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ARTICLES

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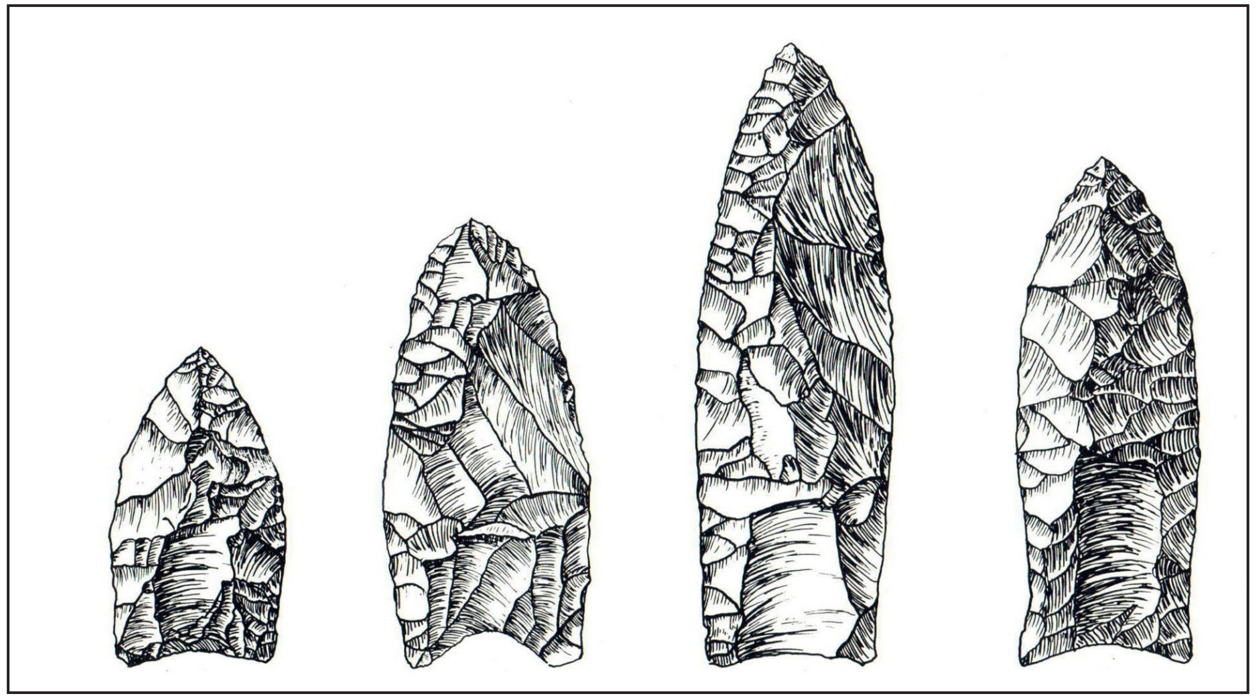

No. 1

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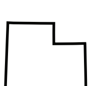

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Utah Division of
State History

Floating Island Cave Stratigraphy and Chronology

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Department of Anthropology, University of Nevada-Reno

Floating Island Cave is located in the western Bonneville basin near Wendover, Utah on the eastern end of the Silver Island Range. We conducted extensive test excavations there in 1986, and identified 59 mappable depositional features within 27 major stratigraphic units. The cultural deposits span the last approximately 8300 calendar years, with the depositional chronology controlled by 10 standard radicarbon age estimates and a layer of the well-dated Mazama tephra. The cultural sediments consist of mid-to-late Archaic and Fremont deposits. A Bayasian model suggests a high liklihood that a major occupational breaks of 2273–2800 and 901–1338 years occurred during the late middle Holocene about 4640 and 3140 cal BP, respectively. When combined with dates from Danger Cave, Bayasian modeling of the Silver Island radiocarbon chronology suggests a number of short occupational breaks, but only one of >500 years, occurring between about 5323–4143 cal BP. Cultural features include 11 simple fire hearths and a single shallow storage pit. The limited diversity of artifacts, together with the lack of open water on Floating Island, suggest the cave occupations consisted of short-term visits of only a few days focused on the collection and processing of pickleweed and saltbush seeds. We hypothesize that these short-term fall occupations were related to longer-term occupations at Danger Cave, located on the western end of the Silver Island Range.

Floating Island is a small, isolated mountain situated in the Great Salt Lake Desert ~33 km east and ~11.75 km north of Wendover, Utah. The rocky outcrop gets its name because, in a mirage often seen on the Bonneville salt flats, it appears to be sitting on a shallow body of water. Due to the mirage, the edges of the island seem to be upturned, making it appear to be floating, or at times, like some enormous, fearsome ship. During much of the regressive phase of Lake Bonneville the feature was indeed an island. At present the roughly triangular-shaped island is ~3.5 km long from southwest to northeast and ~3.0 km wide from northwest to southeast. The island is entirely federally owned and is managed by the U.S. Bureau of Land Management (BLM).

A small cone-shaped cavern or shelter on the southeast side of the island was first identified and recorded in the statewide archaeological data base by John Senulis and Mel Aikens in 1967 and given the trinomial designation of 42TO106 (Figure 1). In their original site form they reported the cave contained "a good deal of deposit," they also indicated there was "scarce occupational debris," and that the cave could be completely excavated by five men in ten days or so. As a result, no professional excavations were carried out at the cave until 1986 when rising Great Salt Lake lake levels during the early 1980s led to a plan to pump lake water into evaporation ponds constructed on the salt flats immediately east of Floating Island (Fidel 2011). Since much of the fill material was to be taken from a quarry near the cave, it appeared likely that increased access to the site would result in disturbance to the cave's cultural deposits. As a result, federal cultural resource management rules led the BLM to require mitigation of those potential impacts.

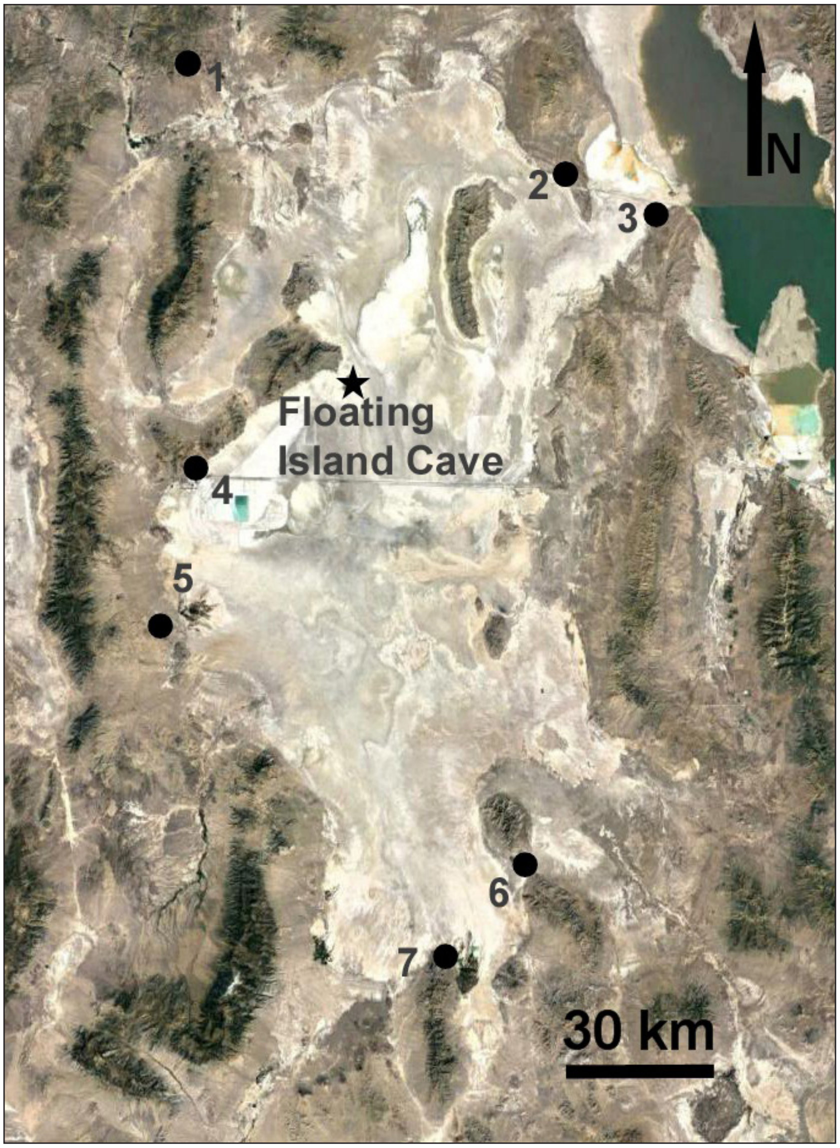

Figure 1. Location of Floating Island Cave and other important cave sites around the periphery of the Great Salt Lake Desert: (1) Swallow Shelter; (2) Hogup Cave; (3) Lakeside Cave; (4) Danger and Juke Box caves; (5) Bonneville Estates Rockshelter; (6) Camels Back Cave; (7) Fish Springs and Owl caves.

At the direction of the Governor's office, the Utah Division of Water Resources contracted with the Antiquities Section, Utah Division of State History (UDSH) to carry out those mitigation efforts (contract #87-0830).

Between August 22nd and November 13th, 1986 the Utah Antiquities Section conducted extended test excavations at Floating Island Cave, as it was officially designated at that time. Excavations were carried out under the overall direction of David B. Madsen, with Kevin T. Jones serving as field director. The excavation crew consisted of a mix of professional archaeologists and numerous unpaid volunteers from the Utah Statewide Archaeological Society. Without the assistance of these volunteers even the extended test excavations could not have been completed with the allocated funding. Approximately half of the deposits in the small cave, consisting of about 61 m^3, were excavated, but only four m^2 were excavated to bedrock.

By coincidence, Madsen, then the Utah State Archaeologist, had sought and received funding from the U.S. National Science Foundation to conduct excavations at Danger Cave. Since Danger Cave is located only ~37 km from Floating Island Cave at the opposite end of the Silver Island Mountains, it was possible to fold the Floating Island excavations into those already being carried out at Danger Cave. More importantly, for reasons detailed below, it appeared that prehistoric occupations at the two sites were related, and it seemed reasonable to use the same theoretical and methodological approaches in the excavation of both sites to enable us to compare and contrast the prehistoric use of related short-term and long-term site occupations.

Unfortunately, the funds provided were only sufficient to partially cover the costs of fieldwork, and efforts over the course of the next decade to obtain sufficient funding from the Utah legislature for laboratory analyes and reporting were unsuccessful. Nonetheless, during the late 1980s and early 1990s all of the intial laboratory processing and sorting was completed on a piece-meal basis. However, detailed analyses of the collected materials by trained specialists could not be accomplished, and in the mid-1990s multiple attempts to obtain analysis funding from the U.S. National Science Foundation were made by Kevin Jones. These efforts also proved to be unsuccessul. Over the following decade some analyses were conducted voluntarily by specialists and graduate students (for example, on the human fecal remains and on lithic materials [e.g., Hall 1988; Friedmann 2001, Lapp 2007]), but the majority of analyses on such major analytical categories as faunal and floral remained to be conducted.

In 2011 the Antiquities Section was largely dismantled by an act of the Utah State legislature. With the dismissal of the State Archaeologist and Assistant State Archaeologist, the Floating Island Cave materials lay relatively fallow until efforts by the BLM to get them properly curated resulted in the final laboratory processing of the remaining collections in 2014 under the direction of Christopher Merritt (UDSH) and Kristopher Carambelas (Logan Simpson Design, Inc.) (Carambelas 2014). In late 2017 these materials, along with copies of all fieldnotes, photographs, and maps) were turned over to the Utah Musuem of Natural History for curation and they are now sufficiently well organized that final analyses and reporting of the excavated materials can proceed. Here we report details of the excavation, stratigraphy, and chronology of Floating Island Cave. Analyses of several artifact categories, such as ground stone, projectile points, and faunal remains, are now underway and will be reported as the work is completed.

Location and Setting

Floating Island lies on the southeastern tip of the Silver Island Mountains, entirely surrounded by the salt flat playa of the Great Salt Lake Desert (Figure 2). This mountain range, including Floating and Crater Islands, extends ~45 km northeast into the desert from the Utah-Nevada border and is also surrounded by a salt desert playa except on its extreme western end. The highest point on the range is Graham Peak on its northeastern end at 2305 meters above sea level (masl), but most of the range varies between the playa floor below ~1300 masl and rocky cliffs ranging from ~1524 to ~1829 masl. The Silver Island Range has a limited number of plant communities, and these, for the most part, are composed of only two of the floral zones in what Cronquist et al. (2013) refer to as the Great Basin Floristic Division.

Plant communities in the shadscale zone are largely controlled by soil salinity and geomorphic setting. Soil salinity is highest around the fringes of the Silver Island Range and plant communities there are dominated by members

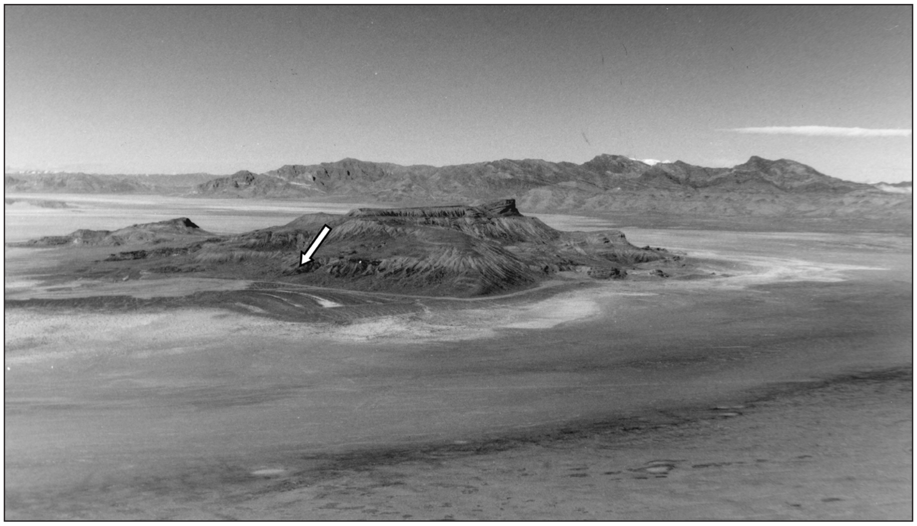

Figure 2. Aerial view of Floating Island looking northwest to the Silver Island Mountains. The arrow shows the location of Floating Island Cave.

of the pickleweed community. These include iodinebush (*Allenrolfea occidentalis*), seepweed (*Sueda fruticosa* or *erecta*), samphire (*Saliconia rubra*), and saltgrass (*Distichilis spicata*). Of these, iodinebush (locally called "pickleweed") is both the most prevalent and one of the most important seed resources used by prehistoric people in the region (Steward 1938; Chamberlin 1911). At slightly higher elevations on the lower alluvial fans, the shadscale zone is dominated by greasewood (*Sarcobatus vermiculatus*) and a few salt-tolerant grasses. Higher in the zone, above the water table, the alluvial fans are dominated by shadscale/saltbush (*Atriplex spinescens*), rabbitbrush (*Chrysothamnus nauseosus*), joint fir or Morman tea (*Ephedra nevadensis*), horsebrush (*Tetradymia* spp.), budsage, winterfat (*Ceratoides lanata*), and a variety of grasses.

Plant communities in the sagebrush-grass zone have a more limited distribution in the Silver Island Mountains due to their need for higher levels of annual precipitation and deeper soils. These plant communities are generally restricted to canyon bottoms, upper alluvial fans, and north or northwest-facing slopes below the upper rocky cliffs. Big sage brush (*Artemisia tridentata*) dominates in this zone, with rabbitbrush and Mormon tea also common bushy plants. Grasses and herbs such as wild rye (*Elymus cinereus*), rice grass (*Achnatherum hymenoides*), and wild buckwheat (*Eriogonum* spp.) are common in protected areas where cheatgrass (*Bromus tectorum*) has not had a chance to displace these native species. Elsewhere this invasive grass dominates most of the upper sagebrush-grass zone.

A pinyon-juniper zone is also present in a limited way in parts of the upper Silver Island Mountains. Utah juniper (*Juniperus osteosperma*) occurs in open to relatively dense stands at elevations above ~1524 masl. At lower elevations it extends into, and is often mixed with, sagebrush-grass communities, while at higher elevations and on northwest-facing slopes and in protected canyons it is quite dense, replacing the brush and grass communities almost completely. Rocky Mountain juniper (*Juniperous scopulorum*) is rare at the highest elevations, and pinyon pine (*Pinus monophylla*) is present in a single small relict stand just below the northwest face of Graham Peak. Other bushy plants, such as cliff rose (*Cowania mexicana*), bitterbrush (*Pursia tridentata*), and current (*Ribes* spp.), occur infrequently along the base of some cliffs where they are fed by rainfall runoff.

The flora of Floating Island itself is much more limited and plant communities of both the sagebrush-grass zone and the pinyon-juniper zone are not present. The open, rocky slopes of the island are dominated by a low, widely scattered black sage (*Artemisia nova*) plant community, but any plants higher than a foot or two are completely absent. A thin band of greasewood and saltbush occurs in places at the interface between the toes of the alluvial fans and the salt playa, particulary on the latest regressive Lake Bonneville features between 1295–1311 masl, but this community is limited in its distribution. Iodine bush is common in a broad band almost completely encircling the island, and it is the seeds of this plant which most likely attacted prehistoric foragers to Floating Island.

The fauna of Floating Island is equally depauperate, and is limited for the most part to microtine rodents and the raptors which prey on them. The lack of brush communities limits the occurance of hares (*Lepus californicus*) and cottontail rabbits (*Silvilagus audubonii*), although we noticed a few during our excavation of Floating Island Cave. Both species are more common on the nearby Silver Island Mountains. Pronghorn antelope (*Antilocapra americana*) are quite common along the lower, open slopes of that range, but are rare to absent on Floating Island. Mule deer (*Odocoileus hemionus*) are found in limited numbers in the juniper forest and in the upper canyon areas of the Silver Island Mountains, occasionally ranging down into the sagebrush-grass communities. Many boreal species in the Bonneville basin associated with the colder temperatures of the last glacial maxium, such as the pygmy cottontail (*Brachylagus idahoensis*), persisted into the early Holocene (e.g., Grayson 1998, 2000; Schmitt et al. 2002) probably as the result of moisture related to the release of stored Lake Bonneville groundwater (Schmitt and Lupo 2018). However, by the time Floating Island Cave was first occupied, modern faunal communities were fully established (Schmitt et al. 2002).

The geology of Floating Island is poorly mapped, but the bedrock formations consist largely of two major units of Pennsylvanian limestone (Schaeffer and Anderson 1960). The lower unit, found on the northeastern side of the island, is the Ely Limestone, consisting of a mix of limestone and sandstone. The upper unit, found on the islands southwestern side, consists of several formations including the Riepetown Sandstone, and the Strathearn, Ferguson Springs, Upper Qquirrh, and Pequop formations. The highest point on the island is only 1545 masl, and when Lake Bonneville was at its maximum extent the island was entirely flooded. During its recessional stage the lake left a number of wave-cut platforms on the limestone bedrock and associated alluvium, the most visible of which is the Provo Shoreline at ~1482–1486 masl. During the regressive stillstands waves also carved a number of small caves or rockshelters into the limestone bedrock. Floating Island Cave is one of these small wave-cut solution caverns, located at ~1345 masl on a southeast facing limestone spur (Figure 3).

There is no open water on Floating Island, and from current evidence it appears there has been none available to human foragers throughout the Holocene occupation of Floating Island Cave. The nearest water source consists of a small drip-fed pool of water in a Silver Island cave located ~11.6 km, as the crow flies (but likely half again as much in walking distance), from Floating Island Cave. This pool only contains about five gallons (19 liters) of water, and in our estimation, based on multiple visits, would likely take several days to a week to refill. It would quickly be exhausted and would probably supply a small group of 5–10 people for only a day or two. More permanent sources of water are found in a number of larger springs along the foot of the Pilot Range some 30 km in a straight line from Floating Island Cave. In terms of actual walking distance, the springs and the cave are more like ~50–65 km apart since a straight-line

Figure 3. Aerial view of Floating Island Cave looking northwest.

route takes one across the top of the Silver Island Range. Another large spring was present outside Danger and Juke Box caves at a slightly greater distance. This spring is ~ 35 km in a straight line from Floating Island Cave, but the walking route is a relatively easy path along the southeastern margin of the Silver Island Range and it may have served as the primary water source for the foragers living in the cave.

Climatically, Floating Island is extremely arid. The nearest weather station is at Wendover, Utah. Average annual precipitation there is only 15.22 cm, with most of that falling in the spring and fall seasons (Table 1). However, part of the precipitation in Wendover is a result of proximity to Pilot Peak and the Toano and Goshute mountains and their associated orographic effects. Precipitation on Floating Island, although unmeasured, is likely much less. During our excavations and subsequent visits, when storms in the vicinity produced rainfall on the Silver Island Mountains, no rain fell on Floating Island. Average monthly temperatures range from 26.5 °C in July to -2.9 °C in January (Table 1), although extremes of 41 °C and -27.78 °C have been recorded.

Research Goals and Design

Excavation of Floating Island Cave was undertaken in order to mitigate the adverse effects of construction work on the island. No test excavations had been conducted at the site prior to our initiation of fieldwork, so our task was twofold: 1) to test and explore the site to determine the extent and nature of the intact deposits; and 2) to determine which aspects and areas of the site contained the most interesting and important data, and to seek to recover as much of that information as possible, given time and financial constraints.

The opportunity to coordinate the studies at Danger and Floating Island caves enabled us to hypothesize a number of points of distinction between the two sites. We thought that contrasting the two would enhance our ability to understand the prehistoric use of each site and their relation to others in the region. While we hypothesized the two caves were linked in some ways, the differences between the two sites are numerous, and we felt the prehistoric use of the caves should differ as well. Danger Cave is a large cavern located on the margin of a rather

Table 1. Monthly Average Precipitation (cm) and Temperature (°C) at Wendover, Utah.

Month	Precipitation	Temperature
January	0.01	-2.9
February	0.33	0.9
March	0.48	5.6
April	1.42	10.3
May	2.48	16.0
June	1.8	21.6
July	0.79	26.5
August	2.11	24.8
September	2.0	18.6
October	2.06	11.1
November	1.73	3.6
December	1.47	-2.4

extensive freshwater marsh which likely provided a substantial, if seasonally variable, source of food. Floating Island Cave is much smaller, is not associated with any appreciable resource concentrations beyond those of pickleweed and saltbush, and, importantly, there is no known local water source.

The range of prehistoric activities that may have taken place at each of the sites varies with the different physical and environmental characteristics of both the caves themselves and their immediate surrounding areas. Danger Cave is much larger and can house more people than Floating Island Cave. The presence of water and marsh resources would have enabled longer stays at Danger Cave, while its lack at Floating Island would have severely limited the length of time that could have been spent there. The array of resources available at Danger Cave, and within viable transport distances to the nearby Goshute Mountains, differs substantially from the more limited array of resources at Floating Island which restricts the number of subsistence activities that could have taken place there.

We assume that the usual group size in the region in prehistoric times was generally similar to that found ethnohistorically (Steward 1938), consisting of a band of from as small as only one or two families to as many as 30 people or more depending on the productivity of local resources. Larger or smaller groups formed at various times of the year by aggregation of two or more bands, or by fissioning of a single band into smaller units. We also assume that band aggregation, or fissioning, and movement were conditioned in large part by the availability of energetically rewarding resources. Storage and long distance transport of meat and meat products are considered to be very limited, if present at all.

The basic hypotheses concerning points of contrast between the prehistoric use of Danger Cave and Floating Island Cave are: 1) Group size at Danger Cave could have included several families, but occupation of Floating Island Cave was probably limited to at the most one or two families; 2) The length of stay at both caves probably varied seasonally and over the longer term, but generally, Danger Cave could have been occupied for months at a time whereas Floating Island Cave occupations were probably limited to a few days duration.

There are several archeological consequences of these hypothesized differences. When hunter-gatherers occupy a camp for only a day or two at a time, they rarely make much effort to clean up and dispose of refuse by sweeping or picking up trash items and throwing them away (Jones 1984; Yellen 1977). When camps are occupied for a longer period of time (e.g., a week), cleaning and secondary disposal are much more likely to affect the deposition of trash items (Yellen 1977; Simms 1988). We therefore expected that the deposition of debris in Danger Cave was skewed with respect to size because larger trash items would have likely been swept away from living areas at regular intervals. At Floating Island Cave, where such cleanup was less likely, the distribution of large and small items should roughly co-vary. It is also likely that hearths were cleaned and dumped occasionally at Danger Cave, resulting in secondarily-deposited ash concentrations and midden-like areas. Such features are unlikely to be present in Floating Island Cave.

If the average occupation at Danger Cave was indeed longer than the average stay at Floating Island, our expectation was that a wider range of activities took place there, involving a wider range of technological and material items. If more items were in use, then the chances of loss, breakage, maintenance and repair was also more likely, so we could expect a more varied and larger array of artifacts at Danger Cave, as well as more evidence of tool manufacture and repair.

We also expected that a wider range of resources was utilized at Danger Cave than at Floating Island. We felt it likely that a more varied array of plants and animals were exploited at Danger Cave, especially including marsh plants and animals that were not available at Floating Island. If groups occupied Danger Cave for a month or more at a time, resources not found in the immediate vicinity may have been included in the subsistence system because forays away from the site could have been undertaken. Archaeologically this should be reflected in the faunal remains, and should be an especially interesting point of contrast between the two sites.

Human-introduced faunal remains at Floating Island likely only included animals taken in the immediate vicinity of the site, and occasionally, bones of animals killed elsewhere and carried enroute to the site. Since storage of meat was not commonly noted ethnographically in the Great Basin, we propose that the introduced faunal remains, especially those of larger animals, should consist of a relatively random selection of body parts representing "leftovers" of animals killed and largely consumed elsewhere. All other animal remains at Floating Island Cave should tend toward complete body part representations, because animals killed over a short time period in the immediate vicinity of Floating Island Cave, whether large or small, should have been transported to the cave intact. The only body parts missing as a result of human transport should be those carried away from the cave as "leftovers," and those should be a relatively random selection of body parts.

There are a number of other testable hypotheses which derive from the general hypothesis that Floating Island Caves served as a short-term logistical foraging site related to a longer-term occupation at Danger Cave. For example, we hypothesize that ground stone metates at Floating Island Cave should exhibit a bimodal distribution dominated by thin, well-worn, but fragile, portable metates made on non-local stone types on one hand, and thick, poorly-worn, non-portable metates made on local rock types on the other hand. At Danger Cave prolonged occupations should produce higher percentages of well-ground, thick, non-portable, metates, resulting in more of a unimodal distribution. Other testable differences may include differences in plant resource transport, with consumed resources at Danger Cave reflecting a higher degree of processing than those at Floating Island Cave. We hypothesize this would result from the importation of foods for consumption at Danger Cave, while Floating Island would be dominated by the processing of seeds for export. These hypothetical differences may be matched by similarities resulting from a linkage between the two sites. For example, textiles at the two caves could show a higher degree of uniformity than that between other Bonneville basin caves, since they may have been produced by the same or related individuals.

These predictions were necessarily kept at a general level due to the small amount of the Danger Cave deposits that were excavated (a single 1x1 m column [Madsen and Rhode 1990]), and to the incomplete excavation of Floating Island Cave (approximately ⅓–½ of the deposits). Detailed quantitative comparison of the sites, especially of faunal remains, therefore lacks some precision. However, we still feel we should be able to contrast the sites in a general way in order to address several of the questions we posed at the outset of our excavations.

Excavation Procedures

For comparability between Danger and Floating Island caves we sampled a portion of the Floating Island Cave deposits in the same way as we did the Danger Cave column. Since the targeted undisturbed portion of the Danger Cave deposits consisted of little more than a square meter column, excavations there were designed to maximize the recovery of data. All of the deposits from Danger Cave column were removed in their entirety, stratigraphically bagged, and taken to the laboratory for processing through graded screens, to insure recovery of even the tiniest cultural and paleoenvironmental specimens. Since all plant macrofossils and bones were recovered from the excavated area, quantitative measures of changes in the subsistence practices and local environmental conditions could be obtained.

At Floating Island Cave we sampled two 1x1 m columns in the same way, removing and bagging stratigraphic units in their entirety and transporting them to the laboratory for processing. Entire stratigraphic units for each of the two 1x1 m squares were bulk sampled except for the lower, moist strata. For these, four 20 liter buckets of each stratum for each square were collected, and the remainder of the material from each stratum was measured for volume and processed through 3.2 mm screens at the site. Because the amount of fill to be removed was much greater at Floating Island Cave, we processed the rest of the removed material through screens at the site. We excavated the cave stratigraphically by removing one square meter at a time. The excavation was advanced wherever possible by working into the deposits from at least one, and preferably more, clean profiles. A small relic hunter's hole in the center of the cave allowed us to work against an existing profile of the upper deposits. Great care was taken to ensure that the strata were removed separately and without mixing. Where the integrity of the deposits was uncertain, the material was in most cases discarded and only diagnostic artifacts were retained as unprovenienced material.

All features and phases of the excavation were photographed in black and white and color, and scaled plan and profile drawings were made of the site, strata, and features. Fill that was processed at the site was screened through 3.2 mm mesh and the material recovered was collected by lots according to stratum and excavation unit (1x1 m square). All flaked and ground stone, bone, ceramics, hair and other animal parts, dried fecal remains, quids, and artifacts, as well as a sample of plant material was collected from the screens. In addition, samples of hearth contents, charcoal, seed concentrations, and other features were collected in their entirety whenever they were deemed to be important or interesting.

Prior to the initiation of excavation the cave was approximately 10 m wide at the mouth and tapered regularly to a point at the back (Figure 4). The east margin of the cave was covered by an extensive litter of sticks, bones, and other debris collected by packrats. An irregular looter's hole centered about a third of the way from the back of the cave revealed about one meter of stratified deposits. We began by laying out a grid system, placing a baseline through the center of the cave, which, coincidentally, also happened to be aligned with magnetic north. We also set hardened nails in the walls of the cave at ~1 m above the cave floor for a vertical control

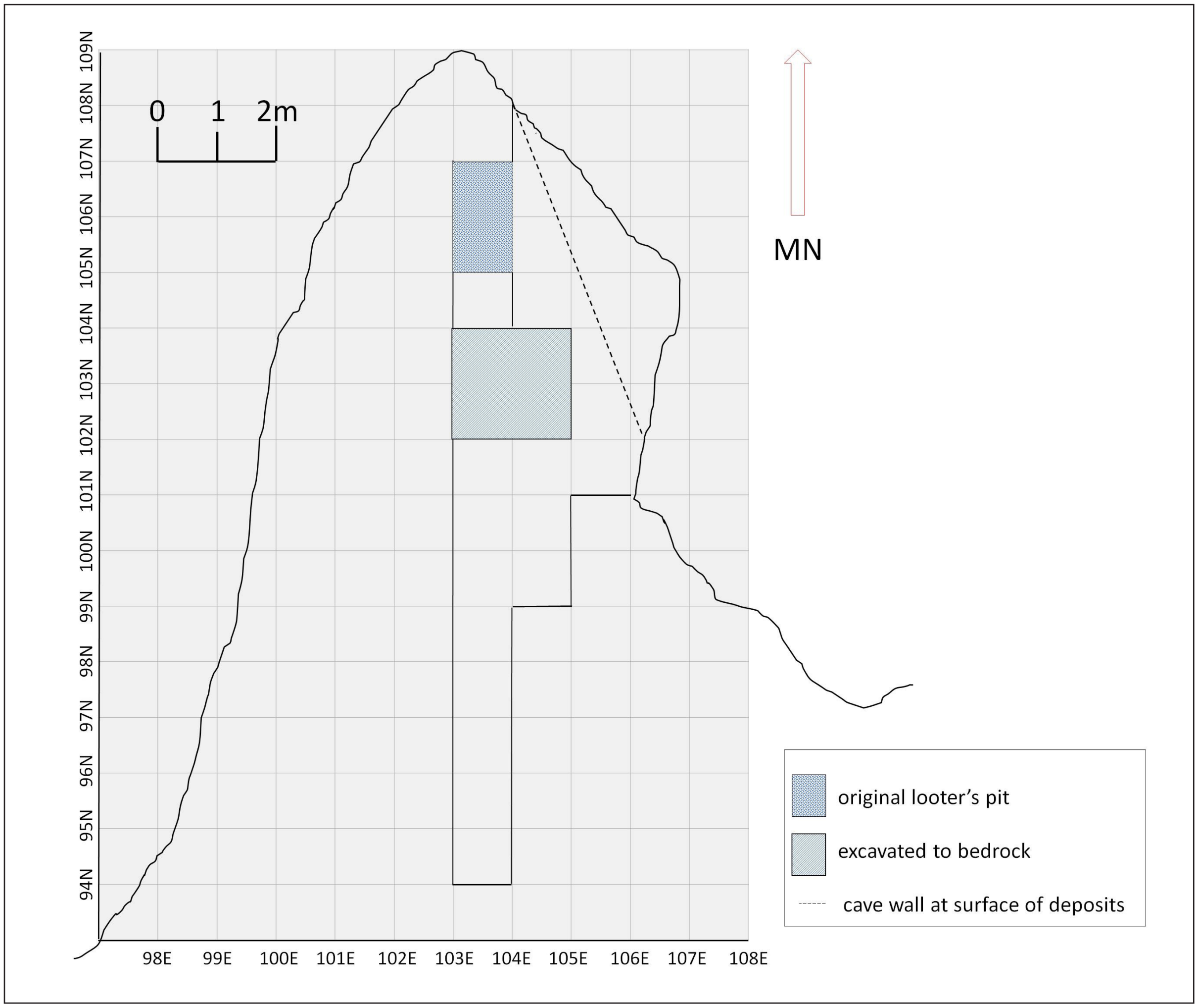

Figure 4. Plan view schematic of Floating Island Cave and the location of the excavation area.

datum. Once the cave was mapped we removed and screened the packrat nest in order to help identify bones introduced by non-human agents and studied separately from those thought to be introduced by humans. After clearing away the packrat nest, which measured roughly 6 m N-S x 1 m E-W x 1 m deep, we noticed that the cave wall along the eastern portion of the site was not perpendicular, as the upper wall had been, but was widening toward the floor of the cave. This was our first indication that Floating Island Cave was larger at depth than it had first appeared.

A looter's pit, shaped like an irregular 2x1 m map of South America, provided us with a glimpse of the stratigraphy in the cave. We squared the walls of a 2.5 m N-S x 1 m E-W area that encompassed the vandalized spot and cleaned down to approximately the bottom of the hole. We identified 16 distinct stratigraphic layers visible in the 1.2 m deep profile. The principal constituent of the cave fill in this area was vegetative matter, ranging from coarse twigs and sticks (mostly saltbush) to finer chaff and husk pieces (mostly pickleweed). Layers of vegetative material 1–15 cm thick were separated by thin (1–2 cm) white dust layers. Lower down in the profile and toward the back of the cave, the deposits were moist and most of the sticks and chaff had decomposed.

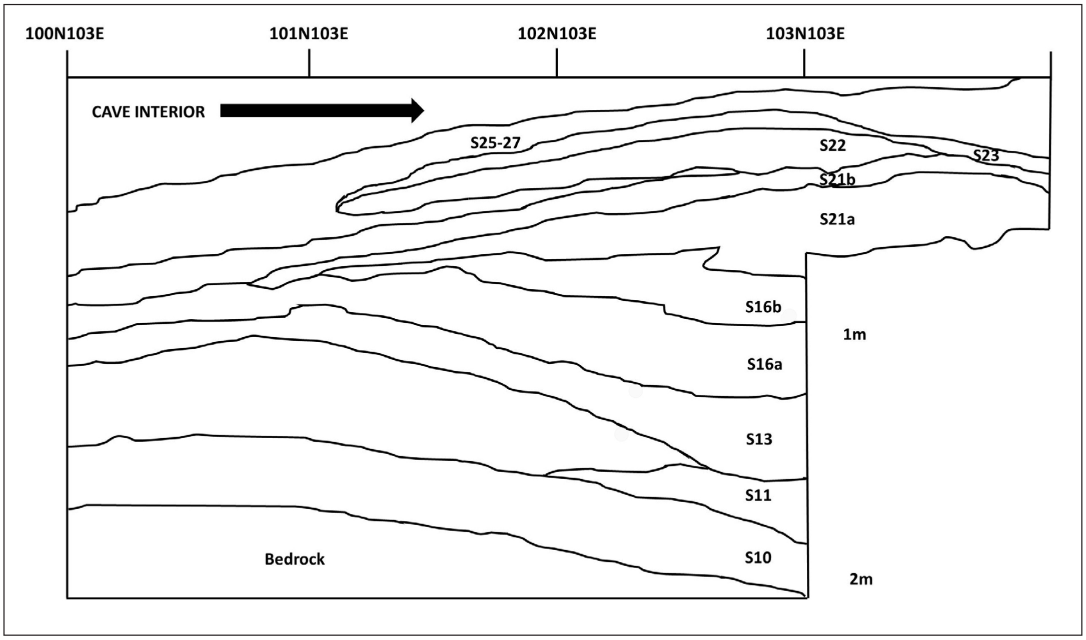

Figure 5. Schematic representation of the stratigraphy in the exploratory trench at the mouth of Floating Island Cave along the 103E N-S line along the central axis of the cave (see Figure 4 for location).

Several places in the profile showed evidence of burning. In the eastern profile and extending east toward the edge of the cave was an area of generalized burning that encompassed four of the upper stratigraphic units. In a dry cave where a substantial proportion of the fill is made up of sticks and other vegetative material, a fire can literally burn away and consume the cave fill. As this burned area was loose and powdery and filled the cave with fine particles when disturbed, we chose to remove the ashy deposit first. This was done to expose more of the east cave wall and to let in a little more light. Where possible we excavated the burned area stratigraphically. That is, we separately excavated the layers that were consumed by the fire. Unfortunately, we were only able to accomplish this in approximately half of the 12 m^2 from which the burned ashy upper units were removed.

We initiated excavation of a 1 m wide exploratory trench beginning on the talus slope approximately 6 m outside the mouth of the cave, heading straight north along the east side of the site centerline. The deposits outside the cave consisted primarily of colluvial talus in a silty matrix. Stratigraphy that was visible, and, most importantly distinct enough to be followed by an excavator, was first encountered approximately under the lip of the cave roof. In Floating Island Cave, and in wide-or high-mouthed caves in general, there is not a distinct “drip line,” but rather a “drip zone” several meters wide where water from precipitation and flow from above dampens the deposits. The delineation between deposits that are dampened during a storm and those that are not is not usually distinct, but graded, and varies between storms, depending on, among other things, the direction and strength of the wind. For this reason, the pronounced stratigraphy inside the cave appeared gradually as we crossed the drip zone with the exploratory trench (Figure 5).

Few artifacts were recovered from the trench relative to the deposits inside the cave, but near the drip zone the incidence of artifacts and charcoal flecks increased, and the subtle stratigraphic distinctions became more pronounced. An initially interesting aspect of the deposits near the mouth of the cave was their depth. Aside from a 1 m talus cone some 4 m outside the drip zone, we did not encounter bedrock despite reaching a depth of over 3 m below the ground surface. More importantly, we began to recover charcoal and artifacts from stratigraphic units nearly 2.5 m deep.

The depth of the trench precluded moving the excavation into the cave on a single face by excavating from surface to sterile before moving on. We therefore opted for a stepped approach - taking off the upper meter, advancing the trench two meters, then stepping back, taking off the second meter, and so on. As the trench entered the cave we jogged it east one meter to leave untouched two 1 m^2 units for later removal of bulk samples. When the trench met the excavation area inside the cave, work there was terminated and all effort was put into extending the trench into the cave, widening the excavation, and finding out how deep the deposits were inside the cave.

To this point we had been excavating the trench down to a light-colored culturally sterile level (Stratum 5) which, outside the cave, was the lowest stratigraphic level above the talus cone. As we followed this stratum, and other higher cultural deposits, toward the cave interior, the strata were fairly level from the surface to approximately 1 m deep. Below that, they dived radically toward the back of the cave. As soon as the trench had penetrated two meters into the cave it was apparent that at least 2.5 m of cultural fill was present.

Once inside the cave we continued the stepped method of removing fill, and expanded the area of excavation horizontally as much as possible between the site centerline and the eastern wall of the cave. Three aspects of the cave stratigraphy caused some difficulties in excavation: carbonate deposits and concretions, stratigraphic mixing, and burning of dry vegetative deposits. Immediately under the upper ashy deposits, and approximately under where the packrat nest had been, was a very hard indurated mass that ran N-S parallel to the east wall of the cave. Between this hard linear feature and the cave wall the deposits were especially mixed and jumbled. The feature appeared to be composed of the same material as the surrounding deposits, but cemented to an almost rock-like hardness by salts and carbonates. The feature extended from within 20 cm of the bottom of the pack rat nest down into the deposits for approximately one meter. This structure appeared to be very similar to the solid crystalline salt mass described by Jennings (1957: 62; Figures 49 and 50) as paralleling the north wall in Danger Cave. Jennings observed that between the crystallized salt formation and the cave wall the strata were moist, devoid of preserved vegetative material, and difficult to trace. He hypothesized (1957:62) that moisture from the cave wall had seeped into the deposits, causing decomposition of organic matter and formation of the crystalline structure.

In Floating Island Cave the deposits between the cemented ridge and the cave wall were also moist and contained very little vegetation. In a profile from west to east, the strata that were visible near the center of the cave became less distinct closer to the indurated deposits, and were only visible as faint lines, when they were visible at all, near the cave wall. Since the packrat nest lay directly over the ridge and between it and the east wall of the cave, it is possible that the lack of visible stratigraphy was due to the action of the nest's denizens. The mixing and obliteration of the stratigraphic layering in this area was not confined to the area between the ridge and the cave wall, but continued down in the deposits below the ridge for approximately 1 m. This may suggest crotavina disturbance, as packrat droppings were found throughout the deposits, indicating their presence for a considerable length of time. It is possible that the nest remained in roughly the same position in the cave over that span of time.

Moisture in the cave was not confined to regions near and adjacent to the cave wall. The deeper deposits were moist in all areas of the cave, with the moist zone varying in thickness depending on the position in the cave. Toward the rear of the cave only the upper meter of the deposits were dry, whereas closer to the mouth, 1.75 m of the deposits were dry and contained well-preserved vegetative material. While the stratigraphy in the moist portions of the deposits was not as clearly demarcated as in the dry portions, it was visible and distinct, not like the churned and faint layers near the cave wall. The line marking the boundary between the lower moist and the upper dry deposits was associated with a cemented structure in a roughly 1x2 m area near the center of the excavation area. In other places, the boundary was simply a gradation over a 10–20 cm distance from moist to dry. This suggested the stratigraphic obliteration between the indurated mass and the cave wall was due to the action of packrats, the longtime, permanent residents of the cave.

Another difficulty was the nature of the dry vegetation layered in the upper deposits. In addition to the upper layers which had been consumed by fire, we found evidence of at least two other generalized fires that affected substantial areas of the cave. These were both limited to relatively thin (5–15 cm) burned layers, which formed good, readily-traced stratigraphic markers. Several areas associated with localized fires or hearths were, however, more problematic. In dry caves, a fire built upon deposits of sticks and chaff will char and darken the underlying deposits, sometimes to a considerable depth (up to 30–40 cm). This happens even if it does not ignite the deposits or if they are deprived of oxygen so that complete combustion does not take place. Several locations presented us with interpretive problems in that the level of origin of the fire was sometimes difficult to determine. This was especially true where the fire had completely reduced its fuel to ash and where the ash had become scattered, leaving only the charred deposits immediately under it. Where a vegetative layer became very charred immediately under the spot of the original fire, it appears to be a fire-basin itself. The effects of this phenomenon were especially pronounced in the lower, moist strata, where in situ deterioration of the organic components may have further blurred the true level of origin of a fire. At Floating Island Cave we found that when evidence of fire was encountered, it was expedient and most informative to immediately section a portion of the feature, in order to determine as soon as possible the level of origin, and to avoid possible confusion. We identified eleven possible fire hearths, but many more may have been built in the cave. At Camels Back Cave, for example, a cave of similar size with deposits of the same age, 99 hearths were identified in roughly the same amount of excavated material (Schmitt and Madsen 2005).

Dry, layered vegetative deposits atop moist strata created some problems in excavation, and resulted in unstable excavation walls that posed safety hazards. Deep walls cut through the deposits became very unstable through time as the lower moist deposits dried out and sloughed off. As a wall was exposed for several days or even weeks, the sloughing eventually resulted in undercutting, and the upper, intact dry deposits threatened to topple over, and several times did. We tried to solve the problem by shoring up the walls, but were not always successful. In one instance, we lost most of a four-meter wide, three-meter deep wall when nearly eight cubic meters slumped into the excavation. Luckily, no one was injured, but slumping did hamper our ability to photograph and map long profile sections.

Inside the cave we excavated approximately 16 m^2 mostly in a contiguous block in the east-center of the cave (Figure 4). Aside from some limited excavation adjacent to the looter's pit, the units were taken down to approximately the level of the culturally sterile unit, Stratum 5, which we thought was the lower limit of cultural material. After finding a hearth on the Stratum 5 surface which appeared to extend down into the stratum, we cut down through the layer and encountered a layer of volcanic tephra tentatively identified as Mazama ash. Two distinct, but thin, cultural layers and three additional hearths were discovered below the tephra. These were underlain by a thin layer of culturally sterile sheep dung. This was

Figure 6. View of the upper 1.8 m of deposits within the cave proper from 103N 102E to 103N 103E.

overlying bedrock, approximately 1 m below Stratum 5 and slightly over 4 m below the surface of the cave (Figures 6–7). We removed 4 m^3 of these lower layers before slumping and time constraints forced us to abandon the excavation.

The excavation took over twice as long as we had originally estimated, owing to the greater than expected depth, the widening of the cave below the surface, and the complex stratigraphic sequence. In all we removed approximately 61 m^3 of fill, including approximately 6 m^3 taken in bulk for processing in the laboratory. Over 500 lots of artifacts and bulk samples were collected, along with several hundred photographs and hundreds of pages of notes. Approximately $^1/_3$ to $^1/_2$ of the deposits remain untouched and waiting for additional excavations.

In summary, twenty-seven stratigraphic units were identified in Floating Island Cave (Table 2), designated Stratum 1 (lowest) through Stratum 27 (surface). Radiocarbon age determinations (Table 3) and the Mazama ash layer (Stratum 4)

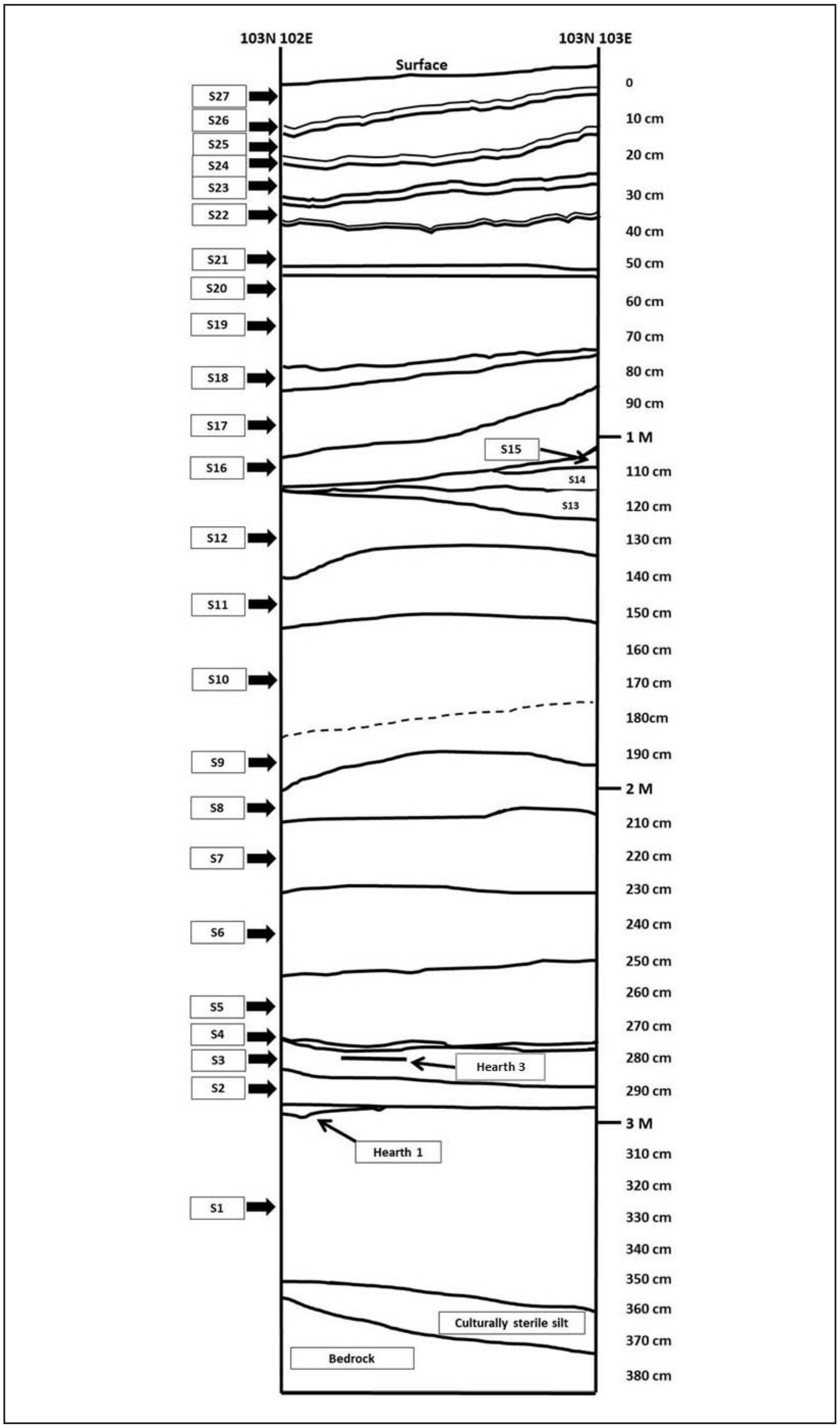

Figure 7. View of the upper 1.8 m of deposits within the cave proper from 103N 102E to 103N 103E.

Table 2. Floating Island Stratigraphy.

Stratum	Description	Median Age Cal BP
27	Surface: protohistoric to present	–
26	Dry, dusty, consolidated in places, loose in others; some burned	–
25	Dry, coarse twigs and rat droppings	–
24	Dry, twigs, more chaff than S25	~1348 Cal BP
23	Dusty, ashy, roof spall	–
22	Dry, coarse vegetation and rat droppings	–
21	Dry, coarse twigs and chaff, some ash	~1265 Cal BP
20	Dry, very dusty, coarse twigs, chaff, pickleweed	–
19	Dry, dust, ash, vegetation, animal hair	~2227 Cal BP
18	Dry, less vegetation than above, burned in places	–
17	Dry, dusty, coarse vegetation	–
16	Dry, dusty, coarse to fine vegetation, moderate roof spall	–
15	Mostly dry; coarse saltbush sticks	–
14	Dry, dusty, compact, fine chaff	–
13	Mostly dry, damp in places, laminated chaff and sticks	~2787 Cal BP
12	Mostly dry, damp in places, layered chaff and twigs	–
11	Dry in places, damp in places; the lowest dry level	–
10	Moist, charcoal-stained, fine-grained sandy	~3923 Cal BP
9	Moist, fine-grained sandy, red-yellow, charcoal stain in places	–
8	Moist, fine-grained with moderate amounts of roof spall	~6459 Cal BP
7	Moist, fine-grained with charcoal flecks throughout	~6966 Cal BP
6	Moist, sandy with spall, many small bones	–
5	Moist, silty with spall, culturally sterile	–
4	Mazama ash	~7633 Cal BP
3	Moist, many small bones and spall pieces. Two hearths	~8105 Cal BP
2	Moist, many small bones and spall pieces. One hearth	~8275 Cal BP
1	Moist, non-cultural, sheep dung, small bones, & spall pieces	~8132 Cal BP

indicate periodic occupation of the cave over the past ~8300 years. The excavations uncovered no structures or prepared firehearths and a relatively low number of finished artifacts, in keeping with the hypothesis that the cave was used for short-term visits by small groups of people. Ground stone was the most common finished artifact, and its presence throughout the deposits is taken as an indication of the importance of seed resources (especially saltbush and pickleweed) to cave occupants. Bone was recovered in profusion in all levels, especially the bones of small mammals and birds. Perishable items such as twine, basketry fragments, pieces of hide and leather, and fragments of a rabbit skin robe were limited to the upper, dry strata, Stratum 11 and above. A large number of human and non-human coprolites were collected from the dry strata, as were a number of quids. A fair number of shell beads or pendants and fragments, including some Olivella shells, were collected. A unique artifact, apparently a necklace, consisting of two lower

Table 3. Floating Island Cave Radiocarbon Age Estimates.

Stratum	Material	Lab Number	14C Age	Median Calibrated Age BP[1]	Age Range at two S.D.[2]
24	Charcoal	Beta 24401	1450±50	1348	1284–1516
21	Charcoal and twigs	Beta 19334	1350±90	1265	1014–1511
21	*Allenrolfea* twigs	PSUAMS 6416	1540±20	1462	1376–1522
20	*Allenrolfea* twigs	PSUAMS 6415	1900±20	1850	1748–1897
19	Charcoal and twigs	2220±60	2220±60	2227	2064–2348
19	*Allenrolfea* twigs	PSUAMS 6414	2190±20	2249	2142–2308
13	Twigs and sticks	Beta 54360	2670±50	2787	2735–2872
10	Hearth charcoal	Beta 19338	3610±70	3923	3716–4142
8	Charcoal	Beta 54362	5670±70	6459	6311–6632
7	Charcoal	Beta 24400	6090±80	6966	6748–7168
4	Mazama Tephra	–	7633[3]	–	7584–7682
3	Hearth charcoal	Beta 18603	7280±180	8105	7740–8414
2	Hearth charcoal	Beta 19339	7460±80	8275	8054–8412
1	Mt. Sheep dung	Beta 19340	7310±140	8132	7865–8391

[1] Calibrations made using Calib 7.1 (Reimer et al. (2013).

[2] Age ranges represent 100% of the area under the probability distribution.

[3] From Egan et al. (2015).

legs and feet of a shorebird was discovered when writer and bird expert Terry Tempest Williams arrived at the site (Figure 8). She wrote about the discovery in her book *Refuge* (Tempest Williams 1991:179–191)

Floating Island Cultural Features

With the single exception of a small shallow pit feature, all the cultural features at Floating Island Cave consist of fire pits or hearths. A number of other ash and charcoal lens identified during the excavation are also likely derived from, or associated with, the use of fires in the cave, but were too amorphous to be definitively identified as hearths. Most of the hearths result from simple small fires laid directly on the underlying surface, with little preparation. At most, preparation appears to have consisted of scoping a shallow basin from the underlying deposits, although even these basins may be a result of the intensity of the fire burning underlying material rather than being due to actual preparation.

Laboratory Procedures

Two 1x1 m sample columns were collected in the field for laboratory processing. A single bulk sample was collected from a third column since preservation in the two primary columns was poor in that stratigraphic unit. Sediments from each stratigraphic unit in the columns were bagged in the field in their entirety and removed to the laboratory in large plastic garbage bags. Samples from each of the three columns were combined into single stratigraphic column based on preservation, stratigraphic thickness, and the degree to which stratigraphic units could be easily separated in the field. In Table 4 below, the field specimen sample numbers shown in bold italics were those selected for laboratory processing. The remaining bulk samples were retained for curation in hopes that improvements

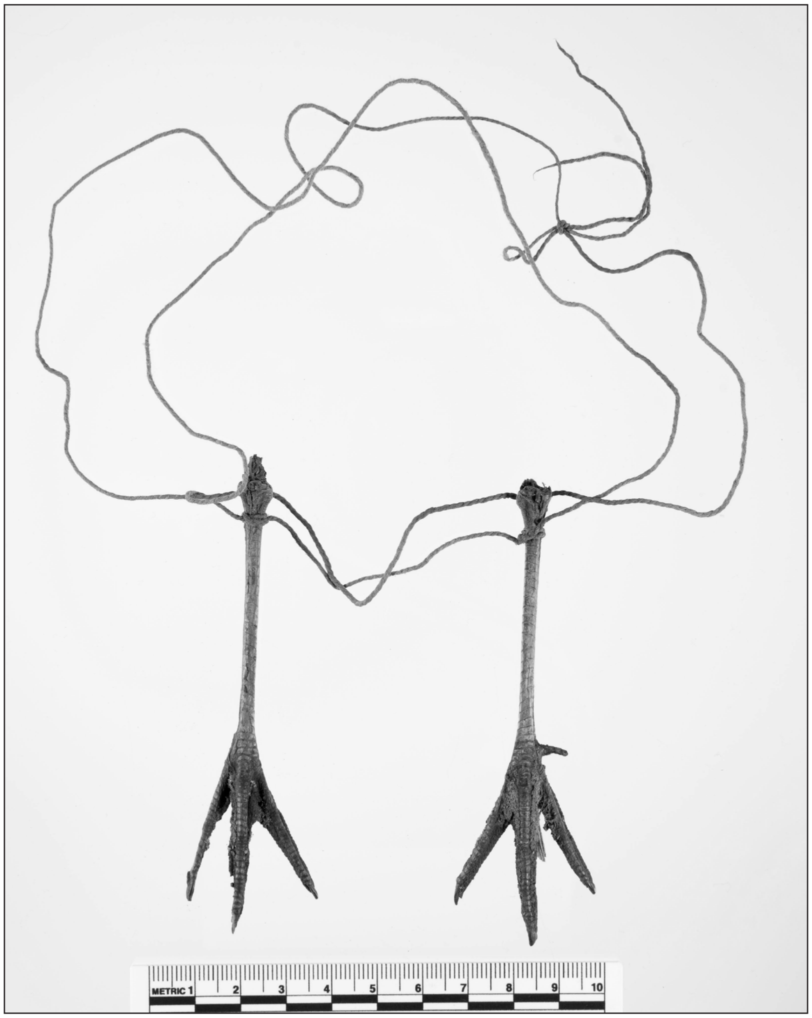

Figure 8. Simple necklace from Floating Island Cave made from twine and bird feet. The feet are tentatively identified as those of a greater yellowlegs (Tringa melanoleuca), a small spring/fall migrant wading bird common to marsh areas in the Bonneville basin. The legs would necessarily have been imported to the Floating Island area, possibly from the marsh areas around Danger Cave.

in analytical techniques developed in subsequent years would allow more details would emerge about the lives of the foragers who occupied Floating Island Cave.

The combined stratigraphic column bulk samples were initially processed in 1986–1989 in the archaeology laboratory of the Antiquities Section, Utah Division of State History. Sediments were screened through a series of nested screens of decreasing mesh sizes. After the sediments from each stratigraphic unit were passed through these screen sizes the remaining material was collected and curated as residual dust. Material collected in the screens was separated by hand into a variety of different categories for analyses. The categories included bone, bone tools, vegetal remains, chipped stone (including both tools and all sizes of debitage), ground stone (including both manos and metates), fecal remains (both human and non-human), quids (chewed and expectorated plant remains), textiles (including

Table 4. Combined Bulk Sample Column Fs#/Stratigraphic Unit Correspondence.

102n/102e	103n/102e	101n/102e
Stratum/Fs#	Stratum/Fs#	Stratum/Fs#
25/417	–	–
24/418	24/356	–
22-23/419	–	–
21/420	21/358	–
20/421	20/359	–
19/422	19/361	–
18/423	18/362	–
17/424	**17/383**	–
16/384	16/384	–
15/427	**15/385**	–
13-14/428	**14/386**	–
–	**13/387**	–
12/429	12/389	–
11/394	11/394	**11/476**
10/432	10/398	–
9/438	9/400	–
7-8/436	**8/402**	–
–	**7/404**	–
6/439	6/416	–
5/479	5/408	–
4/482	–	–
3/483	–	–
2/485	–	
1/487	–	

basketry and twine/netting), hair, feathers, charcoal, and ebouli (rockfall).

The remaining bulk samples were curated in their original field bags until 2014, at which time they were processed by Logan Simpson Design, Inc. for permanent curation at the Utah Museum of Natural History (Carambelas 2014). Prior to processing, two 2-liter sediment sub-samples were collected from each bulk sample and saved for curation. The remaining sediments were passed through $^{1}/_{8}$” screens. All ebouli and material which passed through the screens was discarded, and the remaining artifacts were sorted into categories similar to those listed above. Two grams of charcoal were collected from each bulk sample and saved for curation.

A Chronology for the Floating Island Cave Depositional Sequence

The depositional history at Floating Island Cave is controlled by ten conventional radiocarbon dates, three precision AMS ^{14}C dates, and the presence of a well-dated volcanic tephra (Table 3). Where possible, charcoal from hearths was used to date features within each stratum. Unfortunately, this was only possible for Strata 2, 3, and 10. All the remaining ^{14}C dated samples consist of charcoal fragments hand-picked in the laboratory from bulk samples collected in the field as part of the column sampling exercise described above. In two cases (Strata 19 and 21), charcoal fragments were supplemented with small twigs due to limited sample sizes. In Stratum 13 only a sample of twigs and sticks was dated. The lowest and oldest ^{14}C age estimate is derived from charcoal in a hearth (#1) laid down on non-cultural sediments ~3.0 m below the surface of the cultural deposits.

In dating depositional layers in dry caves, where charcoal from identifiable cultural features, such as a hearth, is unavailable, it is our contention that dating scattered charcoal provides more accurate chronological estimates for the deposition of a particular stratum than does the dating of an individual item, such as dung or wood. Analyses of individual items at Danger and Hogup caves, for instance, have often produced results that are inconsistent with their stratigraphic position (e.g., Rhode et al. 2006; Martin et al. 2017). On the other hand, the dating of scattered charcoal in a tightly controlled stratigraphic Danger Cave sequence produced a very consistent and detailed dating sequence (Madsen and Rhode 1990; Rhode and Madsen 1998). Microscopic analyses of charcoal in sediment samples suggests particles >50 µm are usually not transported far from fires (Patterson et al. 1987; Clark 1988). Since our samples consist of substantially larger visible charcoal fragments they were likely transported even shorter distances and probably derive from hearth fires burned in conjunction with the processing and deposition of cultural debris.

The use of scattered charcoal from bulk samples at nearby Hogup Cave (Aikens 1970) has been questioned (Martin et al. 2017) because it is thought that bulk samples have a greater chance of containing charcoal unrelated to the depositional event (e.g., Ashmore 1999). However, the bulk samples from Floating Island Cave consist of relatively thin depositional units from a relatively constrained area (1 m^2) versus the relatively thick depositional units and broad sampling areas at Hogup Cave (2.3 m^2). Moreover, the occupational area in Floating Island Cave is much smaller than that at Hogup Cave, so much so that occupants necessarily had to dwell in essentially the same area during sequential visits. The much more open floor area at Hogup allowed sequent occupations in different areas of the cave, resulting in horizontal stratification and a higher likelihood of mixing of older and younger deposits within a single stratigraphic unit.

The tephra age is derived from the presence of a volcanic ash identified in Stratum 4. The tephra has not been chemically analyzed to confirm its source, but based on its position, the ^{14}C ages from over- and underlying stratigraphic units, its identification in the Juke Box Trench located only ~20 km west of Floating Island (Oviatt et al. 2018), and its presence in Great Salt Lake cores collected to the east (Thompson et al. 2016), the ash is undoubtedly derived from the eruption of Mt. Mazama in Oregon. Mazama tephra is present in a large number of lakes and bogs throughout western North America and there are a variety of estimates for the age of the eruption based on radiocarbon dating of surrounding sediments. Here we use a median age of ~7633 cal BP for the dating of the eruption and its deposition in Floating Island Cave. This age is based on a Bayesian analysis of dozens of radiocarbon age estimates conducted by Egan et al. (2015). The age is consistent with an age derived from the position of the tephra within the GISP2 Greenland ice core (Zdanowicz et al. 1999), and on precision AMS ^{14}C ages on charcoal fragments recovered from within the tephra (Hallett et al. 1997).

While not all the stratigraphic depositions are dated, the eleven age estimates do suggest the presence of several possible occupational breaks in the record, as well as periods of possibly more intensive and relatively continuous use of the cave. The earliest use of the cave at about 8300 cal BP matches the initial occupation of a number of caves and rockshelters in the Bonneville basin following the final drying of Great Salt Lake

Desert marshes and the onset of intensive seed use after about 8700 cal BP (Madsen et al. 2015; Rhode et al. 2006). From ~8300 cal BP to ~6500 cal BP the cave appears to have been relatively continuously, albeit episodically, occupied. This ~1800 year time span encompasses the lowest seven stratigraphic levels and 15 separately identified depositional features. While short occupational breaks likely occurred they appear to have been of limited duration. However, the largely aeolian and culturally sterile deposits of Stratum 5, may represent a more prolonged occupational break of 500–600 years.

A time span of ~2500 years occurs between the radiocarbon dates for Stratum 8 and Stratum 10, with Stratum 8 dated to ~6459 cal BP and Stratum 10 dated to ~3923 cal BP. Stratum 9 consists of thinly laminated disintegrated vegetation and aeolian sediments containing much more ebouli than many of the other depositional units in the site. The presence of extensive amounts of roof fall debris and aeolian silts suggests the deposit represents an extended period of time and that the apparent occupational hiatus between about 6500 and 4000 years ago, suggested by the over- and underlying ^{14}C dates, may be real. A depositional hiatus occurs at a number of other sites in the western Bonneville basin such as at Hogup Cave (Martin et al. 2017) and Camels Back Cave (Schmitt and Madsen 2005) and a compilation of Great Basin ^{14}C dates suggests a drastic decrease in population numbers may have occurred during this period (Louderback et al 2010; see also Jones and Beck 2012). However, a compilation of 14C dates for the Bonneville basin (Madsen and Schmitt 2005) suggests there are a number of sites with dates corresponding to this period, and that while there is some indication of a population decline, it is much less pronounced in the Bonneville basin than elsewhere in the Great Basin (Louderback et al. 2010).

There is a depositional interval of a little more than 1100 years between the median calibrated ages for Strata 10 and 13, but whether or not this represents an extended period of site abandonment is unclear. The two intervening stratigraphic units consist of multiple depositional events which have been combined into two “excavatable” stratigraphic units. These deposits are composed of mixed twigs, pickleweed chaff, ebouli, and array of artifacts and contain no geomorphological suggestions that they represent a prolonged period of non-cultural deposition.

We attempted to evaluate the possible reality of these occupational breaks using a Bayesian statistical model. All dates were entered into OxCal version 4.3.2 (Bronk Ramsey 2009) and calibrated using IntCal13. The model suggests two possible breaks at the 95.4% confidence level (Strata 8 and 10, 2403 – 2668 years, 1σ, 68.2% HPD; 2273 – 2800 years, 2σ, 95.4% HPD; Strata 10 and 13, 1019 – 1241 years, 1σ, 68.2% HPD; 901 – 1338 years, 2σ, 95.4% HPD), with good overall model agreement index (Aoverall = 91.5) The model also provides an approximate interval for Stratum 4, containing the Mazama tephra, of 6748 – 8319 at the 95.4% confidence level. This fits with the current estimates by Egan et al, (2015).

Comparing Depositional Chronologies at Floating Island and Danger Caves

While there are at least 85 radiocarbon age estimates available for Danger Cave (e.g., Jennings 1957; Harper and Alder 1970; Madsen and Rhode 1990; Mullen 1997; Rhode and Madsen 1998; Rhode et al. 2006; Hoskins 2016; Bryan Hockett and Gene Hattori 2019 personal communications), only 57 of them are useful for dating the cultural deposits in the cave for a variety of reasons. Some were derived using a solid carbon analysis method which is unreliable (Jennings 1957), others consist of samples derived from a mix of deposition layers (Harper and Alder 1970), and still others are dates on faunal bones which may represent non-cultural deposition (Mullen 1997). Finally, some of the early Michigan dates were run on mixed samples of twigs and leaves which may be cultural or could as easily be the derived from woodrat nests. Of the 57 useful age estimates, 15 are directly dated paleofecal remains (Rhode et al. 2006), seven are on projectile point bindings (three of which are provenienced) (Hoskins 2016; Bryan Hockett 2019 personal communication), and seven are on textiles (Gene Hattori 2019 personal communication). Some of these ages have stratigraphic integrity, but most are useful only to show the presence of people at the cave at particular time intervals and are not useful in developing a stratigraphic chronology. Of the remaining 28, eleven are associated with an early, but apparently relatively brief occupation of Danger Cave dating to around 11,900–12,100 cal. BP. The initial intensive occupation of Danger Cave relates to the deposition of what Jennings (1957) referred to as D-II, a set of interfingering sedimentary levels consisting of mixed twigs, pickleweed chaff, rock, hearth features, and artifacts. These deposits mark the onset of seed processing at the cave ~8700 cal BP, and it is these deposits, together with the overlying deposits of D-III through D-VI (Madsen and Rhode 1990), that are most directly comparable to the Floating Island Cave sequence (Table 5).

These 46 dates (17 stratigraphic and 29 paleofecal/binding/textile samples) were entered into OxCal version 4.3.2 (Bronk Ramsey 2009) and calibrated using IntCal13. The calibrated ages were then used to produce a Bayesian model for the 46 age estimates arranged chronologically, but not stratigraphically. This model, somewhat surprisingly, indicates there are twelve occupational breaks in the Danger Cave record at the 95.4% confidence level. However, a number of these are very short, with many of them having median estimated chronological breaks of only 100–200 years. While they may be statistically valid, it seems unlikely that all of them represent real breaks in the Silver Island occupational sequence or in the Bonneville basin as a whole. We therefore combined the data sets from Danger and Floating Island caves, since the occupations of the two sites appear to be related, and ran the model again using a total of 58 age estimates. The number of occupational breaks in the combined record at a 95.4% confidence level increases to 16, largely because several of the longer breaks become divided, but only one of them has a median age of more than 500 years. This occurs between ~5323 and ~4143 cal BP.

Diagnostic Artifacts

Ceramics

A small number of pottery sherds were collected from Floating Island Cave. While the majority derive from the surface and/or from spoil dirt from a looter's hole, and therefore lack provenience, enough were recovered from the upper stratigraphic units to allow some assessment of the cultural affiliation of those deposits. With one possible exception, all 28 sherds can be identified to known Fremont ceramic types.

Twenty-three sherds match previously defined characteristics of a variety of Great Salt Lake Gray pottery found along the western margin of the Bonneville basin (see Madsen and Schmitt 2005: 105–106 for a more complete description). This variant is characterized by a fine micaceous (biotite/muscovite) sand temper and has been variously described as Deep Creek Gray (Malouf 1946) and Knolls Gray (Rudy 1953). It is a thin-walled, well-made pottery type, and it more closely resembles locally made varieties of Snake Valley Gray pottery than it does the coarser varieties of Great Salt Lake Gray found along the eastern margins of the Bonneville basin. The Floating Island Cave sherds are thin walled, ranging from 4.6–5.2 mm thick, well-fired in a reducing atmosphere, with a very uniform clay matrix and very smooth exterior surfaces. Temper consists of uniform fine micaceous sand. There is no indication of decoration on any of the sherds. Twenty-one are body sherds which appear to have come from a small- to medium-sized jar. They are all so similar that they could easily have come from the same vessel, although their distribution in multiple depositional layers argues against such a possibility. Two sherds are parts of

Table 5. Danger Cave Radiocarbon Dates from D-II and Above.[1]

Stratum[2]	Material	Lab Number	^{14}C Age	Median Calibrated Age BP[3]	Age Range at two S.D.[4]
DVI; S37	textile fragment	Beta-23646	330±100	376	83–540
DVI; S35	scattered charcoal	Beta-19335	880±100	809	660–972
–	hearth charcoal[5]	Beta-23645	1310±230	1220	748–1697
–	point binding	Beta-520994	1580±40	1469	1404–1540
DV	scattered charcoal	Beta-23647	2660±90	2782	2488–2990
–	paleofecal	Beta-187445	3020±50	3215	3070–3357
–	paleofecal	Beta-189083	3030±40	3231	3080–3356
–	paleofecal	Beta-187444	3270±40	3501	3398–3580
–	paleofecal	Beta-97898	3310±60	3539	3400–3689
DV; S30	scattered charcoal	Beta-23648	4860±110	5599	5321–5891
–	paleofecal	Beta-187451	5030±40	5797	5662–5895
–	paleofecal	Beta-189085	5060±40	5816	5715–5911
DIV; S25	scattered charcoal	Beta-23649	5160±100	5918	5662–6183
–	point binding	Beta-23649	5280±30	6072	5945–6181
–	point binding	Beta-520998	5320±30	6094	5996–6190
DIII; S24	scattered charcoal	Beta-23650	5360±70	6139	5953–6289
–	point binding	Beta-23650	5440±40	6242	6134–6306
–	paleofecal	Beta-187452	6020±50	6863	6740–6992
DIII; S18	scattered charcoal	Beta-23651	6030±90	6886	6675–7156
–	textile fragment	AA-74506	6188±43	7085	6966–7240
–	textile fragment	Beta-254911	6190±40	7086	6975–7239
–	textile fragment	AA-64984	6586±51	7487	7427–7567
DIII; S14	pinon nut hulls	Beta-43727	6710±70	7577	7460–7678
–	textile fragment	AA-70978	6760±49	7617	7519–7683
–	point binding	DAMS-14556	6791±28	7635	7589–7674
DIII	point binding	UGAMS-21630	7000±30	7842	7756–7932
DIII	point binding	UGAMS-21631	7230±30	8025	7972–8158
DII; S10	limber pine nut hulls	Beta-3623	7410±120	8227	7984–8415
DIII; S11	scattered charcoal	Beta-23652	7490±120	8292	8033–8536
Top DII; S9	scattered charcoal	Beta-23653	7920±80	8774	8582–9001
–	paleofecal	Beta-187453	8100±40	9034	8796–9238

[1] Age estimates from non-cultural and mixed samples are not included; see text for explanation.

[2] Stratigraphic correlations are from Jennings (1957), Madsen and Rhode (1990); Rhode and Madsen (1998), Rhode et al. (2006), and Hoskins (2016).

[3] Calibrations made using Calib 7.1 (Reimer et al. (2013).

[4] Age ranges represent 100% of the area under the probability distribution.

[5] Date is from a hearth in a bog below Danger Cave.

Table 5. Continued.

Stratum[2]	Material	Lab Number	^{14}C Age	Median Calibrated Age BP[3]	Age Range at two S.D.[4]
–	paleofecal	Beta-187454	8100±40	9034	8796–9238
–	paleofecal	Beta-187447	8130±50	9076	8796–9238
–	paleofecal	Beta-189084	8160±40	9096	8992–9255
–	paleofecal	Beta-187448	8190±50	9144	9010–9254
Top DII; S7	scattered charcoal	Beta-190866	8200±50	9161	9015–9299
–	textile fragment	AA-64983	8200±51	9162	9013–9302
Top DII	charcoal lens	Beta-168857	8270±40	9267	9127–9414
–	textile fragment	AA-77641	8286±50	9299	9127–9438
–	paleofecal	Beta-187450	8300±40	9323	9138–9434
Mid DII	pickleweed chaff	Beta-193124	8380±60	9402	9256–9525
–	paleofecal	Beta-187449	8380±40	9417	9299–9484
Top DII; S8	scattered charcoal	NSRL-11436	8410±50	9443	9371–9524
Mid DII; S6	scattered charcoal	Beta-190887	8440±50	9470	9316–9535
Mid DII	pickleweed chaff	Beta-193123	8570±40	9537	9484–9597
–	paleofecal	Beta-187446	8680±50	9632	9536–9882

[1] Age estimates from non-cultural and mixed samples are not included; see text for explanation.

[2] Stratigraphic correlations are from Jennings (1957), Madsen and Rhode (1990); Rhode and Madsen (1998), Rhode et al. (2006), and Hoskins (2016).

[3] Calibrations made using Calib 7.1 (Reimer et al. (2013).

[4] Age ranges represent 100% of the area under the probability distribution.

[5] Date is from a hearth in a bog below Danger Cave.

a jar rim. The recurved rim curves back from the body of the jar at an angle of ~30°. The rim is 20 mm high, has a smooth edge, and a slightly thickened lip (5.9 mm). There is no decoration evident on either the rim or neck of the sherds. Eight of the sherds are unprovenienced, one is from Stratum 21, three are from Stratum 22, one is from Stratum 23, and four are from Stratum 24. The remaining six can be provenienced only to Strata 21–25 since they were recovered from areas of the site where these depositional units could not be readily separated. One of the sherds from Stratum 22 has been reworked into a teardrop-shaped tool of unknown function (smoother, spoon?). The sherd is 75 mm long and tapers from its 44 mm wide broad end to 22 mm on the narrow end. The broad end and the lateral margins have all been ground smooth.

Four sherds, and possibly a fifth, fit the defined characteristics of the coarser varieties of Great Salt Lake Gray (Dean 1992). All are body sherds with a more variable thickness (4.2–6.8 mm) than the Knolls Gray sherds. The temper consists of crushed rock or possibly coarse sand with little edge modification of the individual grains. Their surfaces, while smoothed, have a somewhat pebbly texture, as a result of this coarse tempering material. Four of the sherds have both gray exteriors and cores and have been well-fired in a reducing atmosphere. The fifth has a brown core, with smudged gray exterior surfaces and was apparently fired in an oxidizing atmosphere. It is possible this sherd is from a Late Prehistoric brownware vessel, although in the northeastern Great Basin area it is difficult to distinguish Great Salt Gray Fremont body sherds from Late Prehistoric brownware sherds (Dean 1992; Simms 1999). The possible brownware sherd comes from the surface of the cave. One of the others comes from Stratum 23 and three come from a mixed Stratum 22 / Stratum 23 context. Together, the small collections of sherds closely resemble that found at Buzz Cut Dune, a small Fremont foraging village found south of Floating Island along the northeastern margin of the Deep Creek Mountains (Madsen and Schmitt 2005).

Vegetation

Preserved plant remains from the Floating Island Cave excavations have only been partially analyzed and identified, but floral remains are dominated by pickleweed chaff and small broken saltbush and pickleweed twigs. Some of the other plant remains which have been identified are important because of their cultural historical implications. Nine corn kernels were recovered from the upper deposits in Stratum 24 (2) and in a combined Stratum 22 / Stratum 23 excavation unit. These strata are the same ones containing the diagnostic Fremont ceramics and which are radiocarbon dated to the known Fremont era. The nearest excavated Fremont horticultural sites along the western margin of the Bonneville basin are located near Baker, Nevada on the eastern side of the Snake Range. These villages are nearly 240 km (walking distance) from Floating Island, but an unexcavated village is thought to be present at Trout Creek on the southeastern margin of the Deep Creek Mountains ~170 km away (Madsen and Schmitt 2005). There are closer Fremont village sites near Grantsville, Utah ~115 km east of Floating Island (Steward 1933), but getting to them would require travel over the Great Salt Lake Desert. Other villages may have been even closer, at the ends of permanent mountains streams in areas now destroyed by farming. For example, in places like Callao, Utah on the southern margin of the Great Salt Lake Desert.

With the exception of Strata 12 and 15, pine nut hulls were also identified in all the dry deposits above Stratum 10 dating to after ~4000 cal BP, reaching counts as high as 771 hull fragments in Stratum 24. A very large percentage of these fragments are very small, less than ~2–3 mm in size, and likely result from hulling the pine nuts on a grinding slab and separating the nut meat from the inedible hulls. The pine nut hulls were not identified to species, but most likely represent pinyon pine. Pine nut hulls were present in the Danger Cave deposits beginning as early as ~8300 cal BP. The earliest of these hulls were identified as limber pine, but after ~7600 cal BP all the Danger Cave specimens were pinyon (Rhode and Madsen 1998). While there a few pinyon trees in the tops of the Silver Island Range, the nearest small groves are in the Pilot Range some 40–50 km from Floating Island. Even larger and more prolific pinyon/juniper forests occur along the eastern margin of the Goshute Range ~55 km west of Floating Island Cave and only ~18 km west of Danger Cave.

Projectile Points

The projectile points from Floating Island Cave were initially analyzed by Kat Friedmann (2001) and Amy Lapp as part of their master's theses, employing a classification system devised by Richard Holmer in 1986. That system, the types it categorized, and the associated chronological timespans each type was thought to represent, have remained largely unchallenged since they were first introduced.,

This classification scheme for eastern Great Basin projectile points was revised more than thirty years later by Bryan Hockett (Hockett and Goebel 2018). Not only does Hockett's system recognize a number of new Archaic point types, such as "Leppy Hills" and "Pequop Side-notched," but it results in many of the Floating Island Cave projectile points being reclassified (Table 6). Most of the points from the lower early-mid Archaic strata (6–9) that were originally classified as "Elko" points have now been reclassified as either Large side-notched or Pinto types, and along with a few Humboldt points are consistent with their known chronologies. True Elko points now only occur in the late Archaic

Table 6. Floating Island Cave Projectile Points (from Lapp 2007 and Bryan Hockett 2010 personal communication).

Stratum	Large Side-notched	Pinto	Humboldt	Black Rock Concave Base	Gatecliff	Dead Ceder	Elko	Rosegate	Total
27	–	–	–	–	–	–	1	–	1
26	–	–	–	–	–	–	–	–	0
25	–	–	–	–	–	–	–	–	0
24	–	–	–	–	–	–	–	–	0
23	–	–	1[1]	–	–	–	–	1[1]	2
22	–	–	–	–	–	–	6	–	6
21	–	–	–	–	–	–	4[2]	2	6
20	–	–	–	–	–	–	–	–	0
19	–	–	–	–	–	–	1	–	1
18	–	–	–	–	–	–	1	–	1
17	–	–	–	–	–	–	–	–	0
16	–	–	–	–	–	–	–	–	0
15	–	–	–	–	–	–	1	–	1
14	1	1	–	–	–	–	–	–	2
13	–	–	–	–	–	–	2[3]	–	3
12	1	–	–	–	–	–	1	–	2
11	–	–	–	–	1	1	–	–	2
10	–	2	3	–	1	1	–	–	7
9	2	1	–	–	–	–	–	–	3
8	–	–	1	–	–	–	–	–	2
7	4	–	–	–	–	–	–	–	4
6	4	–	–	–	–	–	–	–	4
5	–	–	–	–	–	–	–	–	0
4	–	–	–	–	–	–	–	–	0
3	–	–	–	–	–	–	–	–	0
2	–	–	–	–	–	–	–	–	0
1	–	–	–	–	–	–	–	–	0
NP	–	–	1	1	–	–	3	1	6

[1] From combined strata 23-25

[2] from combined strata 21-25

[3] from combined strata 13-16

NP- No Provenience

strata dating to between ~4000 cal BP and ~2200 cal BP (Strata 13 and above), with the entire eastern Great Basin "Elko" chronology now consistent with that for the central and western Great Basin (e.g., Thomas 1981). Holmer (1986) suggested that the Rosegate and Cottonwood point styles had overlapping timespans of ~1700–1100 cal BP and ~1000–200 cal BP in the eastern Great Basin and were associated with Fremont and Late Prehistoric occupations, respectively. These point style descriptions and chronologies remain largely unchanged in Hockett's classification system and their occurrence in the Floating Island cave sequence matches both suggested chronologies.

Discussion and Summary

Floating Island Cave (42TO106) was excavated by the Utah Division of State History, Antiquities Section, between August 22 and November 13, 1986. Sixty-one cubic meters of fill was removed and over 500 lots of artifacts were collected from the twenty-seven distinct strata that made up the deposits. A good ladder of radiocarbon dates, and a layer of the well-dated Mazama tephra, indicate periodic, probably seasonal, occupation of the cave spanning the last ~8300 years. Bayesian modeling of the dates suggests there is a high probability the site was unoccupied for a prolonged period during the middle Holocene. Principal occupations span the mid-to-late Archaic and Fremont periods. Eleven fire hearths were identified in the deposits, but many more were likely produced prehistorically. The use of the cave throughout its history was apparently related primarily to the acquisition and processing of pickleweed and saltbush seeds during short-term occupations lasting only a few days. We speculate these occupations may have been related to longer-term occupations at Danger Cave. Analysis of the materials and data recovered from the excavation are continuing by specialists, and their reports will be published in an edited monograph at a future date. The site was backfilled using spoil dirt and straw bales, and armored against vandalism by layers of straw, stone, and heavy wire mesh covering the surface of the cave. ■

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Forager Land-Use at the Old River Bed Inland Delta During the Pleistocene-Holocene Transition, Dugway Proving Ground, Utah

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A preliminary investigation using kernel density estimation of archaeological sites with Western Stemmed Tradition and early Holocene transitional projectile points was used to investigate land-use by hunter-gatherers at the Old River Bed inland delta of central Utah during the Pleistocene-Holocene transition. Results show Western Stemmed Tradition and early Holocene transitional projectile points primarily cluster at the terminal ends of channels where wetlands are found at contemporary inland deltas, indicating that wetland location may have been the primary factor influencing land-use at the Old River Bed inland delta. Although changes in the distribution of the different projectile points are observable, it is difficult to discern if these changes are due to changing environmental conditions during the Pleistocene-Holocene transition or something else. A substantial eastward shift in the distribution of archaeological sites with early Holocene transitional points may support geological evidence that water supply to the inland delta was reduced as result of the regression of Lake Gunnison at ~11,500 cal years BP and indicate that further radiocarbon dating of proximal inland delta channels is warranted.

A dominant theme of archaeological research is a better understanding of the dynamic human-environment relationship and how changes in that relationship affect human behavior (Kintigh et al. 2014). Deciphering this for past cultures can be difficult, as causalities behind behavior are complex; however, attempts can be made at reconstructing them using the spatial and temporal patterns of behavior left behind in the archaeological record (Wobst 1978). This is valuable as it models a reconstruction of the landscape and the natural forces that influenced the daily activities and decisions people made as they used the land around them (Knapp and Ashmore 1999).

Interpreting information from past cultures is difficult, especially as excavation and site-survey techniques are limited in providing the necessary data to discern past large-scale land-use patterns. Landscape archaeology provides an approach to view these data beyond the context of the archaeological site, allowing us to view patterns of human behavior not visible at smaller scales of examination (Wilkinson 2003). As the archaeological record is itself composed of the artifacts and material evidence of past human behavior (Schiffer 1972), the record can be used to reconstruct past landscapes by examining the spatial relationships of clustered and non-clustered artifacts at large geographic scales (McDonald 2015). One approach to this area of inquiry is accomplished using Geographic Information Systems (GIS) software to distinguish patterns from Global Positioning System (GPS) point data and utilizing specialized statistical techniques (Kintigh 1990; Ebert 2004).

For hunter-gatherer cultures, in particular, this approach is suitable for reconstructing past human-environment relationships as it makes use of sparse archaeological data from numerous individual site locations. To illustrate this with a contemporary example, consider the Alyawara people, an Arandic speaking hunter-gatherer culture who live near the ephemeral Sandover River in the Northern Territory of Australia (O'Connell and Hawkes 1984). Alyawara camps are organized into separate kinship households for men, women, and families, where people perform specific activities at particular locations that result in large accumulations or clusters of artifacts, which can be used to demarcate Alyawara camp boundaries in the archaeological record (O'Connell 1987). This analysis shows that due to changing environmental conditions, activity locations are often relocated, leading to Alyawara camps covering areas an order of magnitude greater than most archaeological excavations (O'Connell 1987). This results in a mismatch between the recovered archaeological record and the actual spatial scale of human use for hunter-gatherer cultures (Davidson 1999) that can only be resolved at larger geographic scales utilizing a landscape archeology method of inquiry (Wilkinson 2003).

The first people to inhabit the Great Basin were hunter-gatherers and likely descendants of coastal foragers that moved inland from the western coasts of North America (Madsen 2016). Once in the Great Basin, these foragers made use of the abundant wetlands in the region and practiced a subsistence strategy focused on high-quality resources found at such environments, including artiodactyls, waterfowl, and edible plants (Goebel et al. 2011). Based on existing models, these foragers were probably highly mobile and appear to have moved from resource patch to resource patch within territories that spanned hundreds of kilometers (Jones et al. 2003).

During the Pleistocene-Holocene transition, the largest wetland environment in the eastern Great Basin was the Old River Bed (ORB) delta located on Dugway Proving Ground (DPG) in central Utah (Figure 1) (Madsen 2016). The abundant resources at this locality attracted a population of Pleistocene-Holocene foragers who inhabited the region on a seasonal or annual basis between ~13,200 and ~9,300 cal years BP (Arkush and Pitblado 2000; Madsen et al. 2015). As climate became increasingly xeric in the Great Basin during the Pleistocene-Holocene transition (Madsen et al. 2001), marshes in the region shrank and foragers spent more time in the large marshes that remained, such as those of the ORB delta (Beck and Jones 2015). This settlement behavior is supported in the case of Railroad Valley, Nevada, where it was observed that Pleistocene-age archaeological sites cluster around ancient riparian habitat deposits more than do sites associated with the Holocene (Elston et al. 2014). As the ORB delta sustained the largest wetlands in the eastern Great Basin (Madsen 2016), it stands to reason that spatial analysis might show a similar land-use pattern there as well. This is supported by three separate lines of supporting evidence.

1. Throughout these time periods, the ORB inland delta wetlands were a resource-rich marginal environment in an otherwise xeric region (Madsen et al. 2015). Such locations are ideal for discerning land-use patterns as people make use of the same locations in their environment (Berglund 2003), much as observed by O'Connell (1987) at Alyawara basecamps.
2. Nearest-neighbor statistical analysis of lithic scatter sites on DPG from the Pleistocene-Holocene transition shows statistically significant clustering and hint that locating these clusters on the landscape will reveal land-use patterns (Field 2014).
3. Archaeological sites on DPG were located using block and linear survey techniques of land parcels, many of which are not associated with inland delta channels or areas where one might expect human habitation (Madsen 2016). Over 283,720 acres of the 800,000 acres that comprise DPG have been surveyed, ~98% at a Bureau of Land Management Class III inventory level (Figure 2). This makes sampling bias an

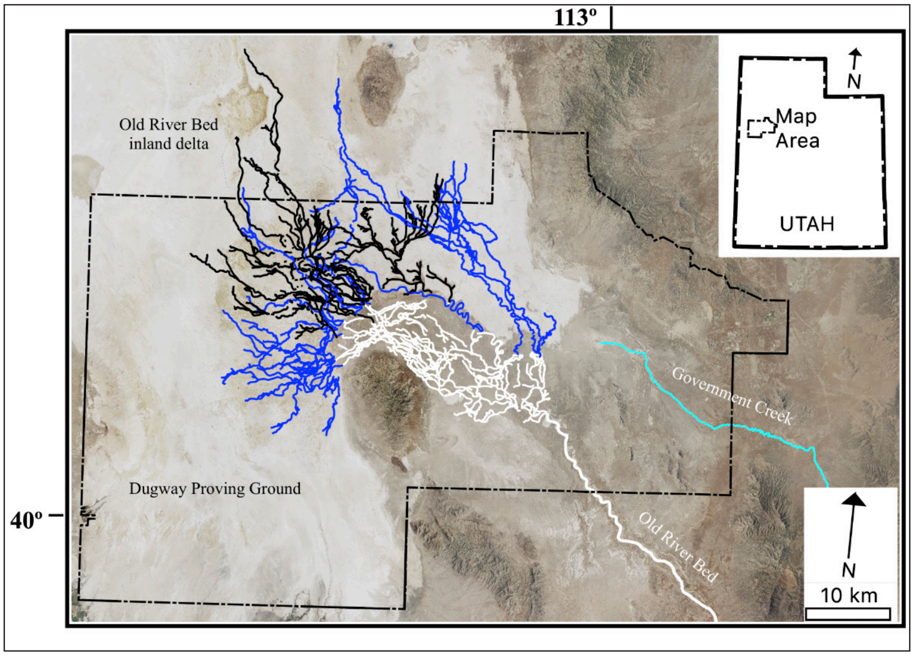

Figure 1. Map of Dugway Proving Ground, in part based on Madsen et al. (2015), showing Government Creek, the Old River Bed, and the Old River Bed inland delta. Channel systems in black are those dated by Madsen et al. (2015) with ages between 13,200 and 11,200 cal years BP and those in blue are those dated by Madsen et al. (2015) with ages between 11,200 and 8,900 cal years BP (see Table 1). The white channels east of Granite Peak near the mouth of the inland delta are undated.

unlikely source for error in spatial analysis of data from the well-surveyed areas of DPG, but leaves uncertainty for much of the under-sampled distal western ORB delta where the landscape between channels has been only partially surveyed. However, this concern is somewhat mitigated, as linear surveys cross-cutting channels of the western ORB delta found archaeological sites to be primarily centered on channels and their margins and not on the mudflats between channels, hypothesized to be because dry ground necessary for forager activities was nearby (Madsen and Page 2008; Schmitt 2015).

Prior spatial analysis of DPG archaeological sites has been unable to find convincing evidence that the distributary channels of the ORB delta influenced land-use (Field 2014), although it is suggested that distributional patterns may be the result of foraging activities in wetlands along channel systems (Schmitt 2015). As hunter-gatherer cultures utilize specific locations on the landscape (O'Connell, 1987), in the context of resource exploitation, it is possible that Pleistocene-Holocene foragers at the ORB delta did the same.

Therefore, if Pleistocene-Holocene foragers at the ORB delta practiced a subsistence strategy focused on wetlands, then land-use patterns should cluster at specific locations in the delta where wetlands were likely to develop. Furthermore, as lithic technology at the ORB delta appears to have changed through time (Duke 2011; Smith et al. 2019), it can be deduced that analyzing the distribution of different artifact typologies might show changes in land-use through time, especially in the context of the dated channel systems of the ORB delta.

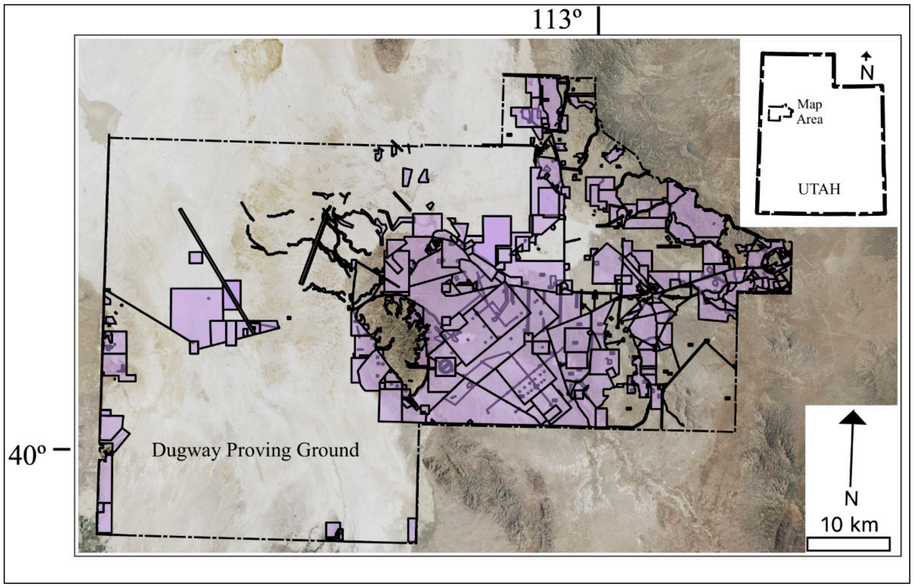

Figure 2. Map of Dugway Proving Ground showing land parcels surveyed up until 2019. Over 283,720 acres of the 800,000 acres that comprise Dugway Proving Ground have been surveyed, ~98% of which at a Bureau of Land Management Class III inventory level. Much of the northern and western inland delta are active test and training ranges and are inaccessible for survey.

Study Area

Established in 1942, Dugway Proving Ground is a military facility in central Utah (Figure 1) and is located in one of the many fault-bounded valleys of the eastern Great Basin (Jones et al. 1992). The landscape consists of eolian and mudflat deposits interspersed with copses of xeric vegetation (Oviatt et al. 2003). The modern climate is arid, with low precipitation and high evapotranspiration rates (Fitzmayer et al. 2004). Landmarks include the vestiges of the Old Lincoln Highway, a World War II-era airstrip, and refuse from decades of military testing. Due to the ongoing nature of such testing, unexploded ordinance are a threat to human use of the area today, and access to the base requires coordination with military personnel and a security clearance. This resultant inaccessibility, however, has prevented the widespread looting of numerous lithic surface scatters and led to a well-preserved archaeological record that dates back to the Late Pleistocene (Madsen 2016).

The DPG landscape was shaped by geological forces that began during the Last Glacial Maximum when temperatures were cooler and precipitation rates much higher in the region (Thompson et al. 1993). These conditions led to many valleys in the Great Basin hosting pluvial lakes, the largest of which was Lake Bonneville (Gilbert 1890). Lake Bonneville at its maximum extent reached surface levels higher than 1,550 m and drained an area that included a significant portion of Utah (Reheis et al. 2014). However, at ~18,000 cal years BP, the failure of a natural barrier at Zenda Pass, Idaho, led to lake levels rapidly falling in what is known as the Bonneville flood, until eventually stabilizing at the 1,450 m elevation Provo shoreline (Oviatt 2015). Here lake levels remained until an increasingly arid regional climate (Madsen et al. 2001) led to reduced hydrologic inputs to the lake and regression resumed at 15,000 cal years BP (Oviatt 2015). By 13,300 cal years BP, regression resulted in the separation of the Provo level lake into two distinct bodies of water: the Great Salt Lake and Lake Gunnison (Oviatt 2015).

A precursor to modern Sevier Lake, Lake Gunnison (Figure 3) was a freshwater lake fed by the Beaver and Sevier rivers whose hydrologic budget allowed it to reach an elevation of approximately 1,390 m in the Sevier basin during the Late Pleistocene (Oviatt 1988). The lake overflowed at its northern end into the ORB valley and a river flowed northwestward into the Great Salt Lake Desert onto present-day DPG (Oviatt et al. 2003). There the river spread out across the desert floor and created a 2,600 km² delta-like system of channels and wetlands referred to in the literature as the ORB delta (Oviatt et al. 2003; Madsen 2016).

However, describing the ORB delta as a delta is inaccurate, as the ORB delta was not a true delta where a river enters a larger body of water. When originally named, the ORB delta was believed to represent where the river entered into a lake in the Great Salt Lake Desert at a level mapped as the Gilbert shoreline (Currey 1982; Oviatt et al. 2003). Further research showed that the Gilbert shoreline is likely not a real entity in the DPG area and that the Gilbert-episode lake did not exist there during the Pleistocene-Holocene transition (Oviatt 2014; Madsen et al. 2015). The channels of the ORB delta disappear into the desert and its geomorphological characteristics are instead more similar to the inland deltas of Africa described by McCarthy (1993). Therefore, it is more appropriate to describe the ORB delta as the *ORB inland delta* in the context of the Pleistocene-Holocene transition.

Methods

For this study, spatial analysis of archaeological data used a three-step strategy originally outlined for k-means cluster analysis that guides discovery, while permitting replication in accordance with the scientific method (Kintigh and Ammerman 1982). This involved:

1. The creation of a location index database indicating the absence or presence of projectile point forms associated with the Pleistocene-Holocene transition and found on DPG. The projectile forms investigated belong to the Western Stemmed Tradition (WST) and/or those described as early Holocene transitional (EHT) point forms which were used by foragers during the principal occupation of the ORB inland delta (Beck and Jones 2015). Using the definitions for these projectile points given by Beck and Jones (2015), WST projectile points are those classified as Cougar Mountain, Haskett, Lake Mojave, Parman, and Silver Lake types, and EHT projectile points include Butte Valley Corner-notched, contracting stem, Dugway Stubby, Eden, Expanding Stem, Pinto, and Square Stem types. In the Great Basin, WST projectile points date to between 13,100 and 7,900 cal years BP (Madsen 2007) and EHT forms, such as Pinto points and other small shouldered morphologies, may have appeared as early as ~10,785 cal years BP (Jones and Beck 2012). In the Great Basin it is postulated that long stemmed WST types occur earlier in time than do short stemmed types associated with the early Holocene (Duke and King 2014; Duke 2016) but a definitive chronology for WST technology in the intermountain west is elusive (Smith et al. 2019). At the ORB inland delta, both typologies appear to have been used concurrently, although there is a slight trend in the use of WST and EHT forms from earlier to later channels (Duke et al. 2007; Schmitt et al. 2007; Duke 2011; Beck and Jones 2015).
2. The use of a cluster analysis method known as kernel density estimation (KDE) that allows the concentration of archaeological sites to be visualized (Baxter et al. 1997) and compared to the DPG landscape as reconstructed by Madsen et al. (2015). This was done using Geographic Information Systems (GIS) software, aerial imagery of the study area, and the distributary channels mapped and dated by Madsen et al. (2015).

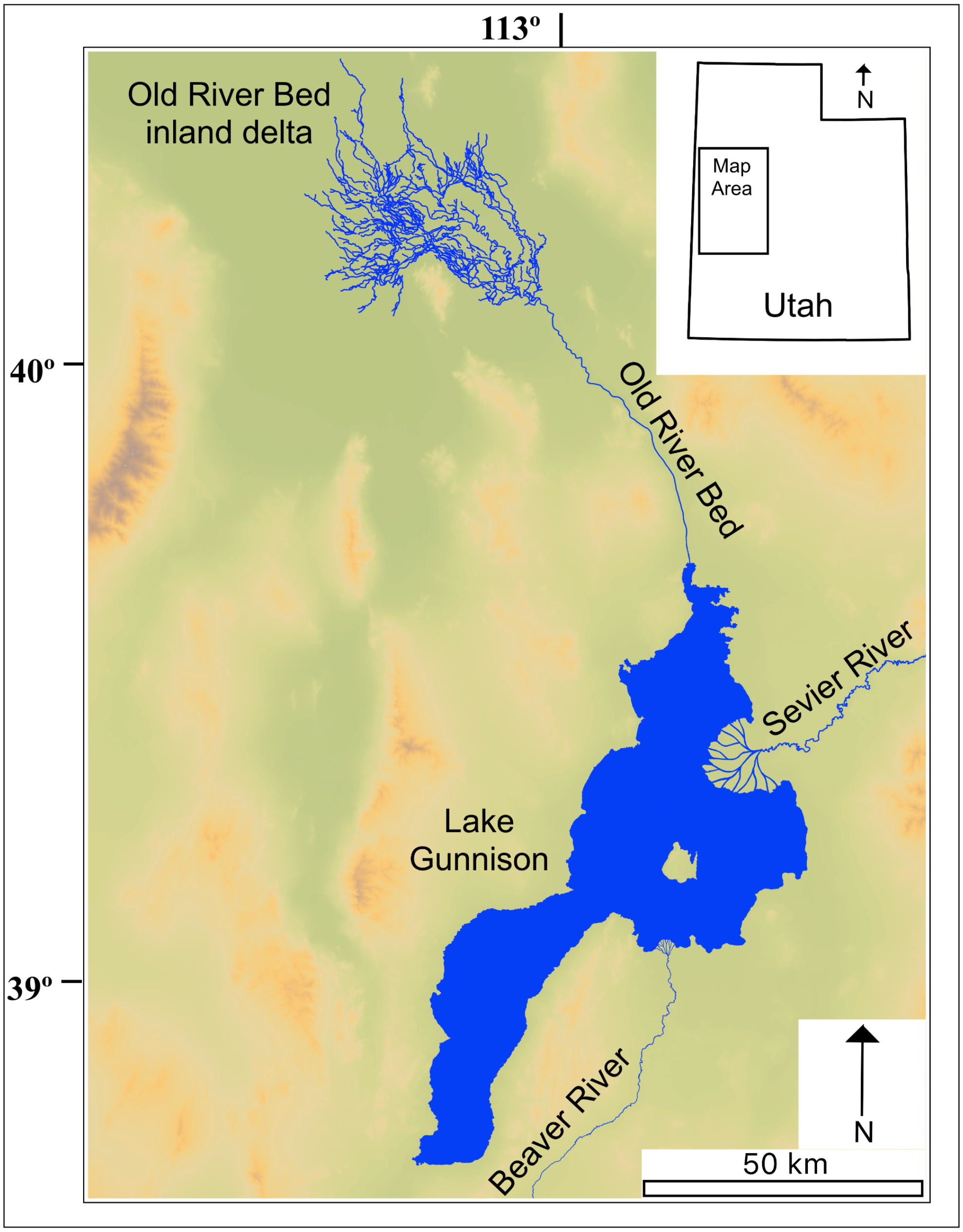

Figure 3. Illustration showing a reconstruction of Lake Gunnison based in part on Oviatt (1988) and the Old River Bed inland delta during the Pleistocene-Holocene transition. Shorelines for Lake Gunnison and the deltas for the Beaver and Sevier rivers are only approximations as they have not yet been mapped in their entirety.

3. Extant knowledge, such as ethnographic information on the foraging behaviors of hunter-gatherer populations in similar environments (Seiner 1910; Vincent 1985; Cashdan 1986; Couture et al. 1986; Kelly 1992; Hilton and Greaves 2008), to inform the proper bandwidth to use in for KDE analysis (McMahon 2007). Mapped and dated

Table 1. Old River Bed Inland Delta Channel Ages.

Channel Name[1]	Age Range (14C years BP)[2]	Age Range (cal BP)[3]	Older/Younger
Mango, Mocha, and Gold	~11,300–10,500	~13,200–10,500	Older
Black	~11,400–10,300	~12,900–12,200	Older
Limestone	~10,500–10,000	~12,500–11,500	Older
Yellow and Fuchsia	~10,500–10,200	~12,500–11,900	Older
Green and Red	~10,300–9800	~12,200–11,200	Older
Blue, Lime, and Royal Blue	~9,800–9,400	~11,200–10,600	Younger
Lavender, Navy, Coral, Orange, and Pink	~9,000	~10,200	Younger
Buff, White, and Brown	~9,200–9,000	~10,300–10,200	Younger
Light Blue	~9,800–8,800	~11,200–9,800	Younger
Seafoam	~9,100–8,300	~10,200–9,300	Younger
Rust	< 8,300	< 9,300	Younger

[1] Color-coded naming scheme for channels as reported in Madsen et al. (2015), see Figure 1.

[2] 2σ radiocarbon age ranges as reported for channel systems of the Old River Bed inland delta by Madsen et al. (2015).

[3] Calibrated years calculated using CalPal_2007 HULU calibration (Danzeglocke et al. 2012).

channels of the ORB inland delta active from ~13,200 until ~9,300 cal years BP (Table 1) (Madsen et al. 2015) were used to provide environmental and temporal context (Figure 4). For the purposes of this study, channels were classified as older or younger channels on the basis of their being described as high-energy or low-energy channels (Figure 1), respectively sustained by overflow from Lake Gunnison or groundwater discharge (Oviatt et al. 2003; Madsen et al. 2015).

Database creation

The database used for this study was created from the DPG electronic archaeological site location information, which includes site number, location coordinates, and tabular data indicating the association of a site with a general cultural period. To create the database used in this study, this data was cross-referenced with analyses in which the presence of WST and/or EHT projectile points were noted (Beck and Jones 2015; Page and Duke 2015; Schmitt 2015). Additional sites were then included after a physical review of DPG site forms, as well as reports in which projectile point typologies were described (Nelson and Eichorn 2012; Schmitt and Page 2014; Trammell and Mullins 2018). Sites with ambiguous artifact descriptions were not included and the final product is a database with the location of an archaeological site and tabular data indicating the absence or presence of WST (n=126) and/or EHT (n=158) projectile point forms (see Supplemental Material).

Kernel density estimation

Kernel density estimation is an interpolative statistical method in which bivariate point data such as coordinates are replaced by a symmetric probability function that integrates to a value of one, known as a kernel (Baxter et al. 1997; McMahon 2007). These kernels are three-dimensional bumps which are added together within a grid that overlies a study area to calculate an estimate for the average density at each intersection point of the grid (Seaman and Powell 1996). This reveals high and low densities in data (Baxter et al. 1997) showing areas of activity on an archaeological landscape using specific attributes such as artifact typology, and which can then be utilized to identify intrasite (Alperson-Afil et al. 2009) and/or intersite relationships (McMahon, 2007).

Mathematically, the bivariate KDE function $\hat{f}(x)$ is

$$\hat{f}(x) = \frac{1}{nh^2}\sum_{i=1}^{n} K\left(\frac{x-X_i}{h}\right) \qquad (1)$$

where n is the number of data points, h the bandwidth or search radius, K the symmetric probability function, x the (x, y) coordinate vector at which K is evaluated, and X_i the (x, y) coordinate vector for the location of each observation i (Seaman and Powell 1996). Of these factors, the bandwidth h has the most impact on the results of kernel density estimation, as it is a measure of the influence each kernel has on its neighbors as the kernel spreads out from its location (McMahon 2007).

Analytical procedures

Kernel density estimation analysis and generated maps were made using Cartographica GIS software installed on a 2017 MacBook Pro. The projection for all analyses was NAD 1983 UTM/zone 12 S. National Agriculture Imager Program (NAIP) aerial imagery was obtained from the Utah Automated Geographic Reference Center (AGRC) and shapefiles for mapped channels of the ORB inland delta were based on data from the Cultural Resources Department of DPG. KDE analysis was completed for archaeological sites with WST (n=126) and EHT (n=158) projectile points present.

For KDE calculations, it was necessary to define parameters for the rectangular grid size, the symmetric probability function utilized, and the smoothing factor or bandwidth h (Equation 1). The rectangular grid is parameterized by Cartographica GIS software with a proportionate number of x and y cells within the map bounds, in this case within the boundaries of DPG that is apportioned into 253 by 170 cells. The width of each grid cell in the x-direction was chosen to be 333 meters. Software parameterization then set the grid cell width in the y-direction to ~ 334 meters because cell widths cannot be equal (Silverman 2018).

For this study, an exponential symmetric probability function was employed since this allows the central point in kernel density estimation to be weighted more heavily, making it easier to distinguish clusters in data (de Smith et al. 2018). This function is

$$K = 1.5e^{-k|t|}, |t| \leq 1 = 0, t > 1 \qquad (2)$$

where k is a parameter for weighting the central point and t a measure of the distance from the coordinates for each data point divided by the bandwidth value h (de Smith et al. 2018).

The bandwidth h was chosen using the method recommended by McMahon (2007) to reflect the hypothesized territorial catchment area for the culture being investigated. As Pleistocene-Holocene foragers at DPG were hunter-gatherers, ethnographic research informs this choice. Hunter-gatherer populations, such as the Tanzanian Hadza, tend to forage within a radius of ~5 km from basecamp, relocating when daily returns from available resources within this radius diminish (Vincent 1985; Kelly 1992). There is evidence that hunter-gatherers at the ORB inland delta stayed in the area for long periods since many lithic tools show signs of extensive recycling (Schmitt et al. 2007). Riverine foragers such as the //Kanikhoe of the Okavango inland delta of southern Africa are also somewhat sedentary, inhabiting dry locations near wetlands for long periods until having to move during the wet season (Seiner 1910; Cashdan 1986). The Pumé of southwestern Venezuela are also wetland foragers and primarily rely on edible roots typically collected within 2–5 km from basecamp (Hilton and Greaves 2008). Edible roots were potentially important resources available to wetland foragers in the Great Basin (Rhode and Louderback 2007) and are observed to be important resources used by contemporary Paiute foragers (Couture et al. 1986). The ORB

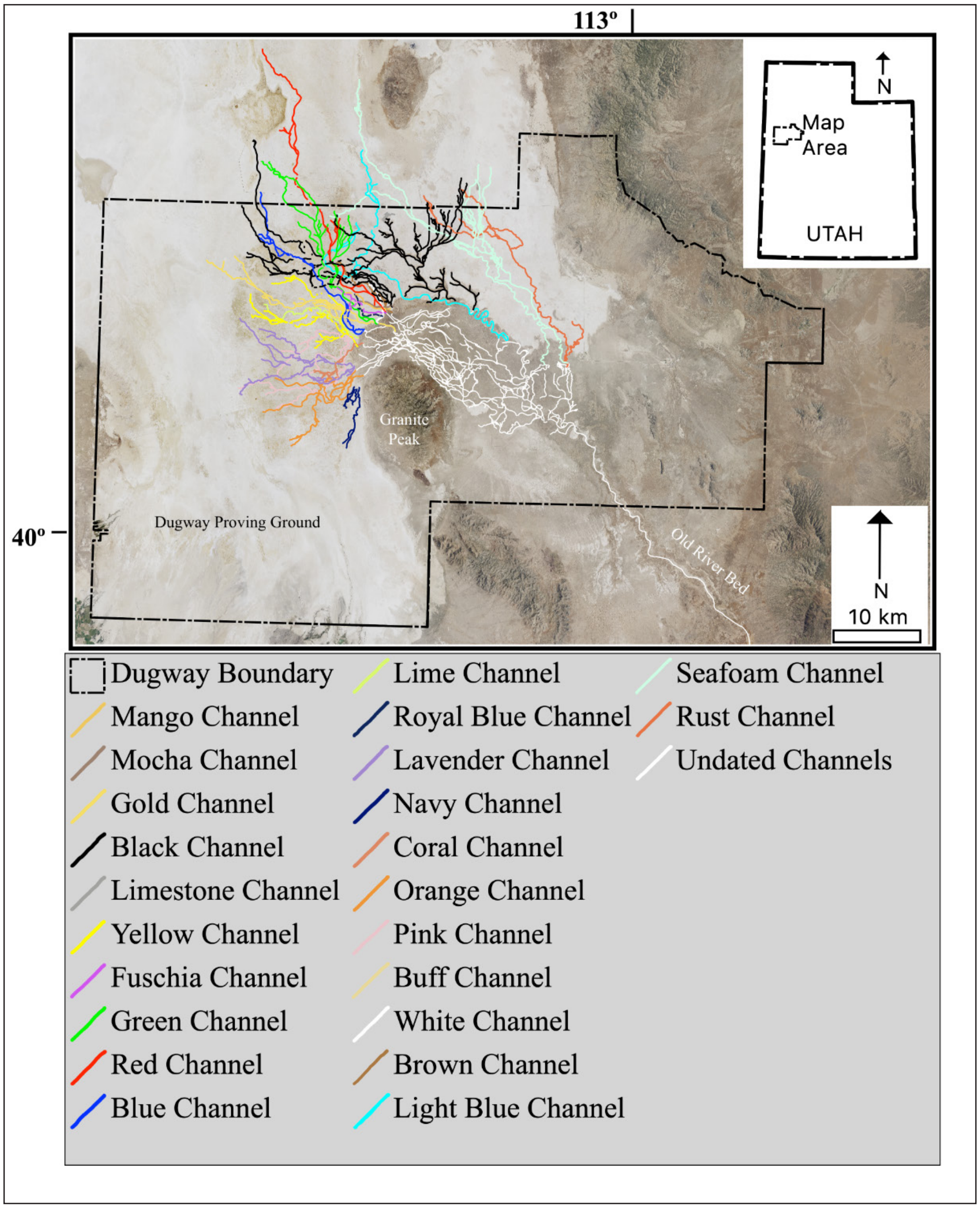

Figure 4. Map of Dugway Proving Ground in central Utah showing the color-coded channel systems (Table 1) of the Old River Delta based in part on Madsen et al. (2015).

inland delta no doubt had an abundance of edible root resources and people would have likely moved short distances within the inland delta as resources became depleted near habitation sites (Oviatt et al. 2003; Schmitt et al. 2007). On this premise, a conservative value of ~2.5 km was chosen for the bandwidth *h* and used for KDE analysis of archaeological sites at the ORB inland delta.

The results of KDE analysis for both WST and EHT projectile points were then overlain the shapefile data for both older and younger channels of the ORB inland delta (Figure 1). This was done because although analysis suggests that WST forms give way to early Holocene transitional forms, with a slight trend from the earliest to latest channels of the inland delta (Beck and Jones 2015), there is significant chronological overlap for both typologies in the region (Duke et al. 2007; Duke 2016). Lacking a firm temporal context for WST and EHT typologies, the distribution of these projectile points was examined in the context of dated ORB inland delta channels that formed before and after the regression of Lake Gunnison in the Sevier basin at ~11,500 cal years BP (Oviatt et al. 2003; Madsen et al. 2015).

Results and Discussion

WST (Figure 5) and EHT (Figure 6) projectile points cluster near the terminal ends of both older and younger channels where they disappear into the desert. In the modern Okavango inland delta of southern Africa, the ends of channels are where standing water and wetlands are present (Tooth and McCarthy 2007) and it is inferred that the high density of archaeological sites and the ends of ORB inland delta channel systems indicates the same. This corroborates the evidence that standing water in abandoned channels and shallow ponds attracted foragers within the ORB inland delta during the Pleistocene-Holocene transition (Schmitt et al. 2007). High site density at channel ends also agrees with evidence that a Gilbert-episode lake did not have a shoreline in the DPG area (Oviatt 2014; Madsen et al. 2015), as these clusters are not on sediment lobes deposited in a desiccating lake but in the pans and playas where wetlands could develop. This supports the hypothesis that land-use of foragers at the ORB inland delta was focused on resources at specific locations where wetlands could develop within the inland delta.

However, changes in land-use through time are more difficult to discern. The distribution of WST and EHT projectile points are similar to each other and agree with prior work showing that both types were used concurrently throughout the human occupation of the ORB inland delta (Duke et al. 2007; Duke 2011; Beck and Jones 2015; Smith et al. 2019). This makes it difficult to identify differences in the distribution between WST and EHT projectile points, likely as a result of many archaeological sites being palimpsests and/or the complex cross-cutting relationships of older and younger channels.

A significant change in distribution is apparent however, with a high density of archaeological sites with EHT projectile points east of Granite Peak near the mouth of the inland delta. Unfortunately, this cluster is associated with distributary channels, the majority of which have not yet been dated (Figure 6). Radiocarbon dates obtained east of Granite Peak span the entire length of human occupation in the area, with ages between 13,240 and 9,740 cal years BP and are primarily associated with the primary distributary channel coming out of the ORB valley or the Light Blue channel (Figure 4) (Madsen et al. 2015), providing little information regarding the age archaeological sites. Although this cluster lacks a temporal context, it does show an overall eastward shift in land-use by foragers using EHT projectile points, which are believed to increase in prevalence later in time at the ORB inland delta and elsewhere in the Great Basin (Schmitt et al. 2007; Duke 2011; Beck and Jones 2015). With the assumption that EHT projectile points represent forager land-use later in time, some inferences regarding their presence at the proximal inland delta can be made.

At contemporary inland deltas, changes in seasonal overflow lead to periodic avulsion and changes in water distribution (McCarthy 1993). This can be invoked to explain the numerous cross-cutting channels of the ORB inland delta during the Late Pleistocene when overflow from Lake Gunnison in the Sevier basin (Figure 3) reached the area (Oviatt et al. 2003). However, at ~11,500 cal years BP, Lake Gunnison regressed and instead of lake overflow, the primary source of water reaching the ORB inland delta was groundwater flow from the Sevier basin (Oviatt 1988; Oviatt et al. 2003; Madsen et al. 2015). Groundwater-fed streams have relatively uniform

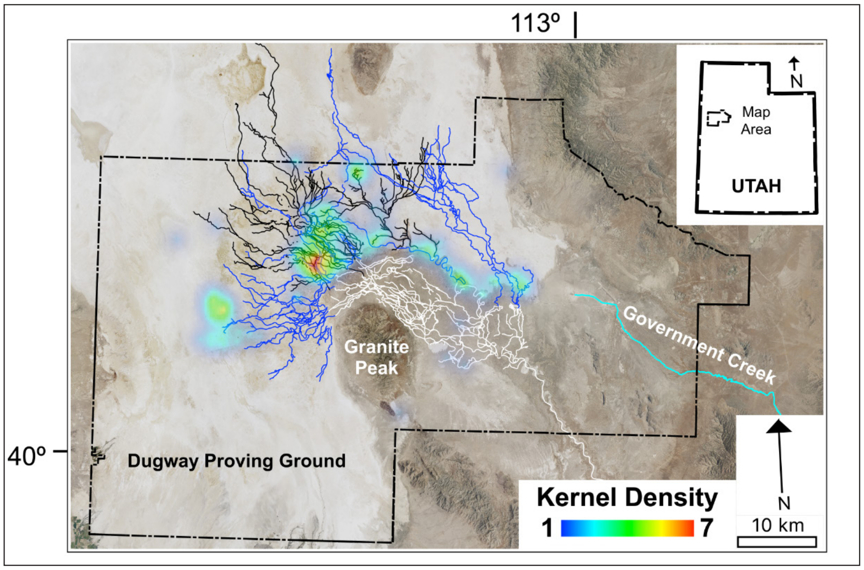

Figure 5. Kernel density estimation map, with a bandwidth of ~2.5 km, showing the distribution of archaeological sites with Western Stemmed Tradition projectile points and their associations with older (black) and younger (blue) channels of the Old River Bed inland delta (dates associated with channel colors are found in Figure 1 caption). Note that many areas of high-density cluster at the ends of channels systems where standing water would have been able to support the development of wetlands.

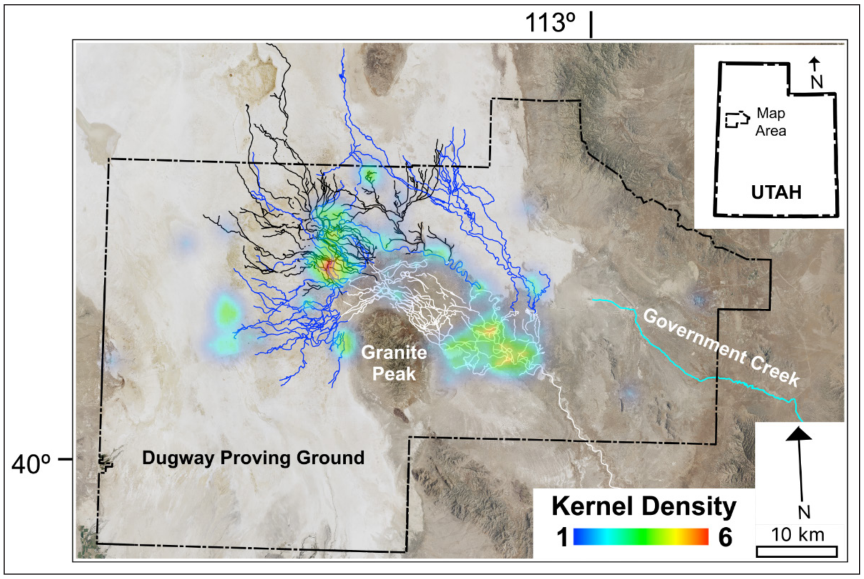

Figure 6. Kernel density estimation map, with a bandwidth of ~2.5 km, showing the distribution of archaeological sites with early Holocene transitional projectile points and their associations with older (black) and younger (blue) channels of the Old River Bed inland delta (dates associated with channel colors are found in Figure 1 caption). Many high-density clusters are found at the terminal ends of channels, similar to that observed for archaeological sites with Western Stemmed Tradition projectile points. A large cluster of archaeological sites is present east of Granite Peak, perhaps suggestive of an increase in dry land available for forager activities in the area. Unfortunately, channels at this location have not yet been dated.

flow rates (Whiting and Stamm 1995), therefore changes in water distribution would have been reduced and more aligned with the sources of water reaching the inland delta during the early Holocene. In this case, perhaps groundwater discharge in the ORB valley in conjunction with streamflow from Government Creek, which is hypothesized to have reached the eastern inland delta during the early Holocene (Figure 6) (Oviatt et al. 2003).

Therefore, if EHT projectile points were utilized later in time at the ORB inland delta by foragers as prior archaeological work suggests, the eastward shift in their distribution could be related to the reduction in water supply to the inland delta due to the regression of Lake Gunnison during the later Pleistocene-Holocene transition. For example, the presence of EHT projectile points at the proximal inland delta may highlight the presence of more dry ground being available for forager activities as water resources dried up, or may alternatively represent increasing usage of resources available in the proximal delta, perhaps due to the growing population of foragers in the region during the early Holocene (Jones and Beck 2012). A crucial test of this hypothesis would be defining the ages of as yet undated channels of the proximal ORB inland delta located just east of Granite Peak (Figure 6). Ultimately, a better chronology for the use of WST and EHT projectile points at the ORB inland delta and the radiocarbon ages of undated channels will be necessary to better understand the observations of this study and to resolve land-use changes through time at the ORB inland delta.

Conclusions

Kernel density estimation appears to be a viable method for analysis of Pleistocene-Holocene archaeological site distribution at the ORB inland delta. This preliminary analysis shows archaeological sites with WST and EHT projectile points often clustering along both older and younger channels of the ORB inland delta. Results also show that archaeological sites with WST and EHT projectile points often cluster at the terminal ends of channels in areas where standing water could have sustained the wetlands foragers subsisted on and suggests that wetland location may have been the primary factor influencing land-use at the ORB inland delta during the Pleistocene-Holocene transition. Future conservation efforts should be aimed at surveying the under sampled parts of the western inland delta and be focused on the preservation of the terminal ends of inland delta channels, including those not yet inventoried by Cultural Resources. The potential for better resolving WST/EHT chronology at the ORB inland delta is significant, especially in the proximal inland delta east of Granite Peak where EHT projectile points are common and the majority of inland delta channels have not yet been radiocarbon dated. A potential direction of future work, would be to investigate the frequencies of point typologies at archaeological sites and weight them accordingly for KDE analysis. ■

Data Availability Statement

Data used in this study are available from the Utah AGRC (https://gis.utah.gov/data/) and/or the IMWU-PWEP (Environmental Programs) section of the Dugway Cultural Resources Office. Locations of archaeological sites on Dugway Proving Ground and the database created for this study are available to authorized individuals upon request by contacting Rachel Quist, the Cultural Resources Manager of Dugway Proving Ground (rachel.quist.civ@mail.mil). Site names and the absence or presence of WST and/or early Holocene transitional point forms at them, are included in the supplemental material of this article.

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Supplemental Material Table 1. Dugway Proving Ground Archaeological Site Database

State Site Number	Western Stemmed Tradition Point Forms	Pinto and Transitional Point Form
04DM02	x	–
04DM03	x	–
08-DM-30	x	–
42TO0385	x	–
42TO0394	–	x
42TO0867	–	x
42TO0962	–	x
42TO1000	x	x
42TO1152	x	x
42TO1153	x	x
42TO1157	x	–
42TO1161	x	x
42TO1163	x	x
42TO1172	x	–
42TO1173	x	–
42TO1177	x	–
42TO1182	x	x
42TO1352	x	x
42TO1353	x	x
42TO1354	x	–
42TO1357	x	x
42TO1358	x	x
42TO1368	x	x
42TO1369	x	x
42TO1370	x	–
42TO1371	x	x
42TO1383	x	x
42TO1459	–	x
42TO1493	–	x
42TO1524	–	x
42TO1666	x	–
42TO1668	x	–
42TO1669	x	x
42TO1671	x	x
42TO1672	x	x
42TO1673	x	–
42TO1676	–	x

Supplemental Material Table 1. Continued.

State Site Number	Western Stemmed Tradition Point Forms	Pinto and Transitional Point Form
42TO1682	x	–
42TO1683	x	–
42TO1684	x	x
42TO1685	x	x
42TO1686	x	x
42TO1687	x	x
42TO1688	x	x
42TO1689	x	–
42TO1859	x	x
42TO1861	x	x
42TO1862	x	x
42TO1872	x	x
42TO1873	x	x
42TO1874	x	x
42TO1875	x	x
42TO1876	x	x
42TO1877	–	x
42TO1878	x	x
42TO1920	x	x
42TO1921	x	x
42TO1922	x	x
42TO1923	x	–
42TO1924	x	x
42TO2052	x	–
42TO2145	–	x
42TO2146	–	x
42TO2152	–	x
42TO2172	–	x
42TO2551	x	x
42TO2552	x	–
42TO2553	x	x
42TO2554	x	x
42TO2555	x	x
42TO2556	x	x
42TO2557	x	x
42TO2558	x	x
42TO2559	x	x

Supplemental Material Table 1. Continued.

State Site Number	Western Stemmed Tradition Point Forms	Pinto and Transitional Point Form
42TO2767	x	–
42TO2954	x	x
42TO2957	x	–
42TO3140	x	–
42TO3141	x	x
42TO3142	x	x
42TO3219	x	x
42TO3220	x	–
42TO3221	x	x
42TO3222	x	x
42TO3223	x	–
42TO3224	x	–
42TO3225	x	x
42TO3226	x	x
42TO3228	x	x
42TO3229	x	x
42TO3230	x	x
42TO3231	x	x
42TO3233	x	x
42TO3234	x	x
42TO3235	x	x
42TO3236	–	x
42TO3237	x	x
42TO3238	x	x
42TO3475	–	x
42TO3520	x	x
42TO3522	x	x
42TO3646	–	x
42TO3733	–	x
42TO3769	–	x
42TO3823	–	x
42TO3824	–	x
42TO3827	–	x
42TO3828	x	x
42TO3831	–	x
42TO3834	–	x
42TO3837	–	x

Supplemental Material Table 1. Continued.

State Site Number	Western Stemmed Tradition Point Forms	Pinto and Transitional Point Form
42TO3846	–	x
42TO3848	–	x
42TO3854	–	x
42TO3855	–	x
42TO3856	–	x
42TO3857	x	x
42TO3858	–	x
42TO3933	–	x
42TO3935	–	x
42TO3941	–	x
42TO3942	–	x
42TO3943	–	x
42TO3945	–	x
42TO3946	–	x
42TO3948	–	x
42TO3951	–	x
42TO3955	–	x
42TO4231	–	x
42TO4232	–	x
42TO4233	–	x
42TO4234	–	x
42TO4239	–	x
42TO4241	–	x
42TO4244	–	x
42TO4577	–	x
42TO4579	–	x
42TO4580	–	x
42TO4585	–	x
42TO4587	–	x
42TO4588	–	x
42TO4649	–	x
42TO4650	–	x
42TO4652	–	x
42TO4654	–	x
42TO4662	–	x
42TO4687	–	x
42TO4693	–	x

Supplemental Material Table 1. Continued.

State Site Number	Western Stemmed Tradition Point Forms	Pinto and Transitional Point Form
42TO4694	–	x
42TO4728	x	–
42TO4731	–	x
42TO4733	–	x
42TO4737	–	x
42TO4738	–	x
42TO4797	–	x
42TO4798	–	x
42TO4799	–	x
42TO4802	–	x
42TO4803	–	x
42TO4809	–	x
42TO4813	–	x
42TO5283	x	x
42TO5557	x	x
42TO5562	x	–
42TO5563	x	x
42TO5564	x	x
42TO5867	x	–
42TO5869	x	–
42TO5870	x	–
42TO5874	x	x
42TO5875	x	x
42TO5880	x	x
42TO5881	x	x
42TO5885	x	–
42TO5886	x	–
42TO6860	x	x
42TO6861	x	–
42TO6862	x	x
42TO6864	x	x
42TO6865	x	–
42TO6866	x	–
42TO6867	x	–
42TO6868	x	x
42TO6869	x	x
42TO6871	x	–

Supplemental Material Continued.

State Site Number	Western Stemmed Tradition Point Forms	Pinto and Transitional Point Form
42TO6872	x	–
42TO6873	–	x
42TO6875	x	–
42TO6876	x	x
42TO6877	–	x
42TO7107	x	–
42TO7108	x	–
42TO7109	x	x
42TO7110	x	x
42TO7111	x	x
42TO7112	x	x
42TO7114	x	x
42TO7115	x	x
42TO7116	x	x

The Loa Clovis Cache from Central Utah

Alan R. Schroedl
St. George, Utah

An obsidian biface and flake cache, discovered in central Utah in 1977, was reported in Utah Archaeology in 1988 with a possible Fremont or Late Prehistoric cultural affiliation. A simple statistical comparison of bifaces in the cache to other caches in western North America demonstrates the cache is Clovis in affiliation. The obsidian artifacts in the cache were manufactured from the Wildhorse Canyon source in western Utah and were transported 100 km east before being cached on the northern Colorado Plateau.

In 1977, a woman, her son, and her sister discovered a cache of 10 large obsidian flakes and bifaces while hiking outside the town of Loa, Utah. Eleven years later in 1988, the obsidian artifacts were briefly reported in *Utah Archaeology* by Janetski et al. (1988). The obsidian cache was reportedly recorded as part of site 42WN1674, which apparently included a nearby cached Late Prehistoric pot and an adjacent Fremont habitation site. Since the 1988 report, the obsidian artifact cache has largely been forgotten.

Papers (Fenn 1999; Stanford 1999a; Woods 1999) presented at the Clovis and Beyond Conference in Santa Fe, New Mexico in 1999, coupled with the publication of *The Fenn Cache: Clovis Weapons and Tools* (Frison and Bradley 1999) that same year, sparked a renewed interest in Paleoindian caches as a specific site type, an interest that continues to grow today (Huckell and Kilby 2014). Prior to the conference, only a few definite caches with Clovis points had been reported from western North America, including Simon in Idaho (Butler 1963), Anzick in Montana (Lahren and Bonnichsen 1974; Wilke et al. 1991), Drake in Colorado (Stanford and Jody 1988), and East Wenatchee in Washington (Gramly 1993).

At that time in 1999, I decided to take a closer look at the Loa obsidian cache and reassess the assignment of cultural affiliation. The general description of the cache by Janetski et al. (1988) 11 years earlier was similar to other caches reported as Clovis. I was intrigued by the striking morphological similarities between the ovate biface from the Loa cache and a large obsidian biface from the Clovis-age Fenn cache (Frison and Bradley 1999). Obsidian biface #100 from the Fenn cache is the largest obsidian biface from that cache. The 170-mm-long ovate obsidian biface from the Loa cache, only slightly smaller and thicker than the Fenn specimen, is similar to it in shape and edge flaking (Figure 1). Confirmed Clovis caches are dominated by very large bifaces and are often associated with Clovis fluted points or preforms. Could the Loa cache be Clovis in origin rather than Fremont or Late Prehistoric as suggested by Janestski et al.? I set out on what turned out to be a long-term quest to obtain more information about the site and the artifacts.

CLOVIS TECHNOCOMPLEX

Clovis is the label applied to the first well-dated, continent-wide prehistoric technocomplex in North America associated with large unifacially

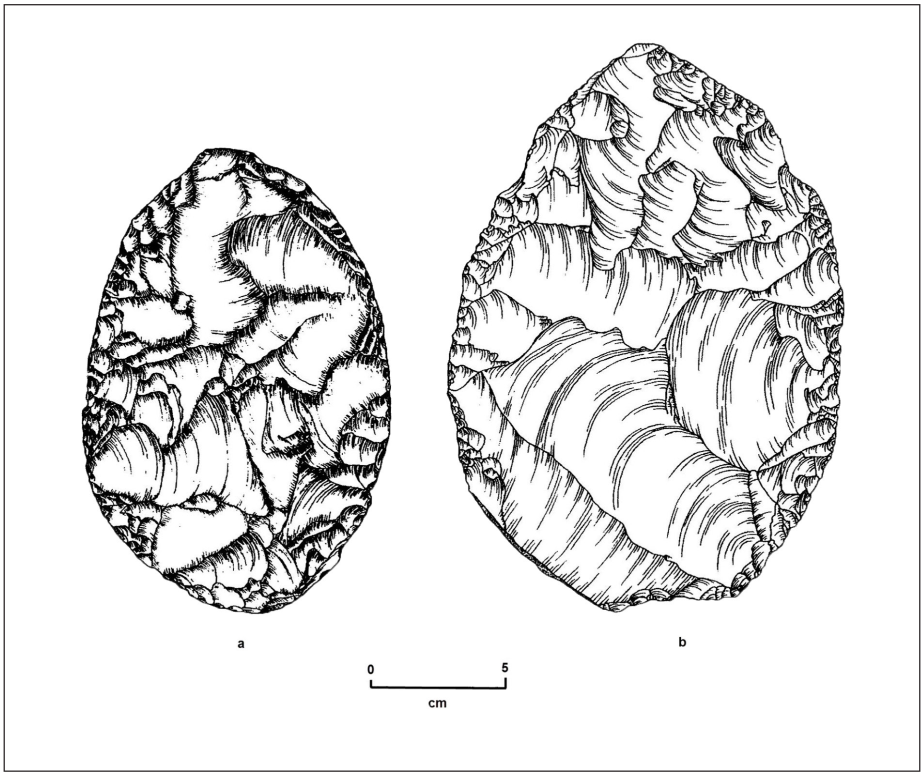

Figure 1. Line drawings comparing obsidian bifaces. (a) Obsidian biface (Number 4) from the Loa cache (Janetski et al. 1988: Figure 5); (b) Obsidian biface (100) from the Fenn cache (Frison and Bradley 1999: Plate 56) used with permission.

and bifacially fluted lanceolate points, the hallmark of the Clovis tool assemblage (Eren and Buchanan 2016). These distinctive fluted points (Figure 2) are found throughout the contiguous lower 48 United States and further south (Stanford 1999b:284). These points are among the largest lanceolate projectile points in North America, with specimens regularly exceeding 100 mm in length, even after resharpening. One other noticeable characteristic of Clovis projectile points, besides the extraordinary length of some specimens, is that they are invariably manufactured from high quality, visually appealing raw material including quartz crystal. Often these points are found hundreds of kilometers from the original source locations of the raw material. Collins (1999) hypothesizes that Clovis points were repeatedly resharpened and then discarded when they were about 50 mm in length when high-quality raw material was immediately available for point manufacture. Collins speculates that Clovis points less than 50 mm in length were only resharpened and reused by Clovis people when they did not have immediate access to high-quality toolstone.

Beside fluted projectile points, the Clovis complex includes a highly diverse lithic technology expressed in a rich artifact assemblage including other types of bifaces, unifaces, and bone implements (Ardelean 2014). Based on investigations at numerous Clovis sites, the general biface assemblage includes projectile point preforms, ovate bifacial knives, and other large ovate bifaces of various stages of manufacture (Stanford 1991). Bifacial gravers and unifacial end and side scrapers, manufactured on both flakes and blades, are also part of the tool kit. A variety of bone and ivory implements

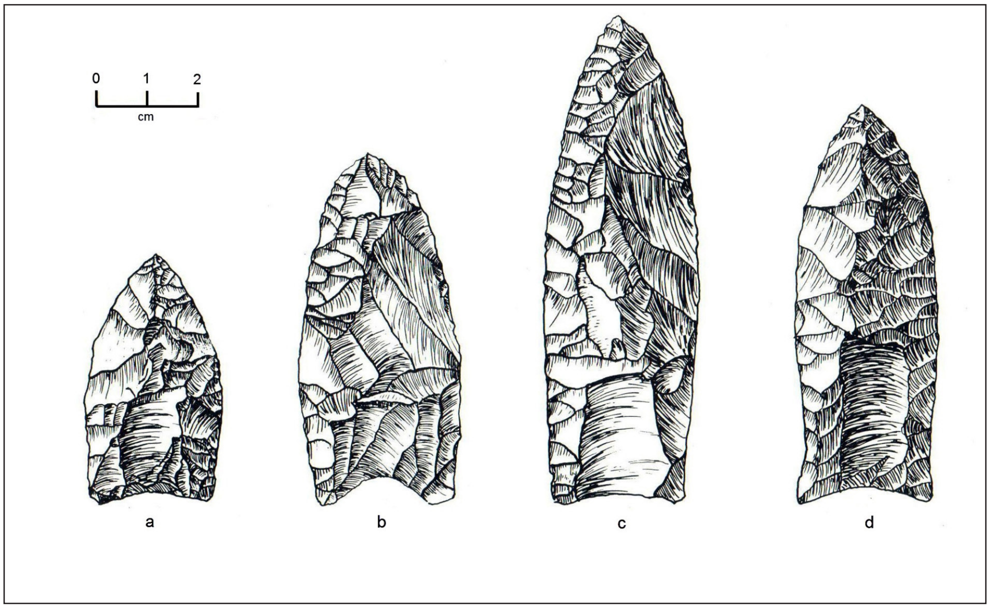

Figure 2. Examples of Clovis points; (a, b) Naco site, Arizona (Wormington 1957: Figure 15); (c, d) Lehner site, Arizona (Wormington 1957: Figure 17), from Schroedl (1991).

including ivory points, shaft wrenches, and beveled rods (Frison 1999:272; Pearson 1999) manufactured from proboscidean remains are also diagnostic of the Clovis technocomplex.

Clovis reduction technology spread across the North American continent primarily by population migration in a very short period of time. Based on an analysis of associated Clovis radiocarbon dates, Waters and Stafford (2007) indicate that the Clovis technocomplex was a short-lived phenomenon from about 13,250 to 12,800 cal BP across North America, with a possible time span of span 250–450 calendar years. Goebel and Keene (2014) present a slightly alternate time range from 13,200–12,700 cal BP. During this short timeframe, the geographic distribution throughout North America of lost, discarded, or cached Clovis points derived from a variety of toolstone from widely disparate raw material sources attests to the high degree of mobility among Clovis people. Because there is no documented evidence of continent-wide human occupation before 13,250 BP, diffusion of Clovis technology among existing populations is not a viable explanation for the widespread presence of Clovis technology. The geographic distribution of Clovis sites within such a short time period indicates that raw material was obtained by direct procurement as Clovis people migrated across the landscape.

One distinctive site type associated with the highly mobile Clovis lifestyle is the artifact cache. According to Kilby and Huckell (2014:257), a Clovis cache is a collection of one or more artifacts that are intentionally or purposefully set aside as opposed to being discarded, abandoned, or lost. Caches represent a distinctive archaeological site type situated along a continuum of Clovis site types between reduction locations at raw material sources and workshops and items lost or discarded at kill sites, campsites, or at other isolated locations (Kilby and Huckell 2014:257). Only recently have analyses of various caches attributed to the Clovis period provided an improved understanding of the composition of these caches and how caching behavior was integrated into the Clovis lifeway (Huckell and Kilby 2014).

Clovis caches are recognized by a combination of traits including the presence of diagnostic artifacts, distinctive toolstone reduction technology, chronometric dating, stratigraphy or association with Pleistocene megafauna (Osborne 2016:162). Many appear to have the utilitarian purpose of the temporary storage of high-quality raw material in anticipation of toolstone needs in the future, although some have been identified as ritual sites (Kilby 2008), and at least one, Anzick, has been identified as a burial cache (Wilke et al. 1991). The presence of fluted points among a Clovis cache assemblage or a radiocarbon date confirms the cache as Clovis in age. Other Clovis caches without fluted points have been identified as Clovis based on other technological and contextual features. Clovis caches are relatively rare. Kilby and Huckell (2014:Table 15.1) only accept 26 caches as Clovis, most of which are in western North America.

Although few in number, the distinctive nature of Clovis caches is *prima facie* evidence that caching was an integral part of the Clovis lifeway. Clovis caching behavior was as short-lived as the tradition. Within several hundred years, Clovis technology gave rise to the Folsom complex. There is no evidence that caching behavior was an integral part of the Folsom technological tradition, although caching of finished artifacts was common among late Paleoindian populations in the western North America (e.g. Amick 2004; Davis et al. 2014).

After a brief history of the Loa cache and its discovery context, the similarities of the individual artifacts with artifacts from other Clovis caches are discussed. This is followed by a comparison of the cache with other Clovis and non-Clovis caches from western North America.

HISTORY OF THE LOA CACHE

After the discovery in 1977, the artifacts remained with the people who discovered the Loa cache until they were inspected and sampled by Janetski and colleagues prior to the publication of the report in 1988. In the 1990s, after the publication of the *Utah Archaeology* report, the artifacts from the cache were displayed in the museum known today as the Utah State University Eastern Prehistoric Museum in Price, Utah. After a number of years, the artifacts were returned to the original discoverers. Since 1999, I continued my quest to get more information about the site and the artifacts. After almost 15 years, I was finally successful. With the help of Craig Harmon, I was able to contact one of the original discoverers of the cache who offered to take me to the site.

Prior to the site meeting in 2016, I contacted the museum in Price for more details about the assemblage, but the museum only had limited documentation on the artifact assemblage. I also contacted the Utah SHPO for a copy of the site form, maps, and artifact photos for site 42WN1674. Although the cache was assigned a site number and possibly recorded by Janetski and colleagues, no site form or supporting documentation is on record at the Utah Department of Heritage and Arts. I also contacted Brigham Young University where the authors were on staff but no field notes nor the site form for 42WN1674 were available (Richard Talbot, personal communication 2016).

The 1988 report provided few specific details of the discovery or the context of these artifacts, information that would be important to Clovis researchers if indeed the cache was Paleoindian in age. Janetski et al. (1988) stated that the cache assemblage consisted of 10 “quarry blanks” recovered from a shallow pit in a boulder field. The artifacts were carefully stacked in the pit and surrounded by a powdery material. Four bifaces were stacked individually in the bottom of the pit with six flakes stacked in three pairs above the bifaces. In the 1988 report, these artifacts were numbered 1–10 from bottom to top. X-ray-fluorescence analysis of a flake removed from each of the 10 artifacts by Janetski and colleagues indicated that all the artifacts were made of obsidian from the Wildhorse Canyon obsidian flow in the Mineral Mountains in the eastern Great Basin. The Loa cache was discovered about 100 km east of the Wildhorse Canyon obsidian source.

LOA CACHE CONTEXT

In the fall of 2016, I traveled to the site area near Loa, Utah to meet with one of the discoverers. After 40 years, she recalled the events of that day. She confirmed many of the details reported in the 1988 article but also pointed out a few discrepancies. I was unable to inspect the original cache pit because she was unable to identify the exact location where the cache of artifacts was recovered. She did, however, point out the general area of the location, perhaps 75 m in diameter, in a boulder field on an east-trending ridge just south of Riley Canyon. The location lies at an elevation of approximately 2240 m, about 50 m above the floor of Dry Valley, and overlooks West Springs about 300 m to the southwest. The springs today are the primary water source for the town of Loa.

The 1988 article illustrates an unscaled schematic cross-section of the artifacts lying in the pit under a boulder overhang. According to the discoverer this is not an accurate depiction. Although there were boulders in the area, she says the pit was not directly under an overhang. She describes the discovery as a fortuitous event. Her son sat down on the ground. When the woman and her sister went over to him, they saw a glint off one of the flakes that was barely visible. They began digging with their hands and eventually recovered the 10 artifacts. Importantly, she recalled nothing distinctive about the location—no evidence of a cairn, unique geological feature, or other kind of permanent marker that would allow the owners to find and return to the cache. Indeed, she emphasized that they would not have found the cache if not for the serendipitous reflection off the obsidian.

THE LOA CACHE ARTIFACTS

Ten artifacts were recovered from the cache in 1977, four bifaces and six flakes (Figure 3) (Table 1). Unexpectedly, the discoverer brought with her five artifacts from the cache that she had in her possession and graciously allowed me to inspect them. The five artifacts were a biface (4) and four flakes (5, 6, 7, and 10). I had just enough time to weigh and photograph them on the tailgate of a truck. These artifacts all exhibited hydration patination on the artifact surface facing up in the cache (cf. Muñiz 2014:109). They also exhibited calcium carbonate encrustations on the underside of the artifact in the pit demonstrating that the assemblage of artifacts represents a single caching event of some antiquity.

The other five artifacts from the cache, three bifaces and two flakes, are still in the possession of the other discoverer. The other discover was unwilling to allow me to inspect them because of long standing tension over government interference with private property rights.[1]

The typological assignments for the bifaces I did not inspect, Bifaces 1, 2, and 3, are based on the published line drawings (Janetski et al. 1988). Only one side of each of the bifaces was illustrated, presumably the side with the most flake scars. As discussed below, the preform, bifaces, and flakes have strong similarities to artifacts from other Clovis caches.

Biface 1 is an exceptionally large early- to middle-stage biface measuring at least 360 mm in length. This is the largest obsidian biface reported from western North America. It also is slightly longer than other large Clovis bifaces recovered from confirmed Clovis caches. A 316 mm biface was reported from the Anzick site (Wilke et al. 1991). The Watts cache contained two bifaces greater than 300 mm long (Kilby 2008; Kilby and Huckell 2014:264).

Interestingly, the largest reported Clovis point from western North America is a surface find from central Washington, not far from the East Wenatchee Clovis cache (Gramly 1993:51). This specimen, also of obsidian, is 247 mm long and may have been longer because it is heavily resharpened and retouched. A very large biface, such as Biface 1, would be necessary for a Clovis knapper to create a large obsidian fluted point similar to the one from Washington.

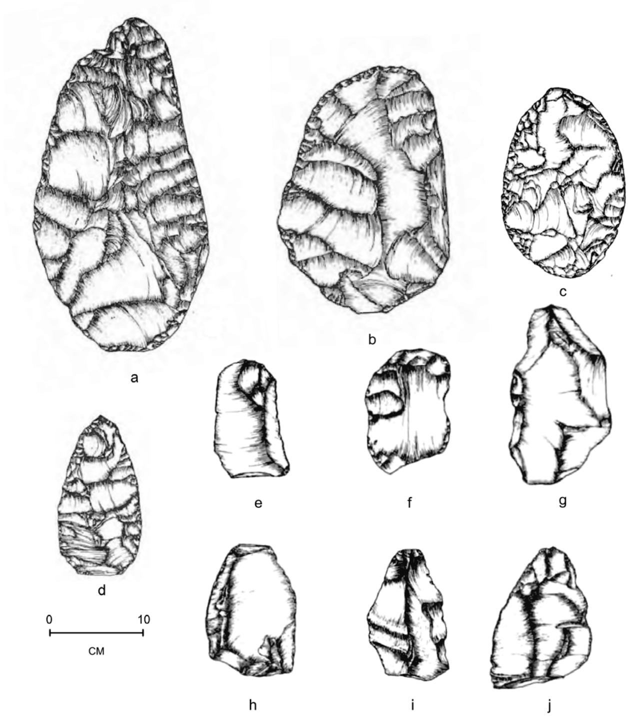

Figure 3. Line drawings of Loa cache artifacts. (a) Early- to middle-stage biface (Artifact 1); (b) Early- to middle-stage biface (Artifact 3); (c) Ovate biface (Artifact 4); (d) Projectile point preform (Artifact 2); (e) Flake (Artifact 5); (f) Flake (Artifact 6); (g) Flake (Artifact 7); (h) Flake (Artifact 8); (i) Flake (Artifact 9); (j) Flake (Artifact 10) (from Janetski et al.1988). Scaled and reproduced with permission.

Biface 2 is the most refined biface from the Loa cache. It is 160 mm long and 10 mm thick, too thin to continue to function as a bifacial core as reported (Janetski et al. 1988). It appears to have been reduced into a lanceolate projectile point preform. The illustrated side of the artifact suggests that the knapper used the opposed diving biface thinning method (Bradley 1982), a thinning technique that is sometimes found on Clovis bifaces. The specimen is similar in shape and size to bifaces in the Simon cache (Woods and Titmus 1985: Figure 4a) and the Fenn cache (Frison and Bradley 1999:Plate 50 [Artifact 105]). This preform also appears to have a beveled fluting platform on the base of the specimen (cf. Wilke et al. 1991).[2]

Biface 3 is an irregularly shaped early- to middle-stage biface about 260 mm in length. No distinctive Clovis technological traits are depicted in the illustration of this biface. Kilby (2008:225–226) notes that very large bifaces were the favored mode of transporting raw material for Clovis people.

As noted above, ovate Biface 4 resembles the large obsidian biface in the Fenn cache. Biface 4 is ovate in shape and 170 mm in length. It also resembles several large bifaces from the Simon cache (Woods and Titmus 1985). This biface, like the bifaces in the Simon cache, is thicker

Table 1. Data for the Ten Artifacts from the Loa Cache (Numbered from the Bottom of the Cache Pit Upward).

Artifact Number	Artifact Type	Material	Length (cm)[1]	Width (cm)[1]	Thickness (cm)[1]	Weight (gr)
10	Flake	Wild Horse Canyon Obsidian	15	10	3	187
9	Flake	Wild Horse Canyon Obsidian	14	9	2	149[2]
8	Flake	Wild Horse Canyon Obsidian	14	9	2	175[2]
7	Flake	Wild Horse Canyon Obsidian	19	11	3	295
6	Flake	Wild Horse Canyon Obsidian	14	9	2	320
5	Flake	Wild Horse Canyon Obsidian	13	8	3	185
4	Early- to middle-stage ovate biface	Wild Horse Canyon Obsidian	17	11	4	1185
3	Early- to middle-stage biface	Wild Horse Canyon Obsidian	26	17	5	435[2]
2	Projectile point preform	Wild Horse Canyon Obsidian	18	8	1	163[2]
1	Early- to middle-stage biface	Wild Horse Canyon Obsidian	36	17	5	1738[2]
Total						4832

[1] from Janetski et al. 1988.

[2] provided by Utah State University Eastern Prehistoric Museum.

than the bifaces from the Fenn cache because the Fenn cache bifaces are further along in the reduction trajectory.

Figure 4 includes photographs of both sides of Biface 4. Side a, the patinated side, is the side illustrated in 1988 (Janetski et al. 1988). It has numerous flakes scars across the surface, none of which are classic overshot flakes. Side b is the opposite side of the biface with fewer, larger flake scars. This biface served as a core for flake removal. While several of the flake scars on this side of the biface are large and travel across the midline of the biface, they cannot be strictly interpreted as overshot flakes.

The pattern of flaking and the lack of overshot flaking on this biface is significant. Overshot flaking, whether intentional or not, is designed to thin a biface by removing large masses of raw material from a biface in a short period of time (Bradley 1982) and is considered one of the technological by-products in the Clovis biface reduction sequence.

It is doubtful that the removal of these flakes on the opposing face of Biface 4 was directed at thinning the biface. The larger flake scars on this side indicate that these flakes were likely being removed for use as expedient cutting implements or flake blanks for smaller tools, not for reducing the volume of the biface. This biface and Bifaces

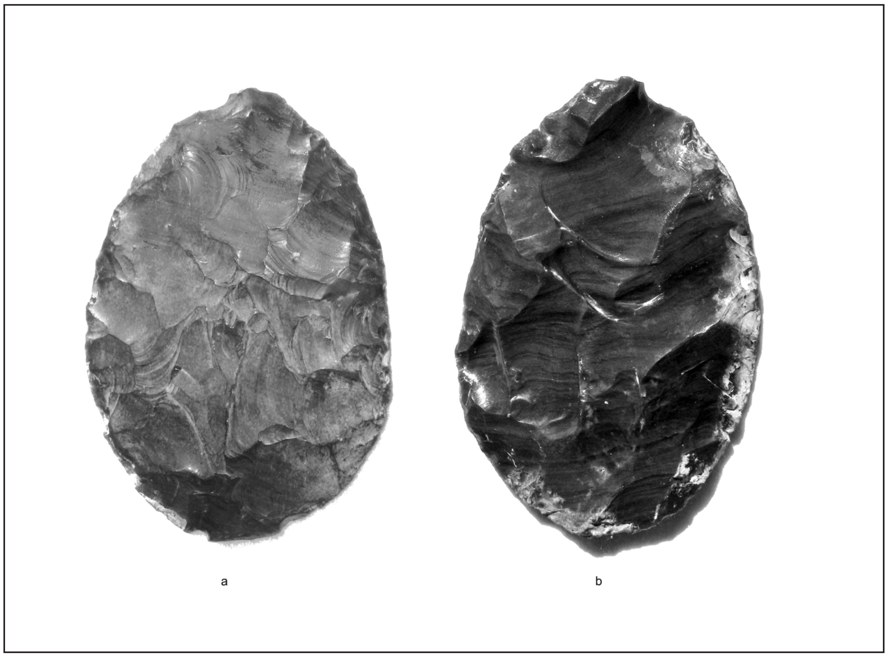

Figure 4. Photo of ovate biface (Artifact 4) from the Loa cache. (a) Side facing up in the cache; (b) Side facing down in the cache.

1 and 3 are thick (40 – 50 mm) compared to Clovis bifaces in other caches. At these thicknesses, they still remained useful as a store of raw material, they had not yet reached the end of their use-life. Muñiz (2014:116) notes that after the maximum thickness of a Clovis biface passes below 30 mm the use-life of the bifacial core is relatively short. At some point in the reduction sequence of these bifaces, the knapper might have switched to overshot flaking to utilize the last remnant of the biface and reduce it to a preform and eventually a projectile point (cf. Davis et al. 2012:Figure 3.3). However, the Loa cache bifaces were never retrieved for additional reduction.

The flakes in the cache were illustrated with the ventral side down (Janetski et al. 1988). The artifacts had little edge damage for having been transported so far from the Mineral Mountains where they were obtained. Several had some areas of weathered surfaces on the dorsal side indicating they were removed from the exterior of large nodules of obsidian.

IS THE LOA CACHE FREMONT OR LATE PREHISTORIC IN AFFILIATION?

Janetski and colleagues speculated that it "is possible that the cache is chronologically related to the Fremont or Late Prehistoric component of site 42WN1674" (Janetski et al. 1988:63) based on the nearby presence of a late prehistoric pot and a Fremont habitation site. Besides the geographic propinquity of the Fremont site, the cache, and the pot, there are no data internal to the cache that support this interpretation.

There are no comprehensive reviews of prehistoric caches from the state of Utah, as there is for Colorado (e.g. Labell 2015). Therefore, a Google scholar search for lithic caches and biface caches among Late Prehistoric or Fremont sites in Utah was conducted. The search did not identify any such caches although there are a number of published reports of lithic caches from the state as noted below. In addition to the published sources, a search of the Utah Department of Heritage and Arts (DHA) site records was also conducted which produced several artifact concentrations identified as lithic caches in CRM reports and site forms. These are also included in the discussion below. Some of the artifact concentrations noted on site forms as caches fail to meet even a common definition of the term cache, but are included below for completeness of discussion.

Besides the Loa cache the only other lithic cache reported from the northern Colorado Plateau is a cache associated with arrow manufacture at 42CB642. One cache, the Broadbent cache, is located in northern Utah in the Wyoming Basin. All of the remaining caches from Utah described below are from the eastern Great Basin.

42BE353

The DHA site records include a punch card record of site 42BE353 recorded in Beaver County in 1977 by Southern Utah State College (now Southern Utah University). The site record states “Lithic cache of ovoid obsidian knives (29).” Of all caches identified as lithic caches in the state of Utah this one appears to be most similar to the Loa cache, but no other information on the cache is available.

42BO702

42B0702 is a site in Box Elder county. A collector’s pile of chipped stone artifact and tools was identified as a lithic cache (Fawcett and Simms 1993:70).

42BO796

Macpherson (1994) describes a cache of 13 chert bifaces from site 42BO796, an Archaic site in northwestern Utah. These middle stage bifaces range from 89 mm to a maximum of 121 mm in length. The presence of two Pinto points and an Elko Corner-notched point on the site confirm an Archaic affiliation of the site and the cache.

42CB642

Site 42CB642 in Nine Mile Canyon, recorded in 1989 (DHA records), includes a cache of 12 chert flakes and a scraper in a sandstone outcrop crack near another crack with 43 phragmites reeds, some with burned ends, one with a maximum length 790 mm. The flakes average 49 mm in length and the site recorders speculate that the flakes and reeds were stored as a cache for later manufacture of arrows which would date this cache to after AD 500.

Broadbent Cache (42DA498)

A cache of 36 chipped stone projectile points and one biface discovered near Manila, Utah was reported by Broadbent (1992). This cache contains one biface and 36 projectile points identified as Mount Albion Side-notched points, an Early Archaic projectile point style associated with the Mountain Tradition (Schroedl 1993). The biface has a maximum length of 103 mm.

42DV2

Cache 1, recovered at 42DV2 in northern Utah, is a concentration of 23 lithic artifacts including two obsidian projectile points, two obsidian cores, nine obsidian flakes, 5 expedient chert tools, and 5 chert flakes (SWCA Environmental Consultants 2011:161). The obsidian from this cache was sourced to the Malad Idaho source. The two projectile points are Cottonwood Triangular points dating the cache to the Late Prehistoric Period. The largest chert flake is 59 mm and the largest obsidian flake is 48 mm.

42GA6147

Gruis and Hutmacher-Cunningham (2008) identify a concentration of 20–25 flakes and shatter in a small area under a log on an historic site, 42GA6147, as a lithic cache. They state:

“The prehistoric component consists of a small cache of 20 to 25 chalcedony shatter and flakes in an area of 50 cm by 10 cm located under one of the logs. The cache does not appear to be a collector’s pile. The shatter and flakes range in size from 5 by 10 cm to 10 by 20 cm [sic: mm?]. One chert core with a blade scar was also identified.” (Gruis and Hutmacher-Cunningham

2008:12). The relationship of the cache to the historic component on this site is not discussed.

42WB31

The artifact concentration identified as a cache at this site near Willard Bay in northern Utah included a concentration of 61 secondary flakes, most of which are small bifacial thinning flakes as identified by Fawcett and Simms (1993:180). This site is assigned a Late Prehistoric affiliation by Fawcett and Simms (1993). No measurements were reported for the biface thinning flakes.

42WB326

This artifact concentration identified as a cache consists of 88 surface obsidian flakes near Willard Bay in northern Utah recovered from a Late Prehistoric site. According to Cornell et al. (1992) the maximum length of any flake is 75 mm.[4]

42WS395

Walling et al. (1986) identified a concentration of grave goods associated with a high-status Virgin Anasazi burial at site 42WS395 in southwestern Utah as a lithic cache. They note "The entire cache of lithics and minerals measured 14 by 11 cm. and included twelve pieces of malachite, fourteen fragments of white ochre, two sherds each of North Creek Gray and North Creek Corrugated, and twenty-eight pieces of lithic debitage. The malachite, the ochre, and the debitage had been segregated into distinct clusters." (Walling et al. 1986:398).

42WS4833

A surface concentration of flakes near St. George, Utah, was pictured as a lithic cache on a prehistoric site without an assigned affiliation (HRA, Inc. 2006:18).

Utah Cache Discussion

The Loa cache has no similarity and is not comparable to any of these 11 caches with the exception of the obsidian tool cache reported from 42BE353, but no further information is available for that cache. The bifaces in the Loa cache are magnitudes of order larger than any of the artifacts in the reported caches or artifact concentrations noted above. During the Fremont and Late Prehistoric periods in Utah on the Colorado Plateau, there is no evidence that groups from these time periods regularly created toolstone caches. Nor are there flaked stone artifact types from these time periods that require bifaces of the size recovered in the Loa cache.

Bifaces are the most expeditious way to transport toolstone over long distances (Kelly 1988). However, if the ultimate goal is to create Fremont Bull Creek or Parowan Basal-notched points or Late Prehistoric Desert Side-notched or Cottonwood Triangular points, it is inefficient to create and transport such large bifaces as those in the Loa cache which are all greater than 170 mm in length. Comparison of the Loa cache with these other caches from Utah does not support Janetski et al.'s assignment of Late Prehistoric or Fremont affiliation for the Loa cache. There is no evidence that post-Clovis people in the eastern Great Basin or the Colorado Plateau had a need for transporting and caching very large bifaces.

If a large fluted point was recovered from a Fremont habitation site no researcher would presume that Fremont people manufactured the Clovis point based on geographic propinquity. Assigning cultural affiliation based only on nearby artifacts or sites is often inappropriate. By 2016, an estimated 90,000 prehistoric sites have been recorded throughout the state of Utah and perhaps no more than 10% of the state has been subjected to intensive cultural resource inventory (Leeflang 2016). This implies that there could be tens of thousands more sites within the state, meaning that, on average, any prehistoric site in the state is probably within an hour's walk of another site in any direction.

The biface cache at 42BO796 (Macpherson 1994) in Box Elder County is a practical example of this issue. Although the site contained evidence of Archaic affiliation, Macpherson (1994:62) notes that 14 other lithic scatters were recorded

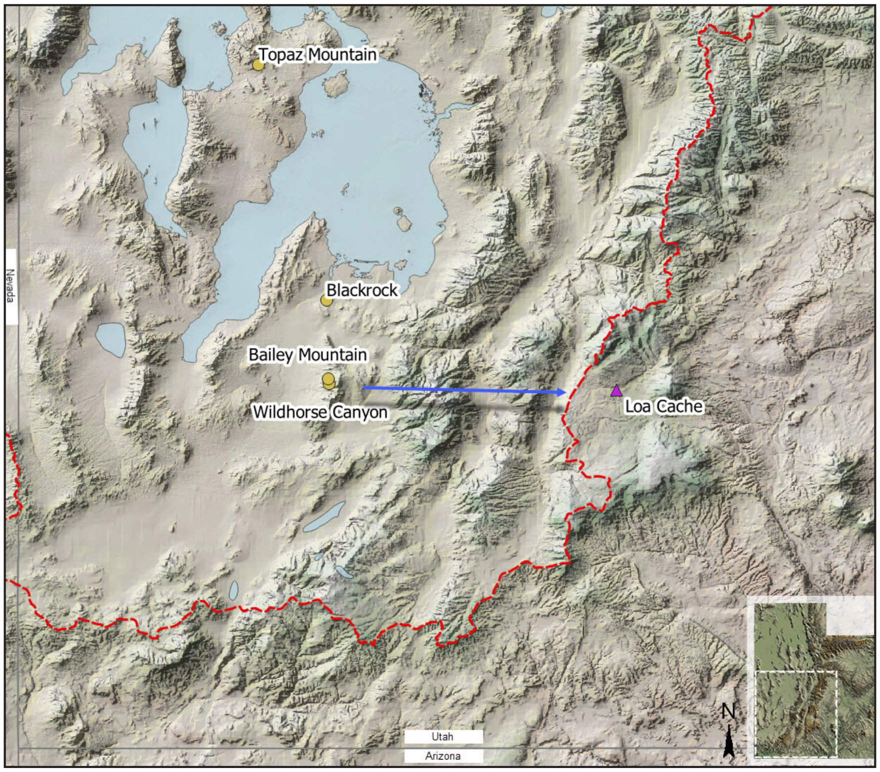

Figure 5. Location of the Loa cache (triangle) in relation to the Wildhorse obsidian source and other obsidian sources used by Clovis people in the region (circles). Pleistocene pluvial lakes are shown in blue and the eastern boundary of the Great Basin is shown with a dashed red line. The blue arrow depicts the direction of travel by Clovis people.

within 1 km of the site. In the Upper Salt Creek area of Canyonlands National Park, site density is as high as 40 sites per square mile. In the Big Pocket area of Upper Salt Creek, a radiocarbon dated Early Archaic site is just footsteps from a Pueblo III Mesa Verde Anasazi cliff dwelling (Schroedl and Coulam 2021). In such situations geographic propinquity is a weak argument for assigning cultural affiliation. Cultural affiliation of any particular feature should be based on distinctive traits present in the feature or the immediate site area and not derived from the affiliation of a nearby site or artifact.

Within Utah, biface caches and even artifact concentrations identified as caches are rare. The lack of caches from the northern Colorado Plateau is expected because there is little need for long distant transport and caching of toolstone on the plateau. The surficial geology of the uplifted Colorado Plateau provides an abundance of high quality, knappable siliceous toolstone across the plateau from widespread outcrops of several toolstone-bearing geological formations. The most distinctive cache on the northern Colorado Plateau is the Loa cache. Ironically, it is not manufactured from toolstone present on the Colorado Plateau, but rather from obsidian obtained from the Wildhorse Canyon source in the Great Basin (Figure 5). Prior to caching, the artifacts in the cache were transported across the Mineral Mountains, the Tushar Mountains, and the Sevier Plateau 100 km to the east. The location of this cache suggests that creators of the cache were unfamiliar with the availability of toolstone on the plateau, otherwise there would

Table 2. Confirmed Clovis Caches with Diagnostic Points from Western North America.

Cache	Location	Shape of Largest Biface	Maximum Biface Length (mm)	Maximum Length of Clovis point (mm)	Reference
Anzick	Montana	Asymmetrical	316	153	Wilke et al. 1991
Crook County	Wyoming	Ovate	218	45	Kilby 2008;Tankersley 1998, 2002
Drake	Colorado	Projectile point	163	163	Stanford and Jodry 1988
East Wenatchee	Washington	Projectile point	234	234	Gramley 1993
Fenn	Wyoming/ Utah/Idaho	Ovate	221	212	Frison and Bradley 1999
Rummells-Maske	Iowa	Projectile point	119	119	Morrow and Morrow 2002
Simon	Idaho	Ovate	290	185	Butler 1963; Kohntopp 2001
Mean			$\bar{x}$ = 223	$\bar{x}$ = 158.7	

have been no need to transport the obsidian that far.

Clovis is the only technocomplex in Western North America with large projectile points that would require such large bifaces as found in the Loa cache. The exceptional length of the largest Loa cache biface exceeds the range of bifaces in confirmed Clovis caches and is far greater than the maximum length of bifaces in non-Clovis caches as discussed below, demonstrating the Loa cache is Clovis in affiliation.

COMPARISON WITH CLOVIS CACHES

Although comparative lithic caches are rare in the state of Utah, there are a number of other biface and lithic caches across the western portion of the continent that are available for comparison with the Loa cache including Clovis caches and non-Clovis caches. In 2014, Kilby and Huckell (2014:Table 15.1) identified 26 caches that they believe are Clovis caches. Osborn (2016) described one additional Clovis biface cache from Nebraska.

These caches are grouped into three distinct categories, the first group of caches are unequivocally Clovis because they included finished Clovis projectile points. Besides the presence of diagnostic projectile points each contained one or more large bifaces, except the Drake cache which was composed entirely of projectile points. The co-occurrence of large bifaces with diagnostic Clovis points demonstrates that large bifaces are an integral component of confirmed Clovis caches. Seven caches are included in this group (Table 2), one of which, the Anzick cache, has been radiocarbon dated to the Clovis time period: 12,905 to 12,695 cal BP (Becerra-Valdivia et al. 2018).

The second group of caches (Table 3) are presumed to be Clovis caches by Kilby and Huckell primarily because of the presence of large bifaces (each with a biface with a maximum length greater than 125 mm) and other technological traits, but they lack distinctive finished Clovis points although some include late-stage preforms. One of these caches without diagnostic implements, the Beach cache, has

Table 3. Confirmed Clovis Caches Without Diagnostic Points from Western North America.

Cache	Location	Shape of Largest Biface	Maximum Biface Length (mm)	Possible Diagnostic Artifact (mm)	Reference
Baller	Nebraska	Lenticular	295	–	Osborne 2016
Beach	North Dakota	Ovate	303	–	Kilby and Huckell 2012; Huckell 2014
Busse	Kansas	Leaf-shaped	293	–	Kilby 2008
Carlisle	Iowa	Ovate	167	–	Hill et al. 2014
CW	Colorado	Ovate	127	–	Muniz 2014
DeGraffenried	Texas	Ovate	211	Preform (170)	Collins, Lohse, and Shoberg 2007
Hogeye	Texas	Ovate	193	Preform (163)	Waters and Jennings 2015
Mahaffy	Colorado	Ovate	218	–	Bamforth 2014
McKinnis	Missouri	Square Base	143	–	Bostrum 2004
Watts	Colorado	Square Base	338	Preform (157)	Patten 2015
Mean			$\bar{x}$ = 228.8		

been radiocarbon dated to the Clovis time period (Huckell and Kilby 2012).

The final group of putative Clovis caches are nine caches dominated by blades (cf. Kilby 2015), with bifaces present in only minor quantities or not at all (Table 4). The assignment of Clovis affiliation to these caches is questionable, as none of these caches have directly associated radiocarbon dates nor do they include diagnostic Clovis points. Most of these caches, excluding the Pelland cache from Minnesota, are clustered on the Southern Plains.

In a recent analysis of the Goodson site in Oklahoma, Eren et al. (2018) provide a cautionary tale noting that not all technological traits such as overshot flaking, bifacial fluting, and blade manufacture are diagnostic traits exclusively associated with Clovis technology. Based on a discriminant function analysis, they show that blades from Archaic caches in the region are statistically indistinguishable from blades within caches identified as Clovis on the southern Plains. Lacking associated radiocarbon dates or associated diagnostic projectile points, it is uncertain that the caches on the southern Plains dominated by blades are Clovis in affiliation. While such caches may date to the Clovis time period, the affiliation of the creators of these caches is in question. Because the Loa cache did not include even a single blade, the nine blade-dominated caches listed in Table 4 are not included in these Clovis cache comparisons. Figure 6 depicts the wide-spread geographic distribution of these caches identified as Clovis by Kilby and Huckell.

The assemblage of the Loa cache is limited to flakes and bifaces. Janetski et al. (1988) identified all the artifacts in the cache as quarry blanks, items suitable for reduction into other tool forms, even though six of the specimens were flakes and four were bifaces. The five large flakes in the cache can only be identified as non-

Table 4. Blade-dominated Caches Not Included in the Comparison with the Loa Cache.

Cache and Location	Reference
Anadarko, Oklahoma	Hammatt 1970; Kilby 2008
Dickenson, New Mexico	Condon et al. 2014
Franey, Nebraska	Grange 1964; Kilby 2008
Garland, Oklahoma	Kilby 2008
Green, New Nexico	Green 1963; Kilby 2008
JS, Oklahoma	Bement 2014
Keven Davis, Texas	Collins 1999
Pelland, Minnesota	Stoltman 1971; Kilby 2008
Sailor-Helton, Kansas	Mallouf 1994; Kilby 2008

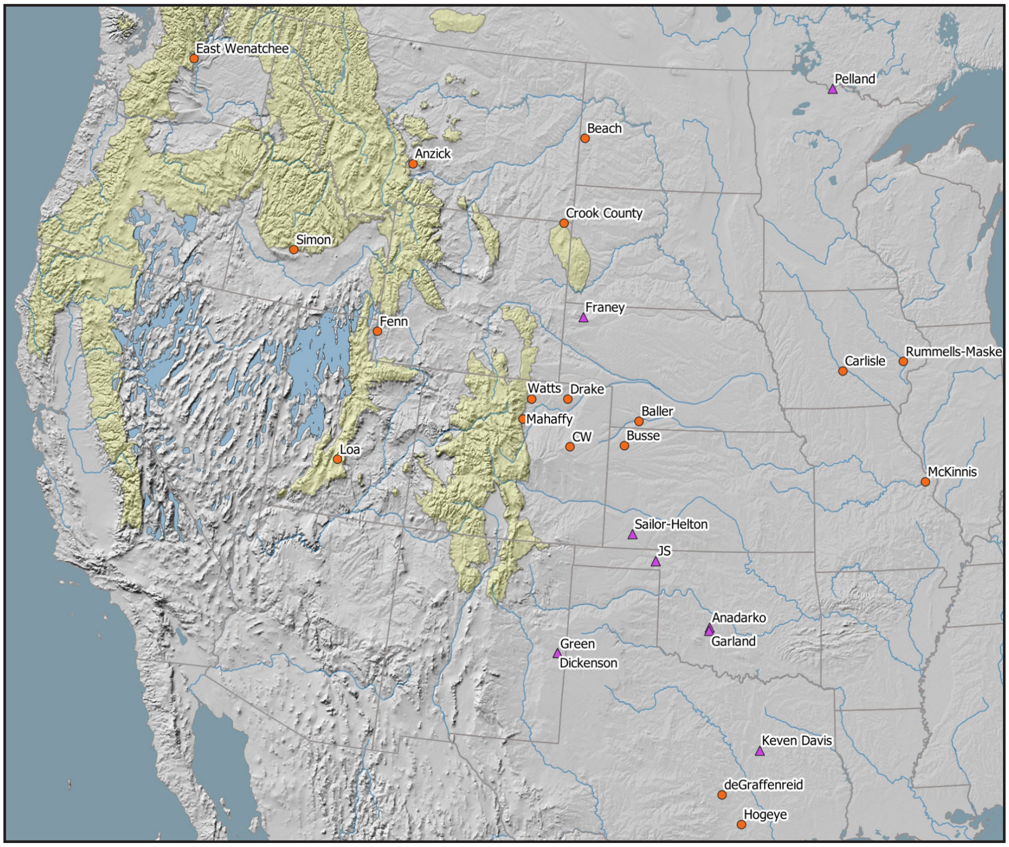

Figure 6. Map of Western North America showing the location of reported Clovis caches. Late Pleistocene pluvial lakes are depicted in blue. Orange circles represent Clovis caches and purple triangles represent caches identified by Kilby and Huckell (2014) as Clovis, but which are dominated by blades and lack diagnostic projectile points. Several of the western caches are situated along the foothills of the Northwestern Forested Mountains ecozone, highlighted in yellow (Omernik and Griffith 2014).

diagnostic types, decortication flakes, primary flakes, or early reduction flakes depending on the flake typology being used. While certain flake types such as overshot flakes and fluting flakes are associated with Clovis lithic reduction loci, none were recovered from the Loa cache.

Grouping the four Loa bifaces as quarry blanks fails to distinguish the fact that some of these bifaces fall at different stages along a biface reduction trajectory as noted in Table 1. A quartet or four-part stage division was used to segregate these bifaces; early, middle, late stage or preform, and finished tool. As previously noted, no finished tools (i.e. Clovis points) were present in the assemblage.

Shott (2017), primarily referencing Paleoindian biface data, compares the use of a stage model of biface reduction following Callahan's model with a continuous reduction model of biface production. Shott conducted an extensive multivariate analysis of several data sets including Callahan's original data, replicas of Paija´n points, a late Pleistocene type found on the central Andean coast, and data from the Paleoindian sites of Adam, Gault, and Thunderbird. He notes that biface typologies based on stage classification are not consistently replicable among researchers.

His statistical analysis demonstrates that the within-group variance is sometimes greater than the between-group variance of the individual stages. Shott notes that biface reduction is a continuous process of removal of excess raw material, a process that is not clearly captured by imposing a stage sequence on a collection of bifaces. His principal component analysis demonstrated that the first principal component, which he identifies as gestalt size, is a multivariate measure of progressive allometric change in preforms from blank to finished biface, primarily because weight declines at a faster rate than plan area during the process of thinning a biface to achieve a preform before completion of the finished implement.

While Shott was only considering a partial analysis of the biface reduction continuum, Smith (2010) conducted various multivariate analyses of geometric morphometric analysis of Clovis points (finished tools in the reduction trajectory). She notes that Principal Component 1 (PC1) was also a shape-size measure of Clovis points. "The extreme decrease in length of the original PC1 was therefore influenced by the noncached sample" (Smith 2010:71). Because the sample of Clovis points from caches were generally longer as they had not been subjected to resharpening and were still in an earlier stage of their use-life trajectory, they greatly affected the continuous variation in plan view of finished points.

Flint knapping is a reductive process. What Shott and Smith demonstrate, in lay persons' terms, is that knapping a large artifact such as a Clovis point requires an even larger piece of raw material to start with. Knapping a large lanceolate shaped artifact or any shape less than a perfect circle, the limiting dimension of the final artifact is always the length of the initial blank or piece of raw material. While detailed comparisons of the stages of manufacture of the Loa cache bifaces with bifaces from other Clovis caches may be useful, these comparisons are not necessary to demonstrate that the Loa cache is Clovis in affiliation.

In both Tables 2 and 3, the maximum length of any biface in each cache is listed. The largest biface in each of the caches represents the upper asymptotic limit to the size of any tool that could be knapped from that biface or any other biface in that cache. Table 2 also includes the maximum length of any finished Clovis point in the cache. Caches without diagnostic points occasionally include preforms. If a late-stage preform was included in these caches without projectile points, its length is also presented in Table 3.

Unless we assume that one or more of these caches were created by the same knapper, these caching events represent separate independent events suitable for statistical analysis. Because maximum biface length is a continuous variable, not dependent on any identifiable stage of reduction, it too is suitable for statistical analysis.

Table 5. T-test Results of Comparison of Maximum Biface Length of Clovis Biface Caches with and without Projectile Points.

Variable	Group	N	Mean	SD	SE
Maximum Biface Length	Clovis caches with projectile points	7	223	68	25.7
	Clovis caches without projectile points	10	228.8	74	23.4
Student's t-test					
	t	df	p		
Maximum Biface Length	-0.164	15	0.872	–	–

Table 5 presents the results of a two sample Student's t-test of these two independent groups of caches, Clovis caches with projectile points and Clovis caches without points. As noted in the table, there is not much variation in the mean maximum biface length between the two groups or the range of the standard deviation. A Shapiro-Wilks test shows that variation in both groups is normally distributed. The t-statistic indicates that the null hypothesis that the two groups are different must be rejected. This test demonstrates that the 10 caches without associated Clovis points but with very large bifaces are best identified as Clovis.

The large biface in the Loa cache is a 360 mm early-middle stage obsidian biface. This biface is even larger than any other Clovis biface and certainly larger than any biface recorded in Utah. Including this cache with Clovis caches in comparison to non-Clovis caches demonstrates that the Loa cache is Clovis in affiliation as discussed in the next section.

COMPARISON WITH NON-CLOVIS CACHES

While the t-tests described above show that caches with very large bifaces (exceeding 127 mm in length) can be classified as Clovis even if no diagnostic implements are present, it has not been determined that such caches are statistically different from lithic caches with no assigned affiliation or with caches that are assigned post-Clovis affiliations based on dating or other diagnostic artifacts. A literature review of caches in western North America produced a selected group of lithic or biface caches that have an unassigned affiliation or have been assigned an affiliation other than Clovis. Table 6 presents a list of 17 non-Clovis caches, their affiliation if assigned, and the maximum length of any biface (or flakes in one case) in the cache. This list includes a ceremonial cache from New Mexico, five caches from the Tosawihi Quarries in north central Nevada, three Western Stemmed Tradition caches, three caches from Utah discussed above, and five other caches from Oregon, Idaho, and California.

A cache of three finely flaked ceremonial bipointed bifaces, referred to as knives by Judd (1954) and Lekson (1997) and tree-ring dated to the 11th century (Windes and Ford 1996), was discovered sealed in the north wall of Kiva Q at Pueblo Bonito in New Mexico. Judd identifies the material of the largest biface as silicified limestone which may have originated from the southeast in Texas. The largest biface in this cache measures 238 mm and is one of the largest, if not the largest, finished bifacially flaked implement in western North America within a cache or not.

Five biface caches were recovered from the Tosawihi Quarries (26EK2032) in north central Nevada, the source for high quality Tosawihi opalite. The Tosawihi source is the largest bedrock quarry in the Great Basin, covering 1400 acres with multiple quarrying areas, and is one of the largest in North America (Elston 2006:2). None of these caches have an associated radiocarbon

Table 6. Selected List of Western Non-Clovis Caches.

Cache	State	Shape of Largest Biface	Maximum Biface (or flake) Length (mm)	Cultural Affilliation	Reference
Kiva Q	New Mexico	Bipointed	238	AD 1043–1048	Judd 1954; Windes and Ford 1996
Rusco (Tosawihi Quarries)	Nevada	Ovate	166	Unassigned	Elston et al. 1987
26EK3095, Feature 24 (Tosawihi Quarries)	Nevada	Bipointed	223	Unassigned	Elston 1989
26EK3192, Feature 1 (Tosawihi Quarries)	Nevada	Bipointed	186	Unassigned	Elston 1989
26EK3197, Feature 5 (Tosawihi Quarries)	Nevada	Leaf-shaped	150	Unassigned	Elston 1989
26EK3184, Feature 1 (Tosawihi Quarries)	Nevada	Ovate	133	Unassigned	Elston 1989
Cooper’s Ferry, PFP1	Idaho	Projectile point	68	Western Stemmed	Davis et al. 2017
Coopers Ferry, PFA2	Idaho	Projectile point	65	Western Stemmed	Davis et al. 2014
McNine	Nevada	Stemmed	173	Western Stemmed	Amick 2004
Broadbent	Utah	Leaf-shaped	103	Early Archaic	Broadbent 1992, Schroedl 1993
42BO796	Utah	Ovate	121	Archaic	Macpherson 1994
42WB326	Utah	Flakes only	75	Late Prehistoric	Cornell et al. 1992
Pahoehoe	Oregon	Lanceolate	94	Post-date 6800 BP	Scott et al. 1986
China Creek	Idaho	Flat-based	132	Unassigned	Kohntopp 2001
Rock Creek	Idaho	Ovate	62	Late Archaic	Kohntopp 2001
Cedar Draw	Idaho	Ovate	56	Unassigned	Kohntopp 2001
Little Lake	California	Leaf-shaped	168	AD 1150–1300	Garfinkel et al. 2004
			$\bar{x}$ = 130.2		

Table 7. T-test Results of Comparison of Maximum Biface Length of Clovis Caches and Non-Clovis Caches.

Variable	Group	N	Mean	SD	SE
Maximum Biface Length	Clovis caches	18	233.8	74.3	17.5
	Non-Clovis caches	17	130.2	56.9	13.8

Student's t-test	t	df	p
Maximum Biface Length	4.614	33	< .001

date or diagnostic artifacts. The artifacts in these caches show minimal reduction so they are not raw material blanks, but rather are early stage bifaces, all of which are true quarry bifaces found cached within the quarry areas. The longest bifaces in these caches fall within the range identified for bifaces from Clovis caches.

However, the maximum length of bifaces in these caches is not unexpected. These early stage specimens were cached on site among the quarry pits. Although these caches may have been a function of over-production, or of purposeful storage for a return visit to the area, Bloomer et al. (1992:114) speculate that these caches were created for retrieval during seasons less suitable for quarrying. As significant as the Tosawihi Quarries were to prehistoric people of later time periods there is no evidence that Clovis people ever visited the quarry or manufactured Clovis points from Tosawihi opalite. Drews et al. note "with the exception of Clovis, virtually the full range of time diagnostic Great Basin projectile points and pottery has been observed in and adjacent to Tosawihi Quarries" (Drews et al. 1989:398).

Three Western Stemmed biface caches are included in the list. Two Western Stemmed caches were recovered from the Cooper's Ferry site in Idaho. Cache PFA2 included projectile points and other stone implements (Davis et al. 2014). The only bifaces in the cache were the projectile points. The second cache from Cooper's Ferry is PFP1which included a few flakes and 14 Western Stemmed points, the largest with a maximum length of 68 mm. Davis et al. (2017:554) claim that Western Stemmed points such as those found in the two caches at Cooper's Ferry were often manufactured from blades or linear macroflake blanks in contrast to Clovis points which are created within a biface reduction trajectory. The third Western Stemmed cache is the McNine cache from Nevada which only includes obsidian bifaces and stemmed Parman points (Amick 2004). The maximum length of the longest point is 115 mm. The presence of bifaces and projectile points in the McNine cache indicates that not all Western Stemmed points are manufactured from large blades or macroflakes.

Three previously discussed caches from Utah are included in the table. Five other selected biface caches from Idaho, California, and Oregon are also included in the table. The distribution of the maximum length of the lithic artifacts in all of these cache meet the assumption of normality and these caches also are believed to represent independent events.

Another t-test was run comparing the maximum biface length between these 17 non-Clovis caches and the Clovis caches with and without projectile points, including the Loa cache. Table 7 presents the results of the t-test. There is a 10 cm (100 mm) greater difference between the mean maximum length of bifaces from Clovis caches compared to the mean maximum artifact length from the non-Clovis caches. The t-test demonstrates that these two groups of caches are highly statistically different with a probability of less than .001. The box and whisker graph in Figure 7 graphically depicts the difference in mean maximum lengths between Clovis and non-Clovis caches.

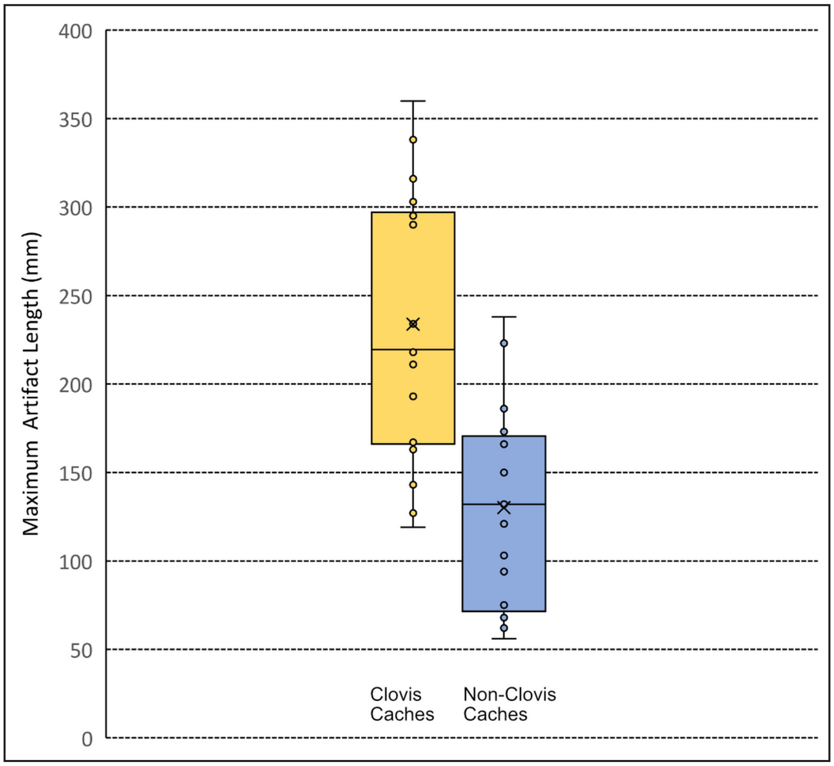

Figure 7. Box and Whisker graph comparing mean maximum length of Clovis caches with non-Clovis caches.

A Mann-Whitney U test, a nonparametric test similar to a t-test, was used to test the difference between the maximum length of finished points and late-stage preforms (excluding the heavily reworked projectile point from the Crook County cache) from the Clovis caches with the maximum length of any artifact, regardless of stage of manufacture, from the non-Clovis caches. The results of this test demonstrate that late-stage preforms and finished points from Clovis caches are statistically longer than the bifaces of any stage of manufacture from the non-Clovis caches. This supports an intuitive observation that, with rare exceptions such as the ceremonial biface from the cache at Kiva Q, finished Clovis points are among the largest finished tool types in western North America.

These statistical tests demonstrate that the maximum length of bifaces in Clovis caches will generally exceed the range for non-Clovis caches. Thus, the maximum biface length in the Loa cache strongly suggests that the cultural affiliation of the cache is Clovis and not some other time period.

CLOVIS CACHE DISCUSSION

It is not surprising that Janetski et al. (1988) attributed a Fremont or Late Prehistoric affiliation to the Loa cache based on the geographic propinquity of the pot and the Fremont habitation site. At that time, the concept of a Clovis cache as a site type had not yet developed. In the 1980s, only the Simon site and the Anzick site were widely accepted Clovis caches.

Also, when the Loa cache was discovered in 1977, Paleoindian occupation in the region was speculative, limited to surface finds of two or three fluted points (Schroedl 1976). However, the presence of Clovis and Folsom in Utah was established in 1988 when Copeland and Fike

(1988) reported on more than 40 Clovis and Folsom fluted points from the state. Copeland and Fike's compendium confirming Paleoindian presence in Utah was published in the first volume of *Utah Archaeology*, the same volume that the Janetski and colleagues' paper on the Loa cache was presented.

The analysis presented here indicates that very large bifaces are an integral part of Clovis caching strategy serving as a store of raw material for further reduction into flake tools or other bifacial implements. The Loa cache with its assemblage of large flakes and bifaces is one of 11 Clovis caches without associated diagnostic points.

Clovis points and preforms from caches represent one of the largest size-class of chipped stone tools in western North America. With the exception of the 119 mm point from the Rummells-Maske site in Iowa and the heavily reworked Clovis point from the Crook County cache, large finished points or preforms in these caches generally exceed 150 mm.

Although some Clovis caches may have had ancillary purposes such as an associated burial at Anzick site (Wilke et al. 1991), in aggregate, Clovis caches represent utilitarian sources of implements and additional toolstone in the form of bifaces. Cached at a known location, these assemblages served as stores of raw material and additional finished implements. Osborn notes:

> "Clovis caches as signatures of colonization are viewed as resupply depots from which early human populations in North America replenished their lithic raw materials if they failed to locate new sources during movement(s) across the landscape. Insurance caches consist of cores, flakes, and bifacial implements placed on a landscape devoid of adequate toolstone." (Osborne 2016:160)

The caches that are discovered today were either abandoned or lost by Clovis people, but the nature of these known Clovis caches suggests that this caching behavior was utilitarian rather than ceremonial. Caches allowed these highly mobile people to move rapidly across the landscape. Without knowledge of toolstone sources ahead of them, the Loa cache, for example, represents a portable store of high quality toolstone for the manufacture of flake tools and bifaces had it been retrieved.

It seems likely that the Loa cache location was not lost to Clovis knappers, it is more likely that the cache was abandoned when other high quality toolstone sources were discovered on the Colorado Plateau. Favoring newly discovered high quality toolstone sources, it was probably not worth the effort to backtrack and retrieve the obsidian bifaces and flakes they had so carefully manufactured and transported for more than 100 km from one hydrological basin to another.

SUMMARY

Clovis caches, a site type associated with the Clovis technocomplex, are rare but are widely scattered across the West from the Columbia Plateau to the Central Plains. This article reports on the Loa cache, a previously unrecognized Clovis cache, discovered on the western edge of the Colorado Plateau. The Loa cache is an important addition to the small but growing number of Clovis caches in western North America that illuminate patterns of Clovis migration. ■

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NOTES

1. Traditionally, as a measure of public recognition, Clovis caches are named after the original discoverers. In this case the discoverer who took me to the site had no interest in having her name made public, and out of respect for her and her sister's privacy, I did not identify them in the report or the acknowledgments. I appreciated the opportunity to visit the site and see a portion of the assemblage. As archaeologists we can only work with archeological data we have access to. I appreciated even the limited opportunity I had to handle only half of the artifact assemblage.
2. One reviewer of a previous draft of this paper suggested that the preform in the Loa cache may be a large western stemmed point fragment with the stem portion broken off terminating in a hinge fracture. I was unable to physically inspect this preform to determine the kind of fracture on the base. However, the Loa preform is 170 mm in length including the potential hinge fracture. Among the stemmed Parman points in the McNine cache (Amick 2004), a hinge fracture at the shoulder of the largest finished Parman point would only produce a blade portion of about 85 mm in length, about half of the size of the Loa biface. Given the large size of finished points and other preforms among the Clovis caches it is more likely that this preform was destined to be reduced into a Clovis point had the cache been recovered by its original creators.
3. A number of other caches are noted in the Utah state site records including tool caches of manos, of hoes, of unfired figurines, and of perishable artifacts such digging implements, prehistoric shields, and pottery. None of these caches are relevant to identifying the cultural affiliation of the Loa flake and biface cache.
4. The cache from this site is discussed in Fawcett and Simms (1993:180) but is incorrectly reported as 42WB325.

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Appliquéd Pottery from Wolf Village

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Appliqué is a decorative pottery technique found at many Fremont sites, but appliquéd sherds or vessels are rarely recovered in large numbers. Excavations at Wolf Village have produced 439 sherds with ceramic appliqué, by far the largest assemblage of this style from a single Fremont site. This article discusses the variation found within the style and proposes a typology of appliqué styles based on the way the appliqué attaches to the vessel body. Appliqué is found on jars and figurines and was used more for its aesthetic value than utilitarian purposes. This visually distinctive technique set these vessels apart, although it is unclear what that might have meant to the prehistoric inhabitants of Wolf Village.

Wolf Village (42UT273), a Fremont site located north of Goshen Canyon in Utah Valley, was the site of Brigham Young University's archaeological field school for six years. To date, excavations revealed seven pit structures, two above-ground adobe structures, and an incredible assemblage of over 300,000 artifacts representing a wide variety of stone, bone, shell, and clay products. Some artifact types are the largest known Fremont sample of that type, which provides an opportunity, in some cases, to characterize and discuss assemblages of relatively uncommon artifacts in a way not previously possible. This is the case with appliquéd pottery.

Appliqué is a decorative technique found on the exterior of vessels where small pieces of molded clay are pressed onto the vessel surface before firing. This form of surface decoration is found on Fremont pottery as well as many Fremont figurines. The use of appliqué is primarily decorative in nature and may have been transformative, turning vessels into representations of plants, animals, or people. This paper provides an overview and description of the appliqué forms at Wolf Village including jar sherds, figurines, and handle pieces. It will also provide some context to place the technique within regional and multiregional perspectives as well as provide possible meanings of its use.

Appliqué Overview

Archaeologists have identified appliquéd pottery at many Fremont sites. Noel Morss described, "small raised squares, made separately and stuck on" (1931:43), pottery recovered from his investigations along the Fremont and Muddy Rivers. Julian Steward reported his observations of archaeological specimens from western Utah:

> The most common applied element is the "coffee bean." Small, oval pellets of clay, about 1/2 inch long, are stuck on end to end, while the vessel is still moist, to form a chain. Then the end of a stick or hollow reed is used to make a small perforation where the ends of the pellets join. These generally encircle the bases of pot necks. Specimens of this type occur at most sites in western Utah. [Steward 1936:7]

Since 1936, 'coffee bean' has become a standard term to refer to most of the appliqué found on Fremont pottery, although there have been other forms and variations noted.

Information from additional excavations enabled ceramicists to look at Fremont pottery on a larger scale. Rex Madsen (1977), David Madsen (1986), and Christopher Watkins (2009) wrote overviews of Fremont pottery, and each noted an appliquéd variation for the five main temper types: Emery, Sevier, Great Salt Lake, Snake Valley, and Uinta. In addition to these works, appliqué on pottery has been noted in site reports from across the Fremont culture region (Aikens 1967a; Ambler 1966; Fry and Dalley 1979; Metcalf et al. 1993; Mooney 2014; Sharrock and Marwitt 1967; Talbot et al. 2000; Taylor 1957; Wormington 1955). Appliqué is one of the most widespread Fremont decorative techniques geographically, although most sites have only small amounts (Janetski et al. 2011). Even with a limited number, appliqué has been involved in the discussions of Fremont origins and demise, style and trade, and ideology.

In the late 1960s, Melvin Aikens suggested that the Fremont culture drew much of its influence from the Plains via the northern part of their territory rather than from the greater Southwest. To support his hypothesis, Aikens (1967b) used observations from skeletal remains, rock art, architecture, and artifacts. He suggested surface manipulation on pottery, including incising, punching, and appliqué, are common in the Northern Plains but "largely foreign to Southwestern pottery" (Aikens 1967b:199). Husted and Mallory (1967), however, contest Aikens' hypothesis declaring that, "Fremont pottery cannot be derived from the Missouri River area because such pottery does not appear in Montana or Wyoming (Pictograph Cave region) until about A. D. 1500 or later" (1967:227). The connection between Fremont appliqué and the pottery from the surrounding areas remains unresolved, but remains an intriguing line of inquiry and only partially addressed in the discussion section of this paper.

More recently, appliqué pottery has been included in discussions of style and vessel personification. Though appliqué has been found on ceramics in many regions in North America, appliqué, Fremont appliqué, and coffee bean appliqué in particular, appears to be regionally specific (Janetski et al. 2011:26). Like other aspects of Fremont material culture such as some rock art styles, appliquéd vessels appear across the Fremont region despite variation in other materials such as ceramic temper (Janetski et al. 2011:25). Watkins, drawing on the similarity between neck banding appliqué on Fremont jars and the decorative appliqué around the necks of anthropomorphic Fremont figurines, suggests that appliquéd vessels have become personified (Watkins 2010). Vessels with appliqué around the neck *became* people. These more recent studies show that there is potential for understanding context for this decorative form. This current study seeks to add to the discussion by adding new data and broadening the scope of inquiry.

Wolf Village Appliqué

Appliqué is the third-most common form of pottery decoration found at Wolf Village after Black-on-gray and Red-on-gray painted styles. There are 439 sherds exhibiting appliqué, representing approximately 0.7 percent of the site's ceramic assemblage. This represents the largest samples of appliqué pottery reported from a Fremont site, providing an opportunity to discuss variation found in this decorative medium. Unfortunately, no complete or reconstructed appliquéd vessels were recovered from Wolf Village and all the information gathered here has been taken from sherds. All appliquéd sherds come from contexts that date to the A.D. 1000s to early 1100s.

The appliquéd sherds reported here were divided into types based on a survey of Fremont ceramic literature and general observations of the Wolf Village assemblage. The three major types proposed here are knobs, pellets, and bands. I further defined elements of each type based on shape, size, manipulation, placement on the vessel, and placement in relation to other elements. Ceramic types were also identified. I determined the height by measuring the appliqué

Figure 1. Examples of knob appliqué from Wolf Village.

and sherd together and then subtracting the thickness of the sherd.

Knobs, reported previously as nodes, bumps, or lumps, are the most prominent form of appliqué at Wolf Village with 191 sherds (44 percent) having this form of appliqué (Figure 1). They are pieces whose edges blend into the vessel surface and are almost exclusively found on the body portion of jars. At Wolf Village, the basic shapes of knobs are rectangular, conical, or subrectangular, largely due to how they were pressed against the surface when they were attached. The height of these protrusions from the body of the vessel ranges from 1 mm to 9.1 mm with a mean of 3.9 mm. None of the knobs show any modification or incising. Because there are no complete examples of vessels with appliqué from Wolf Village that have been recovered, it is impossible to know whether knob appliqué covered entire jar surfaces or only segments. However, the larger sherds show that knobs were arranged in lines either perpendicular to, or spiraling down from, the neck. Two sherds have long knobs alternatively angling towards and away from each other (bottom right sherd in Figure 1).

Pellets are small pieces of clay that are shaped and then pressed onto vessel surfaces, maintaining their original shape. This type of appliqué has been most commonly referred to as "coffee-bean" appliqué but has also been described as beans, doughnuts, fillets, beads, buttons, modular protrusions, and garlands in archaeological literature. This iconic type is found on jars as well as figurines and is considered to be unique to Fremont (Janetski et al. 2011, Ure 2010). Pellets are found on 158 sherds (36 percent) and are the most diverse type of appliqué at Wolf Village with a variety of shapes, arrangements, and manipulations (Figure 2, Table 1).

Figure 2. Examples of pellet appliqué from Wolf Village.

There are 391 individual pellets: 181 are round, 156 are oval, and 54 were elongated ovals. The round pellets have a mean diameter of 6.9 mm while the ovular pellets have an average length of 9.2 mm and width of 6.6 mm. Elongated oval pellets are at least twice as long as they are wide with a mean width of 12.5 mm and length of 5.4 mm. Pellets are found in a number of arrangements in relation to other pellets (Figure 3). Some, including all pellets found on the body or rim, are spaced apart, often in a pattern. Pellets are often placed end-to-end or slightly overlapping, forming a band or bands around the neck. Pellet bands can have multiple rows or can spiral towards the rim. While there is a great deal of variation among pellets, there is no evidence that any single vessel contained more than one kind of pellet.

Bands are continuous ribbons of clay that extend around the entire diameter of a vessel. This form of appliqué has elsewhere been referred to as rings, ribbons, elongated ropes, and strips. Except for three band variations, this type is found at the narrowest point on the necks of jars. Banding is the least frequently found form of appliqué at Wolf Village but occurs on 70 sherds (Figure 4). Bands are sometimes combined with other forms of appliqué, but there is only ever one band per vessel.

The three forms of banding that are not placed at the neck of jars are zigzag, slope, and cross-hatch banding (Figure 5). Zigzag bands are similar to other types of banding except for their arrangement. As can be inferred from the name, this form of banding zigzags between the rim and the neck of the jar. Six sherds have zigzag banding and one of those sherds has an additional piece of appliqué that connects the ends nearest to the neck. Each zig-zag has punched holes spaced 3–4 mm apart. Slope banding acts as a transition from

Table 1. The Shape and Arrangement of Wolf Village Appliquéd Pellets by Impression Placement.

	Between	Center	One end	Off center	Center line	Random	None	Totals
Round								
End-to-end	22	6	7	3	3	–	3	44
Overlapping	–	–	2	1	–	–	–	3
Separated	–	15	3	1	–	–	5	24
Indeterminate	–	–	–	1	–	–	–	1
Oval								
End-to-end	27	–	10	5	4	1	3	50
Overlapping	–	1	2	–	–	–		3
Separated	–	1	–	1	–	–	3	5
Elongated								
End-to-end	14	4	–	2	5	1	–	26
Indeterminate	–	–	–	–	–	–	2	2
Totals	63	27	24	14	12	2	16	158

a smooth surface to pseudo-corrugation. The slope rises gradually from the vessel surface to 2.1–7.6 mm at which point it turns directly back to the vessel body. No sherd with slope banding has been found that also includes a section of the jar base, neck, or rim, so it is difficult to know whether this form of banding is found above or below the pseudo-corrugation. The final unusual form, a crosshatch design, appears on multiple sherds from a single vessel. The appliqué has a low profile and forms a series of diamonds as the lines cross each other.

While knobs are always left plain, both pellets and bands are commonly decorated by impressions and punctations. These decorations are more-or-less evenly spaced impressions made by various sizes of solid or hollow materials (probably vegetal material such as reeds or sticks) and fingernails. On pellets these impressions are found directly in the center, slightly offset from the center (though still along the center), at one end (still along the center), or directly between pellets (Figure 3). When multiple manipulations are found on the same pellet, they are often found along the center line or in rows. Less commonly, the punctations are randomly spread across the pellet. The manner of manipulation stays consistent for each vessel; a band will have a single type of decoration and every pellet will have the same design.

Appliqué decoration is usually limited to one type of appliqué on each vessel, and the arrangement, orientation, and decoration is consistent for each example of appliqué on the vessel. There are, however, several examples of combinations of different kinds of appliqué as well as appliqué used with other forms of decoration. There are five examples of jars with two types of appliqué. Three have a combination of knobs and pellets, and the other two sherds have both knobs and a band. None of the sherds from Wolf Village combines pellets and bands. Seven sherds with appliqué also have red painted designs, a few with the red paint splashing onto the appliqué. Twenty-four of the sherds have a fugitive red pigment wash, which was used as a decorative element on various types of Fremont and Southwestern pottery.

Nodes, knobs, and bands were not the only pieces to be applied to the exterior of vessels. All of the handles at Wolf Village were applied to the outside of jars or pitchers prior to firing. They have not always been considered as applique but have relevance to the present discussion and

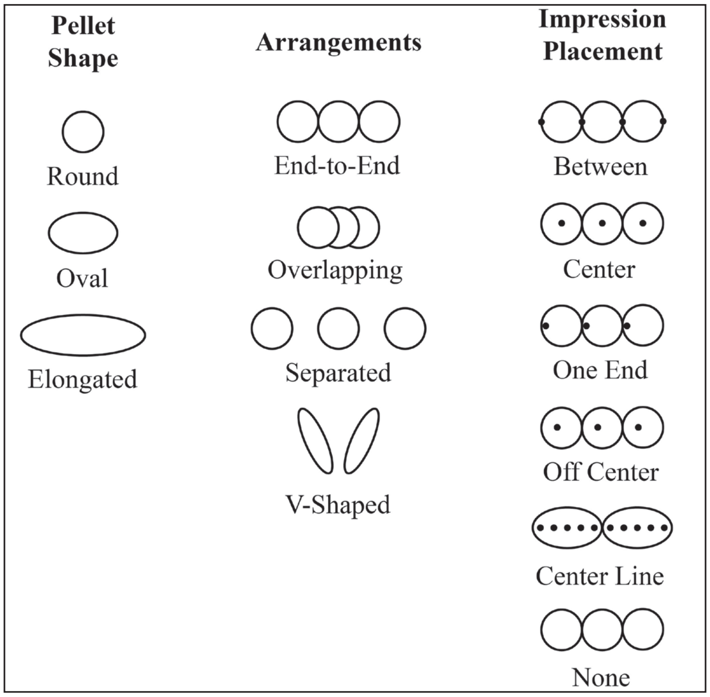

Figure 3. Illustrations of shapes, arrangements, and impression placements found in Wolf Village pellets.

Figure 4. Examples of band appliqué from Wolf Village.

Figure 5. Examples of a) zig-zag, b) slope, and c) crosshatch banding from Wolf Village.

so are included here. There are three types of handles found at Wolf Village: loop, ladle, and lug handles. Loop handles are by far the most common with seventeen complete examples and 441 fragments. As far as can be verified from pieces including a rim, loop handles are oriented perpendicularly to the rim and were attached at or near the rim and to the neck or body of the jar. There is a single ladle handle, which extends directly outward from the rim. Ladles are an uncommon vessel form at Fremont sites and the presence of one at Wolf Village is an oddity.

There are eleven lug handles, which all appear to have been oriented perpendicular to the rim. The size of each lug handle varies, but each has a series of impressed lines on the proximal side of the handle (Figure 6). Similarly designed handles have been found at Snake Rock Village (Aikens 1967a:Figure 19n), Caldwell Village (Ambler 1966:Figure 39j), Injun Creek (Hassel 1967), Radford's Roost (Talbot et al. 1999:88), Five Finger Ridge (Talbot et al. 2000:222), Block 49 (Talbot et al. 2004:Figure 6.12h), Paragonah (Watkins 2010), Evans Mound (Watkins 2010), Witch's Knoll, and the Nephi Mounds. The most complete vessels include a jar from Injun Creek, which may have had at least five lug handles in addition to a loop handle, and bird effigy vessels from Evans Mound and Paragonah (Hassel 1967; Watkins 2010). The location of the incised lug handles on the effigy vessels suggests that they represent wings, and the curvature of the sherd walls on the Wolf Village examples suggest that the incised lug handles may also represent wings.

Appliquéd elements are common on Fremont figurines and are present on the figurines at Wolf Village. Excavations recovered 82 figurines and figurine fragments. Only ten of the figurines have appliquéd elements (Figure 7). The most common use of appliqué is in the representations of eyes, and nine figurines have appliquéd eyes. Six of the sets of eyes are round with central perforations. The eyes on three figurines are ovular with a series of closely grouped impressions across the center of the eye. Four figurines have additional appliquéd elements. One complete figurine has what may be either headgear or hair decoration, and another figurine had what appears to be a necklace and possibly the remains of hair decoration/headgear. Two final figurines are fragmentary and have the remnants of hair decorations or necklaces.

Comparisons with Surrounding Areas

The appliquéd sherds from Wolf Village were sorted into temper categories as suggested by Watkins (2009). He proposed a three-tier classification in which the upper-most tier,

Figure 6. Example of “bird wing” lug handles from Wolf Village.

Figure 7. Examples of figurines from Wolf Village.

Fremont Grayware, encompasses nearly all Fremont ceramics. The second tier divides the grayware into four temper categories: Emery Series, Uinta Series, Great Salt Lake Series, and Snake Valley Series. The final tier designates surface manipulation, which, for the purposes of the ceramics discussed here, particularly applies to appliqué.

The majority of the Wolf Village appliquéd sherds (n=346, 81 percent) are Great Salt Lake Appliqué. This is unsurprising as most of the entire ceramic assemblage at Wolf Village is Great Salt Lake Gray. Seventy-one appliquéd sherds are Emery Appliqué, 61 of which are of the Sevier Variety. Ten sherds are Snake Valley Appliqué, one is Uinta Appliqué, and one is untempered. The Wolf Village assemblage reflects a wide distribution of manufacture with at least one sherd from each Fremont Series. Great Salt Lake Series sherds are likely of local production or acquired locally, and the same may be true of Emery Series, Sevier Variety of Emery tempered vessels as well. The other temper types present at Wolf Village were likely imported from further away.

Although people produced appliquéd pottery across the Fremont region, the type is rarely found in large numbers. Appliqué sherds have been recovered from at least 40 other Fremont sites with an average of 40 appliquéd sherds (Table 2), although many site reports combine counts with surface manipulated sherds. The site with the closest number of appliqué compared to Wolf Village is Round Spring with 67 sherds (Metcalf et al. 1993). Of the surveyed references, there are only two sites (Old Woman Site and Poplar Knob) where the appliqué sherds make up more than one percent of the ceramic assemblages (Taylor 1957).

Appliqué, of course, was not the only decorative style used by the Fremont. Pottery with black paint (Black-on-gray and Black-on-white) is the most common form of decorated pottery at many Fremont sites. It has a widespread distribution, but is primarily produced in the southern portion of the Fremont region (Richards 2014; Ure 2013; Watkins 2006). In contrast, appliquéd vessels are far less numerous (there are 1495 black painted sherds at Wolf Village), have no known production center, and appear to have been manufactured in each of the Fremont temper regions.

Surface manipulated sherds may be a more appropriate comparison. Appliqué is an additive technology, while surface manipulation involves impression, punctation, scraping, or other forms of modification to the vessel surface. There is even less information about surface modification than appliqué, but both styles are primarily found on jars, although surface modification is also found on bowls. At Wolf Village, surface modified sherds are likely to be made locally with 93 percent (n=580) having Great Salt Lake temper. Additionally, most surface manipulation is restricted to the body of a vessel and rarely is found above the neck. It is possible that future research will illuminate patterns between these two types, but, for now, there is limited data.

Appliqué appears to have been a widespread decorative technique throughout Fremont sites in Utah, but it was also a technique used by neighboring cultures. Stylistically, Fremont decorated wares have a lot in common with ceramics made throughout the southwestern United States. Appliquéd variants have been found in Ancestral Pueblo, Sinagua, Mogollon, Salado, Hohokam, and Casas Grandes contexts, although they appear to be rare in each area. The variants have been identified within, or designated as, Tusayan Appliquéd, Alemada Brown Ware, Youngs Brown, Sunset Appliqué, Mogollon Brown Ware, Aquarius Appliqué, and Alma Knobby (Colton 1955, 1958; Huckell and Vanpool 2006). Because of the low numbers of appliquéd sherds found at southwestern sites, studies focusing on this decorative type are lacking. However, the main forms of appliqué appear to be knobs, ribbons, and scrolls. Other than the relative scarcity of appliquéd vessels compared to other vessel types, knobs are the trait that the Southwestern vessels share most with Fremont appliquéd vessels.

Table 2. A list of Fremont sites and reported number of appliquéd sherds with percentage of total assemblage.

Site	Total Ceramics	Appliqué	Appliqué Percentage	Reports
Turner-Look	4416	12	0.27	Wormington 1955
Garrison Site	1992	1	0.05	Taylor 1954
Old Woman Site	3340	44	1.32	Taylor 1957
Poplar Knob	2438	33	1.35	Taylor 1957
Hinckley Mounds	2693	9	0.33	Green 1961
Injun Creek	3825	7	0.18	Aikens 1966
Bear River 1	2012	10	0.50	Aikens 1966
Caldwell Village	5260	24	0.46	Ambler 1966
Snake Rock Village	21362	58	0.27	Aikens 1967a
Bear River 2	3042	28	0.92	Aikens 1967a
Nephi Site	7911	64	0.81	Sharrock and Marwitt 1967
Pharo Village	12273	5	0.04	Marwitt 1968
Hogup Cave	396	1	0.25	Aikens 1970
Median Village	17426	9	0.05	Marwitt 1970
Evans Mound	20541	36	0.18	Berry 1972
Castle Valley	4744	6	0.13	Berge 1974
Windy Ridge Village	458	2	0.44	D. Madsen 1975
Innocents Ridge	959	4	0.42	Schroedl and Hogan 1975
Fallen Woman	1604	3	0.19	Wilson and Smith 1976
Ivie Ridge	584	1	0.17	Wilson and Smith 1976
Backhoe Village	2239	1	0.04	D. Madsen and Lindsay 1977
Bear River 3	2406	6	0.25	Shields and Dalley 1978
Levee Site	2739	11	0.40	Fry and Dalley 1979
Knoll Site	762	2	0.26	Fry and Dalley 1979
Evans Mound	3588	1	0.03	Dodd 1982
Woodard Mound	11988	24	0.20	Richens 1983
Round Spring	27465	67	0.24	Metcalf et al. 1993
Wide Hollow	395	1	0.25	Metcalf et al. 1993
42EM2095	4142	14	0.34	Montgomery and Montgomery 1993
Mukwitch Village	2831	5	0.18	Talbot and Richens 1993
Blue Trail House	4471	2	0.04	Greubel 1996
Icicle Bench	1271	11	0.87	Talbot et al. 1999
Radford Roost	4306	1	0.02	Talbot et al. 1999
Baker Village	10374	1	0.01	Wilde and Soper 1999
Five Finger Ridge	22434	29	0.13	Talbot et al. 2000
South Temple	3004	22	0.73	Talbot et al. 2004
Block 49	2225	15	0.67	Talbot et al. 2004
Durfey Site	686	5	0.73	Baadsgaard and Janetski 2005
Provo Delta	1141	39	3.42	Mooney 2014

Discussion

Appliqué is an intentional choice made by potters and, this section will explore possible influences for creating appliqué pottery by Fremont potters. The discussion will concentrate on the appliqué found on the exterior of jars with minor discussions of handles and appliqué found on figurines. The application of additional clay elements to a vessel may have provided either a functional or aesthetic benefit, or a combination of the two. If functional, appliqué elements would be expected to help a jar with its practical purpose as a vessel, i.e. expanding storage, increasing gripability, conducting heat, providing strength, etc. Aesthetic benefits can be just as important and range from decoration to ceremonial.

One possible benefit provided by appliqué, particularly knobs, is to decrease slippage while handling the vessel. A series of ceramic knobs could aid in holding the pot, but it is unlikely that this was the primary function of the appliqué. The connection between the appliqué and the vessel wall is not always secure and elements become detached. There are 108 sherds with scars from missing pieces of appliqué with as many as 185 missing elements (which would have provided a 22 percent increase to the dataset of appliquéd sherds had they been included in this study). Five unattached elements were recovered during excavation. Elements can become detached during handling or can fall off during firing or other exposure to heat (Rude and Jones 2012:92).

The propensity of appliqué elements to fall off during the process of heating and cooling suggests that appliquéd vessels were likely not used as cooking vessels. Only 58 (13 percent) appliquéd pieces had any trace of soot and some pieces may have only accumulated soot from being deposited in ritually burned structures. There are other possible ways that appliqué could have provided a utilitarian benefit (e.g. providing strength or distributing heat), but these will need further exploration and, considering the characteristics discussed above, appliqué was probably used primarily as a decorative form.

As difficult as it is to determine the practical contributions of appliqué, it can be even more so to consider the aesthetic and symbolic possibilities. For the following discussion, knobs are considered separately from pellets and bands. Knobs, in general, are arranged in a dispersed pattern consisting of rows of lines restricted to the body of the vessel, while bands and pellets are nearly always located around the necks of jars. Many pellets are arranged next to or overlapping other elements and are essentially bands consisting of multiple pieces. The differences between knobs and the other forms of decoration are distinct enough for a separate discussion.

Knobs are the most common appliqué element type at Wolf Village and this form of decoration has analogous examples throughout the greater Southwestern United States and Mexico (Litzinger 1981). The ‘spiked’ vessels from other regions are assumed by some to be effigy vessels. William Litzinger (1979, 1981) noted the wide distribution of this decorative form and associated it with the use of *Datura*. The genus has thirteen identified species in the Americas with all but one being characterized by a large trumpet-shaped flower that results in a spiny capsule filled with seeds. *Datura* has a wide distribution as well as a variety of medicinal, ritual, and, for some of the species, dietary uses. Litzinger identified possible *Datura* effigy vessels from Mesa Verde and Snaketown in the southwestern United States and several sites in Mexico, Guatemala, and El Salvador (Litzinger 1979, 1981). Lisa Huckell and Christine VanPool (2006) identified 150 vessels and fragments from the southwestern United States and northern Mexico. Huckell and VanPool also identified the appliquéd pieces with *Datura* use and sought to corroborate the evidence with botanical evidence and iconography from rock art and Mimbres pottery (Huckell and VanPool 2006).

Despite the evidence for a connection between spiked vessels and *Datura* use, it is unlikely that this is how the Wolf Village vessels were used.

The genus *Datura* includes several varieties, and are more common in the deserts of southern and central Utah. *Datura* has been reported at only a few Fremont sites as modern vegetation in the surrounding area (Bradley et al. 1986; Cole 2012; Metcalf et al. 1993). Analogous shapes may be found in some animals or as conceptual renderings of phenomenon such as rays from the sun. One spiked vessel from Casas Grandes, currently curated at Brigham Young University's Museum of Peoples and Cultures, resembles a horned lizard (Nielsen-Grimm and Stavast 2008:75). It is possible that inspiration for knobbed vessels came from nature, but there is not enough information currently to suggest where the inspiration for the Fremont variant may have originated.

Pellets, while not as common as knobs, may be a style that is particular to the Fremont. Bands and pellets in the following discussion are treated the same; bands are single elements and pellets are discrete elements often placed closely together or overlapping. Both types bear a striking similarity to decorative elements found on Fremont figurines and may have a connection with figurines and personification of pots.

As with the Wolf Village figurines, appliqué is a component on many Fremont figurines. Features such as eyes and hair are sometimes added to the head (Bodily 2012; Green 1964; Stuart 2012a, 2012b). Elaborate decorations may also be added including headdresses, necklaces, pendants, and/or shoulder ornaments (Jardine 2007:15; Lindsay and Loosle 2006:11; Morss 1954:24). On some figurines, clothing has been added that may be skirts, aprons, or belts (Gunnerson 1969:99; Morss 1954:24). Appliqué elements found on Fremont figurines range from minimalist to extravagant, but it is the elaborate necklaces that have the noted similarities with analogous counterparts found on ceramic vessels. Necklace components are often round or oval, placed closely together or overlapping with other elements, and arranged around the neck of the figurine.

Steward (1936) recovered a jar from his excavations at Kanosh that reinforces the connection between appliquéd vessels and figurines. The handle of the jar has molded eyes, nose, and mouth, similar to Fremont figurines (Steward 1936: Figure 5f). Encircling the neck of the jar is a line of appliquéd pellets. There are at least four other figurine/handles, one each from Seamons Mound (Bodily 2012: Figure 4a), Bear River No. 2 (Aikens 1967a:45), Nephi Mounds (42JB2), and Wolf Village. The handles have oval pieces of appliqué that serve as eyes. The Nephi Mounds handle is broken below the eyes, but the Seamons Mound and Wolf Village handles have punctated mouths and nostrils. The Wolf Village example was found with appliquéd jar sherds that are similar in paste and temper, although no connecting pieces have been identified. It is unsure whether the Seamons Mound or Nephi Mound handles had appliqué. However, the four handles put formal faces on the vessels, and appliqué may have served as necklaces. It is quite possible that appliqué also served as a representational necklace for vessels without figurine/handles.

The lack of precise uniformity among the appliquéd vessel styles at Wolf Village presents the possibility that each one may have been unique (if not singular then at least uncommon). Each may have been imbued with its own style and could, therefore, have been individually identified. If vessels were being personified, each could have been a distinct personality.

One possible detraction from the suggestion that appliquéd vessels were personified is that the appliquéd necklaces on Wolf Village figurines are not like the appliqué found on the necks of the Wolf Village jars. There are not many appliquéd figurines and only a few have what might be considered a necklace. Aside from the location at the neck of the vessel, the pellets are not alike. The appliqué on the vessels bear more morphological resemblance to the figurine eyes (round or oval), but none of the elements on vessels are oriented in a way that would clearly indicate that they were representing eyes.

Conclusion

As is the case for many studies in archaeology, the information presented here highlights how much we still do not know, particularly about what appliqué may have meant to the people who made it. There is a problem with assigning a one-to-one value to the meaning of appliqué on ceramic vessels. Without complete vessels or better context, it is difficult to say if the vessels were meant to represent a plant, animal, phenomenon, or human. However, appliquéd vessels do seem to be connected with Fremont ceremonialism in some way (Ambler 1966:241).

Appliqué is a visually distinct technique, and it transformed vessels into something distinctive. The use of appliqué is a conscious choice, and placing the decoration on the exterior of jars means that it was intended to be seen. The vessels were special. Special does not particularly mean valuable or socially important, and exactly why they are special and to what extent, is unknown. It may have affected how they were used (use for specific events or storage for specialized items) or who owned or used them (shamans etc.). The use of appliqué may have simply been an aesthetic choice that showed the skill and style of the potter. Whatever the purpose of their uniqueness, the use of appliqué visually set these vessels apart. ■

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Thirty Years Later: Recommendations for Museum Compliance with NAGPRA and Utah State Laws

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The Native American Graves Protection and Repatriation Act (NAGPRA) was passed nearly thirty years ago. In addition to changing how archaeology is carried out by archaeologists and cultural resource management firms, NAGPRA also changed policies and procedures for museums. This research offers suggestions about how museums in Utah can continue to improve how they follow the NAGPRA process and remain compliant with both the state of Utah and federal laws by building and maintaining relationships with consulting Native American tribes and ensuring that NAGPRA databases are current. Museums can develop relationships with tribes by inviting them to contribute ideas on how to store NAGPRA items and by including them in the development of exhibits. In addition, museums can further recognize their role as stewards of cultural objects and heritage, rather than merely collectors. Doing so will demonstrate respect for Native perspectives and mediate between the beliefs of the tribes and the goals of the scientific community.

Thirty years after the passing of the Native American Graves Protection and Repatriation Act (NAGPRA), the law is considered carefully at all federally funded institutions. The following article focuses on identifying proposed strategies and methods that can aid museums in Utah in the processing of human remains and funerary items in order to comply with NAGPRA. There are several repositories in Utah that currently curate or have curated human remains or items that fall under NAGPRA law, including state parks and public and private museums.

I surveyed staff from several museums in Utah to determine the NAGPRA methods that work well for them and analyze which strategies help museums stay compliant with NAGPRA. The results of my survey identify several common themes, including ensuring that museum professionals receive proper NAGPRA training, techniques for maintaining a NAGPA database and dealing with inadvertent discoveries, and challenges facing Utah museums concerning culturally unidentifiable remains. I also discuss the ethical obligations regarding how museums treat human remains. This includes sometimes restricting scientific studies on them; while allowing research that helps determine cultural affiliation.

Requirements for Museums

Before a discussion on effective methods for implementing the NAGPRA processes begins, a brief description of federal NAGPRA (25 U.S.C. § 3003) and Utah Code 9-9-4 is required. NAGPRA both requires and encourages collaborative efforts between museums and indigenous peoples, which allows for mutual understanding and respect. Some immediate effects on museums by federal NAGPRA included the responsibility of museums to identify and inventory all NAGPRA items within five years after its passage in 1990, a procedure known as the NAGPRA process (Malaro and DeAngelis 2012; Phelan 2014). The term "NAGPRA process" refers to the principle steps of the repatriation process.

Most NAGPRA items and human remains currently enter museums as inadvertent discoveries and are held on behalf of the federal agency responsible for repatriation. Despite the five-year limit to identify and inventory all NAGPRA items, however, most federal agencies believe they still have NAGPRA items in their collections (Akaka 2011:3). I suspect similar trends are present at many museums. All museums and other repositories that receive Federal funds and possess Native American cultural items are required to complete the NAGPRA process (25 U.S.C. § 3001).

25 U.S.C. Chapter 32: Native American Graves Protection and Repatriation

The Native American Graves Protection and Repatriation Act was passed by the United States Congress on November 16, 1990. NAGPRA is important legislation that requires archaeologists and museums to respect the treatment of Native American (including Native Alaskan) and Hawaiian ancestral remains, burial objects associated with ancestral remains, and sacred objects. The law allows federally recognized Native American tribes and Native Hawaiian organizations to obtain custody of their ancestor's remains and all associated funerary objects (Watkins 2000:53).

NAGPRA established three mechanisms for protecting Native American remains and cultural objects. First, it criminalized the illegal sale and trafficking of Native American human remains and cultural objects. Second, it established consultation procedures for Native American remains discovered as part of archaeological excavations on tribal or federal lands. Third, it created procedures for Native American tribes, Native Hawaiian organizations, and lineal descendants to seek repatriation of their ancestor's remains and sacred objects that are held in federally funded museums and federal agencies.

According to the NAGPRA process (see 43 C.F.R. § 10.10), the main responsibilities for museums in following NAGPRA are to first identify any cultural items in their collections that are subject to NAGPRA law. "Cultural items" include all Native American human remains, funerary objects, sacred objects, and objects of cultural patrimony as defined in 43 C.F.R. § 10.2d. Museums must prepare inventories of all humans remains and associated funerary objects in their custody. This includes creating an itemized list of all remains, along with the geographical and cultural affiliation for each item (25 U.S.C. § 3003a; 43 C.F.R. § 10.9). The inventories and identifications must be done in consultation with federally recognized tribes (25 U.S.C. § 3003b). Museums can initiate consultation through a letter or email but should follow up through a telephone call or face-to-face meeting (43 C.F.R. § 10.8, 10.9). Museums must submit inventories to the *Federal Register*, as well as make inventories available to federally recognized tribes. If tribes request further information about objects in inventories, museums are required to provide additional documents, including summaries of existing museum records, museum catalogs, relevant studies, or any other data that can help determine cultural affiliation of geographical origin (25 U.S.C. § 3003b).

Once the cultural affiliation of human remains or NAGPRA objects is determined, museums are required to notify the appropriate Native America tribes within six months. The notices to tribes must include three key pieces of information: (1) a complete inventory of all human remains and associated funerary objects, as well as the circumstances surrounding how each item was acquired by the museum, (2) a list of the human remains and associated funerary objects that are clearly indefinable to a specific tribe or tribes, and (3) a list of all human remains and associated funerary objects that are not clearly identified to a specific tribe, but are "determined by reasonable belief" to likely be culturally affiliated (25 U.S.C. § 3003d). The Notice of Inventory Completion must also be sent to the Secretary of the Interior who will publish them in the *Federal Register*. Museums are also advised to keep records of correspondences regarding NAGPRA items (McKeown 2001).

In lieu of creating a detailed inventory, museums are required to provide a written summary for all unassociated funerary objects, sacred objects, and items of cultural patrimony in their collections. The summary must state what kinds of objects are included in the collection, their geographic location, the period and circumstances that led to the museum acquiring the objects, and the cultural affiliation of the objects (25 U.S.C. § 3004; 43 C.F.R. § 10.8). While NAGPRA states that the creation of the summaries must be, "followed by consultation with tribal government" (25 U.S.C. § 3004b), museums should consult with tribes during the process since museum professionals would not be able to determine what is sacred or identify items of cultural patrimony on behalf of other cultural groups. Museums must provide all potential culturally affiliated tribes with a copy of the summary, and if one of the tribes chooses to claim some or all of the items, the museum must publish a Notice of Intent to Repatriate in the *Federal Register*. The museum must wait 30 days following the publication of the notice to begin the transfer of control for the cultural items (43 C.F.R. § 10.10).

Once human remains or NAGPRA objects are culturally affiliated with a Native American tribe, the museum must repatriate the remains and objects upon request. Museums must communicate with the tribe to determine how and where to deliver the NAGPRA objects. If cultural affiliation cannot be determined, tribes can claim association with NAGPRA objects or remains through geography, kinship, linguistic, folklore, oral traditions, or other relevant information (25 U.S.C. § 3005a). If multiple tribal groups request repatriation of cultural items and the museum cannot determine which is the most appropriate claimant, they are required to retain the requested items until all claimant groups agree who can receive the NAGPRA objects or until a court makes the decision (25 U.S.C. § 3003e). However, NAGPRA also allows for tribes to claim ownership of NAGPRA items based on a "preponderance of the evidence," in which one tribe has a stronger cultural relationship to the items than another (25 U.S.C. § 3002).

According to federal NAGPRA, museums are only obligated to consult with federally recognized tribes. At times it may also be ethically appropriate to work with and possibly repatriate objects to non-federally recognized tribes. Such an action would require a request made by the museum to the NAGPRA Review Committee. The NAGPRA Review Committee was established under NAGPRA law to monitor and review the inventorying of objects, the identification of cultural affiliation, and repatriation activities (25 U.S.C. § 3006).

Utah Code 9-9-4: Native American Grave Protection and Repatriation Act

In 1992, the State of Utah enacted laws as a response to the passage of federal NAGPRA. Seidemann (2009:200) notes one major weakness of federal NAGPRA, namely, that it only applies to Native American remains on federal and tribal lands. Therefore, Native American NAGPRA items are only protected on federally owned or controlled lands and tribal lands, whether in Utah or in other U.S. states and territories. NAGPRA items are also protected on any project that receives federal funding as part of an undertaking, regardless of who owns the land. For other types of lands in Utah, including state and private lands, Utah NAGPRA applies.

Since the passing of federal NAGPRA in 1990, several states and territories have enacted their own responses to human burial protections on state lands (Seidemann 2010). Seidemann (2010:199–200) explains that state laws are often more extensive than federal NAGPRA, protecting burials found on state and local lands. Utah Code 9-9-4 or the Native American Grave Protection and Repatriation Act was written to

Table 1. A comparison of key differences and similarities between federal NAGPRA (25 U.S.C. Chapter 32) and Utah Code 9-9-4.

	25 U.S.C. Chapter 32	Utah Code 9-9-4
Definition of "cultural items"	Human remains, associated and unassociated funerary objects, sacred objects, and items of cultural patrimony	Human remains and attached funerary objects
Protects cultural items found on:	Federal and tribal lands	State, county, city, tribal land not held in trust by the federal government, and private lands
The law applies to:	All museums or institutions who receive or have received federal funding	All museums or repositories in Utah
Authorized claimants	Lineal descendants and federally recognized tribes with cultural affiliation	Lineal descendants, federally recognized tribes with cultural affiliation, and tribes with proven aboriginal claim to the area that the cultural items were found
Overseeing organization	NAGPRA Review Committee under the direction of the Secretary of the Interior	Native American Remains Review Committee
Repatriation process	Museums must complete inventories and summaries of NAGPRA items in consultation with tribal governments	Museums must complete an inventory in consultation with the Director of the Division of Indian Affairs and the Review Committee
Scientific studies on cultural remains	Can be done if the results are of great benefit to the United States	Can be done with permission of the owner, or for identifying cultural affiliation and according to the rules established by the Review Committee
Penalty for failure to comply with law	Fines based on the number of violations and the severity of the damages suffered by the owners	No specific penalty

compliment federal NAGPRA but applies only to nonfederal lands. Nonfederal lands include all land in the state, "that is not owned, controlled, or held in trust by the federal government" (Utah Code 9-9-402). This includes state, county, city, tribal land not held in trust by the federal government, and private land (Utah Codes 9-8-309 and 9-9-402). To avoid confusion, I refer to federal repatriation law as NAGPRA and state repatriation law as UC 9-9-4.

There are several differences and similarities for the role of museums according to UC-9-9-4 and NAGPRA (Table 1). UC 9-9-4 defines "cultural remains" as "all or part of a physical individual and objects on or attached to the physical individual that are placed there as part of the death rite or ceremony of culture" (Utah Code 9-9-402). In other words, associated burial items near human remains do not fall under UC 9-9-4. The term "on or attached" refers to clothing, jewelry, or other cultural objects placed on the actual physical remains. In addition, the Utah antiquities law states that "ancient human remains" refers to all body parts, including those shed naturally such as teeth or hair, as falling under the authority of UC 9-9-4 (Utah Code 9-8-302, 9-8-309). Again, this only applies to objects or remains found in Utah on nonfederal lands.

UC 9-9-4 also created a Native American Remains Review Committee comprised of four tribal members and three members to represent state repositories (Utah Code 9-9-405). The Review Committee has many tasks, including monitoring the repatriation process of objects found on state lands, mediating disputes between Native American tribes on the ownership of objects that fall under UC 9-9-4, and making recommendations to museums and other repositories on how objects must be repatriated (Utah Code 9-9-405).

Museums in Utah are affected by UC 9-9-4 in several ways. First, Utah law requires that museums work in consultation with the Antiquities Section of the Utah Division of State History to inventory all human remains and attached funerary objects found on nonfederal lands. This must be done biannually until all remains are either unclaimed, unaffiliated, or placed in the state burial vault. The inventory must include the information about the lineal descendant, cultural affiliation, and the geographic context for the remains. Museums are responsible for completing their inventories within one year of the discovery of the human remains (Utah Administrative Code R456-1-6). Once completed, museums must send the inventory to the Director of the Division of Indian Affairs who will forward it to the Native American Remains Review Committee, Native American tribes, and any other interested parties. The Director will notify the museum of all claims or lack thereof (Utah Administrative Code R456-1-9). Like federal NAGPRA, any interested parties can claim lineal descent and cultural affiliation through various evidences, including kinship, biological, oral traditions, archaeological, linguistic, folklore, and more (Utah Administrative Code R456-1-6). Museums, in consultation with the Review Committee, will grant ownership of human remains to the lineal descendants or the claimant with the preponderance of evidence (Utah Administrative Code R456-1-10).

Both NAGPRA and UC 9-9-4 have conditions on when museums or other researchers can conduct scientific studies on Native American human remains. For NAGPRA, scientific studies on cultural items can be done with the permission of their owner, or if the results are of great benefit to the United States (25 U.S.C. § 3005). State law does not allow scientific studies on human remains without permission of the owner unless the purpose is to identify cultural affiliation and according to the rules established by the Native American Remains Committee (Utah Code 9-9-403; Utah Administrative Code R456-1-16).

While NAGPRA threatens fines to museums and institutions based on the number of violations and the severity of the damages suffered by the owners (25 U.S.C. § 3007), the law excuses any museum who puts in a "good faith" effort to follow the NAGPRA process (25 U.S.C. § 3005). Likewise, UC 9-9-4 requires that museums fulfill their obligation to provide inventories within one year of discovery but can be excused if they show evidence of making a good faith effort to consult and identify the remains (Utah Administrative Code R456-1-6). There are no listed penalties for museums who fail to comply with UC 9-9-4 in a timely manner.

Previous Research

Previous research on how museums can engage with tribes regarding NAGPRA items are discussed in Sullivan et al. (2000) and Abraham et al. (2002). Sullivan et al. (2000:232) argue that for a museum to successfully implement an effective repatriation program they must have, "a genuine belief in the primary rights of indigenous people in the management of their own cultural materials presently held in museum collections." Part of this genuine belief would entail engaging in consultation with indigenous peoples on collections management matters that are not covered by NAGPRA. Sullivan et al. (2000) use a questionnaire to discover effective museum practices at various museums across the United States, including the specific methods for the treatment of human remains and sensitive materials. However, their research shows that much of the practices of museums in the early 2000s was focused on only communicating with tribal groups on matters that were mandated under NAGPRA.

Legislative change such as NAGPRA can impact how museums work with collections and Native American groups. Abraham et al. (2002) sent a questionnaire to 19 museums across the United States in order to gather data regarding how changes in legal policies were received and implemented at museums. Their data indicated that museums do not need to involve all employees in the NAGPRA process for it to be efficient (Abraham et al. 2002:43). Only a small group of museum professionals or even one individual is enough to effectively implement the museum side of NAGPRA. Their data suggest that applying NAGPRA policies and procedures at museums is helpful for implementing NAGPRA regulations; however, none of the responding museums collaborated or consulted with indigenous people on matters relating to museum collection management policies (Abraham et al. 2002:46). While not required by NAGPRA law, engaging with tribal groups on collection management procedures builds relationships of trust between museums and Native American groups, and allows indigenous peoples to contribute to the management of their own material culture.

Methods

There are very few repositories in Utah that deal with both Utah state and federal NAGPRA. In order to research the best NAGPRA policies and procedures at museums in Utah, I interviewed representatives from four repositories across the state with experience in both Utah state and federal NAGPRA. Interviewers were promised that their responses and affiliations would be kept confidential. Interviews with curators were focused on determining the types of strategies that worked well at each museum, what specific complications they faced regarding NAGPRA, the processes they employed to determine the cultural affiliation of human remains and NAGPRA objects, and how they made efforts to build and maintain relationships with consulting tribes.

To better understand which NAGPRA policies and procedures were working well or could be improved at Utah museums, I asked each respondent the same series of questions regarding the NAGPRA processes at their respective museums:

1. What strategies has your museum used to stay current with NAGPRA regulations? What worked well, and what did not work well?
2. What internal administrative documents, plans, or files has your museum used to help comply with NAGPRA?
3. What kinds of efforts has the museum made with building and maintaining relationships with consulting tribes? Which tribes have you been successful in building relationships? How have these relationships been successful?
4. What kinds of specific complications or challenges has your museum faced regarding NAGPRA?
5. How do you determine the cultural affiliation of human remains and NAGPRA objects?

Results

The responses to my questions suggest several policies and procedures that should be employed or strengthened at Utah museums, and many of these would also benefit other institutions. These policies and procedures include providing proper training for NAGPRA coordinators to ensure that they remain current with NAGPRA regulations, developing policies on accepting (or not accepting) new NAGPRA items, and building lasting relationships with Native American groups.

NAGPRA Training

Each respondent was asked how their museum maintains current standards with NAGPRA regulations and specifically what worked well and what did not. One respondent noted that potential pitfalls for implementing the NAGPRA process can be new and confusing to recent hires with no background in NAGPRA. In other words, training can be a serious issue. As previous research has suggested, a lack of time and money can affect whether museums can effectively implement the NAGPRA process (Abraham et al. 2002:45). It should also be noted that very few museums have a dedicated NAGPRA specialist. Most NAGPRA coordinators also serve as curators, meaning that NAGPRA compliance is a small part of their responsibility. To help overburdened museum professionals in fulfilling their NAGPRA responsibilities, the National Park Service (NPS) began offering online training on NAGPRA through a series of webinars and videos (https://www.nps.gov/subjects/nagpra/training.htm), and recently the Society for American Archaeology published an excellent resource that guides museum professionals through the NAGPRA process (Knoll and Huckell 2019:28–29).

Another respondent suggested that all museums could do better at implementing NAGPRA and recommended that museums learn of changes in NAGPRA regulations by communicating with other museum professionals. One of the responsibilities of a museum professional, especially the NAGPRA coordinator, is to ensure that the museum remains compliant with NAGPRA. Part of this includes researching where each NAGPRA object originated, whether on federal, state, or private lands. This can be a monumental task since some objects have questionable provenance and other objects come from archaeological projects with massive amounts of paperwork and field notes. The respondent's advice was to research as much as possible about the origin of NAGPRA objects or human remains to ensure that museums correctly comply with NAGPRA laws.

Internal Administrative Documents at Utah Museums

When asked what internal administrative documents, plans, or files were used by each museum to help them comply with NAGPRA, there were two different methods. The predecessor of one of the respondents compiled all the NAGPRA files, providing a clear paper trail to follow. In addition, their museum uses an electronic database to list their NAGPRA inventory and the current status of each object. This is an approach that would be beneficial to any Utah museum not currently tracking the NAGPRA process, since it allows incoming museum employees to benefit from access to a database where they can check the current status of each NAGPRA item or burial.

The status of NAGPRA items or human remains can change several times while housed at a museum. My own recommendation for different statuses or phases for NAGPRA objects includes pre-inventoried, inventoried, in consultation, and completed. "Pre-inventoried" objects are those that are recognized as NAGPRA items but still need to be inventoried according to NAGPRA requirements. "Inventoried" objects are those whose inventories were published in the *Federal Register*. If possible, these objects have had their cultural affiliation identified. Objects that are "in consultation" are ones that the museum is actively working with a consulting tribe on. "Consultation" does not mean that the museum is simply trying to contact tribes through email or telephone calls, nor does it refer to merely providing summaries, inventories, and other information that museums must provide to tribal groups upon request. Instead, it refers to actively working together with tribal groups regarding NAGPRA items. Despite this distinction, museums should keep a record of all attempts at establishing contacts with tribal groups. "Completed" objects are those that have gone through the rest of the NAGPRA process and are awaiting repatriation.

Another method for dealing with NAGPRA law is for museums to not accept new NAGPRA items into their collections. Complications can arise, however, when NAGPRA items or human remains are excavated as the result of inadvertent discoveries by organizations such as cultural resource management companies who hold Curation Agreements with the museums. In such cases however, the NAGPRA items are the responsibility of the government agency who is responsible for the project or undertaking. As such, before museums agree to temporarily house inadvertent discoveries while the government agency undergoes the NAGPRA process, the NAGPRA coordinator should make a record that the land manager has initiated this process. This will help land managers feel the incentive to fulfill their NAGPRA responsibilities in a timely manner and avoid NAGPRA items languishing in the museum for years.

Building and Maintaining Relationships with Consulting Native American Tribes

Building and maintaining relationships with consulting Native American groups is essential to properly implement the NAGPRA process. One respondent noted that their museum has developed friendly relationships with Pueblo groups, such as the Hopi, Zuni, and Acoma, in addition to making connections with the Ute and Navajo Nation. They stressed the importance of museums developing personal relationships with tribal groups and Native American representatives. Diligently maintaining tribal relationships is important so that when tribal leadership or the tribal historic preservation office (THPO) employees change, museums will already have a solid foundation in which to build and develop new relationships.

Native American groups can and should be consulted for more than just NAGPRA matters. One respondent stated that at their museum Native American groups are involved in interpreting artifacts, as well as in the planning of exhibits. Museums who actively work with Native American groups go above and beyond what NAGPRA requires in tribal consultation. Such museums adhere to the advice of Abraham et al. (2002) and Sullivan et al. (2000) by building and maintaining relationships with Native American groups outside of the required NAGPRA obligations.

Some museums also seek to maintain a respectful relationship with consulting tribes, despite no official programs to do so. A suggestion by one respondent was to build friendly relationships with tribal members before NAGPRA issues arose. One means of doing this is to respect the beliefs and culture of tribal groups. This can be done by ensuring each repatriation is a good experience for the tribes by remembering small actions a museum can take to show respect for human remains and burial objects. Examples of these small, but meaningful actions, can include packing human remains carefully in the position in which they were excavated, and upon repatriation, ensuring that all burial objects travel together with the human remains. Above all, museum professionals must remember that human remains should be respected as the ancestors of modern groups.

Challenges Facing Utah Museums

When questioned about the challenges facing Utah museums regarding NAGPRA, respondents offered specific complications that varied for each museum. Such challenges include working with different NAGPRA items from different ownerships, including various federal agencies and items falling under UC 9-9-4. Other challenges come from working with multiple Native American tribes, each with a different perspective on how human remains should be treated.

Many Native American groups advocate for reburial of human remains out of respect for their ancestors, while many archaeologists and museum professionals may want to examine the remains using a scientific approach, often including analyses that may be destructive. One respondent advocated for museum professionals and consulting tribes to find a balance between the emotions felt by descendants and the goals of the scientific community. This statement echoes one by Goldstein and Kintigh (1990) immediately prior to the passage of federal NAGPRA:

> There is no question about the treatment of Native Americans in the United States. The record is abysmal and we must do all we can to rectify that treatment. Museums and other institutions have operated from a position of dominance where even a question from a Native American could be ignored without fear of consequences. We must change the way we do business. On initial consideration, one's gut reaction might be to reverse this situation of dominance by putting Indians into the position of power and dominance. As much as that might appeal to some people's desires for retribution, we think that it is ultimately a poor decision. Reversing the relationship does not remedy it – it only perpetuates the fundamental inequal [Goldstein and Kintigh 1990:589].

Museums and Native Americas should collaborate together on how to interpret the past. Each group brings important knowledge about past cultures. However, museum professionals must also remember that NAGPRA law was created not for the scientific community, but to empower tribes to request the return of their ancestor's remains, funerary objects, and objects of cultural importance.

Determining Cultural Affiliation

Section 10.11 of the Code of Federal Regulations describes the disposition of culturally unidentifiable human remains in the possession of museums or federal agencies. There are three subcategories of culturally unidentifiable remains. These subcategories include (1) human remains with too little information or context to determine cultural affiliation, (2) human remains associated with modern tribal groups who lack federal recognition and cannot make a NAGPRA claim, and (3) human remains that belong to a recognized cultural group but have no known living descendants (McLaughlin 2004:193).

One challenge specific to Utah museums is the process involving culturally unidentifiable remains. The National NAGPRA Committee requires a full report on all NAGPRA objects, including a statement on their cultural affiliation. This is a challenge that is especially problematic for Utah museums since the Fremont, a group of hunter-gathers and agriculturalists who lived in Utah from approximately A.D. 500 to 1300, have no definitive tribe with lineal descent (Baker et al. 1999; Berry and Berry 2003; Coulam and Simms 2002). One respondent stated that the section in NAGPRA concerning the disposition of culturally unidentifiable human remains (43 CFR § 10.11) could potentially be a problem for Utah museums. In their opinion, this new NAGPRA policy goes against the spirit of NAGPRA since it exists solely for the purposes of reburial. Under this new policy culturally unidentifiable remains can be claimed by any federally recognized tribe (Dalton 2010). Ultimately, museum employees must follow federal NAGPRA law and work with all Native American tribes that wish to consult with museums on NAGPRA items and human remains. The responsibility for human remains and burial objects found on state or nonfederal lands, however, falls on the Antiquities Division of the State Historic Preservation Office (SHPO) in consultation with the Division of Indian Affairs Native American Remains Review Committee (Utah Code 9-9-405).

Having a plan in place for determining the cultural affiliation of human remains and NAGPRA objects is essential for museums. One respondent provided guidelines on how to do so. First, museum employees should consider the context of each item. Then, they should research that location across time by studying ethnographic sources, archaeological reports, and other scholarly sources to determine the tribal groups that claim affiliation with that area. Next, museum professionals should send out at least two letters and inventories to all tribal groups associated with the area, as well as any other tribes interested in consulting. The respondent stated that they research only the groups that chose to respond to the letters and considers each claim. Museum staff should attempt to find evidences of cultural affiliation for each group archaeologically and linguistically. In addition to using scientific methods, one respondent advocated for museum professionals to also consider Native American traditions, folklore, and migration patterns. This process is very detailed and is one required by federal NAGPRA law. Lastly, museum professionals must also remember that NAGPRA law requires them to consider the preponderance of evidence if multiple tribes make competing claims on NAGPRA items.

Discussion

The Role of Museums

Museums need to reconsider their function regarding collections. Watkins (2006) explains that museums must understand that there is conflict between the Western concept of museums as stewards of all cultural items and the Native American concept of indigenous peoples being protectors of their own culture and cultural materials (see also Echo-Hawk 2002:170). Although in the past museums have viewed themselves as repositories for cultural objects and curiosities, repatriation laws such as NAGPRA allow for indigenous peoples to have more of a say in how their cultural objects are treated. Museums are required to carefully balance their responsibility to fulfill their legal obligations under federal and state laws, while also ensuring that they do not to send the message that tribes need to justify their cultural beliefs regarding NAGPRA objects (Robbins and Kuwanwisiwma 2017:67–68).

The policy of some museums is to not accept NAGPRA items; however, Edgar and Rautman (2014) describe an alternative practice at the Maxwell Museum of Anthropology (MMA) in Albuquerque, New Mexico. The policy of the MMA is to accept any human remains into their collections when offered, thereby accepting all associated legal, ethical, and financial obligations. The ethical reasoning behind this policy is that, "it is better for [human remains and burial objects] to be in a museum, where they can be properly curated and available for repatriation (when relevant), than it is for them to be in private hands or on the open market" (Edgar and Rautman 2014:240). It is under these circumstances that NAGPRA items should be collected by museums to protect human remains and sacred objects from being in the hands of private citizens or exchanged on the black market. The MMA accepts NAGPRA items and human remains in order to protect and conserve these items until repatriation can occur, and also to build relationships between their museum and Native American groups. While some museums may lack the time, physical space, and resources necessary to accept new NAGPRA items, they can still learn and implement many of the suggested steps below to build and improve their relationships with Native groups.

Building Relationships between Museums and Indigenous Peoples

NAGPRA presents museums with opportunities to create new relationships with indigenous peoples. O'Loughlin (2013) discusses how museum professionals and Native American groups can better collaborate with one another. She sent out two surveys to museum professionals at the "NAGPRA at 20 Symposium" for the National NAGPRA Program. The first survey had questions regarding the audience's expectations of the symposium, but the second had questions about how museum professionals, archaeologists, and Native American groups can improve accountability among repatriation participants (O'Loughlin 2013:229–231). The results of the survey suggest that museum professionals and Native American groups are still struggling to work together twenty years after the passage of NAGPRA. O'Loughlin (2013) hopes that current students will lead the charge for a new dialogue concerning NAGPRA, but she offers no real solutions about what to do in the present.

One possible solution, as the above respondents suggest, is that Utah museums (and museums outside of the state) can build and maintain relationships of trust and respect with Native American communities by inviting them to collaborate on matters relating to exhibition and interpretation. This does not mean that museums must completely reject science in favor of oral traditions. It simply means allowing tribal groups to have a voice on their own history and being open to other interpretations of the past. If tribal interpretations are at odds with current scientific consensus, museums can bridge the gap by allowing multiple perspectives to be represented in collaborative exhibits. McLaughlin (2004) argues for museums to balance their scientific interests and the interpretations of Native Americans, both in issues relating to NAGPRA and exhibits. This will allow museums to become active participants in promoting Native American cultures, while also instructing the public on the past (McLaughlin 2004:190–191).

Previous research suggests that implementing NAGPRA has led museums to build better relationships with tribal groups, which in turn has led to other unforeseen benefits for the museum (Ambler and Goff 2013; Harms 2012; McLaughlin 2004). The implementation of NAGPRA at History Colorado (HC), the state history museum in Denver, led to a better understanding of their collections. Since inventories and summaries are required for all NAGPRA items, this provided HC an opportunity to better research and study their collections (Ambler and Goff 2013:198). These stronger relationships have resulted in collaboration between HC and tribes on matters relating to museum exhibits and education programs. Thus, their tribal partnerships go far beyond consulting tribes as part of the NAGPRA process, resulting in exhibits and education programs that, "convey to a general audience what Native American community members want others to understand about them" (Ambler and Goff 2013:198). Collaboration in Colorado is not limited to only HC and tribes, other museums in the state also work hard to develop productive relationships with tribes to ensure that the NAGPRA process serves its purpose (Harms 2012:620–623).

Fostering relationships with Native American tribes can go beyond the required consultation. Since there are high costs associated with the repatriation process, NAGPRA authorizes the Secretary of the Interior to provide grants to museums, Native American tribes, and Native Hawaiian organizations (25 U.S.C. § 3008b). Chari (2010) describes how these grants can help museums build and maintain relationships with Native American groups. The Museum of Northern Arizona (MNA) in Flagstaff received a Consultation/Documentation Grant to develop a plan to work with tribes and implement appropriate care, handling, and housing guidelines that the tribal groups could agree upon. Fostering relationships between museums and Native American groups can help museums have better success in contacting and working with tribes during the NAGPRA process (Chari 2010), a sentiment also promoted by several respondents to my Utah museums survey. Building better relationships between museums and Native American groups are vital to the success of NAGPRA, especially when it comes to the potentially complex process of culturally unidentifiable human remains.

Likewise, after receiving a NAGPRA grant from the NPS, HC reached out to hundreds of tribes in their effort to produce NAGPRA summaries. This led to collaborative research efforts between tribal groups and the museum, as well as tribal groups with other tribal groups. One benefit of collaborating with tribes was that each consultation became easier. The museum and the tribes embraced the idea of partnering in research, causing both to share information about the collections with each other, thus, increasing knowledge about the past (Ambler and Goff 2013:204).

The NAGPRA program at HC is one worth emulating. It's NAGPRA program calls for museums and Native Americans to develop relationships beyond those required by NAGPRA. They argue that museums and tribal groups should have, "open and full communications with interested Native American communities and lineal descendants regarding … collections" (https://www.historycolorado.org/nagpra-program). Likewise, the Peabody Museum states that its collaborative activities go far beyond those required by law, including efforts of co-curation, in which they consult with tribal groups how to provide traditional care to collections (https://www.peabody.harvard.edu/node/310). The Peabody also collaborates with Native American groups on how to meet the ethical goals of archaeology and museums in teaching the public about the past. For example, when the Peabody consulted with Native Alaskans about repatriating a totem pole, both groups worked together to meet the scholarly and educational needs of the museum, while respecting the beliefs of the tribe. The museum commissioned a carver to create a new totem pole for display at the museum, using a large cedar log donated by the tribe (McLaughlin 2004:190).

A similar result occurred when the Glasgow Museum repatriated the Ghost Dance Shirt to the Wounded Knee Survivors Association (WKSA), despite the fact that the museum was under no legal obligation to do so. The WKSA donated a replica of the shirt that was put on display in the museum to explain its history to the public, as well as to demonstrate the sacred importance of the real object through its repatriation (Curtis 2010:237–238). Thus, the educational needs of the museums were met (as was the Peabody's ethical fulfillment to NAGPRA), along with the cultural beliefs of the tribes.

Current Views on NAGPRA Laws: Science vs. Tradition and Folklore

Some current researchers among the rising generation of archaeologists and museum professionals suggest that museums should improve their relationships with Native American groups (Capone 2013; Daehnke and Lonetree 2011). In addition to scientific evidence, archaeologists and museum professionals should acknowledge Native American traditions and folklore about determining the cultural affiliation of NAGRPA items and human remains. Capone (2013:123) calls for museums to improve on how they act regarding traditional knowledge and argues that museums must stop valuing scientific knowledge over indigenous people's evidences, such as traditions, folklore, and stories.

Sullivan et al. (2000) explain how opposition to NAGPRA has mostly been centered on the views of archaeologists and other members of the scientific community. They explain that some museum professionals were concerned with the repatriation of cultural objects leading to the diminishment of scholarly research (Sullivan et al. 2000:235). This idea is exemplified by Jones (2002), who argues that it is unrealistic to expect archaeologists and government agencies to compare scientific data with Native American folklore, traditions, and current geographical locations. He states that comparing scientific evidence to oral history is "akin to comparing apples with apoplexy" (Jones 2002:38). He also states that NAGPRA is a "poorly-thought out law" since it expects Native American groups to accept scientific study to determine cultural affiliation and archaeologists to accept Native American traditions and folklore rather than scientific data (Jones 2002:39). Ultimately, Jones concludes that NAGPRA is a law enacted with the best intentions but argues that archaeologists and Native American groups need to work together to ensure that NAGPRA does not further drive a wedge between the two groups.

Most Native Americans argue for reburying human remains and their associated funerary objects out of respect for their ancestors and the humanity of the skeletal remains. Archaeologists and museum professionals adhere to ethical reasons for studying ancient Native American human remains and their funerary objects and many argue in favor of science for gathering information about the heritage of humanity as a whole (Goldstein and Kintigh 1990; see also Sullivan et al. 2000). One possible way of achieving more effective relationships between scholars and indigenous peoples is, "through tolerance: acceptance of peaceful coexistence, with respect, conciliation, cooperation and, above all, compromise" (Goldstein and Kintigh 1990:586). This echoes the respondents of my interviews who stressed the importance of respecting and building friendly relationships with Native American groups even prior to NAGPRA consultations.

The Statement Concerning the Treatment of Human Remains by the Society for American Archaeology (SAA) states that archaeologists have an ethical responsibility "to advocate and aid in the conservation of archaeological data" by analyzing human remains to determine information about demography, diet, disease, and genetic relationships among prehistoric Native Americans (Society for American Archaeology 1999). Although the SAA stresses that it "recognizes both scientific and traditional interests in human remains," they argue that all human remains should receive scientific analysis and should be accessible for legitimate scientific or educational purposes (Society for American Archaeology 1999). This is a fairly reasonable argument. Archaeologists are scientists who have an obligation to preserve and obtain available data about the past. This means that archaeologists and museum professionals should advocate for the advancement of science; however, NAGPRA laws were made to empower Native American groups, not scientists. Thus, in terms of NAGPRA related issues, museum professionals are obligated to ethically follow the standards of federal and state laws regarding the study of human remains.

Lovis et al. (2004) present an "SAA-centric" perspective on NAGPRA since the authors are long-term members of the SAA Committee on Repatriation, and as such, were influential in the passing of NAGPRA. The SAA recommends that museums, government agencies, and Native American groups develop strong and mutually beneficial relationships. Lovis et al. (2004) argue that archaeologists need to use both scientific evidence and Native American traditions and folklore to determine cultural affiliation of human remains and objects. They point out that the SAA has always been in favor of repatriating Native American human remains and cultural items (Lovis et al. 2004:174).

Modern views on NAGPRA and repatriation were explored in recent research by Alonzi (2016) when she surveyed 1,905 individual members of the SAA regarding the SAA's Statement Concerning the Treatment of Human Remains. As part of her analysis, Alonzi attempted to discover possible demographic trends related to opinions about how the SAA has responded to NAGPRA and repatriation efforts. Most of the respondents received their highest academic degrees in 2000 or later, meaning that they were already accustomed to NAGPRA laws. For example, the recent NAGPRA regulation on the Disposition of Culturally Unidentifiable Human Remains (43 C.F.R. § 10.11) was, in general, viewed in a positive light by graduates who received their degree after 2000, and negatively by those who received their degrees before 2000 (Alonzi 2016:16). The survey suggested that most SAA members are not calling for a revision of the SAA's Statement Concerning the Treatment of Human Remains, but that some are asking for a revision to be added to the statement that emphasizes either Native American individual rights or scientific values (Alonzi 2016:20).

Bettinger (2016) responded to the survey by Alonzi (2016) and stated that the most interesting thing about the results of the survey were the biases based on the respondent's date-of-degree. Bettinger (2016) explained how many individuals who obtained their degrees before 1980 wanted the SAA to push for more protection and long-term curation of NAGPRA items. While this is currently the minority view, Bettinger (2016:21) explained that when he was involved on the SAA Board during the passage of NAGPRA it was the majority view. He explained that time has reversed this view, a fact that is concerning to him. He argues that the SAA must continue to defend the right for archaeologists to conduct appropriate scientific research on human remains since there is no other group willing to do so (Bettinger 2016:21).

Bettinger's (2016) response is interesting because it represents an older view of archaeologists and museum professionals, prioritizing what can be considered scientific research over Native concerns. Scientific endeavors are not inappropriate in archaeological or museum research. Using scientific methods and analyses to understand more about the human past is important. The argument made in this paper is simply that archaeologists and museum professionals should also consider Native American traditions and folklore when conducting museum research and implementing the NAGPRA process.

Conclusion

The responses from staff at several Utah museums and previous research on the subject suggests several common themes among museums in how they ensure continued compliance with NAGPRA. One common theme is the importance of museums building and maintaining relationships of trust and respect with Native American groups. Although there is some opposition to NAGPRA procedures, specifically regarding the ethical argument between relying on scientific evidences over Native American folklore and traditions (see Alonzi 2016; Bettinger 2016; Jones 2002; Lovis et al. 2004; McLaughlin 2004; O'Loughlin 2013), the fact of the matter is that NAGPRA is here to stay.

NAGPRA requires that museums consult with tribes regarding human remains, funerary objects, and other cultural objects as defined in NAGPRA law. Therefore, museums need to develop professional and personal relationships with tribal leadership and tribal historic preservation offices (THPO). Echo-Hawk (2002:170) explains that often tribal delegates view the NAGPRA experience as, "a legacy of cultural oppression and dispossession," while many museums take pride in their role of preserving objects for posterity and future research. These competing views can make the NAGPRA process complicated.

Museums should also collaborate with tribal groups on non-NAGPRA related issues. Previous research has shown the benefits of working with Native American groups on other collections-based projects (see Abraham et al. 2002; Ambler and Goff 2013; Chari 2010; McLaughlin 2004; Sullivan et al. 2000). The NAGPRA program at HC and the Peabody have philosophies that can be adopted by museums in Utah and elsewhere. Indeed, in order to remain relevant in a post-NAGPRA world, museums must continue evolving to serve as not only collectors of cultural objects, but as stewards of cultural heritage. This distinction is important since the term "steward" implies that museums will only curate and conserve NAGPRA objects until the repatriation process can begin.

Rather than waiting until the time of consultation, museums can engage tribal members in several ways, including by inviting them to contribute ideas on how to respectfully store NAGPRA items according to their cultural beliefs, curating other cultural objects that do not fall under NAGPRA, and reaching out to tribal communities to seek input on developing museum exhibits. If museums incorporate these practices into their policies and procedures, they will benefit from developing personal relationships with tribal groups and learn new information about their archaeological and anthropological collections through interpretations by cultural descendants. At the same time, tribal communities will be empowered not only in terms of NAGPRA claims and repatriation, but also as contributing voices in their own history and the preservation of their cultural materials. Building relationships of trust between tribal groups and the museum community will help to foster an environment that respects the cultural values of Native Americans, while still meeting the scientific and educational goals of museums.

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Abalone Shell Pendants

Mark E. Stuart

One of the rarest artifacts found in the Great Salt Lake region of the eastern Great Basin are *Haliotis* spp. shell pendants. At present, these pendants have been found at only a handful of sites, mostly of Fremont affiliation.

Haliotis, or abalone as it is commonly known, is a large edible sea snail. It is found along the west coast of North America from Oregon to Baja California, Mexico. It lives in rocky areas with kelp on which it feeds. They are found from the intertidal zone to water of 100 foot depth. The shell of abalone is large, thick, and dome shaped. The exterior of its shell ranges in color from brick-red to brownish-red and it has three or four oval respiratory pores. The inside of the shell is strongly iridescent (rainbow colored), and it is used by many cultures around the world for making decorative ornaments.

Abalone has been used since prehistoric times, with abalone shell from California's Channel Island archaeological sites dating to nearly 12,000 years ago (Gibbon and Ames 1998). Abalone shell middens are especially abundant in archaeological sites dated after 7500 years ago. Prehistoric Californians used abalone shell to make a variety of fish hooks, beads, ornaments and other artifacts (Gibbon and Ames 1998).

Abalone shell working and exchange was most prominent during California's Late Period, approximately A.D. 500 to 1800. In the Great Basin area abalone shells were considered valuable prestige items and highly sought after (Bennyhoff and Hughes 1986). It is believed that most of the abalone shell ornaments in the eastern Great Basin were obtained through the Colorado River trade route or the Mojave Desert route (Hughes and Bennyhoff 1996). It has been suggested by Janetski (2002) that the Fremont held trade fairs at large sedentary villages (like those in the Parowan Valley) where exotic trade items were dispersed either as gifts to build alliances or exchanged for other trade commodities with other Fremont groups. The abalone shell pendants in the Great Salt Lake region may have been obtained through down the line trade from such trade fairs, and it is possible that the Great Salt Lake region may have been the tail end of such Fremont trade patterns.

Below are descriptions of four abalone shell pendants from the Great Salt Lake region. The first pendant (Figure 1a) was found at 42WB185A, a Fremont mound site with a great deal of surface wattle and daub fragments indicating the presence of habitation structures. The site has only been minimally tested, but radio carbon analysis suggests it likely dates from ca. A.D. 813 to 1000 (Simms 2002). The pendant is rectangular in shape and measures 3.6 cm (1 $^{7}/_{16}$ inches) long; 1.6 cm ($^{13}/_{16}$ inch) wide, and 0.4 cm ($^{2}/_{16}$ inch) thick. At the top of the pendant are two holes assumed to be for suspension. The back side of the pendant bears some traces of reddish brown cortex from the outside of the shell. The pendant was found on the surface of a midden.

The second pendant (Figure 1b) is from site 42WB282. This Fremont habitation site, based on wattle daub patterns, is a cluster of at least three round Bear River Phase pithouses.

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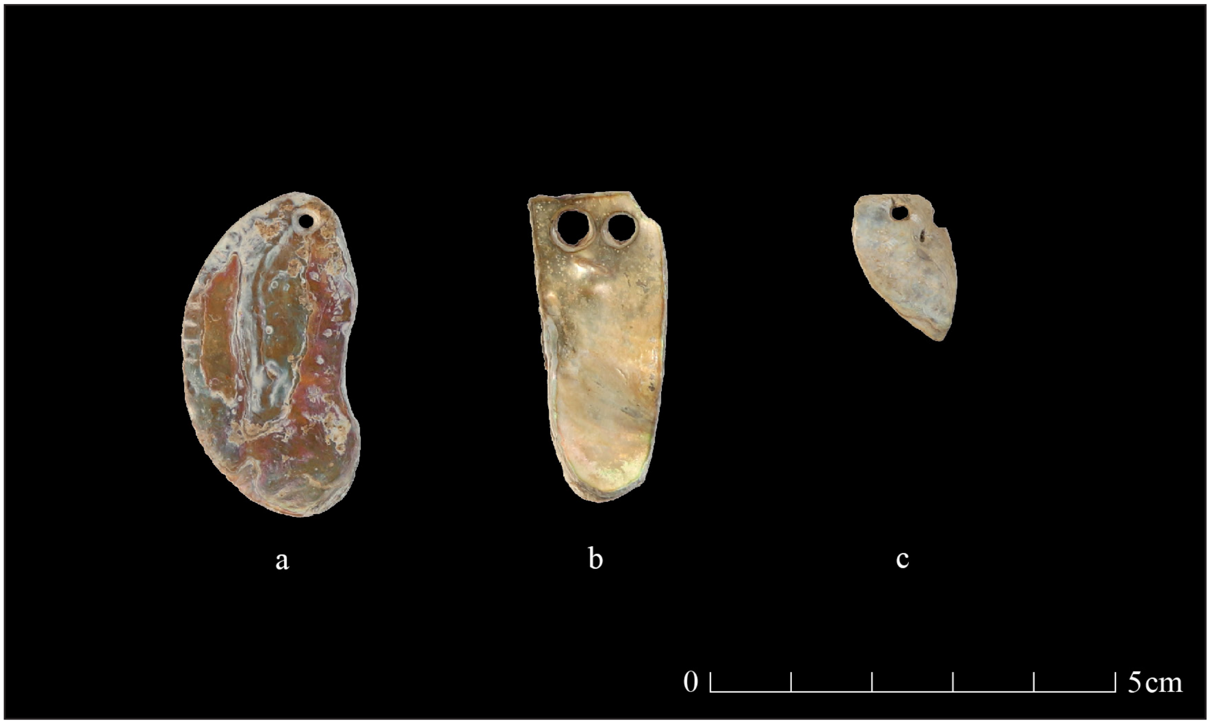

Figure 1. Abalone shell pendants from the Great Salt Lake region: (a) 42WB185a; (b) site 42WB282; (c) site 42WB185b.

Although undated, diagnostic surface artifacts suggest the site may date to ca. A.D. 800 to 1000 (Stuart 1980). Found mixed with wattle daub refuse, this pendant is roughly oval shaped and is 4 cm (1 $^{10}/_{16}$ inches) long, 2 cm ($^{13}/_{16}$ inch) wide, and 0.3 cm ($^{1}/_{16}$ inch) thick. It has a drilled hole in the middle of one end and is decorated by a series of eight parallel incised lines along its left edge. When held to light the interior of the pendant gives off a brilliant rainbow luster.

The third pendant is a small triangular shaped pendant (Figure 1c). It is 2.1 cm ($^{13}/_{16}$ inch) long, 1.2 cm ($^{8}/_{16}$ inch) wide, and 0.3 cm ($^{1}/_{16}$ inch) thick. At the top of the pendant is a single suspension hole and a decorative cut notch on the left side. It too gives off a brilliant rainbow luster in the light. This pendant was found on the surface of 42WB185B, another Fremont habitation site dating to A.D. 1127 (Simms 2002).

The last pendant (not illustrated) comes from the large "Warren Mounds Site" (42WB57) which has a maize AMS radiocarbon date of A.D. 1240 (James Allison, personal communication 2019). This site was extensively excavated by the University of Utah in the late 1940s but was never published except for a short article on the burials by Enger and Blair (1947). It is unfortunate that this important excavation was never reported and is a great loss to both science and the general public. The abalone shell pendant reported here was found by Gill Thomas, the owner of the site in 1938. It was found with eight *Olivella dama* and sixteen *Olivella biplicata* shell beads. Thomas assumed the cluster of ornaments was part of a bracelet or necklace, and re-strung them as such with the abalone pendant in the center. This pendant is round, and measures 4 cm ($^{19}/_{16}$ inch) long, by 3.9 cm ($^{18}/_{16}$ inch) wide, and 0.4 cm ($^{2}/_{16}$ inch) thick. It has a single suspension hole at one edge.

Discussion and Conclusions

Although the sample size is small, some general observations about abalone shell pendants in the Great Salt Lake region can be made. First, as reported in the professional literature they do indeed appear to be a rare occurrence in the region and support Janetski's idea of the region being the tail end of a down the line trading system from Fremont trade fairs. Second, although occasional abalone shell has been found in earlier Archaic deposits and the later Promontory period (see Hughes 1986), the heaviest use of abalone in the region appears to be during the Fremont period from A.D. 400 to 1300. The historic Northwestern Shoshoni who occupied the Great Salt Lake area at Anglo-European contact denied the use of abalone shell (Steward 1943). So far, abalone has been found at sedentary Fremont habitation sites and in Fremont deposits in long term campsites Hogup Cave and Swallow Shelter in the desert west of the Great Salt Lake. It may be that abalone shell was brought to these sites from sedentary habitation sites on the east shore of the Great Salt Lake. Third, the rarity of abalone shell in the region adds support to it being a highly valued prestige item.

It would be of benefit for future researchers to carefully record the context of abalone shell from dated, excavated sites and carefully describe them in detail by written description and illustrations. By doing so, important insights into trade patterns and group social interactions may be found.

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