the dripline and excavated to 20 cm below surface ("surface" in all shelter test excavations is defined as the test unit's SW corner); the south half of this unit was then excavated to 50 cm below surface. Debitage increased in abundance to about 40 cm below surface, but declined slightly at 50 cm below surface. The upper deposits were largely roof spall, rodent feces, and windblown dust, with pockets of silt; but at about 40 cm below surface the deposit became a more loamy sand, still mixed with rubble. The bottom of the site was not reached. However, a pin was pushed another 20 cm down. Thus, the shelter contains at least 70 cm of deposit, meaning that at one time the shelter had at least twice the clearance (at last 1.5 m) it presently has.

A single piece of worked wood (about 6 cm long, with a tapered end and a shallow notch completely around the opposite end; Ch1079/2), a historic button (Ch1079/1), and two biface fragments (Ch1079/3, 4) were the only artifacts, other than debitage, recovered.

Figure 39. Photo of Foxtail Shelter No. 1, facing NNE.

26CH1077

This site is located in a canyon in the southern Stillwater Mountains at 1427 m above sea level (figures 41 - 43). Its name as listed on the site form is not given here as it could give the shelter's location away.

The site is located in an outcrop of tuft that sits atop a knoll at the end of a ridge overlooking a saddle at the head of a wash on the south side of the canyon. The shelter is wide, about 6.5 m, but shallow, at most about 2.5 m, with a high ceiling. The surface is level. The site faces north and provides ample shade in the afternoon. A metate (36 x 35 x 17 cm) sits at the western edge of the shelter, along with a metate fragment and a slightly used mano (none was collected). A single rock next to the test pit with wire wrapped around it may be a coyote trap weight.

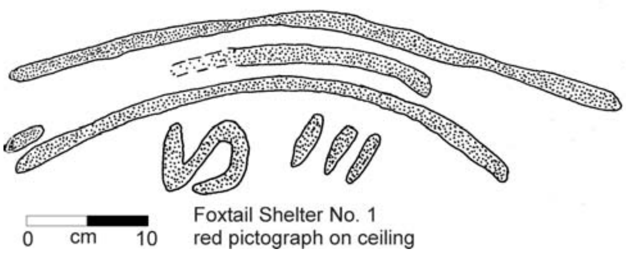


Figure 40. Possible pictograph in Foxtail Shelter. No. 1.

A 1 x 1 m test pit was placed just behind the dripline and excavated to bedrock, which lay at most about 20 cm below surface. The bedrock slopes from the front to the rear of the shelter and slightly deeper deposits may lie away from the dripline, but the shelter does not have any significant depth to it. The deposits are primarily windblown dust, granular eroded bits of bedrock and shelter walls, and some charcoal.

No artifacts other than debitage were recovered. Among the faunal remains were some identified as fish in the field.

MAD BIRD SHELTER (26CH1081)

Named after a remarkably irate bird that pestered the excavators, Mad Bird Shelter is located at 1683 m in a small outcrop of volcanic rock just west of (down canyon from) the confluence of two canyons at the bottom of the west side of the Stillwater Mountains (figures 44 - 46). It sits on the south side of a canyon about 5 m above the canyon floor. A talus cone at

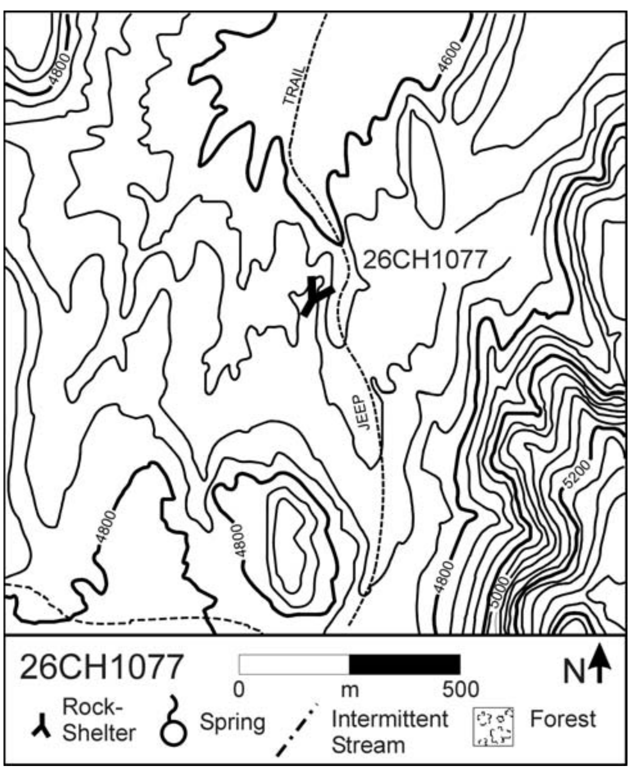


Figure 41. Location of 26CH1077.

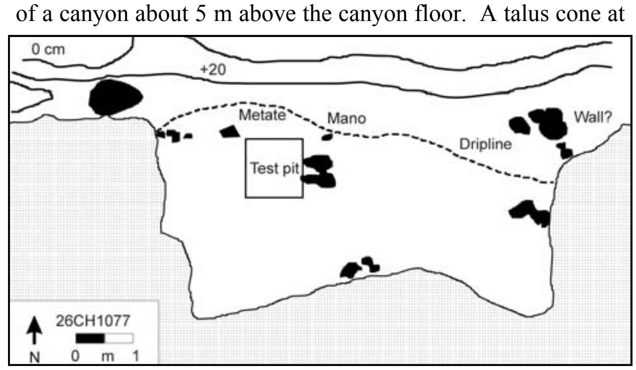


Figure 42. Map of 26CH1077 with 1986 test unit.

Figure 43. Photo of 26CH1077, facing south.

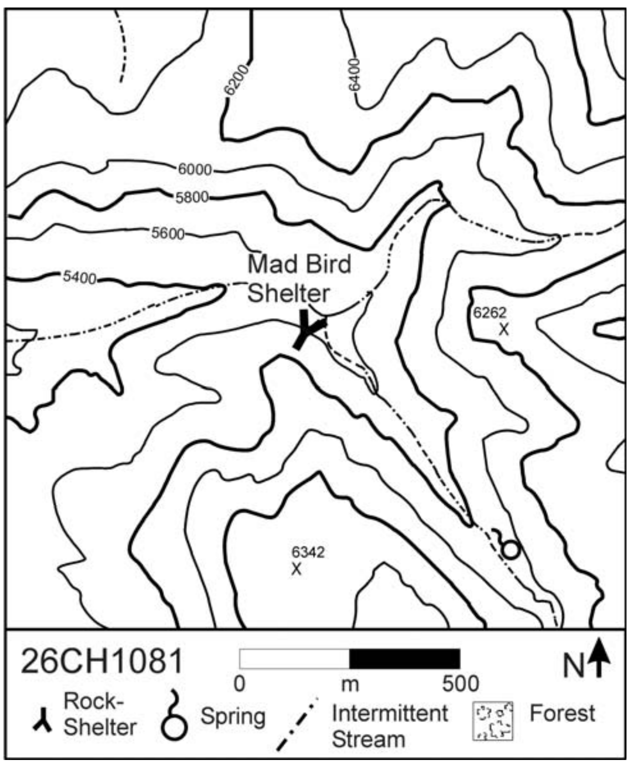


Figure 44. Location of Mad Bird Shelter.

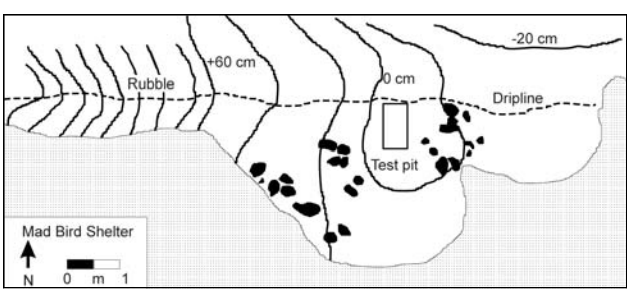


Figure 45. Map of Mad Bird Shelter with 1986 test unit.

the west side of the shelter produces a slope from the west to the east. The shelter is about 5-6 m wide, and 3 m deep, with sufficient headroom for a standing person. The shelter faces north and provides good afternoon shade.

A .5 x 1 m pit was excavated just behind the dripline. The entire unit was excavated to 20 cm below surface; the southern half (.5 x .5 m) was excavated to 30 cm below surface. A pin was pushed down another 20 cm suggesting at least 50 cm of deposit in the shelter. The deposit was largely windblown dust, rodent feces, organic debris and roof spall. Among the copious faunal remains were a few specimens identified as fish in the field.

A Rosegate projectile point (Ch1081/2), a Desert Side-notched projectile point (Ch1081/3), a point tip (Ch1081/5), an unidentified point of obsidian (Ch1081/11), 4 bone beads (Ch1081/7-10), one shell bead (Ch1081/4), a flat, oval piece of siltstone or tuft with smoothed edges, about 7 cm long (Ch1081/1), and a piece of hematite (Ch1081/6) were the only artifacts recovered other than debitage. Table 41 provides data on the three measurable projectile points.

DIXIE SHELTER (26CH1078)

Dixie Shelter is the only shelter in this sample located on the east side of the Stillwater Mountains (figures 47 – 49). It sits at 1341 m above sea level on the southern side of a steep, rocky gully. The shelter faces north and provides good afternoon shade. The site is some 9 m wide at the front, and 3.5 m deep. The surface of the site slopes slightly from the west to the east, with a steeper slope at the eastern edge. A wood rat nest is located at the western end.

A 1 x 1 m test was placed just behind the dripline. The entire unit was excavated to 10 cm below surface; the southern half was excavated to 20, and then the SE quarter was excavated until a layer of flat-lying stone was encountered at 35 cm below surface. The deposit was largely windblown dust, rodent feces, organic debris and roof spall. No evidence of historic period use was observed.

No artifacts other than debitage were recovered from the shelter.

COMPARISONS TO MUSTANG SHELTER

The question arises as to whether Mustang Shelter is typical of shelters in the Stillwater Mountains or if this site pro-

Table 41. Data on projectile points from Mad Bird Shelter.

Ch1081 /	Stratum	Len. mm	Wid. mm	Thick. mm	Wt. gm	Portion	Material	Ax. Len Mm	Max Wid Pos. mm	Base Wid. mm	Nk Wid. mm	Notch open. deg.	PSA deg.	Type
2	2	30.3	17.7	3.4	1.2	Whole	Chert	30.3	8.8	9.2	6.4	60	120	Rosegate
3	2			2.9		Base	Chert						150	Desert Side-notched
11	2	19.6	11.4	3.8	0.7	Whole	Obsidian	19.6	9.1	8.5	8.1	130	100	Unknown

Figure 46. Photo of Mad Bird Shelter, facing southwest.

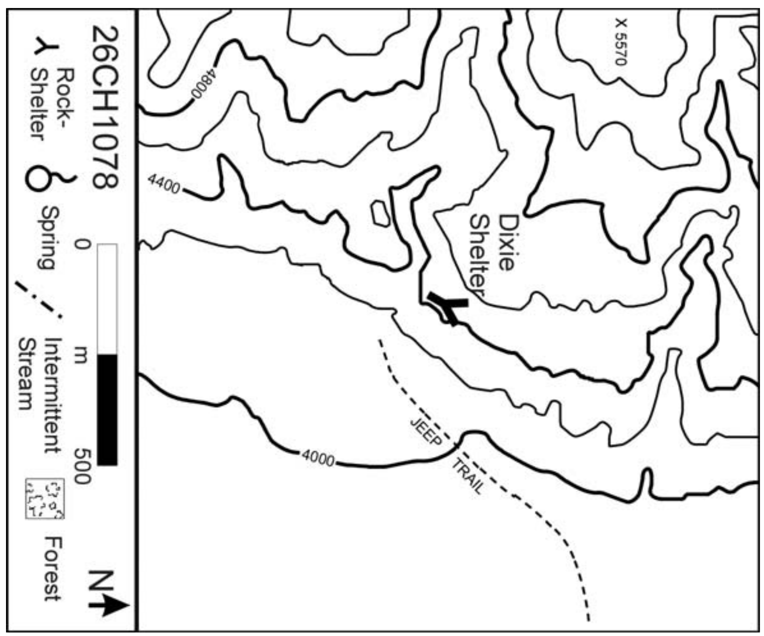


Table 47. Location of Dixie Shelter.

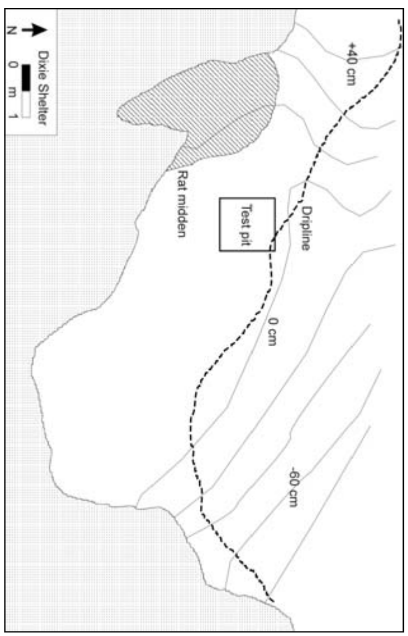


Figure 48. Map of Dixie Shelter with 1986 test unit.

Figure 49. Photo of Dixie Shelter, facing southeast.

more years of deposition into a shallower sequence.

On the other hand, the debitage density at Mustang is the highest of the shelters. The value in table 41 is based on the results of the 1986 test excavation; taking the 1990 material into account the density rises to 5521 flakes/m^3. Taking into account the fact that Mustang probably has a much higher rate of sedimentation than the other shelters, as suggested above, the debitage density suggests that Mustang Shelter was used much more intensively than the other shelters. Undoubtedly, this is because Mustang is the most habitable of the shelters, providing shade all day long, even at the summer equinox, and a recess that with only a small fire could have provided a warm space in the winter. It is also located near a spring and in a canyon that provides good access between the valley floor and piñon groves in the Stillwater Mountains. The other shelters may have provided temporary relief for daily foraging parties or an overnight camp but Mustang could have been used by an entire family or two for a longer stay. Such a difference could condition not only the density of material in the site, but the kinds of material found there as well.

vides a biased sample. This is a difficult question to answer and we cannot with the present comparative data set evaluate the representativeness of chronological changes seen at Mustang Shelter. However, a rough comparison between Mustang and these other shelters may suggest whether or not Mustang is a biased sample or not. In doing so, we will primarily compare the upper deposits of Mustang (strata 1 through 4) to the entire assemblage recovered from each shelter. The reason is that we have no temporal control over these shelters' deposits, with the exception of Mad Bird where a Desert Side-notched and a Rosegate projectile point suggest a late occupation that is coeval with the upper deposits of Mustang. But it is most likely that all the deposits we tested are "late" since we did not go very deep into any of the sites. 26CH1077 has very shallow deposits, and the others have deposits of an unknown depth, but are probably not very deep. We are undoubtedly mixing material of different ages by looking at the entire assemblage recovered from each shelter's test excavation, but at present there is no logical basis on which to subdivide the shelters' deposits.

Density of Material

The density of debitage and bone from each of the five shelters is summarized in table 42. There are some large differences in these values. Mustang appears to have, by far, the lowest density of faunal remains. Strata 1 through 4 at Mustang contain a high density of organic debris, including some basketry splints but also some material that is probably rodent nest. This could lower the bone density relative to the other sites. However, the bone density of Mustang Shelter as a whole is only 1417 bones/m^3, still lower than the least dense of the four tested shelters. It is possible that the bone density is higher in the tested shelters because they have considerably more shallow deposits than Mustang and thus compress many

Table 42. Debitage and bone density for Mustang and four other rockshelters in the Stillwater Mountains.

Shelter	Debitage Density (flakes/m^3)	Bone Density (bones/m^3)
Mustang (strata 1-4)	3663	613
Mad Bird	3580	9447
26CH1077	1152	7123
Foxtail	645	3720
Dixie	1131	4336

Is There a Difference Between the "Late" Assemblage at Mustang Shelter and the Other Shelters?

Comparisons are not easy because there are too few retouched stone tools from the shelters, no organic artifacts, and the faunal remains have not been examined (and their samples are very small). This leaves the debitage as the basis for comparison. The data on debitage from these rockshelters were collected by different analysts than those who collected data on the Mustang Shelter assemblage. Nonetheless, the students worked under Kelly's direction and the data are expected to be roughly comparable; in addition, all dorsal flake scar counts and platform assignations were double-checked by Kelly. Data collection followed the procedure described above for the

Table 43. Debitage comparisons between Mustang Shelter and other tested rock-shelters in the Stillwater Mountains.

Raw Material	Mustang (1-4)	Mustang (10-11)	Mad Bird	26CH 1077	Foxtail No. 1	Dixie
Obsidian	6	23	12	45	10	14
Cherts	263	884	114	36	56	100
Other	27	136	276	42	67	102
Total	303	1043	402	123	133	216
Flake Portions						
Whole	62	97	35	7	11	25
Proximal	37	64	15	2	7	52
Distal	123	269	47	17	27	52
Shatter	41	148	14	10	9	8
Total	263	578	111	36	54	100
Cortex						
Present	5	17	8	2	3	1
Absent	84	164	125	30	30	60
Total	89	181	133	32	33	61
Platform Type						
Single facet	25	45	23	6	8	6
2-3 facets	17	31	29	3	23	14
>3 facets	39	46	40	24	24	13
Crushed	27	52	49	14	19	14
Lipped	7	37	38	6	14	0
Total	115	211	183	55	48	92
Flake Size						
N	69	55	119	28	29	55
Mean	.26	.58	.09	.10	.30	.06
Variance	.14	.42	.02	.02	.19	.003
Dorsal Scar Count Density						
N	55	118	119	28	29	55
Mean	.05	.02	.07	.06	.05	.07
Variance	.001	.001	.001	.001	.001	.001

Mustang Shelter assemblage. Data for all debitage comparisons are presented in table 43.

Raw Material

A series of chi-square comparisons between the late Mustang Shelter assemblage and each of the other shelter assemblages shows that there is a significant difference (df=2, p<.001) between Mustang and each shelter (for Mad Bird, χ^2=255.3; for 26CH1077, χ^2=161.5; for Foxtail, χ^2=105.66; for Dixie, χ^2=110.2) in the frequency of different raw materials. In each case, the adjusted standardized residuals (ASR) point to the "other" category as the primary agent. Obsidian is also a factor in the case of 26CH1077, where it comprises 36 percent of the assemblage; in all other shelters, obsidian accounts for less than 10 percent of the assemblage.

In each of the four tested shelters the "Other" raw material category is almost entirely comprised of siltstone (some silicified). I suspect that some of the difference lies in the misclassification of silicified siltstone as chert in the Mustang analysis. But a stronger factor may simply be that knappable siltstones are found primarily in the southern Stillwater Mountains, near Rainbow Mountain (see Kelly 2001). Mustang is located much farther to the north than the other shelters, and thus it is less likely that siltstone would have been transported to it.

Flake Portions

In this comparison we considered only the chert aspect of each assemblage. However, a series of chi-square tests shows no significant differences between Mustang and each of the other shelters.

Cortical Flakes

In this comparison we examine only whole flakes, but all raw materials, and look only at the presence/absence of cortex. Again, a series of chi-square tests between Mustang Shelter and each of the other shelters shows no significant differences. Flakes bearing cortex are rare in all the shelters.

Platform Types

In this comparison we look at the platforms of all raw materials. We have left some platform types aside (split and snapped) as they are rare in the assemblages. Again, a series of chi-square tests were performed between Mustang Shelter (strata 1-4) and each of the other shelters. Here we see some significant differences between Mustang and each of the other shelters.

Comparing Mustang to Mad Bird (χ^2=17.86, df=4, p<.005) the ASR indicate that there are more flakes with single-facet and >3 facets or ground platforms flakes, and fewer lipped platform flakes in the Mustang assemblage than expected.

There is no significant difference between Mustang and 26CH1077 (χ^2=7.33, df=4, p>.05).

Comparing Mustang and Foxtail Shelters, there is a significant difference (χ^2=13.9, df=4, p<.01), with more flakes bearing ≤3 facets, and fewer flakes with platforms of >3 facets or ground platforms and flakes with lipped platforms in Mustang Shelter than expected.

Finally, there is no significant difference between Mustang Shelter and Dixie Shelter (χ^2=9.12, df=4, p>.05).

Flake Size

Using five percent trimmed means, there appears to be a difference in the mean size of whole flakes among the shelters (F=8.387, p<.001) although the range of variances is large and that may discount the significance of the differences (Drennan 1996:172). A series of t-tests shows that there are significant differences between the Mustang assemblage and that of all others shelters except Foxtail. Mustang Shelter and Foxtail Shelter have similarly large means (t = -0.45, p = .325; but both with large variances as well), while Mad Bird (t = 3.65, p<.001), 26CH1077 (t = 3.02, p<.002), and Dixie (t = 4.29, p<.001) Shelters have smaller mean flake sizes (with concomitantly smaller variances).

Dorsal Scar Count Density

Again, using five percent trimmed means, there is a difference among the shelters in terms of the dorsal scar count density of whole flakes (F=62.9, p<.001); here, the variances are within a reasonable range. The lowest dorsal scar count density of all the assemblages is found at Mustang Shelter.

A series of t-tests points to a significant difference between Mustang and Mad Bird (t = -4.509, df=172, one-tailed p=.001) as well as Dixie (t = -3.76, df = 108, one-tailed p =.0001) Shelters. There is no difference between Mustang and 26CH1077 (t = -1.52, df=81, one-tailed p=.065) or Foxtail Shelter (t = -0.64, df= 82, one-tailed p=.26). Mad Bird and Dixie Shelters have significantly higher dorsal scar counts than flakes in Mustang's strata 1-4.

These comparisons suggest that Mad Bird Shelter contains a debitage assemblage suggestive of somewhat later stage tool reduction than that of strata 1-4 in Mustang Shelter. Flakes in Mad Bird Shelter are smaller, have a higher dorsal scar count density, and have platforms suggestive of later stage reduction than in strata 1-4 at Mustang Shelter. Foxtail contains flakes with platforms that also suggest a later stage of reduction, but there are no differences in flake size or dorsal scar count density. Likewise, Dixie Shelter's flake platforms show no difference with Mustang, but wholes flakes at Dixie Shelter have a higher dorsal scar count density and are smaller than those at Mustang Shelter. Flakes at 26CH1077 are smaller than flakes at Mustang, but otherwise show no differences. It is unlikely that the higher frequencies of siltstone in the other tested shelters can account for these differences. The differences, if anything, point to late stage reduction at the other shelters compared to Mustang and siltstones found in the Stillwater Mountains are less easily knapped than the cherts and obsidians that appear in the shelters and so tend to be used for expedient tool production.

Is There a Difference Between the Early Assemblage at Mustang and that of the other Shelters?

The comparison between the other shelters and strata 1-4 at Mustang is interesting because the analysis of the Mustang assemblage suggested that there was a shift over time from predominantly early stage stone tool reduction in strata 10 and 11, to later stage reduction in strata 9 and 1-4. The rockshelters might therefore be predicted to be dissimilar to Mustang's lower deposits. Adding the data together from Mustang's strata 10 and 11 (see table 43) and comparing this data set to each of the four tested rockshelters, we find differences between some of the shelters and the combined strata 10 and 11 assemblage.

Raw Material

A series of chi-square tests show significant differences between Mustang's early assemblage and the other shelters (df=2, p<.001 in all cases) in terms of the three raw material categories (for Mad Bird, χ^2=449.2; for 26CH1077, χ^2=298.03; for Foxtail, χ^2=133.9; for Dixie, χ^2=155.65). For Mad Bird the ASR indicate that the difference lies in a greater than expected frequency of chert and a lower than expected frequency of "other" raw materials at Mustang. For all others, the difference lies in a greater than expected frequency of cherts, and a lower than expected frequency of obsidian and "other" raw material in the Mustang assemblage. The differences here, then, are similar to those seen between the assemblage found in the upper deposits of Mustang and the other shelters, although the lack of obsidian in the lower deposits of Mustang plays a larger role here.

Flake Portions

As in the comparison of the Mustang 1-4 assemblage with the other shelters, here we look only at chert flakes (df=3 in all cases). There are no significant differences between the Mustang assemblage and that of 26CH1077 (χ^2= 1.16) or Foxtail (χ^2=2.24), although the assemblages of these two shelters are small and low cell values may affect the results. There are significant differences between Mustang's early assemblage and that of Mad Bird (χ^2=18.1, p<.005) and Dixie Shelters (χ^2=16.34, p<.005). In both cases, the ASR point to fewer than expected whole flakes and more than expected shatter at Mustang.

Cortical Flakes

As with the assemblage of the upper deposits of Mustang, there are no significant differences in the frequency of cortical flakes between Mustang's early assemblage and that of the other shelters.

Flake Platforms

There is no difference between Mustang's early assemblage and Mad Bird Shelter (χ^2=5.11, p>.05, df=4 in all cases). But there is a significant difference between Mustang Shelter and the other sites. Compared to 26CH1077 (χ^2=14.74, p<.01) there are more flakes with >3 facets/ground platforms than expected at Mustang. And compared to Foxtail Shelter (χ^2= 10.88, p<.05), there are more single-facet platforms and fewer flakes with ≤3 facet platforms at Mustang. There are also fewer flakes with ≤3 facet platforms and more lipped platform flakes than expected at Mustang compared to Dixie Shelter (χ^2= 15.66, p<.005).

These comparisons suggest that Mustang's early assemblage has more later reduction stages represented than at 26CH1077 or Dixie Shelters, but possibly not compared to Foxtail (the data pattern there is contradictory). Based on flake platforms, then, it is difficult to generalize how Mustang Shelter's early assemblage compares to that of other shelters.

Flake Size

There is a significant difference in the mean whole flake sizes among the rockshelters and Mustang's early assemblage (F=95.09, p<.001, using five percent trimmed means) although the variances are large and they may undermine the validity of the comparison. Mustang's early assemblage contains the largest mean whole flake size of any of the assemblages examined here, suggestive of more expedient and/or early stage lithic reduction.

Dorsal Scar Count Density

Again, there is a significant difference among the shelters and Mustang's early assemblage in terms of the mean dorsal scar count density (F=77.6, p<.001, using five percent trimmed means). The Mustang assemblage contains the lowest dorsal scar count density of any of the assemblages examined here. This also points to early rather than late stages of reduction.

As noted above, the assemblage in strata 10 and 11 at Mustang appears to represent early stage lithic reduction compared to strata 9 and 1-4. Analysis in this chapter suggests that the other rockshelters contain debitage resulting from a still later stage of reduction than that of Mustang's strata 1-4. These strata were, in turn, thought to contain debitage from a later stage in reduction than strata 10 and 11. In terms of flake size and dorsal scar count density, the assemblage from Mustang's strata 10 and 11 appears to be very early stage reduction. But there are also a few instances of later stage biface reduction (lipped platforms) in strata 10 and this may be driving the contradictory results given by the comparison of platforms between strata 10 and 11 and the other shelters.

If we had to rank the shelters and Mustang's stratigraphic units, we would place Mustang 10 and 11 as containing the earliest stages of reduction, followed by Mustang's upper deposits (strata 1-4), then by 26CH1077, Foxtail and Dixie, and finally by Mad Bird. The fact that Mad Bird appears to contain the latest stage in tool reduction, may be driven in part by the relative abundance of obsidian debitage at that site.

This analysis suggests that the lithic assemblage of the upper deposits of Mustang Shelter is more similar to that of the other shelters than is the assemblage from the lower deposits. The late stage of lithic reduction present in the other shelters suggests a more logistical use than at Mustang Shelter. Mustang probably saw more residential use than the other shelters. As noted above, this could be expected given Mustang Shelter's comparatively large size and a configuration that offers greater protection than any of the other shelters. Based on the projectile points found at Mad Bird, and the shallow nature of the test excavations, these other shelters probably record the latest way in which shelters in the Stillwater Mountains were used. Mustang, with its deeper deposits, seems to record a change in the way shelters were used. During the deposition of strata 1-4, Mustang Shelter was used in a way similar to that in which very small shelters were used in the Stillwater Mountains.

Chapter 7: Conclusion

In this chapter, I first place the Mustang Shelter excavation into its larger research context, focusing on the issue of whether the period of apparently more intensive use of the Stillwater Marsh, in the late Reveille and Rosegate Phases, was part of a settlement pattern that was different from what came before and what came after. As noted in chapter one, I hypothesize that the late Reveille and Rosegate Phases saw lower residential mobility, and more logistical use of the uplands than in earlier or later time periods. We will then consider whether the data from Mustang Shelter support or refute this hypothesis. Finally, we consider whether a postulated late Holocene Numic expansion played a role in creating the observed patterns.

Previously, I argued that data suggest there was a major settlement pattern shift in the central and western Great Basin soon after 1500 uncal. BP, or 1400 cal. BP (Kelly 1997, 2001). Mustang Shelter was tested in the summer of 1986 during a program that aimed to locate a shelter that could provide stratigraphic data capable of testing this hypothesis from an upland setting. The test excavation at Mustang is small, and our sample of the pre-1500 uncal. BP deposits is smaller than the sample of post-1500 uncal. BP deposits. Thus, the conclusions here are quite tentative. Dates below were calibrated with CALIB 5.0.2.

When was Stillwater Marsh Used?

Previous research in the Stillwater Marsh (Kelly 2001) suggested that occupation focused on the wetland during a generally dry interval, when the wetland provided a better foraging alternative in most seasons than that presented by the upland environment. Important questions here are: when was the wetland *used*, and when was a wetland *present*?

Gatecliff series projectile points are relatively rare in the Stillwater Marsh, suggesting that the region saw little occupation from 5800 to 3300 cal. BP. This may be because the wetlands were greatly reduced in size prior to about 3500 years ago. A pollen core from Pyramid Lake suggests that western Nevada was extremely dry from 8450 to 7300 cal. BP (with one intense wet period during that interval); the aridity ceased about 5800 cal. BP though it probably returned for a brief interval about 4700 cal. BP; Booth et al. 2005); Owens Lake was nearly desiccated from 6850 to 4300 cal. BP (Bacon et al 2006). From 3700 to 2900 cal. BP climate was relatively cool and wet (Mensing et al. 2004; Wigand and Rhode 2003). Hidden Cave, a site used to cache gear, saw its first major period of use from 4200 to 3700 cal. BP (Rhode 2003) but this site was probably just one stop on a seasonal round during this wet interval. We know that a wetland existed during this occupation of Hidden Cave, judging from the materials found there, and that that wetland existed through 2700 cal. BP to permit an occupation in its center at 26Ch1052 (the latest date from 26Ch1052 is on an "organic layer" and may not be cultural).

Most cultural radiocarbon dates on archaeological sites and human burials in the Stillwater Marsh, however, fall within the Underdown Phase, 1450 to 650 uncal. BP (1390 to 630 cal. BP; Kelly 2001; Rhode et al. 2000). Although this phase falls mostly within a warm-dry period from about 1900 to 980 cal. BP (Wigand and Rhode 2003), a pollen core from Lead Lake shows that during this arid time wetland vegetation

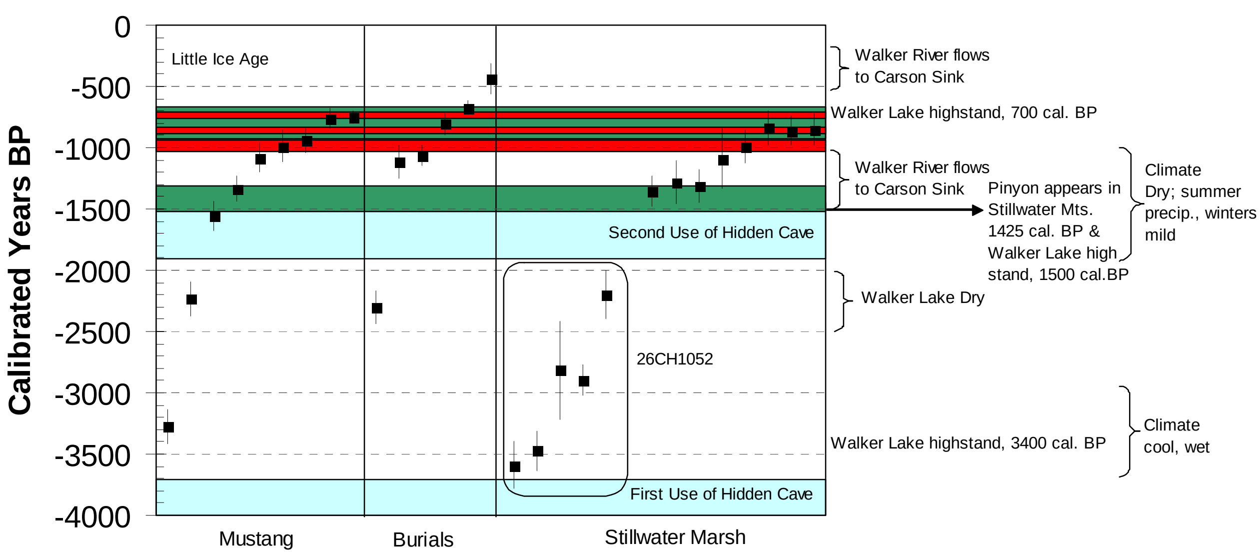


Figure 50. The distribution of dates, with two sigma ranges, from Mustang Shelter, Stillwater burials and marsh sites (calibrated using CALIB 5.0.2; present = AD 2000). Green = Stillwater highs; red = droughts. Other environmental events to the right.

such as cattail increased at the expense of greasewood, and piñon pine increased at the expense of juniper. These data suggest that while climate may have been dry, precipitation shifted to the summer and winters declined in severity (Wigand and Rhode 2003:330-331). The shift to summer precipitation may have helped sustain a wetland in the Carson Desert throughout this interval despite the overall arid conditions.

Adams (2003) has restudied and redated shoreline features in the Carson Desert that were once presumed to be late Pleistocene in age. His data show that the shoreline features are actually late Holocene in age. One lake, dating from 1519 to 1308 cal B.P rose to 1198 meters, flooding the modern Stillwater Marsh and much of the Carson Sink (and preventing occupation of the current marsh). This lake then fell, but rose again to a slightly higher elevation, 1204 meters, from 915 to 652 cal BP. Figure 50 shows the distribution of radiocarbon dates from Mustang Shelter, burials in the Stillwater Marsh and dates on the Stillwater Marsh sites. Adams' two high stands are shown as the two green bars in figure 50.

The dry interval from 1900 to 980 cal. BP also saw extreme droughts. Stine (1994) documented droughts in the western Great Basin from 1095 to 895 cal BP, between the two high stands, and 857 to 657 cal BP, which overlaps in time with Adams' second high stand. A pollen core from Pyramid Lake points to droughts from 2600 to 2000, 1425 to 1270, 760 to 725, and 600 to 560 cal. BP (Mensing et al. 2004; Benson et al. 2002). It is not unusual for extreme climatic periods to see short-term extremes in climatic fluctuations. Woodlands declined during the period from about 875 to 575 cal. BP, and did not return until the Little Ice Age brought more mesic conditions, beginning about 400 uncal. BP (circa 525 cal. BP).

Recently, Benson et al (2007) have refined the drought chronology. Based on several data sources and a recalibration of Stine's dates, they see droughts from 1017 to 947, 872 to 837, and 731 to 710 cal BP. These are shown as red bars on figure 50; hydrologic events at Walker Lake are shown to the right (Adams 2007). This figure also shows the two primary periods of use at Hidden Cave, the 3800—3400 uncal BP period mentioned above and a second, from 1900 to 1425 cal. BP. These dates roughly bracket the dates from site 26Ch1052, and fall before the more intensive period of marsh use after 1500 cal. BP (Rhode 2003).

Two things are clear from these data. First, the time period from roughly 1500 to 500 cal BP was a time of climatic extremes in the Carson Desert – remarkably severe droughts were mingled with high lake stands. Second, plotting the calibrated archaeological dates against these lake levels, it appears that much of the occupation in the Stillwater Marsh falls between the high lake stands (although I caution that the radiocarbon dates on sites in the marsh are limited). This makes sense as the lakes would have flooded the marsh and forced occupation to the edges, away from the current wetland where flooding exposed sites in the mid 1980s. There is less evidence for occupation before the first high stand; in fact, five of the six dates that precede the first high stand are from one site, 26Ch1052. This site is strikingly different from others in the Stillwater Marsh: it has a very high density of mussel shell, and no discernible house pits on its surface (Kelly 2001; Raven and Elston 1989; it does have storage pits). The presence of Elko series projectile points on the valley floor shows that the Carson Desert was occupied prior to 1425 cal. BP, and dates on cultural layers and human coprolites at Hidden Cave also show human use of the region at this time.

Only one radiocarbon date falls clearly after the second high stand, and this is on a burial. Yankee Blade Phase points (post 630 cal. BP) are noticeably rare in the modern wetland (Kelly 2001; Raven and Elston 1988, 1989, 1990; Raymond and Parks 1989), although they occur elsewhere on the valley floor and in the uplands, and they are abundant relative to the length of the cultural phase (Kelly 2001; Raven 1994). It is possible that the Carson River ran entirely into southern (or Upper) Carson Lake at the south end of the Carson Desert, before 1425 cal. BP and after 630 cal. BP This could have greatly reduced or even destroyed a marsh where one exists today, and human settlement might simply have shifted to the south. Such shifts in the river's course are well-documented historically. However, paleoecological data from elsewhere in the western and northern Great Basin point to drier regional conditions after 760 cal. BP, even as an increase in narrowleaf cattail points to marsh expansion at this time (Wigand and Rhode 2003). Piñon makes its first appearance in the region about 1425 cal. BP. Its expansion is largely attributable to milder winters and higher summer precipitation after 1900 cal BP.

At present, then, it appears that the wetlands were used by a less residentially mobile population during a warm interval that nonetheless saw a considerable wetland in the Carson Desert. One possible explanation for this apparent paradox is that the two late Holocene high stands may have been a product of a re-routing of Walker River, from Walker Lake to the Carson Sink. Although it is clear that Walker River occasionally did change its course and flow into the Carson River (and thus into the Carson Sink), the timing of these switches is less well known. Research at Walker Lake suggests that the Walker River may have flowed into the Carson River about 5000 uncal. BP, 2900 to 2100 uncal. BP, and about 1000 uncal. BP (reviewed in Kelly 2001). Recently, Adams (2007) has revised the last two dates for change in the flow of the Walker River to 1500—1000 and 500—300 cal BP. These could partially account for the increased inflow into the Carson Desert and the late Holocene high stands. We say partially, however, because Adams (2003) demonstrates that the combined flow of the Carson and Walker Rivers cannot account for the volume of water necessary to create a lake that would reach 1198 m, let alone 1204 m. There must have been an increase in the flow of one or both rivers, and/or a shift from winter to summer precipitation to ensure the presence of the marsh during an otherwise warm-dry interval.

What does this period of climatic volatility mean for the ancient people who relied upon wetlands in the Carson Desert? From a foraging point of view, a large lake in the Carson Desert was probably less useful than a mosaic of wetlands. Thus, too much water can be nearly as bad as too little. This might explain why people clustered in the Stillwater Marsh when there was a marsh present during a warm-dry climatic interval, and why they apparently avoided the region when it was flooded (though it is possible that we have simply missed sites dating to those intervals). It is interesting, however, that the latest Holocene focus on the wetlands coincides with a generally dry interval, when the relative differences in foraging returns between the wetlands and the uplands would perhaps have been greatest. At present, our radiocarbon record is not sufficient to judge the effects of the droughts on human use of the region. We can note, however, that the sites' dates do not appear to overlap much with either drought, suggesting that the marsh might have gone dry and been abandoned. This remains only a hypothesis. However, it might be clearer that the marsh was abandoned after the second drought, especially since Desert series points are rare in the wetland.

But the archaeological sites in the modern marsh tell us that a wetland existed there prior to 1425 cal. BP as well as after 660 cal. BP This suggests that the time period between roughly 1270 and 630 cal. BP, the Rosegate era, was characterized by a substantially different settlement system than what came before, and from what came after. I have previously suggested (2001) that this entailed a reduction in residential mobility, and a greater focus on the wetland with some logistical forays into the mountains to hunt large game such as bighorn sheep. Before 1425 cal. BP, when climate was cooler and wetter, and with less of a difference in the foraging returns of the wetlands and the uplands, hunter-gatherers are predicted to have been more nomadic (Kelly 2001). This, in turn, implies more residential use of upland sites than during the Underdown Phase. After 630 cal. BP, during the Yankee Blade Phase, people might have returned to a more mobile lifeway, with the marsh as one stop in a seasonal round; piñon pine nuts may have also taken on increased importance in diet, especially as a storable winter resource.

Mustang Shelter As a Test Case

Mustang Shelter provides some support for this reconstruction. The debitage data from all the rockshelters suggest that it was primarily prepared tools that entered the sites, as we might expect if the shelters were used through logistical mobility, as perhaps overnight camps of hunting parties. We have no dates on four of the five shelters tested or adequate stratigraphic information. However, at Mustang Shelter, this pattern breaks down below stratum 9, which dates to about 1325 to 1550 cal. BP, about the time of intensive habitation in the Stillwater Marsh. Below this stratum, the debitage suggest more knapping of unprepared cores and expedient flake tool production. This is the pattern that we would expect to see were the shelter used by residential groups. Thus, the debitage data point to the expected transition at the expected time. We caution, however, that this is only a limited test excavation of one site, and a conclusion based on debitage data—data that are notoriously different to interpret.

The faunal record also provides some support for the hypothesis. Much of the faunal material in Mustang Shelter can be attributed to the natural background "noise" of a rockshelter. There are, however, specimens of bighorn sheep and artiodactyls (as well as cottontails) with cut-marks that indicate that

Table 44. Occurrence of "large" mammal remains (NISP) versus all other mammalian remains (based on data in tables

Stratum	Sheep, Artiodactyl and Body Size V	All other mammals	Totals
1-4	172	557	729
9	32	381	413
10	86	815	901
11	39	794	833
Totals	329	2547	2876
	Treating unidentified mammals as if they were body size 5		
1-4	327	557	884
9	173	381	554
10	353	815	1168
11	143	794	937
Totals	996	2547	3543

Note: "All other mammals" does not include unidentified mammals but does include body size IV/V.

these animals were hunted. If the shelter were used as a residential base, we would expect to see a wider range of fauna taken than if it were a logistical camp. If the shelter were used as a logistical camp, then we would expect to see a focus on large mammals whose return rates would make a logistical foray from a distant residential camp worth the effort (as Szuter and Bayham [1989] explained a late Holocene increase in artiodactyls at Ventana Cave in Arizona). The hypothesis that the shelter's use shifted from residential to logistical use during the time of stratum 9 would thus predict that there should be a higher frequency of large mammal remains in stratum 1-4 than in the lower strata.

One way to examine this hypothesis is to look at the distribution of large mammal remains relative to the distribution of all other mammalian remains. We have some evidence that at least some of the large mammals were deposited in the site through human activities. Some small mammals are also in the site as a function of hunting, but the analysis of the faunal remains suggests that most are there as a result of non-human activities. Still, assuming that the natural "background" rate of deposition of animal remains was constant over time (in the late Holocene), significant changes in the frequency of large mammal remains could be attributable to changes in human use of the site.

Table 44 shows the distribution of large mammal remains in Mustang Shelter. In the upper part of the table we have combined the sheep, artiodactyls, and body class size V NISP in one column for strata 1-4, 9, 10, and 11, and in the other column added together all other mammalian remains, excluding unidentifiable mammal remains but including body size class IV/V. This table shows a significant difference in the distribution of these two categories of remains (χ^2= 152.59, p<.001) with the ASR pointing to the predicted pattern: more than expected large mammal NISP in strata 1-4, and fewer than expected in 9, 10, and 11.

It is possible that the older deposits have fewer large mammal remains because they are more poorly preserved and more difficult to identify. In fact, 70 percent of the unidentifiable mammal remains are in strata 9, 10, and 11. These remains are largely unidentifiable because they are too fragmented to contain distinctive landmarks.

So, perhaps the pattern in the stratigraphic distribution of large mammal remains is accounted for by the more fragmentary nature of the mammalian faunal record in the lower strata. If the bones of large mammals were more thoroughly broken in the lower than in the upper strata, then the NISP of large mammals in table 44 could be artificially reduced in the lower strata relative to the upper strata. The assumption here is that we have missed some large mammalian remains in the lower

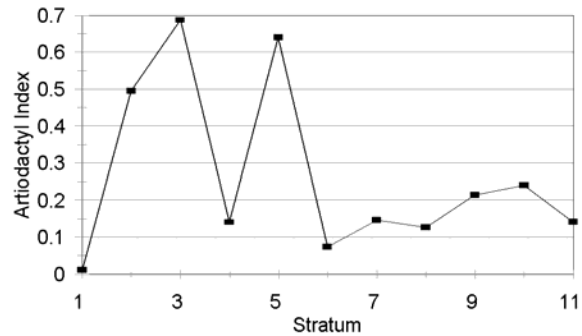


Figure 51. Graph showing the changing values of the artiodactyl index across the Mustang Shelter strata.

strata because they were so highly fragmented that they could not even be assigned to the body size V category.

But preservation is unlikely to account for the fragmentary remains. We noted in the field that, while many bones were fractured, bone preservation, even at the base of the excavation, was excellent. Good preservation in the lower levels is also indicated by the presence of small, delicate, yet identifiable fish remains in strata 10 and 11 (the only fish remains recovered).

Nonetheless, what if *all* the unidentifiable mammal remains were those of large mammals such as sheep? Would greater fragmentation of these large mammal remains (due to carnivore or other taphonomic factors) in the lower strata have biased the pattern? One way to check this is to simply treat all unidentifiable mammal remains as if they were body size V and add them to our figures. We have done this in the lower portion of table 44. These data still show a significant difference among the four stratigraphic units (χ^2= 116.28, p<.001), with the ASR indicating more than expected large mammal remains in strata 1-4 and fewer than expected in stratum 11, but not 9 and 10. Fragmentation, then, does not appear to be the only factor driving the higher prevalence of large mammal remains in strata 1-4.

Perhaps, then, the larger number of fragmented bones in the lower strata is a product of a residential group breaking the bones for marrow or grease. The larger number of identifiable mammalian remains in the upper levels might have resulted from hunting parties who were primarily interested in processing carcasses for transport, and who thus left more bones "intact" and identifiable to taxon.

We cannot assess this possibility with the present data set, but another way to ask whether there has been a change in the use of large game at the site is to consider the artiodactyl index (Broughton 1999). Recognizing that artiodactyls and lagomorphs are two major categories of meat in Great Basin societies, changes in large game use over time can be monitored

Table 45. Relationship between artiodactyl index and the ratio of carnivore to human-damaged Sylvilagus and artiodactyl remains. Counts based on NISP.

Strata	Artiodactyl Index	*Sylvilagus* carnivore damage	*Sylvilagus* human damage	Artiodactyl carnivore damage	Artiodactyl human damage	Ratio, carnivore to human damage
1	0.011	0	2	0	5	0.00
2	0.496	0	4	7	19	0.30
3	0.687	0	3	10	9	0.83
4	0.141	0	7	7	16	0.30
5	0.641	0	1	2	9	0.20
6	0.074	0	1	0	2	0.00
7	0.146	0	0	1	6	0.17
8	0.126	0	5	0	7	0.00
9	0.214	0	4	3	13	0.18
10	0.24	0	4	2	36	0.05
11	0.141	0	0	8	19	0.42
Total	0.011	0	2	0	5	0.00

faunal assemblage of the upper strata. The low value in stratum 1 may point to a declining use of the shelter; at present, we cannot account for the low value in stratum 4 as debitage density (see figure 16) points to heavy use of the shelter during that stratum's deposition. Byers and Broughton (2004) point out that such a change in the artiodactyl index could be a product of a more intensive use of a shelter over time and not necessarily a change in the way that the shelter was used. They suggest checking this possibility by looking to see if the artiodactyl index correlates with evidence of human use of a fauna relative to carnivore, rodent, and raptor damage. Table 45 shows the NISP counts of *Sylvilagus* and artiodactyl carnivore and human-damaged remains. The sample sizes are small, but the artiodactyl index correlates positively and significantly ($r = .65$, $df = 9$. $p < .02$) with the ratio of carnivore to human damage (figure 52; note that this is the opposite ratio used by Byers and Broughton; the zeros in some columns required that we examine the ratio in this manner). The sample sizes are small, but a positive correlation with a carnivore-to-human NISP ratio is the *opposite* that would be expected if the increase in the artiodactyl index were simply a function of increasing use of the site through time. Although these data could mean that high artiodacyl indices are the product of carnivore action, it could also mean that carnivores preyed heavily on remains left behind by logistical parties that stripped carcasses of meat rather than residential groups who more thoroughly processed carcasses on site.

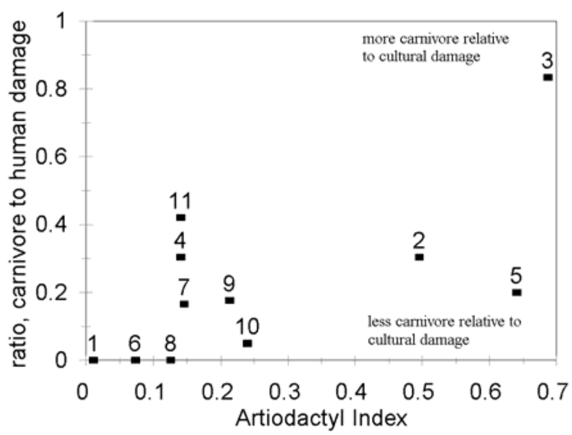


Figure 52. Graph showing the relationship between the artiodactyl index and the ratio of carnivore to human damage of Sylvilagus and artiodactyl remains, using NISP counts.

with the artiodactyl index, Σ Artiodactyl NISP/(Σ Artiodactyl NISP + Σ Lagomorph NISP). In this case, the artiodactyl category contains the large mammal NISP (again, bighorn sheep, artiodactyls, and class V mammals), and the lagomorph NISP includes the *Sylvilagus* NISP and class III NISP, since we assume that many of those body size class remains are probably those of rabbits.

The artiodactyl index by stratum is presented in figure 51. There is a clear difference between the lower and upper strata that points to a higher contribution of large mammals to the

Byers and Broughton (2004) point out that a late Holocene increase in the artiodactyl index is common at many Great Basin caves and rockshelters. In the Bonneville Basin, they attribute this pattern to a climatic shift, one of greater effective moisture that promoted growth in artiodactyl populations. Higher artiodactyl indices, therefore, could simply be a result of hunters relying more heavily on the more abundant artiodactyls. However, they see this shift as occurring about

3000 uncal. BP, the current bottom of the Mustang sequence. Climatic data from the western Great Basin point to a somewhat drier climate at the time of the increase in the artiodactyl index at Mustang Shelter. Therefore, it is more likely that a shift in the settlement system and consequently in the way Mustang Shelter was incorporated into that system accounts for the post-1500 uncal. BP increase in the artiodactyl index, rather than a climatically-induced increase in artiodactyls.

In sum, the debitage data as well as the faunal data support the hypothesis' predictions. However, it is clear that other activities went on in the shelter besides hunting. For example, it is apparent that late in the shelter's occupation someone gathered serviceberry for basketry manufacture (although there is no direct evidence of basketry manufacture on site), and Polanich's analysis suggests that the baskets represented by a few fragments were for seed collecting and processing (although whether they were used for seed collecting at the time they were discarded is not known). But since we do not have the same level of organic preservation throughout the deposits we cannot assess changes in activities that are primarily reflected in organic artifacts.

In addition, the few tui chub remains recovered in strata 10 and 11 might have been transported by humans into the shelter. I suggest this because the remains do not appear to have passed through a digestive track (Virginia Butler, personal communication to Shannon Gilbert). Given that the wetland is at least 30 airline km distant, fish brought to the shelter by animals would most likely be deposited as fecal matter or raptor pellets. Thus, the fish remains suggest that humans who used the shelter, at least early in the shelter's use, visited the wetlands as well.

THE NUMIC MIGRATION

There is one final matter to be considered, namely, the role of the Numic migration in producing the pattern we see in Mustang Shelter, which, as I have argued here, is part of a larger settlement pattern shift. The role of the Numic migration in producing the archaeology of the Carson Desert was previously discussed by Kelly (2001) and is discussed more generally in Madsen and Rhode (1994). We will repeat just the essential elements of the argument here.

Part of the Northern Uto-Aztecan family, Numic languages (figure 53) include Northern Numic (Northern Paiute, or Paviotso, and Mono), Central Numic (Western Shoshone and Panamint), and Southern Numic (Ute, Southern Paiute, and Kawaiisu). These three pairs form a triangular distribution that appears to have "spilled" out of southern California. Some researchers argue that this migration displaced the existing Great Basin population that spoke a different language or different languages. While we have attributed changes in the late

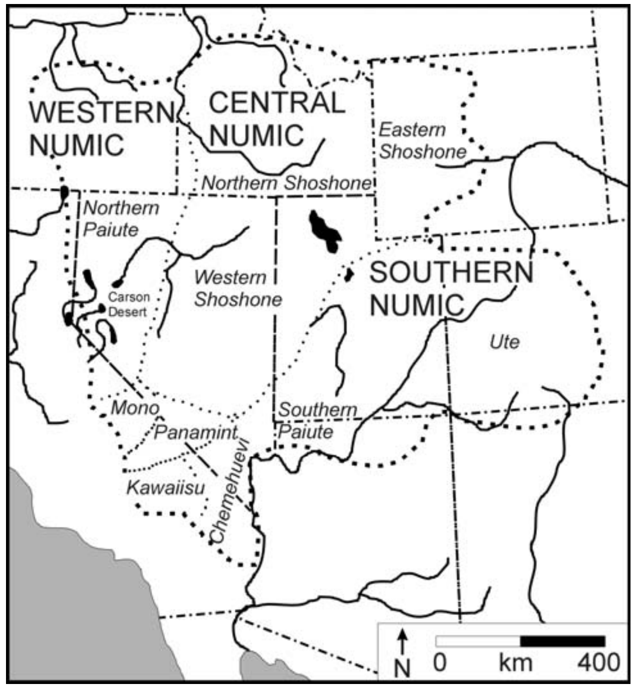


Figure 53. The distribution of Numic languages in the western U.S. at the time of European contact.

Holocene archaeology of the Carson Desert and Stillwater Mountains to an *in situ* adaptive shift linked to climatic change, it is possible that the changes are related to the movement of a new ethnolinguistic population into the Great Basin which brought with it a new adaptive strategy.

Tracking the movement of linguistic units is difficult. All we know for certain is that at some time in the last 12,000 years the Numa moved into the Great Basin (at least once). And we know that linguistic analyses strongly suggest that southeastern California is the Numic "homeland" (see review by Sutton and Rhode 1994).

But the timing of the migration is problematic. Many archaeologists accept Sydney Lamb's (1958) glottochronological estimate of about 1000 years ago, even though Lamb himself cautiously suggested it only as a minimum date of divergence. Looked at most critically, glottochronology is useless as a chronometric device (see Grayson 1994); most charitably, the method puts the Numa in the Great Basin sometime in the last 5000 years--not terribly useful. Thus, linguistics points to a migration from southern California, but its timing is unclear.

There are three accounts of the Numic expansion that use different entry times. Grayson (1993, 1994) suggests that Numic speakers migrated into the Great Basin in the mid-Holocene following a virtual abandonment of the region during the warm-dry early Holocene. Aikens (1994; Aikens and Witherspoon 1986) argues that Numic speakers were present in the central Great Basin about 5000 uncal. BP. He sees them as migrating east to the Fremont region, and west into the Carson Desert and other wetland areas when increasing aridity after 1000 uncal. BP made horticultural and wetlands adaptations untenable; abandoned by their occupants, these regions were then occupied by the Numa.

Neither Grayson's nor Aikens' hypotheses require that the Numa replace an existing population. However, Bettinger argues that the Numa migrated out of their southeast California homeland about 1000 uncal. BP and out-competed the existing population in the Great Basin (whoever they were) by using an alternative adaptive strategy (Bettinger and Baumhoff 1982; Bettinger 1989, 1993, 1994; Young and Bettinger 1992).

Bettinger argues that the pre-Numa were more residentially mobile, and primarily used high return rate resources such as large game (what Bettinger calls a *traveler* strategy), while the Numa, with reduced residential mobility, made more intensive use of low return rate, but abundant and reliable resources such as piñon and grass seeds (a *processor* strategy). The Numa did this by using alternative subsistence tactics such as green cone piñon procurement and the use of seed beaters to gather resources at a lower return rate, but in greater bulk. Thus, they could store more food for the winter, providing them with a competitive advantage (Bettinger 1999a, 1999b).

Bettinger argues that the Numic expansion began with population growth in Owens Valley about 1350 cal. BP. A computer model simulating population growth, migration and replacement through competitive exclusion predicts that the Numa should have been in the vicinity of the Carson Desert after only about 200 years, or about 1150 cal. BP (Young and Bettinger 1992). Excluding 26Ch1052, this would in fact be about the time that the wetland village sites appear in the Stillwater Marsh, though perhaps a little "late" given the age of the Stillwater sites. Bettinger and Eerkens (1999) also argue that differences in projectile point variation between southern California and the central Great Basin also suggest a population replacement during the Underdown Phase. Specifically, they note that weight and basal width measurements of Rosegate points in southeastern California are not correlated, while they are for Rosegate points in the central Great Basin. They argue that this difference points to a difference in the way that the bow and arrow was adopted, through individual experimentation and varying social strategies in southeastern California and through more consistent means in the central Great Basin. This, they suggest, is in line with a model in which a bow-and-arrow using population moved into a new region where they were using an existing technology (complete with an unvarying template of projectile point form) to out compete the indigenous inhabitants.

Bettinger's Numic expansion model and the foraging model espoused here and elsewhere (Kelly 2001) converge on their expectations: both anticipate a more intensive use of wetland resources sometime after about 1500 uncal. BP. Perhaps both models are correct, with environmental change providing the selective mechanism that allowed the incoming Numa to more successfully compete against the non-Numa inhabitants of the western Great Basin. Therefore, do we have any independent checks on the presence of the Numa in this region? Were the people who lived and died in the Stillwater Marsh Numic-speaking peoples?

This is a difficult issue, perhaps the most difficult that faces archaeology. In this case, there are two major classes of data that can help answer the question, genetics and artifacts. In addition, the intensive use of piñon might be an indirect indicator of the presence of the Numa.

Genetics

Genetic analyses can tell us if a prehistoric population could or could not have been related to a modern ethnolinguistic unit, assuming minimal change in the frequency of key genetic markers.

One study used serum albumin protein to search for similarities between the Stillwater burial population and modern ethnolinguistic units (Smith et al. 1995). The most common allele for this trait among the indigenous peoples of North America is Al^{A}. Within some populations, however, another allele, Al^{Me}, occurs at low frequencies. This allele is present in four of the 27 Stillwater burials analyzed, a frequency that is about as high as that known for any living population. However, this allele does not appear among Washoe or Northern Paiute, the modern Native American (Numic) population in the western Great Basin; it does appear in Ute and Shoshone, other Numic-speaking peoples. Using the Al^{Me} trait, Smith et al. suggest that the closest connections are between the Stillwater population and modern southern Uto-Aztecan and Yuman speakers in the American Southwest, but their study "cannot exclude the Numic speakers as descendants of the ancient Stillwater population" (Smith et al. 1995:72).

Another approach used the frequency of the 9 base pair deletion in mitochondrial DNA. Kastle (1995) found a very low frequency of this trait in mtDNA of the Stillwater burial population. Her study suggests that the Stillwater population is probably not ancestral to any group with a much higher deletion frequency (e.g., California Penutian, Zuni, Yuman, Washo, Southern Uto-Aztecan language groups). This finding is in part consistent with Smith et al. (1995), who also exclude Californian Penutian and Washo as descendants of the Stillwater population. However, Kaestle's analysis also suggests that the Yuman and/or Southern Uto-Aztecan groups are also unlikely descendants of the Stillwater population.

More recently, Frederika Kaestle and David Glenn Smith (2001; Kaestle et al. 1999; Kaestle and Horsburgh 2004) have examined a large sample of Great Basin human remains, including those from the Stillwater Marsh, to determine their mtDNA haplogroup affiliation. They found that human burials from western Nevada suggested some admixture with the Numa, but the strongest relationship was with central California groups, especially speakers of Penutian (in contrast to the previous analyses). In sum, while the genetic data are preliminary, the most recent research suggests that the people who lived and died in the Stillwater Marsh some 1000 years ago were not related to the Numa.

Artifacts

A second way to trace relationships is through key forms of material culture that we believe track ethnolinguistic groups. This endeavor, too, is fraught with difficulties. Specifically, we run up against a perennial problem in archaeology of using material culture to track ethnic change. How much has to change for us to infer ethnic replacement? Material culture of the ethnographically-known inhabitants of the Great Basin is in some instances radically different from the respective archaeological material (Fowler 1994), but it is not clear if these differences can be interpreted in 'ethnic' terms. Neither Elston (1994) nor Raven (1994) detected significant changes in material culture in the western Great Basin at the postulated times of the Numic expansion.

Adovasio argues that basketry is the best indicator of ethnic replacement (Adovasio 1986b; Adovasio and Pedler 1994) because of the need to learn the complicated techniques at an early age. Following the old-dog-can't-afford-to-learn-a-new-trick argument, the complexity of basketry manufacture may make this technology a more reliable ethnic marker than more ubiquitous stone tools. Adovasio cautiously and tentatively dates the transition from non-Numic to Numic basketry to about 1000 uncal. BP The few pieces of coiled basketry at Mustang Shelter, however, are not Paiute (Northern Numa); these are in deposits that date between 750 and 950 cal. BP Thus, the basketry data from Mustang, while admittedly a small sample, suggest that the Numa were not in the region until sometime after 750 cal. BP. The parallel-warp basketry fragment found on the surface may be Numic (though Shoshone rather than Paiute), but could date to historic times.

Analyses of feathered and coiled baskets dated to 1410 to 890 cal. BP from Charlie Brown Cave near Lake Winnemucca suggest that these baskets are more comparable to those made by speakers of languages within the Penutian language family, specifically the Maidu, Miwok, Nisenan and/or Knokow, rather than to those made by Numic speakers (Jolie 2004; Burgett 2004). A growing number of dates on Lovelock basketry, with stronger ties to the basketry of Penutian rather than Numic speakers, are no earlier than 650—740 cal BP (Jolie, pers. comm., 2007; see also Benson et al. 2007). In sum, the basketry data also suggest that Numic speakers arrived sometime after the postulated adaptive shift occurred.

Piñon

Finally, a less direct indicator of the Numa is their reliance on piñon. One of the chief elements of Bettinger's Numic expansion model is the role of piñon pine nuts, which were important to the diet and storage strategy of many prehistoric peoples of the Great Basin, including those who lived historically in the Carson Desert (Wheat 1967).

Unfortunately, the analysis of Mustang Shelter has little to say about the use of this resource. As pointed out, analyses of sediment samples could not locate evidence of piñon in the strata below stratum 8. This does not mean that it was not present, but, packrat midden and pollen data suggest it is unlikely that piñon was in the Stillwater Mountains until sometime after 1425 cal. BP (Wigand and Rhode 2003). (One hull dated to 1670 cal. BP in a Hidden Cave coprolite [Rhode 2003], but since piñon was probably never present in the immediate vicinity of Hidden Cave, the seed had to be transported from elsewhere, including, perhaps, a range further to the east where piñon was present considerably earlier than 1425 cal. BP.)

Piñon nut use is generally associated with groundstone. There were only two metate fragments recovered at Mustang Shelter, both in stratum 6, and one possible mano fragment in stratum 9. The ethnographically-documented reliance on piñon almost certainly began not when the first piñon tree appeared in the Stillwater Mountains, but sometime later, when the trees were present in sufficient abundance to make them an economically useful resource. At present, we cannot contribute much to our knowledge of when intensive piñon nut use began in the Stillwater Mountains, but it was not before 1425 cal. BP. This means that any use of pinon after 1425 cal. BP may not be evidence of the Numa, but only evidence of the presence of this resource in economically-useful amounts.

CONCLUSION

While recognizing the limitations of test excavations, the data from Mustang suggest that there was a transition in the way the mountains were used, from a predominantly residential use to a predominantly logistical use. This transition appears to have occurred soon after 1500 calendar years ago, and appears to be coeval with a change toward a more intensive, less mobile use of wetland resources in the Carson Desert. This transition correlates with environmental changes that may have made the wetlands more productive relative to the surrounding upland environment. This environmental situation encouraged people to reside residentially on the wetlands and make a more logistical use of the uplands. Logistical use of the mountains included a range of activities, but was probably directed primarily toward the hunting of large game.

Although archaeological and genetic data are difficult frustrating traces of the movements or appearance of an ethnolinguistic unit, the emerging picture from these sources is that the Numa were not present in the western Great Basin until sometime after 700 to 800 radiocarbon years ago. If this is correct, then it would mean that the transition noted in the Stillwater Marsh and in Mustang Shelter cannot be attributed to the influx of a new people, the Numa, with a new adaptation.

Instead, the Numa may have migrated into the Carson-Stillwater region later, perhaps sometime after the last severe drought (circa 700 cal. BP) that marks the end of the Medieval Climatic Anomaly, and perhaps closer to the beginning of the Little Ice Age, about 400 cal. BP. It is important to note that the later drought marks the end of the use of Mustang Shelter, the cessation of the Stillwater Marsh site occupation, and the appearance of a new kind of projectile point, Desert Side-notched. This is also about when pottery appears in the Great Basin (though it is quite rare in the western Great Basin), pottery that is associated with the technology of small seed processing. Pottery may also mark important changes in not only what foods were collected, but how they were stored and possibly shared (Eerkens 2004). Bettinger (1999b) argues that a change from a focus on communally hunted large game to small game (taken with a bow and arrow, rather than atlatl) and seeds changed the social relations of production and reduced the sharing radius of families. This, in turn, could have produced population growth that would have exacerbated this pattern.

Did the Numa migrate into the western Great Basin after 660 cal. BP? If so, did environmental change play any role in the replacement of one ethnolinguistic unit by another rather than only competition between foraging strategies? Or, was the Little Ice Age, with its harder winters and a consequent need to rely more heavily on stored foods, such as small seeds, the selective factor that permitted one ethnolinguistic unit with a particular adaptive strategy to replace an existing one. All occupants of the Great Basin could have been developing strategies to cope with the dry environment of 2000 to 1000 years ago, but the Numa in southern California were the first to develop the technology and social relations that allowed them to move into and displace the pre-Numa throughout the Great Basin beginning about 660 cal. BP. While these strategies might have been developed during a warm-dry interval, they may have taken on new adaptive significance with the onset of the Little Ice Age. In particular, strategies designed to broaden the diet in the face of population growth and depletion of large game might have provided their users with an adaptive advantage with the onset of the Little Ice Age and its need for stored resources.

Clearly, the implications of late Holocene climatic change as a watershed feature in western Great Basin culture history remain to be fully understood. Doing so will require much finer control over the chronology of the Carson Desert and Stillwater Mountains than we presently have. This monograph makes a small contribution toward control of the chronology of adaptive strategies that will be needed to evaluate differing models of the Numic expansion as well as evolutionary models of change in foraging societies.

References Cited

Adams, K.D.

2003 Age and Paleoclimatic Significance of Late Holocene Lakes in the Carson Sink, NV, USA. *Quaternary Research* 60: 294-306.

2007 Late Holocene Sedimentary Environments and Lake-Level Fluctuations at Walker Lake, Nevada, USA. *Geological Society of American Bulletin* 119 (1/2): 126-139.

Adovasio, J.M.

1970 The Origin, Development and Distribution of Western Archaic Textiles and Basketry. *Tebiwa* 13(2):1-40. Idaho State University Museum, Pocatello.

1977 *Basketry Technology: A Guide to Identification and Analysis*. Aldine, Chicago.

1986a Prehistoric Basketry. In *Handbook of North American Indians, Vol. 11, Great Basin*, edited by W. L. d'Azevedo, pp. 194-205. Smithsonian Institution Press, Washington, D.C.

1986b Artifacts and Ethnicity: Basketry as an Indicator of Territoriality and Population Movements in the Prehistoric Great Basin. In *Anthropology of the Desert West: Essays in Honor of Jesse D. Jennings*, edited by C.J. Condie and D.D. Fowler, pp. 43-88. University of Utah Press, Salt Lake City.

Adovasio, J. M., and R.L. Andrews

1983 Material Culture of Gatecliff Shelter: Basketry, Cordage, and Miscellaneous Fiber Constructions. In *The Archaeology of Monitor Valley 3: Gatecliff Shelter*, edited by D.H. Thomas, pp. 279-289. Anthropological Papers of the American Museum of Natural History, Volume 59. New York.

Adovasio, J.M., and D.R. Pedler

1994 A Tisket, A Tasket: Looking at the Numic Speakers Through the "Lens" of a Basket. In *Across the West: Human Population Movement and the Expansion of the Numa*, edited by D. Madsen and D.Rhode, pp. 114-123. University of Utah Press, Salt Lake City.

Aikens, C.M.

1970 *Hogup Cave*. University of Utah Anthropological Papers 93. Salt Lake City.

1994 Adaptive Strategies and Environmental Change in the Great Basin and its Peripheries as Determinants in the Migrations of Numic-Speaking Peoples. In *Across the West: Human Population Movement and the Expansion of the Numa,* edited by D.B. Madsen and D. Rhode, pp. 35-43. University of Utah Press, Salt Lake City.

Aikens, C.M., and Y.T. Witherspoon

1986 Great Basin Numic Prehistory: Linguistics, Archaeology, and Environment. In *Anthropology of the Desert West: Essays in Honor of Jesse D. Jennings,* edited by D.D. Fowler and C.J. Condie, pp. 7-20. University of Utah Anthropological Papers 110. Salt Lake City.

Ambro, R.D.

1966 Two Fish Nets from Hidden Cave, Churchill County Nevada. *Reports of the University of California Archaeological Research Facility* 66(5):101-135. Berkeley.

Bacon, S.M., R. M. Burke, S.K. Pezzopane, A.S. Jayko

2006 Late Glacial Maximum and Holocene Lake Levels of Owens Lake, Eastern California, USA. *Quaternary Science Reviews* 25: 1264-1282.

Balfet, H.

1957 Basketry: A Proposed Classification. Translated and with a Preface by M.A. Baumhoff. *University of California Archaeological Survey Reports* 47: 1-21.

Barrett, S.A.

1908 Pomo Indian Basketry. *University of California Publications in American Archaeology and Ethnology* 7(3):134-308.

Bennyhoff, J.A., and R.E. Hughes

1987 *Shell Bead and Ornament Exchange Networks Between California and the Western Great Basin*. Anthropological Papers of the American Museum of Natural History 64(2):79-175. New York.

Benson, L., M. Kasgarian, R. Rye, S. Lind, F. Paillet, J. Smoot, C. Kester, S. Mensing, D. Meko, and S. Lindstrom

2002 Holocene Multidecadal and Multicentennial Droughts Affected Northern California and Nevada. *Quaternary Science Reviews* 21: 659-682.

Benson, L., M.S. Berry, E.A. Jolie, J.D. Spangler, D.W. Stahle, and E.M. Hattori

2007 Possible Impacts of early-11th-, middle-12th-, and late-13th-century Droughts on Western Native Americans and the Mississippian Cahokians. *Quaternary Science Reviews* 26: 336-350.

Bettinger, R.L.

1989 *The Archaeology of Pinyon House, Two Eagles, and Crater Middens: Three Residential Sites in Owens Valley, Eastern California*. Anthropological Papers of the American Museum of Natural History No. 67. New York.

1993 Doing Great Basin Archaeology Recently: Coping With Variability. *Journal of Archaeological Research* 1:43-66.

1994 How, When, and Why Numic Spread. In *Across the West: Human Population Movement and the Expansion of the Numa,* edited by D.B. Madsen and D. Rhode, pp. 44-55. University of Utah Press, Salt Lake City.

1999a From Traveler to Processor: Regional Trajectories of Hunter-Gatherer Sedentism in the Inyo-Mono Region, California. In *Settlement Pattern Studies in the Americas; Fifty Years since Virú*, edited by B.R. Billman and G.M. Feinman, pp. 39-55. Smithsonian Institution Press, Washington, D.C.

1999b What Happened in the Medithermal? In *Models for the Millennium: Great Basin Anthropology Today*, edited by C. Beck, pp. 62-74. University of Utah Press, Salt Lake City.

Bettinger, R.L., and M.A. Baumhoff

1982 The Numic Spread: Great Basin Cultures in Competition. *American Antiquity* 47: 485-503.

Bettinger, R.L., and J. Eerkens

1999 Point Typologies, Cultural Transmission, and the Spread of Bow-and-Arrow Technology in the Prehistoric Great Basin. *American Antiquity* 64: 231-242.

Binford, L.R.

1978 *Nunamiut Ethnoarchaeology*. Academic Press, New York.

1980 Willow Smoke and Dogs' Tails: Hunter□Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* 45:4□20

1981 *Bones: Ancient Men and Modern Myths*. Academic Press, New York.

Booth, R.K., S.T. Jackson, S.L. Forman, J.E. Kutzbach, E.A. Bettis, III, J. Kreig, and D.K. Wright.

2005 A Severe Centennial-Scale Drought in Mid-Continental North America 4200 Years Ago and Apparent Global Linkages. *The Holocene* 15: 321-328.

Bradbury, A.P., and P. Carr

1995 Flake Typologies and Alternative Approaches: An Experimental Assessment. *Lithic Technology* 20 100-115.

1999 Examining stage and continuum models of flake debris analysis: An experimental approach. *Journal of Archaeological Science* 26: 105-116.

Brooks, S., Haldeman, M.B., and Brooks, R.H.

1988 *Osteological Analyses of the Stillwater Skeletal Series*. U.S. Fish and Wildlife Service Region 1 Cultural Resource Series 2. Portland, Oregon.

Brooks, S. T., and R. H. Brooks

1990 Who were the Stillwater Marsh people? *Halcyon* 12:63-74.

Broughton, J.

1999 *Resource Depression and Intensification During the Late Holocene, San Franscisco Bay: Evidence from the Emeryville Shellmound Vertebrate Fauna*. University of California Publications, Anthropological Records 32.

Burgett, R.B.

2004 *Coiled Basketry Designs from Charlie Brown Cave, Western Nevada.* Masters Thesis, Department of Anthropology, University of Nevada, Reno.

Byers, D., and J.M. Broughton

2004 Holocene Environmental Change, Artiodactyl Abundances, and Human Hunting Strategies in the Great Basin. *American Antiquity* 69: 235-256.

Core, H.A., W.A. Cote, and A.C. Day

1979 *Wood Structure and Identification.* Second ed. Syracuse University Press, Syracuse.

Dawson, L.E.

n.d. Notes on Archaeological Basketry. On file at the Bancroft Library, University of California at Berkeley.

Drennan, R.D.

1996 *Statistics for Archaeologists*. Plenum, New York.

Eerkens, J.

2004 Privatization, Small-Seed Intensification, and the Origins of Pottery in the Western Great Basin. *American Antiquity* 69: 653-670.

Elsasser, A.. B.

1978 Basketry. In *Handbook of North American Indians, Vol. 8, California*, edited by R. F. Heizer, pp. 626-641.Smithsonian Institution Press, Washington, D.C.

Elston, R.G.

1994 How Will I Know You? Archaeological Visibility of the Numic Spread in the Western Great Basin. In *Across the West: Human Population Movement and the Expansion of the Numa,* edited by D.B. Madsen and D. Rhode, pp. 150-151. University of Utah Press, Salt Lake City.

Emery, I.

1966 *The Primary Structures of Fabrics: An Illustrated Classification*. The Textile Museum, Washington, D.C.

Esau, K.

1977 *Anatomy of seed plants.* Second ed. John Wiley and Sons, Inc., New York.

Fowler, C.S.

1992 *In the Shadow of Fox Peak: An Ethnography of the Cattail-Eater Northern Paiute People of Stillwater Marsh.* U.S. Fish and Wildlife Service Region 1 Cultural Resource Series No. 5. Portland, Oregon.

1994 Material Culture and the Proposed Numic Expansion. In *Across the West: Human Population Movement and the Expansion of the Numa*, edited by D. Madsen and D. Rhode, pp. 103-113. University of Utah Press, Salt Lake City.

Fowler, C. S., and L. E. Dawson

1986 Ethnographic Basketry. In *Handbook of North American Indians, Vol. 11, Great Basin*, edited by W. L. d'Azevedo, pp. 705-737. Smithsonian Institution Press, Washington, D.C.

Goodman, S.

1985 Material Culture and Fiber Artifacts. In *The Archaeology of Hidden Cave, Nevada*, edited by D.H. Thomas, pp. 262-298. Anthropological Papers of the American Museum of Natural History, Volume 61. New York.

Grayson, D.K.

1984 *Quantitative Zooarchaeology*. Academic Press, New York.

1993 *The Desert's Past*. Smithsonian Institution Press, Washington, D.C.

1994 Chronology, Glottochronology, and Numic Expansion. In *Across the West: Human Population Movement and the Expansion of the Numa*, edited by D.B. Madsen and D. Rhode, pp. 20-23. University of Utah Press, Salt Lake City.

Grosscup, G. L.

1960 *The Culture History of Lovelock Cave, Nevada*. Reports of the University of California Archaeological Survey 52. Berkeley.

Hale, J.B.

1949 Aging Cottontail Rabbits by Bone Growth. *Journal of Wildlife Management* 13: 216-225.

Haynes, G.

1980 Evidence of Carnivore Gnawing of Pleistocene and Recent Mammal Bones. *Paleobiology* 5: 341-351.

Heizer, R.F.

1951 Preliminary Report on the Leonard Rockshelter Site in Pershing County, Nevada. *American Antiquity* 17 (2): 89-98.

1967 Analysis of Human Coprolites from a Dry Nevada Cave. *University of California Archaeological Survey Report* 70: 1-20.

Heizer, R.F., and A.D. Krieger

1956 *The Archaeology of Humboldt Cave, Churchill County, Nevada*. University of California Publications in American Archaeology and Ethnology 47:1-190.

1967 Analysis of Human Coprolites from a Dry Nevada Cave. *University of California Archaeological Survey Report* 70: 1-20.

Heizer, R.F., and L.K. Napton

1970 *Archaeology and the Prehistoric Great Basin Lacustrine Subsistence Regime as seen from Lovelock Cave, Nevada*. Contributions of the University of California Archaeological Research Facility 10.

Hockett, B.

1989 Archaeological Significance of Rabbit-Raptor Interactions in Southern California. *North American Archaeologist* 10: 123-139.

1991 Toward Distinguishing Human and Raptor Patterning on Leoporid bones. *American Antiquity* 56: 667-679.

1993 *Taphonomy of the Leoporid Bones from Hogup Cave, Utah: Implications for Cultural Continuity in the Eastern Great Basin.* Ph.D. dissertation, Department of Anthropology, University of Nevada, Reno.

Ingbar, E.E., Larson, M.L., and B.A. Bradley

1989 A Nontypological Approach to Debitage Analysis. In *Experiments in Lithic Technology*, edited by D. Amick and R. Mauldin, pp. 117-136. British Archaeological ReportsBSeries 528.

Janetski, J.C.

1986 The Great Basin Lacustrine Subsistence Pattern: Insights from Utah Lake. In *Anthropology of the Desert West: Essays in Honor of Jesse D. Jennings*, edited by D.D. Fowler and C. Condie, pp. 145-168. University of Utah Anthropological Papers 110. Salt Lake City.

Janetski, J.C., and D.B. Madsen (editors)

1990 *Wetland Adaptations in the Great Basin.* Brigham

Young University Museum of Peoples and Cultures Occasional Papers 1. Provo, Utah.

Jolie, E.A.

2004 *Coiled Basketry from Charlie Brown Cave, Western Nevada*. Masters Thesis, Department of Anthropology, University of Nevada, Reno.

Jung (Gilbert), S.

1997 *An Examination of Methods for Determining Small Mammal Depositional Origin*. MA Thesis, Department of Anthropology, Chico State University.

Kaestle, F.A.

1995 Mitochondrial DNA Evidence for the Identity of the Descendants of the Prehistoric Stillwater Marsh Population. In *Bioarchaeology of the Stillwater Marsh: Prehistoric Human Adaptation in the Western Great Basin*, edited by C.S. Larsen and R.L. Kelly, pp. 73-80. Anthropological Papers of the American Museum of Natural History, Number 77. New York.

Kaestle, F.A., and K.A. Horsburgh

2004 Ancient DNA in Anthropology: Methods, Applications and Ethics. *American Journal of Physical Anthropology* 119: 92-130.

Kaestle, F.A., Lorenz, J.G., and D.G. Smith

1999 Molecular Genetics and the Numic Expansion: A Molecular Investigation of the Prehistoric Inhabitants of Stillwater Marsh. In *Understanding Prehistoric Lifeways in Great Basin Wetlands: Bioarchaeological Reconstruction and Interpretation*, edited by B. Hemphill and C.S. Larsen, pp. 167-183. University of Utah Press, Salt Lake City.

Kaestle, F.A., and D.G. Smith

2001 Ancient Mitochondrial DNA Evidence for Prehistoric Population Movement: The Numic Expansion. *American Journal of Physical Anthropology* 115: 1-12.

Kelly, R.L.

1985 *Hunter-Gatherer Mobility and Sedentism: a Great Basin study*. Ph.D. dissertation, Department of Anthropology, University of Michigan, Ann Arbor.

1988 The Three Sides of a Biface. *American Antiquity* 53:717-734.

1990 Marshes and Mobility in the Western Great Basin. In *Wetland Adaptations in the Great Basin*, edited by J.C. Janetski and D.B. Madsen, pp. 259-276. Brigham Young University of Museum Peoples and Cultures Occasional Papers 1. Provo, Utah.

1995 Hunter-Gatherer Lifeways in the Carson Sink: A Context for Bioarchaeology. In *Bioarchaeology of the Stillwater Marsh: Prehistoric Human Adaptation in the Western Great Basin*, edited by C.S. Larsen and R.L. Kelly, pp. 12-32, Anthropological Papers of the American Museum of Natural History 77. New York.

1997 Late Holocene Great Basin Prehistory. *Journal of World Prehistory* 11: 1-49

2001 *Prehistory of the Carson Desert and Stillwater Mountains: Environment, Mobility and Subsistence in a Great Basin Wetland.* University of Utah Anthropological Papers 123. Salt Lake City.

Larsen, C.S., and R.L. Kelly

1995 *Bioarchaeology of the Stillwater Marsh: Prehistoric Human Adaptation in the Western Great Basin*. Anthropological Papers of the American Museum of Natural History 77. New York.

Larsen, C.S., Ruff, C.B., and R.L. Kelly

1995 Structural Analysis of the Stillwater Postcranial Human Remains: Behavioral Implications of Articular Joint Pathology and Long Bone Diaphyseal Morphology. In *Bioarchaeology of the Stillwater Marsh: Prehistoric Human Adaptation in the Western Great Basin*, edited by C.S. Larsen and R.L. Kelly, pp. 107-133. Anthropological Papers of the American Museum of Natural History 77. New York.

Larson, M.L., and J. Finley

2004 Seeing the Forest but Missing the Trees: Production Sequences and Multiple Linear Regression. In C. Hall and M.L. Larson, eds., *Aggregate Analysis in Chipped Stone*, pp. 95 – 112. Salt Lake City, University of Utah Press.

Livingston, S.

1986 Archaeology of the Humboldt Lakebed Site. *Journal of California and Great Basin Anthropology* 8: 99-115.

1988 *The Avian and Mammalian Faunas from Lovelock Cave and the Humboldt Lakebed Site*. PhD dissertation, University of Washington, Seattle.

Loud, L.L., and M.R. Harrington

1929 *Lovelock Cave*. University of California Publications in American Archaeology and Ethnology 25:1-183.

Lyman, R.L.

1994 *Vertebrate Taphonomy*. Cambridge University Press, Cambridge.

Madsen, D.B., and D. Rhode (eds.)

1994 *Across the West: Human Population Movement and the Expansion of the Numa*. University of Utah Press, Salt Lake City.

Marean, C., and L.M. Spencer

1991 Impact of Carnivore Ravaging on Zooarchaeological Measures of Element Abundance. *American Antiquity* 56: 645-658.

Mason, O. T.

1885 *Basket-work of the North American Aborigines*. Annual Report for 1994 of the United States National Museum. U. S. Government Printing Office, Washington, D.C.

Meighan, C. W.

1953 The Colville Rock Shelter, Inyo County, California. *University of California Anthropological Records* 12 (5):171-223. Berkeley.

Mensing, S.A., L.V. Benson, M. Kashgarian, and S. Land

2004 A Holocene Pollen Record of Persistent Droughts from Pyramid Lake, Nevada. *Quaternary Research* 62: 29-38.

Moerman, Daniel E.

1998 *Native American Ethnobotany*. Timber Press, Portland, Oregon.

Morris, E. H. and R. F. Burgh

1941 Anasazi Basketry: Basket Maker II Through Pueblo III. A Study Based on Specimens from the San Juan County. *Carnegie Institute of Washington Publication* 533.

Napton, L. K.

1969 Archaeological and Paleobiological Investigations in Lovelock Cave, Nevada. *Kroeber Anthropological Society Papers, Special Publication* 2. Berkeley.

O'Connell, J.

1993 Discussion: subsistence and settlement interpretations. *In From Bones to Behavior: Ethnoarchaeological and Experimental Contributions to the Interpretation of Faunal Remains*, edited by J. Hudson, pp. 169-178. Carbondale: Center for Archaeological Investigations, Southern Illinois University.

O'Connell, J., Hawkes, K., and N. Blurton Jones

1990 Reanalysis of Large Mammal Body Part Transport Among the Hadza. *Journal of Archaeological Science* 17: 301-316.

1992 Patterns in the Distribution, Site Structure and Assemblage Composition of Hadza Kill-Butchery Sites. *Journal of Archaeological Science* 19: 319-345.

O'Connell, J., Hawkes, K., and N. Blurton Jones

1988 Hadza Hunting, Butchering, and Bone Transport and Their Archaeological Implications. *Journal of Anthropological Research* 44: 113-161.

Odell, G.H.

2000 Stone Tool Research at the End of the Millenium: Procurement and Technology. *Journal of Archaeological Research* 8: 269-331.

Osborne, D., and C. Osborne

1954 Twines and Terminologies. *American Anthropologist* 56(6):1093-1100.

Prentiss, W.C., and E.J. Romanski

1989 Experimental Evaluation of Sullivan and Rozen's Debitage Typology, in *Experiments in Lithic Technology*, edited by D. Amick and R. Mauldin, pp. 89-100. BAR International Series 528. Oxford, UK.

Raven, C.

1990 *Prehistoric Human Geography in the Carson Desert, Part II: Archaeological Field Tests of Model Predictions*. U.S. Fish and Wildlife Service Region 1 Cultural Resource Series No. 4. Portland, Oregon.

1994 Invisible from the West: Numic Expansion from the Perspective of the Carson Desert. In *Across the West: Human Population Movement and the Expansion of the Numa,* edited by D.B. Madsen and D. Rhode, pp. 152-156. University of Utah Press, Salt Lake City.

Raven, C., and R. Elston

1988 *Preliminary Investigations in Stillwater Marsh: Human Prehistory and Geoarchaeology*. U.S. Fish and Wildlife Service Region 1 Cultural Resource Series No. 1. Portland, Oregon.

1989 *Prehistoric Human Geography in the Carson Desert. Part I: A Predictive Model of Land-Use in the Stillwater Wildlife Management Area*. U.S. Fish and Wildlife Service Region 1 Cultural Resource Series No. 3. Portland, Oregon.

1992 *Land and Life at Malheur Lake: Preliminary Geomorphological and Archaeological Investigations*. U.S. Fish and Wildlife Service Region 1 Cultural Resource Series No. 8. Portland, Oregon.

Raymond, A.W., and Parks

1989 *Surface Archaeology of Stillwater Marsh, Churchill County, Nevada*. U.S. Fish and Wildlife Service, Fallon, Nevada.

Rhode, D.

1990 Settlement Patterning and Residential Stability at Walker Lake, Nevada: The View From Above. In *Wetland Adaptations in the Great Basin* edited by J.C. Janetski and D.B. Madsen, pp. 107-120. Brigham Young University Museum of Peoples and Cultures Occasional Paper 1. Provo, Utah.

2003 Coprolites from Hidden Cave, revisited: Evidence for Site Occupation History, Diet, and Sex of Occupants. *Journal of Archaeological Science* 30: 909-922.

Rhode, D., Adams, K.D., and R.G. Elston

2000 Geoarchaeology and Holocene Landscape History of the Carson Desert, Western Nevada. In *Great Basin and Sierra Nevada, Geological Society of America Field Guide 2*, edited by D.R. Lageson, S.G. Peters, and M.M. Lahren, pp. 45-74. Geological Society of America, Boulder.

Roust, N. L.

1966 Archaeology of Granite Point, Perching County, Nevada. *Reports of the University of California Archaeological Research Facility* 66(2):37-72. Berkeley.

Rozaire, C. E.

1969 The Chronology of Woven Materials from the Caves at Falcon Hill, Washoe County, Nevada. *Nevada State Museum Anthropological Papers* 14:178-186.

1974 Analysis of Woven Materials from Seven Caves in the Lake Winnemucca Area, Pershing County, Nevada. *Nevada State Museum Anthropological Papers* 16:76-79.

Schmitt, D.N., and K. Juell

1994 Toward the Identification of Coyote Scatological Faunal Accumulations in Archaeological Contexts. *Journal of Archaeological Science* 21: 249-262.

Schmitt, D.N., and K. Lupo

1995 On Mammalian Taphonomy, Taxonomic Diversity, and Measuring Subsistence Data in Zooarchaeology. *American Antiquity* 60: 496-515.

Schmitt, D. N., and N. D. Sharp

1990 Mammals in the Marsh: Zooarchaeological Analysis of Six Sites in the Stillwater Wildlife Refuge, Western Nevada. In *Wetland Adaptations in the Great Basin*, edited by J. C. Janetski and D. B. Madsen, pp. 75-95. Brigham Young University Museum of Peoples and Cultures Occasional Paper No. 1. Provo, Utah.

Schoeninger, M.J.

1995 Dietary Reconstruction in the Prehistoric Carson Desert: Stable Carbon and Nitrogen Isotopes Analysis. In *Bioarchaeology of the Stillwater Marsh: Prehistoric Human Adaptation in the Western Great Basin*, edited by C.S. Larsen, C.S. and R.L. Kelly, pp. 96-106. Anthropological Papers of the American Museum of Natural History 77. New York.

Shott, M.

1996 Stage versus continuum in the debris assemblage from the production of a fluted biface. *Lithic Technology* 21(1): 6-22.

Smith, D.G., R.L. Bettinger, and B.K. Rolfs

1995 Serum Albumin Phenotypes at Stillwater: Implications for Population History in the Great Basin. In *Bioarchaeology of the Stillwater Marsh: Prehistoric Human Adaptation in the Western Great Basin*, edited by C.S. Larsen and R.L. Kelly, pp. 68-72. Anthropological Papers of the American Museum of Natural History 77. New York.

Stine, S.

1994 Extreme Persistent Drought in California and Patagonia During Mediaeval Time. *Nature* 369:546-549.

1995 ***An Optimal Foraging Model of Hunter-Gatherer Land Use in the Carson Desert.*** Report in partial fulfillment of U.S. Fish and Wildlife Service Contract # 14-48-0001-93015(DB) prepared for U.S. Fish and Wildlife Service and U.S. Department of the Navy.

Wheat, M.

1967 *Survival Arts of the Primitive Paiutes*. University of Nevada Press, Reno.

Wigand, P.

1990 The Study of Links Between Climate and Human Activities in the Lahontan Basin. In *Studies of Climatic Variations and Their Impacts on the Great Basin*, compiled by J. Warburton, pp. 64-117. Final Report, Contract #NA878A-D-cp114, National Climatic Center Program Office, N.O.A.A. Rockville, Maryland.

Wigand, P.E., M.L. Hemphill, S.E. Sharpe, and S. Patra

1995 Great Basin Woodland Dynamics During the Holocene. In *Proceedings of the Workshop-Climate Change in the Four Corners and Adjacent Regions: Implications for Environmental Restoration and Land-Use Planning*, edited by W.J. Waugh, pp. 51-69. United States Department of Energy, Grand Junction, Colorado.

Wigand, P.E., and D. Rhode

2003 Great Basin Vegetation History and Aquatic Systems: The Last 150,000 Years. In *Great Basin Aquatic Systems History*, edited by R. Hershler, D. Currey, D.B. Madsen, pp. 309-367. Smithsonian Institution Press, Washington D.C.

Wissler, C.

1914 Material Cultures of the North American Indians. *American Anthropologist* 16: 447-505.

Young, D. A., and R. L. Bettinger

1992 The Numic Spread: A Computer Simulation. *American Antiquity* 57: 85-99.

Zeanah, D.W.

1996 *Predicting Settlement Patterns and Mobility Strategies: An Optimal Foraging Analysis of Hunter-Gatherer Use of Mountain, Desert, and Wetland Habitats in the Carson Desert*. Ph.D. Dissertation, Department of Anthropology, University of Utah.

2004 Sexual Division of Labor and Central Place Foraging: A Model for the Carson Desert of Western Nevada. *Journal of Anthropological Archaeology* 23: 1-32.

Zeanah, D.W., Carter, J.A., Dugas, D.P., Elston, R.G., and Hammett, J.E.

1995 *An Optimal Foraging Model of Hunter-Gatherer Land Use in the Carson Desert.* Report in partial fulfillment of U.S. Fish and Wildlife Service Contract # 14-48-0001-93015(DB) prepared for U.S. Fish and Wildlife Service and U.S. Department of the Navy.