UC Merced
Journal of California and Great Basin Anthropology

Title
Paleoarchaic Surface Assemblages in the Great Salt Lake Desert, Northwestern Utah

Permalink
https://escholarship.org/uc/item/0v19c97z

Journal
Journal of California and Great Basin Anthropology, 22(1)

ISSN
0191-3557

Authors
Arkush, Brooke S
Pitblado, Bonnie L

Publication Date
2000-07-01

Peer reviewed

eScholarship.org Powered by the California Digital Library
University of California

Journal of California and Great Basin Anthropology
Vol. 22, No. 1, pp. 12-42 (2000).

Paleoarchaic Surface Assemblages in the Great Salt Lake Desert, Northwestern Utah

BROOKE S. ARKUSH, Dept. of Sociology and Anthropology, Weber State University, Ogden, UT 84408.
BONNIE L. PITBLADO, Dept. of Natural and Environmental Sciences, Western State College, Gunnison, CO 81231.

Recent cultural resource management surveys within the central Great Salt Lake Desert have resulted in documentation of a high number of Western Stemmed Tradition lithic scatters associated with the Gilbert Shoreline of ancient Lake Bonneville. Obsidian and basalt are the predominant lithic materials at these sites, and X-ray fluorescence analysis of 22 obsidian tools from 13 sites suggests that the Topaz Mountain and Brown's Bench sources provided the Paleoarchaic occupants of this region with much of their obsidian toolstone, whereas volcanic glass from the Black Rock (west-central Utah) and Malad source areas was infrequently used. Trace element analysis of 22 glassy basalt implements from eight sites indicates the use of two unknown and presumably local basalt sources that may occur in the Sevier Desert south of the project area. Technological analysis of 64 projectile points from 22 sites revealed that approximately half of them were expediently manufactured from flake blanks (as opposed to bifacial blanks), a pattern that is atypical for Terminal Pleistocene/Early Holocene Great Basin lithic industries. When combined with paleoenvironmental information, the geochemical and technological data suggest that many of these sites were occupied by seasonally sedentary groups who focused much of their foraging efforts on marsh and shallow lake resources that occurred within the Gilbert Shoreline zone.

THE Gilbert Shoreline of the central Great Salt Lake Desert dates between approximately 11,000 and 10,000 years ago, and represents the Terminal Pleistocene/Early Holocene stand of Lake Bonneville (Currey et al. 1984; Benson et al. 1990). This article reports on various Paleoarchaic (ca. 11,000 to 7,500 B.P.) (Willig and Aikens 1988) lithic scatters located within the Gilbert Shoreline zone, and focuses on geochemical sourcing data and lithic technology associated with various chipped stone tools recovered from these sites. All of the archaeological sites discussed herein are situated within the greater Wildcat Mountain area, which is located on the Wendover Air Force Range (WAFR) of the U. S. Air Force Utah Test and Training Range (UTTR) (Fig. 1). The range encompasses more than 571,000 acres, and is one of three range complexes that comprise the UTTR (which occupies a total area of approximately 952,000 acres). The southern border of the WAFR abuts the northern border of the U. S. Army Dugway Proving Ground, and because public access to these extensive military complexes has been restricted for some 50 years, much of the central and southern Great Salt Lake Desert contains numerous pristine archaeological sites, including caves, rockshelters, and extensive open-air camps (Schmitt et al. 1994; Carambelas and Josephson 1996; Arkush 1997, 1998).

The primary purpose of this article is to present new data regarding igneous toolstone use patterns and lithic reduction/production practices as evidenced by a recently recovered sample of Great Basin Stemmed projectile points, in order to improve our understanding of the basic Terminal Pleistocene/Early Holocene settlement systems associated with the central Great Salt Lake Desert. Great Basin Paleoarchaic settlement and subsistence practices, as well as temporal affiliations of different stemmed point styles, are poorly understood. For the most part, this situation results from a dearth of excavated cultural deposits and a poorly defined projectile point tradition.

Following the example of Beck and Jones (1997: 163), we use the term "Paleoarchaic" to refer to

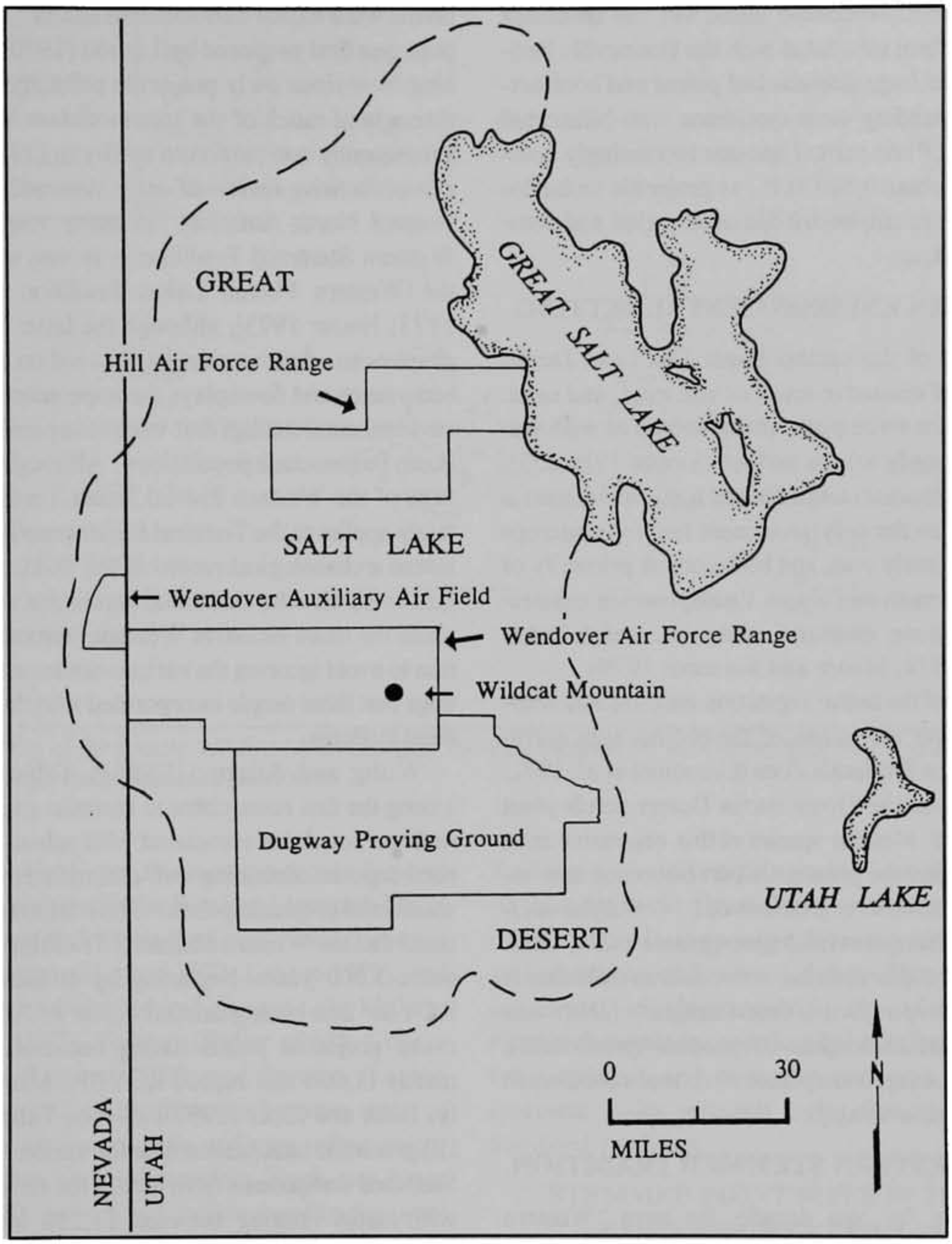

Fig. 1. Map of the general Great Salt Lake Desert region, showing locations of the three UTTR properties, the Wildcat Mountain area, and Dugway Proving Ground.

human groups who occupied the Great Basin during Terminal Pleistocene and Early Holocene times (ca. 11,500 to 7,500 B.P.), and whose primary early weapon system consisted of thrusting spears commonly tipped with Western Stemmed style projectile points. In the eastern Great Basin, this four-millennia-long cultural tradition coincides with two main time periods, the Bonneville Period (11,000 to 9,500 B.P.) and the Wendover Period (9,500 to 6,000 B.P.) (Aikens and Madsen 1986).

The stemmed lanceolate point was the dominant projectile form associated with the Bonneville Period, whereas large side-notched points and contracting or expanding stem specimens with bifurcated bases (i.e., Pinto series) became increasingly common after about 9,500 B.P., as projectile technologies began to emphasize use of the atlatl and composite dart.

MODERN ENVIRONMENTAL SETTING

Much of the central Great Salt Lake Desert consists of extensive areas of silt, mud, and sand. Virtually the entire playa area is saturated with water to (or nearly to) the surface (Stokes 1986:255). Wildcat Mountain and adjacent Kittycat Mountain (Fig. 2) are the only prominent bedrock outcrops within the study area, and both consist primarily of Lower Permian and Upper Pennsylvanian calcareous sandstone, quartzite, limestone, and dolomite (Hintze 1974; Moore and Sorensen 1979).

Most of the native vegetation encountered within the lower elevations of the project area correspond to the Shadscale Zone (Cronquist et al. 1972: 114-122) of the Great Basin Desert scrub plant community. Member species of this vegetative zone found within the greater Gilbert Shoreline area include iodine bush or pickleweed (*Allenrolfea occidentalis*), halogeton (*Halogeton glomeratus*), black greasewood (*Sarcobatus vermiculatus*), shadscale (*Atriplex confertifolia*), desert saltgrass (*Distichlis spicata*), Indian ricegrass (*Oryzopsis hymenoides*), budsage (*Artemisia spinescens*), and rabbitbrush (*Chrysothamnus* sp.).

THE WESTERN STEMMED TRADITION

During the past decade, the term "Western Stemmed Tradition" (Willig and Aikens 1988) has been used to describe Terminal Pleistocene/Early Holocene archaeological complexes in the far west characterized by large stemmed and lanceolate projectile points (e.g., Beck and Jones 1990a; Haynes 1996). As noted by Willig and Aikens (1988:4-5), this term was adapted from the concept of a widespread stemmed point tradition in which projectile points were hafted into socketed shafts. The latter term was first proposed by Layton (1970) in referring to various early projectile point styles found throughout much of the Intermountain West, and subsequently was reinforced by Bryan (1980) in his comprehensive review of early stemmed points in western North America. In many respects, the Western Stemmed Tradition is synonymous with the Western Pluvial Lakes Tradition (Bedwell 1973; Hester 1973), although the latter term emphasizes an adaptive strategy focused on paleolake ecosystems and downplays the importance of other environmental settings that were occupied by Great Basin Paleoarchaic populations. Although the concept of the Western Pluvial Lakes Tradition certainly applies to the Terminal Pleistocene/Early Holocene archaeological record of the Wildcat Mountain area, all sites described herein are subsumed under the more inclusive Western Stemmed Tradition to avoid ignoring the various nonlacustrine settings that these people incorporated into their settlement systems.

Willig and Aikens (1988:10, Table 3) were among the first researchers to compile a number of radiocarbon dates associated with subsurface cultural deposits containing well-defined stemmed and shouldered projectile points. Their tabulation indicated that the Western Stemmed Tradition spanned some 3,500 years, beginning by at least 11,000 RCYBP and ending around 7,500 RCYBP, with many projectile points dating between approximately 11,000 and 10,000 RCYBP. More recently, Beck and Jones (1997:195-196, Tables II and III) presented radiocarbon data for various Western Stemmed components from across the Great Basin, with dates ranging between 11,200 and 7,100 RCYBP, thereby extending the known temporal range of Western Stemmed assemblages to slightly over 4,000 years. These dates also suggest that stemmed points occurred earliest in the northern and eastern Great Basin (11,200 RCYBP and 11,140 RCYBP, respectively) and latest in the Mojave Desert (ca. 9,100 RCYBP) (Beck and Jones 1997:196, Table II).

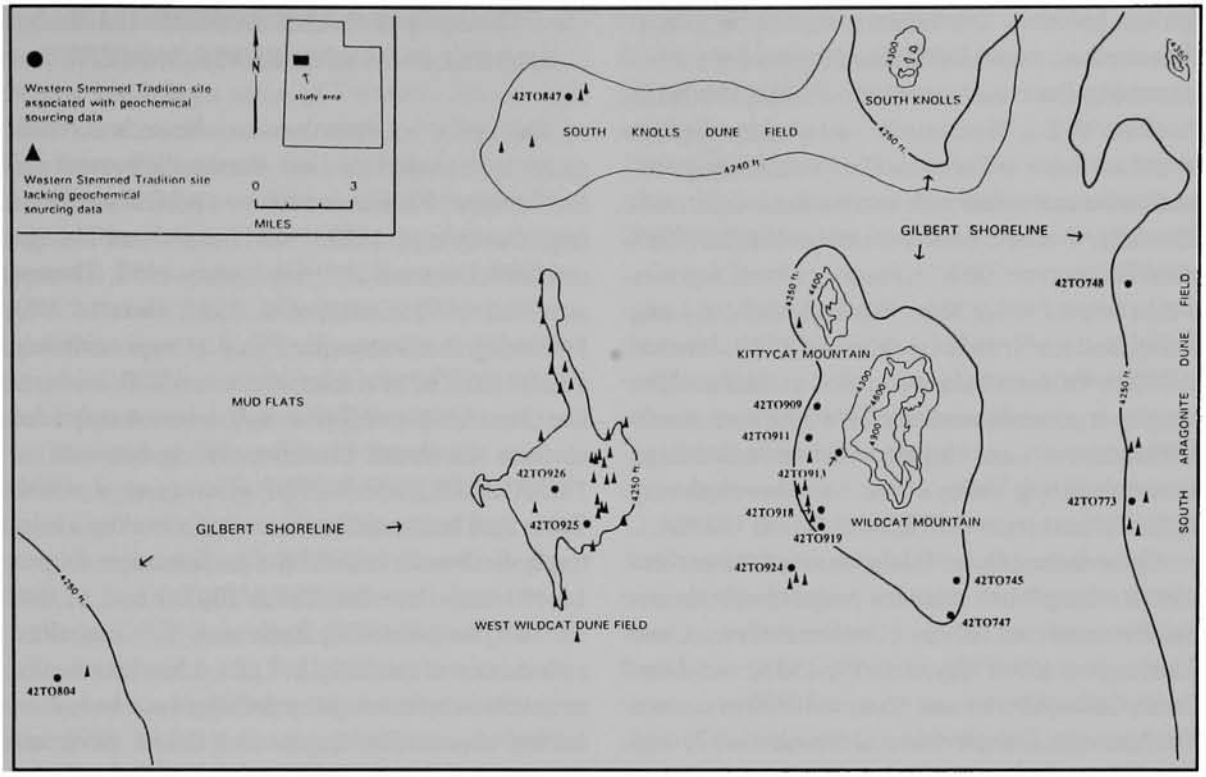

Fig. 2. Map of the greater Wildcat Mountain area, showing locations of the Gilbert Shoreline and associated Great Basin Stemmed point sites.

Within the Great Basin, most projectile point styles associated with the Western Stemmed Tradition are classified within the Great Basin Stemmed series (Tuohy and Layton 1977; Layton 1979), and include such types as Silver Lake and Lake Mohave (Amsden 1937), Haskett (Butler 1965), Cougar Mountain (Layton 1970), and Parman (Layton 1970). Morphological differences between many of these types are quite subtle, and may reflect extensive curation and resharpening (Beck and Jones 1990a:243), as well as functional and/or temporal variability (e.g., Beck and Jones 1993).

Sites containing Great Basin Stemmed series points occur in a variety of environmental settings, including on or near Pleistocene lakeshores and terraces, as well as riverine and upland settings (Layton 1970, 1972; Bryan 1979; Beck and Jones 1990b; Basgall 1993; Hall 1993; Basgall and Hall 1994). Although a number of Western Stemmed Tradition sites and components has been documented thus far in the Great Basin, most are open-air lithic scatters lacking subsurface cultural deposits and associated radiocarbon dates. Therefore, the question of initial human occupation of the Basin, along with questions regarding Paleoarchaic subsistence systems and microenvironmental settings, represent major research topics for the Western Stemmed Tradition.

STEMMED POINT SITES IN THE EASTERN GREAT BASIN

Prior to our work on the UTTR, the spatial distribution of most known Great Basin stemmed point sites in eastern Nevada and the Bonneville Basin reflected a broadly dispersed settlement pattern involving single sites in a variety of environmental settings, as opposed to relatively dense occurrences of multiple sites associated with ancient lacustrine and riparian habitats. One of the more notable exceptions to this scattered distributional pattern was documented by Beck and Jones (1988, 1990a, 1990b) in the Butte Valley of eastern Nevada, where they recorded a number of Terminal Pleistocene/Early Holocene sites associated with ancient Lake Gale. Additionally, a cluster of surface and subsurface Terminal Pleistocene/Early Holocene cultural deposits is also evident at Sunshine Wash in southern Long Valley, eastern Nevada (Hutchinson 1988; Jones et al. 1996). Paleoarchaic occupation of the Sunshine Locality is primarily associated with the final stands of Pleistocene Lake Hubbs, which occupied large portions of Long Valley at various intervals during the Late Pleistocene (Mifflin and Wheat 1979).

In the eastern Great Basin, some of the earliest known examples of stemmed projectile points derive from sheltered sites such as Smith Creek Cave (Harrington 1934; Bryan 1979, 1988) and Deer Creek Cave (Shutler and Shutler 1963) in eastern Nevada, and Danger Cave (Jennings 1957) and Hogup Cave (Aikens 1970) in western Utah. More recently, several open sites in the Bonneville Basin have yielded stemmed projectile points. These include 42MD300 in the Sevier Desert (Simms and Lindsay 1989), 42BO538 in the southern Curlew Valley (Russell 1993), and three sites (42TO385, 42TO394 [Zier 1984], and 42TO798 [Schmitt et al. 1994]) on Dugway Proving Ground.

All four of the above-mentioned cave sites, along with 42MD300, have yielded radiocarbon dates associated with stemmed point components, resulting in a temporal range of about 11,150 to 7,800 RCYBP for the Paleoarchaic lifeway in the eastern Great Basin (e.g., Beck and Jones 1997:192-193, Table II). Radiocarbon dates from recent excavations at Danger Cave (Madsen and Rhode 1990) comprise an important contribution to the corpus of Terminal Pleistocene/Early Holocene archaeological dates for this region, and when combined with the previous work conducted there by Jennings (1957), this site currently has one of the best-dated stratigraphic sequences in the entire Great Basin (Beck and Jones 1997:193).

TERMINAL LAKE BONNEVILLE SHORELINES AND ENVIRONMENTS

During the last three decades, numerous investigators have studied the Lake Bonneville system and its Terminal Pleistocene Provo and Gilbert levels (e.g., Currey et al. 1983, 1984; Benson and Thompson 1987; Benson et al. 1990; Currey 1990; Thompson et al. 1990; Oviatt et al. 1992; Oviatt 1997). Following the Bonneville Flood at approximately 14,500 RCYBP, the lake fell some 350 ft. in elevation (from 5,090 to 4,740 ft. asl), where it stabilized to form the Provo Shoreline dating between ca. 14,500 and 13,500 RCYBP (Currey et al. 1984: Table 1). The Provo Shoreline was formed by a relatively freshwater lake with a surface area of some 14,400 mi.^{2} Between about 13,000 and 12,000 RCYBP, the Bonneville Basin may have contained a succession of relatively low and saline lakestands, as indicated by extensive pre-Gilbert red beds containing desiccation cracks and desert pavement (Currey et al. 1988), and by relatively deep mirabilite deposits (Benson et al. 1990).

From approximately 12,000 to 11,000 RCYBP, the northern Bonneville Basin supported a series of shallow pre-Gilbert transgressive phase lakes (Benson et al. 1992), and fishes that were present during the Bonneville and Provo stands apparently populated the lake at this time. A Terminal Pleistocene ichthyofaunal assemblage consisting of some 13,500 specimens and dating between ca. 11,400 and 10,100 RCYBP was recently recovered from the basal stratum (Stratum I) of a sample column at Homestead Cave, located in the northern Lakeside Mountains just west of the Great Salt Lake (Broughton et al. 2000:Tables 1 and 2)). The Homestead Cave fish assemblage is represented by four families and 11 species, including Bonneville cisco (*Prosopium gemmifer*), Bonneville whitefish (*Prosopium spilonotus*), cutthroat trout (*Oncorhynchus clarki*), Utah chub (*Gila atraria*), Utah sucker (*Catostomus ardens*), and Bear Lake sculpin (*Cottus extenus*).

The nature of the Stratum I deposits at Homestead Cave suggests that the fish remains were introduced to site sediments by scavenging owls, and most of these specimens probably resulted from a process involving a series of Terminal Pleistocene die-offs and recolonizations of the Lake Bonneville fish fauna (Broughton et al. 2000). At this time, the Homestead Cave fish remains comprise the only known Terminal Pleistocene-aged fish fauna from the Bonneville Basin, but it seems unlikely that a lakestand supposedly lower in elevation than the Gilbert level (e.g., Thompson et al. 1990; Oviatt et al. 1992) would have consisted of fresh water and supported such a diverse fish population.

The Gilbert phase of Lake Bonneville existed between approximately 11,000 and 10,000 RCYBP (published radiocarbon dates on wood and shell samples associated with the Gilbert Shoreline range from 11,050 to 10,000 RCYBP; see Benson et al. [1990:Table II]; Oviatt et al. [1992:Table I]), when it stood at about 4,250 ft. (1,290 m.) asl and had a surface area of approximately 6,600 mi.^{2} (Currey et al. 1984:Table 1). During this Terminal Pleistocene cycle, the lake rose relatively slowly, and reached its maximum height between 10,900 and 10,300 RCYBP (Oviatt et al. 1992). Within the Great Salt Lake region, altitudes of the Gilbert Shoreline now range from about 4,240 ft. to 4,300 ft., indicating that up to 60 ft. of differential isostatic rebound occurred following decline of the Gilbert level (Currey 1980:76).

Of the four major lake levels associated with the post-28,000 RCYBP Bonneville cycle (Stansbury, Bonneville, Provo, and Gilbert), the Gilbert Shoreline is least conspicuous, and perhaps best represented by the Mills Junction and Magna spits in the east-central Great Salt Lake subbasin (Currey et al. 1983). The Gilbert level of Lake Bonneville formed during the widespread cooling trend of the Younger Dryas iceberg-rafting event in the North Atlantic Ocean (Oviatt 1997). A post-Gilbert regression of the lake occurred between about 10,000 and 9,500 RCYBP, when the Younger Dryas event terminated and the climate of the North Atlantic region warmed abruptly (Oviatt 1997).

At present, the paleoenvironmental record of the biotic communities associated with the Gilbert Shoreline is superficial. Published paleolake sediment core data for the Bonneville Basin are meager, and lack information concerning the Gilbert stand. The radiocarbon chronology of a lake sediment core (Core C) recovered from the south-central portion of Great Salt Lake by Spencer et al. (1984) was revised by Thompson et al. (1990) using accelerator mass spectrometry (AMS) dating, and provided additional support for the proposition that several low-level and highly saline stands of Lake Bonneville existed prior to the Gilbert episode.

Unit IIIa from the upper part of Core C consisted of a light-colored mottled mud dating between 12,300 and 12,000 RCYBP (Thompson et al. 1990: 306), and the presence of brine shrimp throughout much of this sub-unit indicates that the lake waters were concentrated and saline at this time. Pollen from xeric desert scrub plant species such as greasewood and other chenopods increased markedly during this period, and corroborate the paleoenvironmental interpretations of Currey et al. (1988) and Benson et al. (1990). The base of the stratigraphic unit immediately above Unit IIIa (Unit II) is AMS dated at 10,000 RCYBP, and contains significant amounts of pollen from xeric desert scrub plants as well as conifer pollen (which probably was derived from the nearby Wasatch Range [see Rhode and Madsen 1995:252]). Therefore, the critical 2000-year-long Terminal Pleistocene pollen record associated with the Gilbert transgressive phase and Gilbert phase is missing from Core C.

The study conducted by Broughton et al. (2000) suggests that fishes were present in Lake Bonneville during the Gilbert transgression from about 11,000 to 10,400 RCYBP. Therefore, a variety of taxa probably were readily available to Paleoarchaic occupants of the study area prior to about 10,400 RCYBP. In fact, the southeastern portion of terminal Lake Bonneville (which coincides with the general study area) may have supported one of the largest fish populations in the entire Great Salt Lake Desert portion of the lake during the Gilbert cycle due to influxes of fresh water from Old River, which discharged northward from the Sevier Desert basin (Lake Gunnison) during the final regressive stages of Lake Bonneville (Currey et al. 1983:69-70). Preliminary data from Old River suggest that the river flowed sluggishly between approximately 11,000 and 9,500 RCYBP, and that an extensive marsh system existed in the delta area, some eight to ten miles south-southeast of the southern base of Wildcat Mountain (D. Madsen, personal communication 1998).

In view of the high density of Paleoarchaic sites on the western side of Wildcat Mountain and around the periphery of the West Wildcat Dune Field (Fig. 2), it seems reasonable to infer that this area (just north-northwest of the Old River delta) supported a fairly lush marshland that was a focus of seasonal human foraging efforts. This same assessment was made by Carter (1999:20) based on his work in the West Wildcat Dune Field (TS-5 Target Complex area), in which he suggested that "during the Gilbert Shoreline period of transgression and early regression, the southern Great Salt Lake Desert basin would maintain standing water suitable for the development of paleomarshes—slightly saline wetlands and meadows wetted or dampened perennially by evaporative pumping of shallow groundwater." Hence, these marshy areas would have supported emergent vegetation, such as cattail and sedges, where water was freshest, and other species, such as bulrush and saltgrass, in areas characterized by higher salinity and less available moisture (Carter 1999:20).

One of the more comprehensive vegetational records for the Terminal Pleistocene Bonneville Basin has been reconstructed by Rhode and Madsen (1995), and is based on plant remains recovered from 15 woodrat middens dating between 14,000 and 9,000 RCYBP. Two of the woodrat midden samples were recovered from the Lead Mine Hills (BE 3a) and Leppy Hills (LO 3) in the greater Wendover area, and date to the first half of the Gilbert episode (11,100 to 10,550 RCYBP). The BE 3a midden was dominated by xeric desert scrubs, such as sagebrush, shadscale, horsebrush, snakeweed, and rabbitbrush, with limber pine and prostrate juniper being rare to uncommon elements of this midden. The LO 3 midden was dominated by limber pine needles and seeds, as well as the remains of sagebrush, snowberry, and greasebush (Rhode and Madsen 1995:251).

The occurrence of both limber pine and fish remains in some of the Bonneville Basin woodrat midden samples led Rhode and Madsen (1995:253, 255) to conclude that Terminal Pleistocene summer temperatures in the Wendover area were some six to seven degrees C. lower than those of today, and that a large, cold, and relatively freshwater lake occupied the Bonneville Basin between about 13,000 and 11,300 RCYBP. As noted by Rhode and Madsen (1995:255), these findings conflict with those of Currey (1990), Thompson et al. (1990), and Oviatt et al. (1992), who maintained that Lake Bonneville fell to very low levels after about 13,000 RCYBP, and after 12,200 RCYBP, experienced a transgressive phase that culminated at the Gilbert level by about 10,500 RCYBP. Only new and compelling data will resolve this conflict, but at the very least, the Bonneville Basin woodrat middens and Homestead Cave fishes necessitate a careful evaluation of traditionally held views concerning the post-Provo Lake Bonneville cycle.

Cored sediments recovered from the Great Salt Lake subbasin indicate that during most of the Holocene, water levels have remained at altitudes almost equal to the Great Salt Lake's historic average of just over 4,200 ft. asl (Benson et al. 1990). However, between approximately 9,600 and 9,000 RCYBP, an early Holocene transgressive cycle culminated in a shoreline at about 4,235 ft. asl, a height roughly midway between the Gilbert level and the highest Late Holocene level of the Great Salt Lake (Madsen 2000; Murchison 1989). Subsequent oscillations within the modern fluctuation range of the lake also occurred between 8,000 and 7,000 RCYBP and again at about 5,900 RCYBP (Madsen 2000; Murchison 1989). Two peaks in the abundances of Utah chub within the Holocene deposits at Homestead Cave suggest that these fish may have recolonized the Great Salt Lake during highstands at ca. 3,400 RCYBP and ca. 1,000 RCYBP (Broughton et al. 2000).

This brief discussion reflects the dynamic and complex hydrologic history of the Great Salt Lake Desert during Terminal Pleistocene/Early Holocene times. During the next several years, publication of recently acquired paleoenvironmental data should significantly improve our understanding of ancient lakestands and landscapes in the central Bonneville Basin.

PROJECT BACKGROUND

Most of the ancient aboriginal sites discussed in this article were documented during a long-term cultural resources inventory of the UTTR conducted between 1991 and 1996. The ecologically stratified survey inspected 223,500 acres (23.5%) of the UTTR, resulting in the discovery of 185 archaeological sites, 161 of which were prehistoric in age (Arkush 1997). The vast majority of significant, or potentially significant, archaeological sites documented during the course of this project occur within eight proposed National Register districts, which include the Wildcat Mountain area, and the South Knolls and South Aragonite dune fields (Fig. 2).

Of the seven distinct environmental zones that were sampled during the UTTR survey, the Gilbert Shoreline area comprised Zone 2, and on the WAFR consisted of sparsely vegetated playa and scattered stabilized dunes ranging between about 4,230 and 4,260 ft. asl. On the WAFR, the Gilbert Shoreline zone comprised approximately 105,500 acres (18.47%) of the WAFR, and 60,470 acres (57.30%) of this zone were surveyed. A total of 33 lithic scatters containing either Great Basin Stemmed and/or Pinto series projectile points was documented on the WAFR, and the vast majority of these sites occur within the Gilbert Shoreline zone (Fig. 2). A minority of them occur on sandy flats near the bases of low, stabilized dunes (Zone 4) immediately above the Gilbert Shoreline zone, and none were documented on playa surfaces below the Gilbert zone (Zone 1) (Arkush 1997).

The most recent survey work to be conducted within the study area focused on a 9,500-acre parcel in the Gilbert Shoreline zone of the West Wildcat Dune Field, resulting in the recordation of 29 additional Great Basin Stemmed sites (Fig. 2) (Carter 1999). One of these sites (42TO1009) contained water-windrowed terrestrial gastropod shell that was AMS dated at 9,640 ± 60 RCYBP, equivalent to a two-sigma calibrated range between 10,975 and 10,530 calendar years B.P. (Carter 1999:17-18). Although the gastropod shell at 42TO1009 may not be affiliated with actual human occupation of this site, the dated sample represents an important addition to the small suite of radiocarbon-assayed Gilbert Shoreline deposits, and relates to the Gilbert transgression. The presence of so many Paleoarchaic sites in the Wildcat Mountain area suggests that Gilbert and post-Gilbert shallow lake and marsh environments in this locality were quite productive, and experienced intensive use and occupation by some of the earliest human inhabitants of the Great Salt Lake Desert.

STEMMED POINT SITES IN THE WILDCAT MOUNTAIN AREA

Most Great Basin Stemmed sites documented within the greater Wildcat Mountain area are either medium- or large-sized lithic scatters, and probably represent seasonal encampments. Some of the larger sites—as well as somewhat smaller ones with relatively high artifact densities—may have witnessed multiple occupations over the span of several centuries. For the most part, these sites occupy areas ranging from about 3,000 to 17,000 m.^{2}, and contain chipped stone tools and debitage dominated by fine-grained basalt, with smaller quantities of obsidian and microcrystalline silicates. Both formed artifacts and flakes often exhibit extensive wind-scouring and patination (Figs. 3-10), indicating that they have been in exposed surface contexts for millennia.

Both cores and cortical flakes, especially those of basalt, are almost entirely lacking at the Wildcat Mountain Paleoarchaic sites. This pattern is similar to that documented in Butte Valley by Beck and

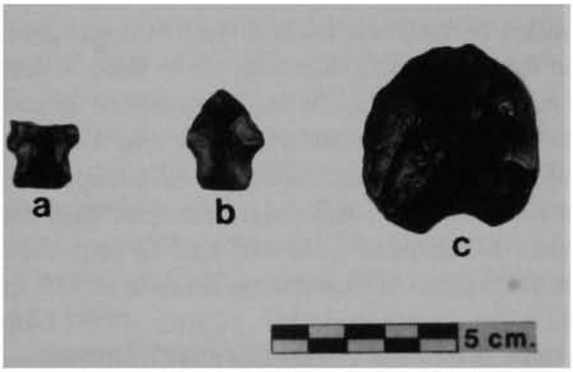

Fig. 3. Examples of artifacts from site 42TO745: (a-b) Great Basin Stemmed projectile points; (c) ovate biface. The specimen shown in Figure 3b (Cat. No. 3-3-4) is made of Brown's Bench obsidian.

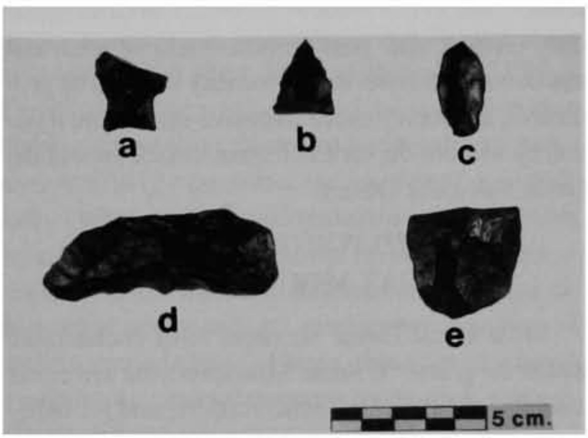

Fig. 4. Examples of artifacts from site 42TO747: (a, c) Great Basin Stemmed points; (b) distal projectile point or biface fragment; (d) crescent; (e) proximal biface fragment. The specimen shown in Figure 4c (Cat. No. 3-5-7) derives from the Topaz Mountain source.

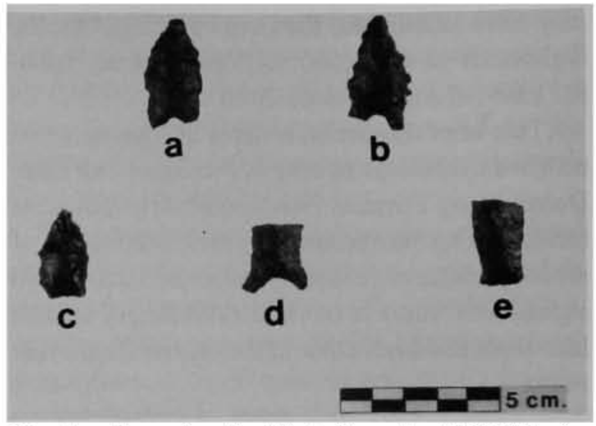

Fig. 5. Examples of artifacts from site 42TO748: (a-b, d) Pinto points; (c) Great Basin Stemmed point or Pinto point preform; (e) Great Basin Stemmed point. The specimen shown in Figure 5c (Cat. No. 3-6-2) is manufactured from the Topaz Mountain source.

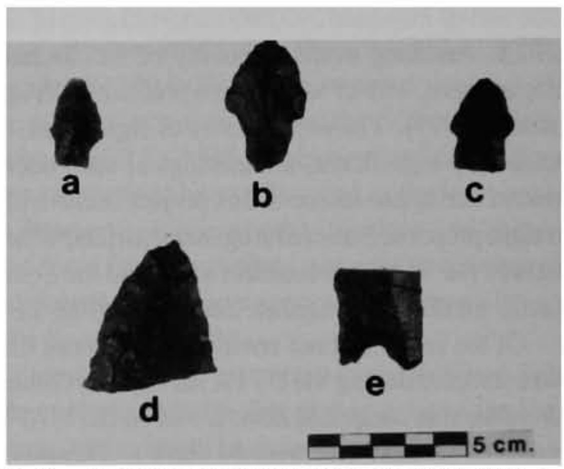

Fig. 6. Examples of artifacts from site 42TO909: (a-c) Great Basin Stemmed points; (d) distal biface fragment; (e) Black Rock Concave Base point or basal-notched biface fragment. The specimens shown in Figures 6a (Cat. No. 9-3-7) and 6c (Cat. No. 9-3-3) are made of Topaz Mountain obsidian, and the specimen in Figure 6b (Cat. No. 9-3-2) is made of Brown's Bench obsidian.

Jones (1990c), and suggests that initial basalt core reduction typically took place at quarries as opposed to residential sites. Available evidence indicates that most formed tools produced at the ancient lakeside encampments within the study area were fashioned from flake blanks and bifacial cores (e.g., Kelly 1988). One of the larger Great Basin Stemmed sites in the Wildcat Mountain area is 42TO909, which is situated at an elevation of 4,255 ft. asl (Fig. 2), and occupies an area of approximately 79,000 $m.^2$ This site contains a diverse basalt-dominated artifact assemblage, including 10 bifaces, 15 Great Basin Stemmed points (Fig. 6a-

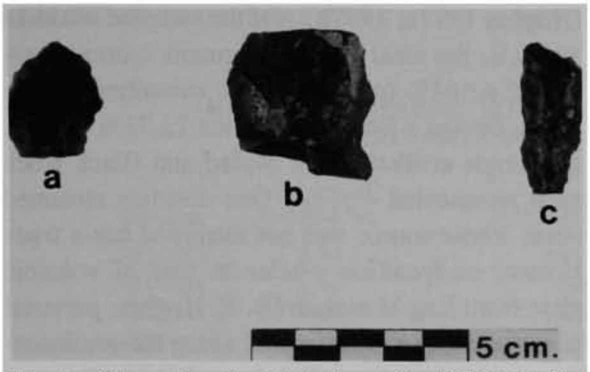

Fig. 7. Examples of artifacts from site 42TO911: (a, c) Great Basin Stemmed points; (b) medial early stage biface fragment. The specimens shown in Figures 7a (Cat. No. 9-5-2) and 7c (Cat. No. 9-5-1) are made of Topaz Mountain obsidian.

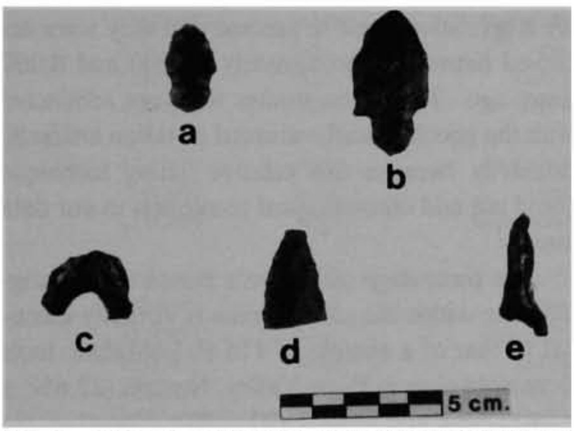

Fig. 8. Examples of artifacts from site 42TO918: (a-b) Great Basin Stemmed points; (c) crescent; (d) medial/distal biface or projectile point fragment; (e) possible drill. The specimen shown in Figure 8a (Cat. No. 9-9-3) derives from Black Rock obsidian.

c), 23 Pinto series points, over 1,200 pieces of debitage (most of which are basalt biface thinning flakes), and several fragmentary projectile points, cores, and manos.

Slightly over 15% (n = 5) of the Great Basin Stemmed point sites documented during the long-term UTTR study also contained Pinto series projectile points (Fig. 5), and Pinto points comprise the

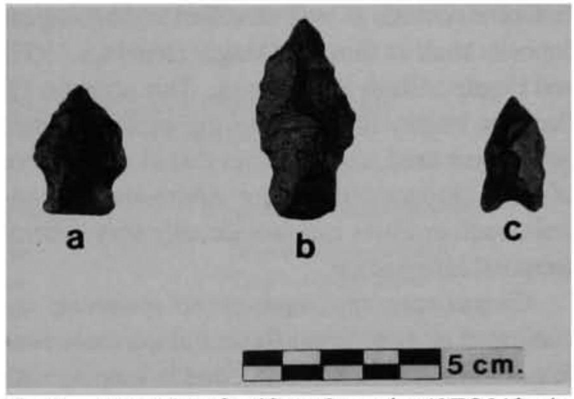

Fig. 9. Examples of artifacts from site 42TO919: (a-b) Great Basin Stemmed points; (c) Pinto point. All three specimens are made of glassy basalt.

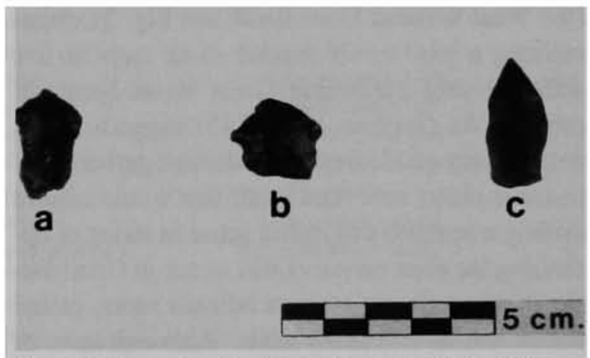

Fig. 10. Examples of artifacts from site 42TO924: (a-c) Great Basin Stemmed points. The specimens shown in Figures 10a (Cat. No. 9-15-8) and 10c (Cat. No. 9-15-6) are made of Topaz Mountain obsidian, while 10b (Cat. No. 9-15-7) derives from Brown's Bench.

sole projectile point style represented at just over 12% (n = 4) of sites within the Gilbert Shoreline zone near Wildcat Mountain. These data suggest that some of the Gilbert Shoreline zone sites in our sample postdate ca. 9,500 RCYBP, and were occupied during the Gilbert period lake regression or during a series of post-Gilbert period lake transgressions that peaked between 9,600 and 9,000 RCYBP (Murchison 1989). It is important to note that in the eastern Great Basin, Western Stemmed points co-occur with Elko and Pinto forms in Early

Holocene contexts at well-stratified archaeological deposits such as those at Danger (Jennings 1957) and Hogup (Aikens 1970) caves. This scenario reflects the lengthy time span during which stemmed points were used, and indicates that in the absence of solid chronometric and/or environmental controls, such artifacts can provide only very general temporal information.

Ground stone implements are not commonly encountered at most Great Basin Paleoarchaic sites (e.g., Grayson 1993:244-246), and in keeping with this pattern, a minority of the Wildcat Mountain stemmed point sites contained a few ground stone tools, typically consisting of crude manos and metates. Carter (1999:172) observed a similar pattern on the proposed TS-5 Target Complex landform (the West Wildcat Dune Field; see Fig. 2), documenting a total of six ground stone tools at five different sites containing Great Basin Stemmed points. As Grayson (1993:245) suggested, this pattern may result from the selective gathering of nonseed plants over hard seeds that would require milling, a scenario that makes sense in terms of optimizing the plant resources that occur in Great Basin marsh settings, such as bulrush roots, cattail pollen, and various fleshy seeds. Although some of the metates associated with these ancient sites may have been used for milling plant foods, they may also have functioned as anvils for bone processing tasks and various other nonfood-related activities.

LITHIC SOURCING AND TECHNOLOGY

Geochemical Sourcing Data

In order to gain a general understanding of the different igneous toolstone sources represented at the Wildcat Mountain Paleoarchaic sites (Table 1), a sample of 44 artifacts (consisting of 22 obsidian specimens from 13 sites and 22 basalt specimens from eight sites) was subjected to X-ray fluorescence analysis. This resulted in the identification of four known obsidian sources (Topaz Mountain, Brown's Bench, Malad, and Black Rock) (Fig. 11) and one or two unknown glassy basalt sources (Hughes 1997a, 1997b). Of the sampled obsidian artifacts, the local Topaz Mountain source represented 63.64% (n = 14) of the submitted assemblage, Brown's Bench comprised 22.73% (n = 5), and single artifacts from Malad and Black Rock each represented 4.55%. One obsidian stemmed point whose source was not identified has a trace element composition similar to that of volcanic glass from Keg Mountain (R. E. Hughes, personal communication 1997), located along the southeastern margin of the Great Salt Lake Desert. Because the sites discussed herein are associated with the Gilbert Shoreline and contain time-sensitive projectile points dating to the Terminal Pleistocene/Early Holocene throughout the Great Basin (keeping in mind that our understanding of the absolute chronology of Great Basin Stemmed points is problematic), it is relatively safe to assume that they were occupied between approximately 11,000 and 8,000 years ago. Hydration studies were not conducted with the geochemically sourced obsidian artifacts, primarily because this relative dating technique could not add chronological resolution to our data set.

The percentage of Brown's Bench obsidian/ignimbrite within the source areas is virtually identical to that of a sample of 115 Paleoarchaic tools from eight sites in Butte Valley, Nevada (22.6%; n = 26) (Beck and Jones 1990c:289). Together, the Wildcat Mountain and Butte Valley assemblages indicate that igneous toolstone from the extensive Brown's Bench source area in northeastern Nevada and southwestern Idaho was utilized by eastern Great Basin native peoples for over 10,000 years. Not surprisingly, Topaz Mountain glass dominates the sourced obsidian tool assemblage for the Wildcat Mountain study, and its presence in this population indicates a lengthy quarrying history similar to that of Brown's Bench. Topaz Mountain comprises the southeastern portion of the Thomas Range, and occurs some 80 km. south-southeast of Wildcat Mountain (Fig. 11). Obsidian from this source area commonly occurs at prehistoric sites in the southern Great Salt Lake Desert and Tule Valley regions, in-

Table 1
IGNEOUS TOOLSTONE SOURCES REPRESENTED AT PALEOARCHAIC PERIOD SITES ALONG THE GILBERT SHORELINE

Site No.	Catalog No.	Artifact Description	Obsidian or Basalt Source
42TO745	3-3-2	Parman point	Unknown Basalt Source A
42TO745	3-3-3	ovate biface	Unknown Basalt Source B
42TO745	3-3-4	Parman point	Brown's Bench, Idaho/Nevada
42TO747	3-5-2	proximal biface fragment	Unknown Basalt Source B
42TO747	3-5-5	crescent	Unknown Basalt Source B
42TO747	3-5-7	Lake Mohave point	Topaz Mountain, Utah
42TO747	3-5-8	Parman point	Unknown Basalt Source A
42TO747	3-5-11	distal projectile point fragment	Unknown Basalt Source B
42TO748	3-6-1	Pinto Square-shouldered point	Unknown Basalt Source B
42TO748	3-6-2	Great Basin Stemmed or Pinto point preform	Topaz Mountain, Utah
42TO748	3-6-3	Pinto Sloping-shouldered point	Unknown Basalt Source B
42TO748	3-6-6	Pinto Shoulderless point	Unknown Basalt Source B
42TO748	3-6-8	Haskett-like stemmed point	Unknown Basalt Source A
42TO773	4-7-1	Parman point	Topaz Mountain, Utah
42TO804	7-1-5	Lake Mohave point	Keg Mountain, Utah?
42TO847	8-6-4	Lake Mohave point	Topaz Mountain, Utah
42TO847	8-6-13	Lake Mohave point	Brown's Bench, Idaho/Nevada
42TO909	9-3-2	Lake Mohave point	Brown's Bench, Idaho/Nevada
42TO909	9-3-3	Parman point	Topaz Mountain, Utah
42TO909	9-3-4	large Pinto Shoulderless point or basal-notched biface	Unknown Basalt Source B
42TO909	9-3-5	distal biface fragment	Unknown Basalt Source B
42TO909	9-3-7	Parman point	Topaz Mountain, Utah
42TO911	9-5-1	Haskett-like stemmed point	Topaz Mountain, Utah
42TO911	9-5-2	Lake Mohave point	Topaz Mountain, Utah
42TO911	9-5-3	medial early stage biface fragment	Unknown Basalt Source B
42TO913	9-6-2	Lake Mohave point	Brown's Bench, Idaho/Nevada
42TO918	9-9-1	Lake Mohave point	Unknown Basalt Source B
42TO918	9-9-3	Lake Mohave point	Black Rock, Utah
42TO918	9-9-5	medial/distal biface or point fragment	Unknown Basalt Source B
42TO918	9-9-8	crescent	Unknown Basalt Source B
42TO918	9-9-9	possible drill	Unknown Basalt Source B
42TO918	9-9-10	Lake Mohave point	Topaz Mountain, Utah
42TO919	9-10-2	Pinto Shoulderless point	Unknown Basalt Source B
42TO919	9-10-3	Lake Mohave point	Unknown Basalt Source B
42TO919	9-10-4	Parman point	Unknown Basalt Source A
42TO924	9-15-2	uniface	Unknown Basalt Source A
42TO924	9-15-4	core	Unknown Basalt Source B
42TO924	9-15-6	Lake Mohave point	Topaz Mountain, Utah
42TO924	9-15-7	Parman point	Brown's Bench, Idaho/Nevada
42TO924	9-15-8	Lake Mohave point	Topaz Mountain, Utah
42TO924	9-15-9	Lake Mohave point	Topaz Mountain, Utah
42TO925	9-16-10	Lake Mohave point	Malad, Idaho
42TO925	9-16-13	Lake Mohave point	Topaz Mountain, Utah
42TO926	9-17-4	Haskett-like stemmed point	Topaz Mountain, Utah

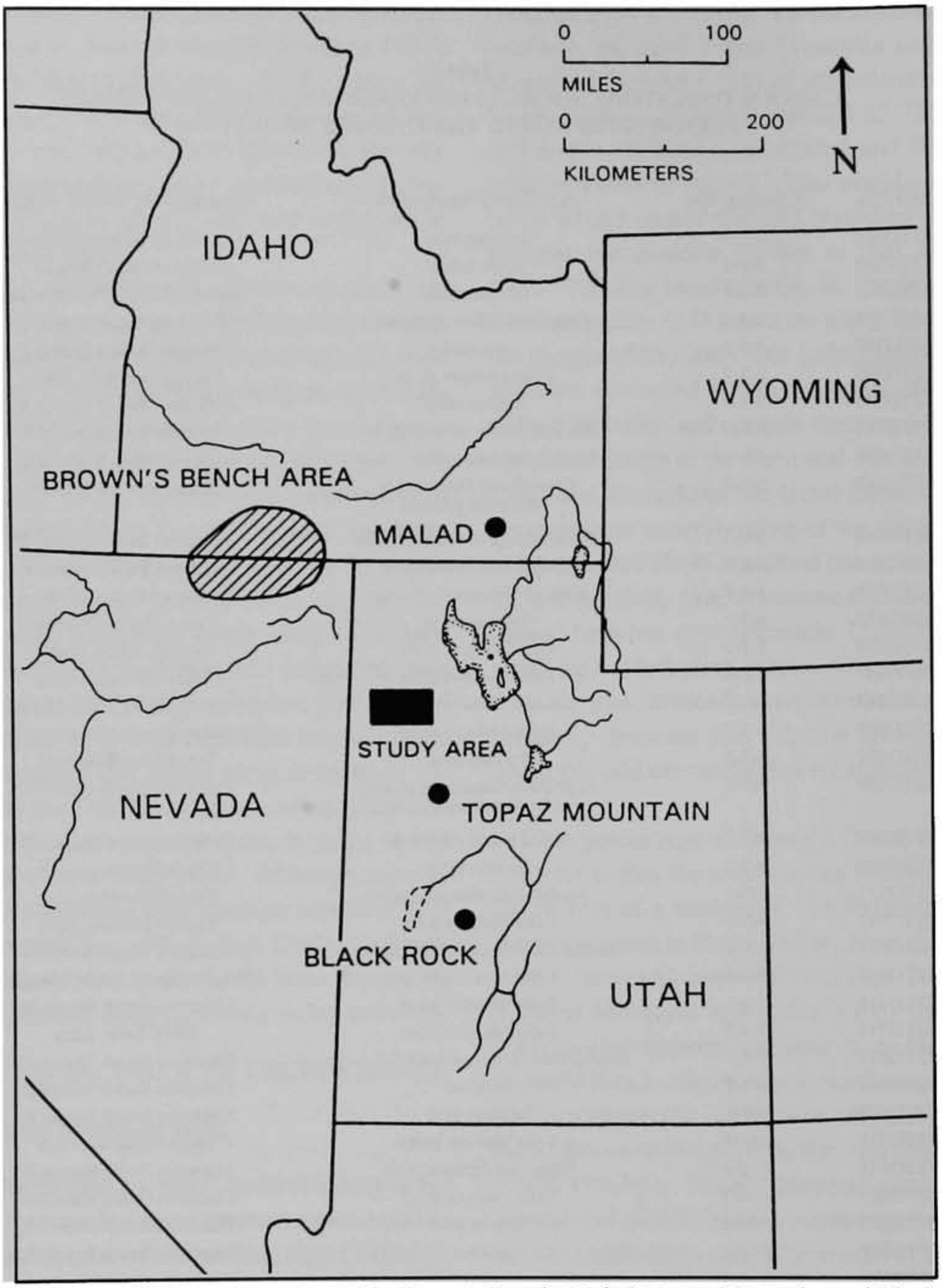

Fig. 11. Map showing locations of the Brown's Bench, Malad, Topaz Mountain, and Black Rock obsidian source areas in relation to the Wildcat Mountain study area.

cluding the Deep Creek, Trout Creek, Fish Springs, Simpson Springs, Coyote Spring, and Tule Spring areas (Nelson and Holmes 1979:Table VI).

Trace element chemical attributes of the 22 basalt artifacts subjected to X-ray fluorescence analysis suggest that two source groups exist within this population. One group of samples (Unknown Basalt Source A) has strontium (Sr) values between

330 and 370 ppm with yttrium (Y) values between 30 and 35 ppm, whereas another group (Unknown Basalt Source B) contains much more Sr (600 to 650 ppm) and less Y (10 to 15 ppm) (Hughes 1997a). Within this assemblage, Source B is dominant, comprising 77.27% (n = 17) of all specimens. Because relatively few archaeological investigations have been conducted in nearby upland areas, the locations of local basalt sources are unknown at this time. It is possible that many of the glassy basalt artifacts within the study area derive from as-yet undocumented quarries in the Fumarole Butte and Pavant Butte areas of the Sevier Desert (D. Madsen, personal communication 1998), which occur 100 and 160 km. south-southeast of Wildcat Mountain, respectively. Both formations consist almost entirely of Quaternary-aged basalts (Hintze 1974), and may have furnished a good deal of basalt toolstone to the Paleoarchaic groups who frequented the Gilbert Shoreline sites.

Lithic Technology

The following presents the results of a technological analysis of a subsample of primarily Great Basin Stemmed projectile points recovered during the UTTR surveys. Sixty-four projectile points from 22 sites were examined, and an array of quantitative and qualitative observations was recorded. Conclusions drawn on the basis of this analysis were resolved into two major themes. First, this small collection of Paleoarchaic projectile points represents, at least in part, a lithic reduction trajectory not often reported in the Great Basin or elsewhere for the Late Pleistocene/Early Holocene. Second, one variable above all others—raw material—appears to be responsible for observed variability within the sample. These two conclusions are discussed below, and the final discussion evaluates their possible relationship to larger issues of Paleoarchaic mobility and land use.

A Holistic Look at the UTTR Projectile Point Assemblage. On the basis of overall morphology, all but one of the projectile points included in this analysis can be typologically classified as Great Basin Stemmed (GBS) (Tuohy and Layton 1977). The two predominant GBS point types in the sample are Lake Mohave and Silver Lake (Amsden 1937) (e.g., Fig. 12a-b); however, many of the specimens defy conventional type assignments and are really only appropriately classified at the more encompassing GBS level (e.g., Fig. 12c). A single projectile point base is lanceolate in outline (Fig. 12d). Like many of the stemmed artifacts, this projectile point is very thick, was expediently manufactured, and fails to conform neatly to defined Great Basin Paleoarchaic point classes. The closest resemblance is to the Black Rock Concave Base type (Clewlow 1968), but even this is a poor fit, given its thickness, random flaking pattern, lack of final pressure flaking, and indiscernible basal grinding (possibly a result of heavy patination).

Two raw material types overwhelmingly dominate the UTTR assemblage (Fig. 13), obsidian (n = 38; 59.4%) and glassy basalt (n = 21; 32.8%). Chert and quartzite are the only other identifiable materials present, and they appear in very low frequencies (n = 2 [3.1%]; n = 1 [1.6%], respectively). The two remaining specimens (3.1%) within this sample were unidentifiable as to material. This heavy reliance on basalt and obsidian at the expense of microcrystalline materials is consistent with patterns of raw material use for stemmed projectile points noted by many other researchers throughout the Great Basin (e.g., Pendleton 1979; Beck and Jones 1990a, 1990b, 1997; Amick 1995).

Most of the points (60; 94%) in this surface-collected assemblage exhibit patinas. In many instances, the patina is so heavily developed that it obscures technological characteristics, especially possible basal grinding. Heat treatment, on the other hand, is virtually absent in the assemblage. Just one projectile point—one of the two chert specimens—shows features consistent with heat treating (e.g., color and textural changes). The lack of evidence for heat treating in the assemblage is undoubtedly at least partially a function of the fact that the bulk of the assemblage is manufactured of glassy volcanics that knap readily without thermal alteration.

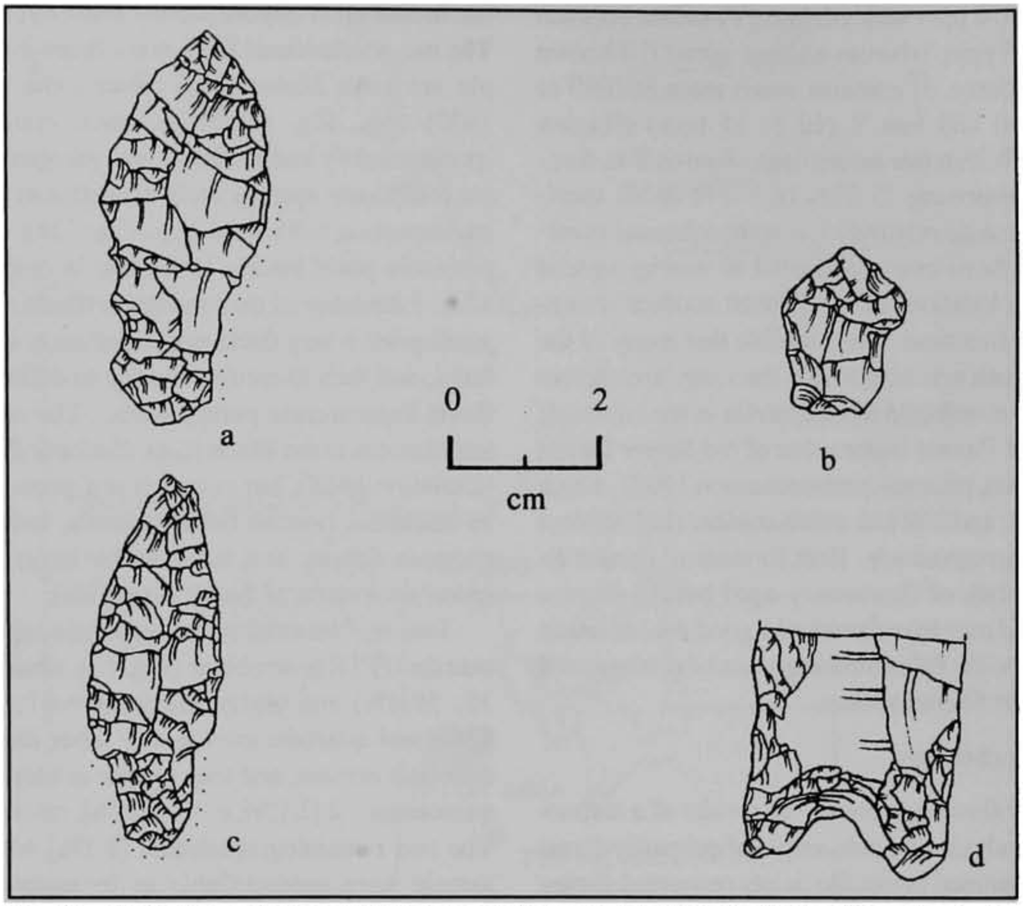

Fig. 12. Illustrations of selected projectile points recovered along the Gilbert Shoreline in the central Great Salt Lake Desert: (a) Lake Mohave (42TO925, Cat. No. 9-16-13); (b) Silver Lake (42TO918, Cat. No. 9-9-10); (c) Great Basin Stemmed (42TO847, Cat. No. 8-6-13); (d) unclassified lanceolate (42TO909, Cat. No. 9-3-4). Dots along lateral and proximal margins indicate extent of edge grinding.

The most noteworthy elements of the UTTR projectile point assemblage are the represented reduction trajectories, which differ in some important respects from those outlined in other studies of similar Great Basin Stemmed point collections (e.g., Beck and Jones 1990a, 1990c; Pendleton 1979; but see Wilke 1991). In perhaps the most complete and often-cited analysis of both concave-base and stemmed Paleoarchaic point forms, Pendleton (1979) argued that stemmed points found near Lake Tonopah were produced via a five-stage process. In highly simplified terms, the process begins with the roughing out of a biface through hard hammer percussion, and moves progressively through ever better executed soft hammer percussion and pressure flaking, both in a collateral pattern, until the final—and highly variable—stemmed projectile point form results.

Importantly, the artifacts examined in this study represent only the final stage of biface reduction, and it is thus impossible to draw the sorts of detailed conclusions about manufacturing techniques that Pendleton (1979) did with her thorough study of all phases of the process. Nonetheless, it is quite clear, even with a cursory glance at the UTTR assemblage, that production techniques were quite

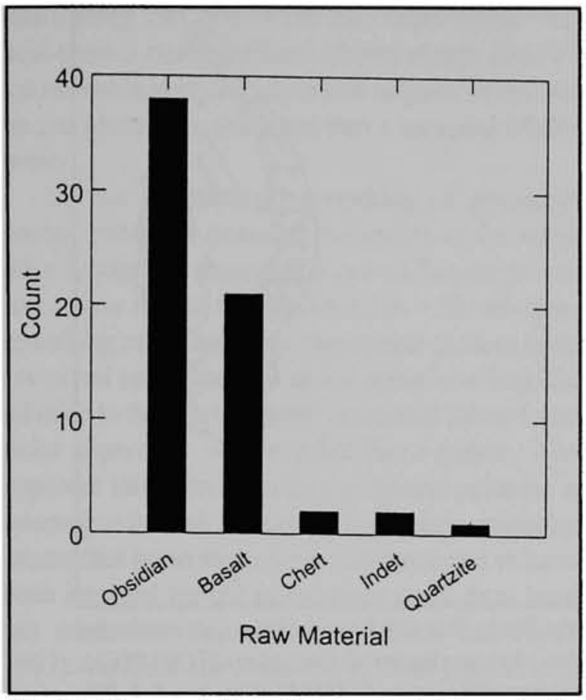

Fig. 13. Representation of raw material types in the UTTR sample (n = 64). (Indet = material indeterminate.)

different here, at least in some cases. While some of the stemmed points in the collection could certainly have been manufactured in the way that Pendleton (1979) described, others were undeniably produced from flake blanks, and extremely expediently at that.

Of the specimens whose original blank forms could be inferred, about half were classified as bifacial blanks and half as flakes. The difference between the two is quite dramatic, with the former conforming to multitudes of published illustrations of GBS points (e.g., Bryan 1980; Hutchinson 1988; Haynes 1996; Fig. 12a-c), and the latter conforming rather better to stereotypes of specimens manufactured today for sale to tourists (Fig. 14a-b). Consistent with recent origins as flakes, 39 (61%) of the UTTR points exhibit an asymmetrical (concavo-convex) longitudinal cross section, often very pronounced (e.g., Fig. 15a-b). Only 25 (39%) of the artifacts display more or less symmetrical, biconvex longitudinal profiles. Transverse cross sections are similarly distributed, with 26 (41%) best characterized as lenticular (symmetrically lens shaped), and the remaining 38 (59%) falling into such classes as "D-shaped," "beveled," and "other."

Flaking patterns on the 64 analyzed artifacts are overwhelmingly irregular and/or random (47; 73%). Moreover, to assign some specimens to the "random" flaking pattern class is to obscure the fact that they were so expediently produced that they exhibit almost no flaking pattern at all (e.g., Fig. 14a-b). Particularly when manufactured of locally available glassy basalts, some of the UTTR projectile points, while still technically within the morphological range of variability for GBS, again appear to share far more in common *technologically* with modern roadside souvenirs than they do with many of the more "classic" point types (e.g., Cougar Mountain, Haskett, Parman) subsumed under the GBS label.

The nonrandom flaking patterns, including collateral and horizontal, characterize only 17 (27%) of the projectile points, a statistic that again highlights the difference between this assemblage and that studied by Pendleton (1979) from Lake Tonopah. In evaluating the flaking styles of the Lake Tonopah stemmed points, Pendleton (1979:117) observed that "the single unifying characteristic of the Stemmed series, other than the stem, is a fine collateral flaking style." The UTTR specimens are unified by their stems, but the collateral flaking pattern appears on only a minority of the points (n = 7; 11%).

To summarize the salient features of the assemblage as a whole, the UTTR projectile points are made almost exclusively from obsidian and basalt, and virtually all fit morphologically within the Great Basin Stemmed series. Technologically, however, although some of the points may have been produced along the reduction trajectory described by Pendleton (1979), many others were expediently knapped from flake blanks. Original interior flake surfaces of the blanks are evident on numerous specimens, and many are profoundly curved in longitudinal cross section, both clear markers of the flake production technique. The relative degree of

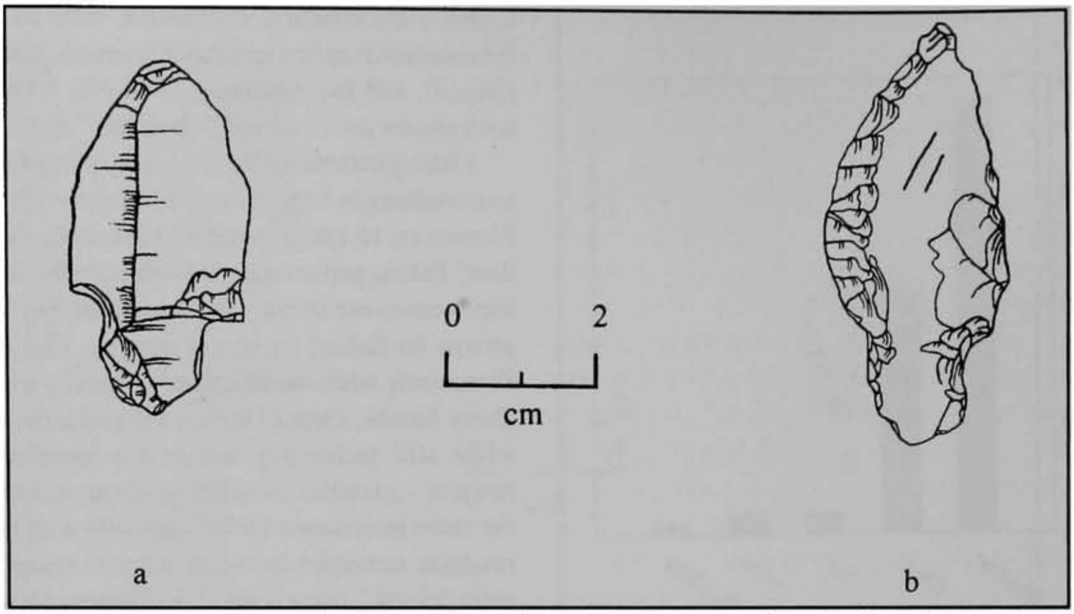

Fig. 14. Examples of expediently manufactured Great Basin Stemmed projectile points recovered from the UTTR. The specimen shown in Figure 14a was recovered from site 42TO918 (Cat. No. 9-9-1); the specimen in Figure 14b was recovered from site 42TO847 (Cat. No. 8-6-22).

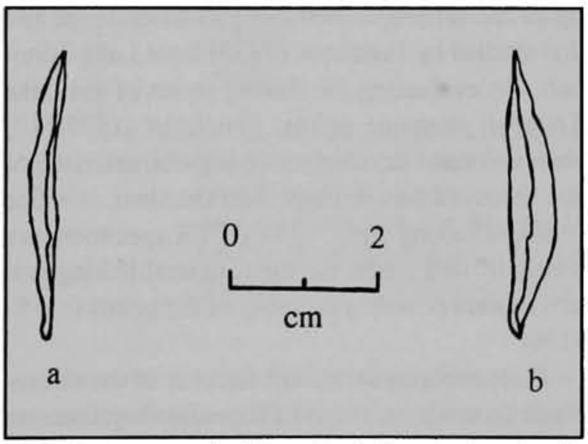

Fig. 15. Asymmetrical Great Basin Stemmed projectile point longitudinal cross sections. The specimen shown in Figure 15a was recovered from site 42TO847 (Cat. No. 8-6-5), and the specimen in Figure 15b was recovered from site 42TO924 (Cat. No.9-15-5).

reduction expediency associated with some of the artifacts is reflected by their flaking patterns, which are usually random, and are nearly nonexistent in the most extreme cases.

The Influence of Raw Material on Intra-Assemblage Variability. In exploring the data set and attempting to determine what factors contributed to observed variability within the UTTR projectile point assemblage, one factor quickly emerged as being of paramount importance; that is, choice of raw material. Other elements certainly contributed to intra-assemblage variability as well, including subtle variation in the topographic settings of sites and possibly age. Precise chronology is impossible to establish directly, but the location of some sites away from the Gilbert Shoreline suggests an antiquity either slightly older or younger than that of the Gilbert advance (ca. 11,000 to 10,500 RCYBP). However, the influence of these and other factors paled in comparison to the impact that the selection of one of the two dominant material types—basalt or obsidian—had on the resulting projectile points.

These two major rock types are the focus of the remainder of this discussion, as the only other identifiable materials—chert and quartzite—were used to produce just three points (compared to 59 total basalt and obsidian artifacts). However, it is worth mentioning that one of the two chert points (the heat-treated one mentioned above) stands alone in the assemblage in one important respect, in that its tip and blade were reworked into a scraping implement.

In this assemblage, reworking of projectile points, either for reuse as projectiles or for some other function, is somewhat common but not prevalent. Over half of the specimens (n = 38) show no reworking at all, and only two appear to have been reworked specifically to create some new tool. In addition to the chert scraper, one small Silver Lake point apparently was recycled into a graver. The apparent intention to reuse a projectile point for a nonprojectile task supports suggestions made by others that some stemmed points seem not to have been intended for use as weapons at all, or at least not exclusively as such (e.g., Beck and Jones 1997). As Beck and Jones (1997:202) pointed out, "differences in material requirements suggest, perhaps, differences in tool function." A single artifact can hardly be invoked to strenuously argue this scenario, but nevertheless, it is noteworthy that in an assemblage of 64 points, one that was made of a rare material was also reworked, possibly to fulfill a function for which the other tools (made of different materials) were unsuited.

Although a single chert point does no more than hint at what might or might not be a meaningful pattern, the differences between obsidian and basalt in the UTTR assemblage can be explored in a more significant way. Systematic comparisons revealed considerable differences in both the morphology and technology of projectile points made of obsidian and basalt. Table 2 outlines comparative dimensional data for all complete projectile points, all complete obsidian points, and all complete basalt points. The variables reported are a representative sample of quantitative observations recorded during analysis, including weight, maximum dimension, maximum width, maximum thickness, and the ratio of stem length to overall length. Metric attributes for all 64 projectile points in the UTTR sample are provided in Table 3.

The data in Table 2 suggest that when compared to the obsidian specimens, the basalt projectile points are heavier, longer, and wider (but thinner); and that the stems of basalt points are proportionately shorter than those of obsidian points. Significance tests were run for each variable, with results indicating that at the 95% confidence level ($p < 0.05$), there are indeed significant differences between the basalt and obsidian points in weight (Mann-Whitney $U = 141.00$; $p = 0.01$), maximum dimension (Mann-Whitney $U = 157.00$; $p = 0.01$), and width (Mann-Whitney $U = 160.50$; $p = 0.02$). Differences were not significant at the $p < 0.05$ level for thickness (Mann-Whitney $U = 364.50$; $p = 0.08$) or stem ratio (pooled variance $t = 1.25$; $df = 50$; $p = 0.22$), although the somewhat low probability value for thickness suggests that the difference might be practically meaningful. Identical tests comparing various obsidian sources to one another and various basalt sources to one another showed no significant differences.

The significantly different morphologies of obsidian and basalt points are in some ways mirrored in technological differences between the two materials. For example, if flaking patterns are viewed as a simple dichotomy and are examined relative to material type, then it becomes apparent that 29% (n = 11) of obsidian points—compared to just 10% (n = 2) of basalt points—express a regular (nonrandom) pattern of some kind. Viewed another way, of 17 total points in the assemblage with any regular flaking pattern, 11 are obsidian and just two are basalt (interestingly, the two chert points and one quartzite point are all characterized by regular patterning in their manufacture). The difference between the basalt and obsidian points is not significant at the 95% confidence level (Pearson chi-square = 2.97, $df = 1$, $p = 0.08$), but the relatively low probability value nonetheless suggests that a larger sample could reveal a significant difference between the two populations.

A second technologically relevant variable recorded during analysis of the UTTR points is the index of flaking intensity. Values were obtained by

Table 2
SUMMARY OF METRIC CHARACTERISTICS OF ALL COMPLETE UTTR POINTS (n = 56)

Variable[a]	Min.	Max.	Median	Median	SD
Weight					
All Artifacts	2.3	20.6	5.4	6.4	3.6
Obsidian	2.3	20.6	4.6	5.9	3.9
Basalt	4.3	12.0	6.8	7.5	2.3
Max. Dimension					
All Artifacts	22.7	69.3	39.3	40.7	11.8
Obsidian	22.7	69.3	35.2	38.9	12.0
Basalt	33.2	64.9	43.5	45.4	9.4
Max. Width					
All Artifacts	14.3	35.7	22.0	22.1	4.7
Obsidian	14.3	35.7	19.7	21.2	5.1
Basalt	19.6	29.1	23.8	23.9	2.2
Max. Thickness					
All Artifacts	4.6	9.4	7.0	7.0	1.1
Obsidian	5.0	9.4	7.4	7.2	1.1
Basalt	5.3	9.2	6.1	6.6	1.1
Stem Ratio[b]					
All Artifacts	0.3	1.0	0.5	0.5	0.1
Obsidian	0.3	1.0	0.5	0.5	0.1
Basalt	0.3	0.6	0.4	0.4	0.1

[a] Weight is in g.; all linear measurements are in mm.
[b] Ratio of stem length to overall length.

counting the number of flake scars removed along both faces of a single blade edge. The counts from the two faces were averaged together, and the result was divided by the length of the edge (see Warren and Phagan [1988:124] for an example of use of a similar variable). A smaller number indicates that fewer flakes were removed per unit of edge, thus flaking intensity is lower than that represented by a higher index value (see Fig. 16). The mean result for the whole assemblage (n = 64) is 0.23. For obsidian projectile points (n = 38), the mean is 0.24; for basalt (n = 21), the mean is 0.18. Thus, the index for obsidian is significantly higher than that for basalt (pooled variance t = 3.64, df = 57, p = 0.00), indicating that the obsidian points show a significantly greater number of flake removals per unit of edge. Theoretically, this could represent a somewhat greater time investment in at least the final stage of production of obsidian points, relative to their basalt counterparts.

In terms of flaking intensity, and possibly flaking patterns, obsidian and basalt points show some clear technological differences. It is important to point out, however, that there is a fundamental technological element that does not appear to vary in a way that corresponds to material type; that is, the use of bifaces versus flakes as projectile point blanks. As noted above, the UTTR assemblage as a whole appears to differ from many other reported Great Basin stemmed assemblages in that flake blanks were used roughly half of the time for manufacturing stemmed points. This difference is not accounted for by material type, as the same percentage (55%) of obsidian and basalt points were made on flakes. Longitudinal cross sections show a similar result, with the same percentage (62%) of ob-

Table 3
METRIC ATTRIBUTES OF THE UTTR PROJECTILE POINT SAMPLE

Cat. No.	Site No.	Material Type	Max. Edge Length[a] (mm.)	Max. Width (mm.)	Max. Thickness (mm.)	Max. Stem Length (mm.)	Max. Stem Width (mm.)	Weight (g.)
3-3-2	42TO745	basalt	17.2	19.4	6.2	13.0	15.2	2.6
3-3-4	42TO745	obsidian	27.4	20.9	7.4	12.3	12.3	4.2
3-5-7	42TO747	obsidian	29.4	16.2	5.0	8.8	9.4	2.9
3-5-15	42TO747	basalt	28.8	31.2	8.0	25.0	20.5	10.5
4-7-1	42TO773	obsidian	36.7	27.1	7.5	12.9	17.3	6.6
4-7-2	42TO773	indeterm.	25.8	16.3	4.6	10.8	11.8	2.3
4-8-2	42TO774	indeterm.	24.2	18.6	7.6	11.6	15.6	3.4
7-1-3	42TO804	basalt	31.8	21.7	7.1	17.9	11.2	5.5
7-1-5	42TO804	obsidian	45.2	27.0	9.0	16.0	18.7	9.7
7-1-7	42TO804	obsidian	28.4	20.0	7.7	15.0	16.0	4.9
8-3-1	42TO844	obsidian	26.8	19.1	8.1	14.9	13.6	3.8
8-4-6	42TO845	obsidian	30.2	19.3	8.0	16.8	13.5	4.6
8-6-2	42TO847	obsidian	30.7	17.7	7.0	13.4	10.2	3.9
8-6-4	42TO847	obsidian	58.8	29.2	8.8	20.7	15.7	14.8
8-6-5	42TO847	obsidian	32.5	19.7	5.5	16.0	14.4	3.9
8-6-8	42TO847	obsidian	36.6	18.1	7.3	15.9	11.1	5.0
8-6-10	42TO847	obsidian	28.7	22.2	7.7	19.8	13.9	4.5
8-6-11	42TO847	obsidian	35.6	23.2	5.8	15.9	11.5	4.6
8-6-12	42TO847	obsidian	36.4	16.6	7.0	16.9	15.3	5.3
8-6-13	42TO847	obsidian	47.5	17.2	6.0	15.0	8.4	4.8
8-6-19	42TO847	basalt	38.4	21.6	6.1	20.3	16.1	5.7
8-6-21	42TO847	basalt	34.1	25.1	6.1	19.4	17.9	5.9
8-6-22	42TO847	basalt	47.7	24.4	9.2	14.7	13.1	10.1
8-6-23	42TO847	obsidian	61.8	35.7	9.4	19.7	20.5	20.6
8-6a-8	42TO848	obsidian	35.0	24.7	8.7	22.0	18.2	7.5
8-6a-11	42TO848	basalt	55.8	25.0	5.3	22.8	17.0	9.9
8-6a-12	42TO848	obsidian	31.9	24.3	7.9	16.0	13.9	5.8
8-11-3	42TO849	basalt	27.2	15.3	5.7	17.9	13.0	3.7
8-15-2	42TO850	quartzite	32.7	22.1	5.7	35.9	8.5	4.4
8-16-1	42TO852	basalt	38.5	22.9	7.4	15.9	18.6	8.2
9-3-2	42TO909	obsidian	39.6	25.8	7.7	20.7	12.1	7.5
9-3-3	42TO909	obsidian	30.1	20.0	5.6	14.1	16.6	3.4
9-3-4	42TO909	basalt	28.8	28.4	10.1	–[b]	26.7	10.6
9-3-7	42TO909	obsidian	28.7	17.7	6.9	11.4	11.6	3.0
9-3-13	42TO909	basalt	36.4	25.6	5.9	10.7	15.4	5.9
9-6-2	42TO913	obsidian	34.9	18.8	6.4	19.0	7.3	3.9

Table 3 (continued)
METRIC ATTRIBUTES OF THE UTTR PROJECTILE POINT SAMPLE

Cat. No.	Site No.	Material Type	Max. Edge Length[a] (mm.)	Max. Width (mm.)	Max. Thickness (mm.)	Max. Stem Length (mm.)	Max. Stem Width (mm.)	Weight (g.)
9-9-1	42TO918	basalt	42.0	23.8	5.6	16.3	13.3	6.8
9-9-2	42TO918	obsidian	25.3	18.7	6.6	17.1	9.6	2.4
9-9-3	42TO918	obsidian	23.0	15.6	6.0	14.1	13.0	2.5
9-9-4	42TO918	basalt	39.9	23.8	5.8	18.4	11.0	6.1
9-9-6	42TO918	obsidian	29.7	19.4	7.4	13.6	14.0	4.7
9-9-10	42TO918	obsidian	21.5	16.4	6.2	13.0	11.7	2.3
9-10-1	42TO919	basalt	26.0	16.0	5.9	12.2	9.3	2.4
9-10-3	42TO919	basalt	48.6	26.0	8.5	18.9	15.6	10.1
9-10-4	42TO919	obsidian	32.4	23.5	6.1	12.9	18.2	5.1
9-12-1	42TO921	basalt	44.6	22.5	7.5	18.8	18.1	9.0
9-12-2	42TO921	chert	48.5	30.2	6.4	12.9	14.5	11.0
9-12-5	42TO921	obsidian	42.5	24.4	8.4	13.6	15.9	8.0
9-13-1	42TO922	basalt	32.6	19.6	5.8	15.5	11.9	4.3
9-14-1	42TO923	obsidian	26.6	16.4	6.2	16.7	8.9	2.8
9-15-5	42TO924	obsidian	33.5	21.8	8.0	16.1	14.8	6.1
9-15-6	42TO924	obsidian	29.7	14.3	5.7	10.4	12.0	3.0
9-15-8	42TO924	obsidian	20.7	16.5	6.4	20.8	12.6	2.4
9-15-9	42TO924	obsidian	40.1	16.5	7.3	19.7	9.4	4.3
9-15-11	42TO924	basalt	45.1	23.5	6.7	17.8	15.4	7.6
9-16-5	42TO925	basalt	64.6	36.2	5.9	19.2	19.6	17.6
9-16-7	42TO925	obsidian	48.0	36.2	5.9	19.2	19.6	17.6
9-16-8	42TO925	obsidian	54.1	27.9	8.3	15.8	15.5	10.6
9-16-10	42TO925	obsidian	58.5	31.2	8.4	24.7	21.3	13.9
9-16-11	42TO925	chert	48.3	27.1	6.9	21.0	17.5	10.9
9-16-13	42TO925	obsidian	45.9	22.3	7.6	29.7	14.2	7.8
9-17-1	42TO926	basalt	31.3	36.8	5.9	34.9	25.2	9.6
9-17-2	42TO926	obsidian	60.6	29.1	6.3	34.5	14.9	12.0
9-17-4	42TO926	obsidian	42.3	15.7	6.8	22.1	6.7	3.9

[a] Maximum linear distance from point tip to basal corner.
[b] Lanceolate-shaped specimen.

sidian and basalt points exhibiting asymmetry in profile. The lack of a material type constraint on this particular element of projectile point production technology is a compelling result (see below).

DISCUSSION

Two main themes have been raised as a result of the technological analyses of 64 Paleoarchaic pro-

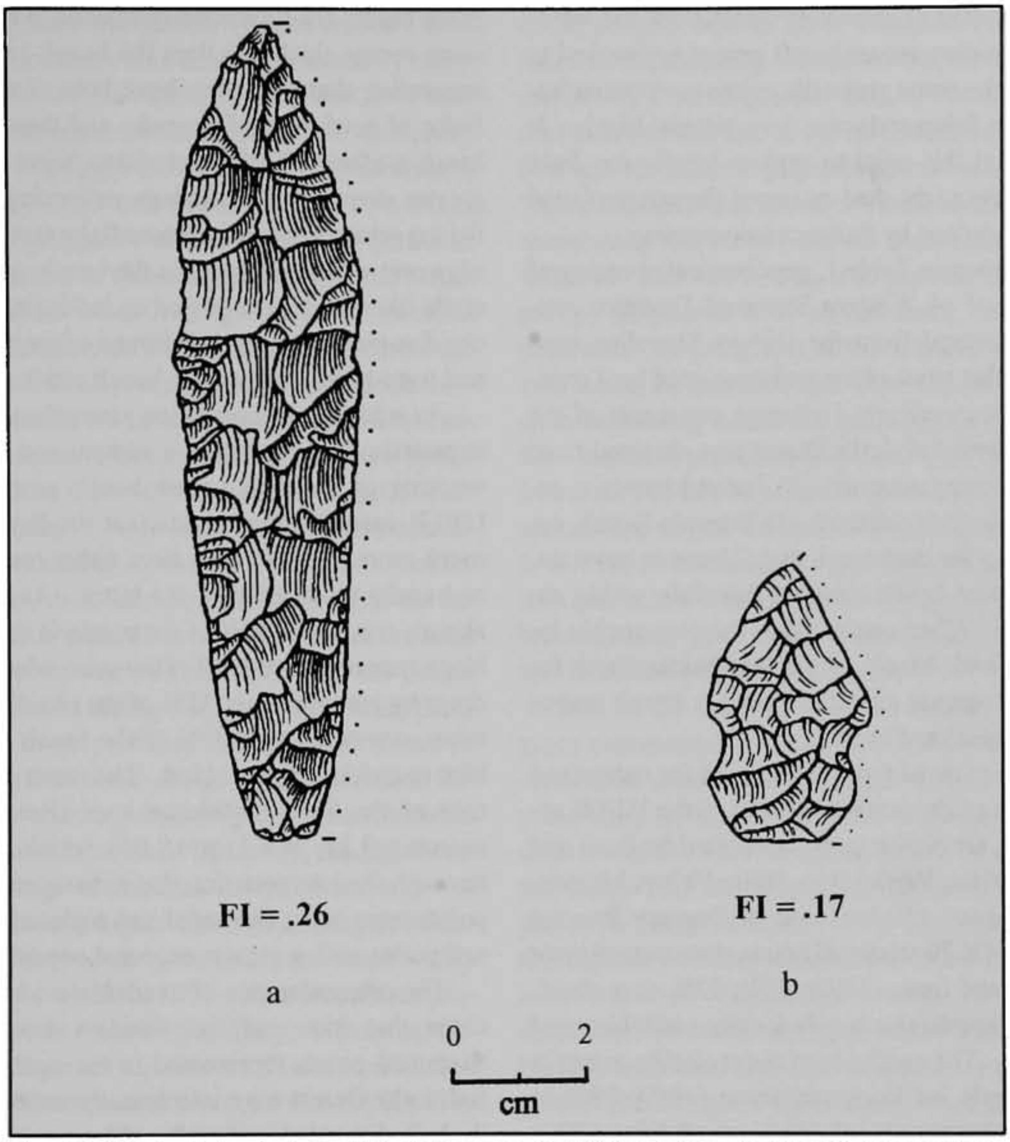

Fig. 16. Flaking Intensity Index Calculation examples: (a) Haskett projectile point, Lake Channel Locality, Idaho (Butler 1964:Fig. 1a; Sargeant 1973:Fig. 21a). Length of designated side = 122 mm. Average number of flake scars along designated side = 32. 32 scars/122 mm. yields a flaking intensity index of 0.26; (b) Silver Lake projectile point, Pleistocene Lake Mohave (Amsden 1937:82; Beck and Jones 1997:186). Length of designated side = 47 mm. Average number of flake scars along designated side = 8.8 scars/47 mm. yields a flaking intensity index of 0.17.

jectile points collected from the Wildcat Mountain area. First, the assemblage as a whole differs from many others reported from other parts of the Great Basin in that about half of the artifacts were expediently manufactured from flakes, rather than from bifaces. Second, variability within the assemblage relates largely to the choice of basalt or obsidian as raw material. The choice of a particular type of obsidian, on the other hand, does not introduce measurable variability to the sample. Furthermore, despite a number of important differences, the selection of obsidian versus basalt cannot be invoked to explain why some projectile points were manufactured from flakes and some from bifacial blanks. It is useful at this point to explore briefly any light these results might shed on use of the eastern Great Basin landscape by Paleoarchaic people.

As shown in Table 1, geochemical sourcing of a sample of 44 Western Stemmed Tradition artifacts recovered from the Gilbert Shoreline zone suggests that much of the toolstone used by Terminal Pleistocene/Early Holocene occupants of the central Great Salt Lake Desert was obtained from several primary sources: (1) Topaz Mountain, ca. 100 km. to the southeast; (2) Brown's Bench, ca. 200 km. to the northwest; and (3) one or more unknown local basalt quarries (possibly within ca. 100 km.). When compared to the presumably locally available basalt, as well as obsidian from the Topaz Mountain area, the Brown's Bench source can be considered exotic.

These material types, along with the nature and condition of the projectile points in the UTTR assemblage, are similar to those reported by Beck and Jones (1990a; 1990c) from Butte Valley, Nevada, located about 150 km. west of Dugway Proving Ground. Of 79 stemmed points documented there by Beck and Jones (1990c:289), 32% were obsidian, 57% basalt (also largely locally available), and 6% chert. The condition of the projectile points in their sample led Beck and Jones (1990c:294) to conclude that "two basalt sources, both lying within about 50 km of the project area, appear to have been utilized for the replacement of exhausted obsidian projectile points. The sources of the obsidians are located at least 100 km from southern Butte Valley, and one—Brown's Bench—is over 200 km away."

The general conclusion drawn by Beck and Jones (1990c) regarding the refurbishment of exhausted stemmed points in Butte Valley may be appropriate for explaining the results of the UTTR analysis as well (see Bamforth [1985] for a similar case in a Plains setting). The UTTR obsidian projectile points are significantly smaller in all dimensions except thickness than the basalt specimens, suggesting that they may have been discarded in favor of newly manufactured—and thus larger—basalt artifacts. That the obsidian points exhibit a greater degree of nonrandom patterning in their flaking schemes, as well as more flake removals per edge unit when compared to the basalt specimens, could likewise be interpreted as indicating that the obsidian points had reached the end of their use-life, and were being replaced by basalt artifacts.

An additional observation strengthens this interpretation further; that is, a comparison of the reworking of obsidian versus basalt points in the UTTR assemblage suggests that the former were much more likely to have been either resharpened or basally modified than the latter. As indicated above, only about half of the points in the assemblage were reworked at all. However, when broken down by material type, 55% of the obsidian specimens, compared with 29% of the basalt ones, exhibit reworking of some kind. The result is significant at the 95% confidence level (Pearson chi-square = 3.88; df = 1; p = 0.05), which is consistent with the interpretation that exhausted obsidian points were being discarded and replaced with basalt points with a greater expected use-life.

The preponderance of available evidence indicates that many of the obsidian Great Basin Stemmed points represented in the central Great Salt Lake Desert were intentionally removed from the haft, discarded, and replaced by new projectiles manufactured of locally available basalts. This scenario is further supported by the fact that debitage at most of the UTTR study sites is dominated by biface thinning flakes consisting of glassy basalt, as opposed to those of obsidian (Arkush 1997).

Although we have presented a general overview regarding projectile point manufacture, refurbishment, and replacement among Paleoarchaic groups in the Wildcat Mountain area, we are left with a major unresolved issue, which concerns direct versus indirect procurement of obsidians found within the study area. At this point, it is impossible to determine whether the Brown's Bench and/or Topaz Mountain obsidians were directly procured by occupants of the UTTR stemmed point sites, and thus making inferences about Paleoarchaic settlement patterns is extremely difficult. Various researchers (e.g., Kelly and Todd 1988; Ellis 1989; Meltzer 1989) have grappled with this and similar questions as they pertain to Paleoindian mobility and settlement systems. Most investigators have concluded that it is extremely difficult to discriminate between direct and indirect procurement of semiexotic toolstones because we lack adequate information regarding Terminal Pleistocene/Early Holocene settlement patterns, especially those in the Great Basin.

For example, Beck and Jones (1990c) considered this issue carefully in their interpretation of the Butte Valley data, ultimately concluding (on the basis of a much more diverse assortment of artifacts than is represented by this study) that the people utilizing the area during Terminal Pleistocene/Early Holocene times probably travelled well over 100 km. during the course of a given annual round, obtaining raw toolstone material from various sources in the process. In terms of this study, the high overall percentage of obsidian in the assemblage—at 59%, it is much higher than the percentage of obsidian points present in the recovered Butte Valley assemblage, which is 32%—hints that direct procurement of the material was likely. If the total obsidian point percentage was small and restricted to somewhat distant and/or divergent sources (such as Malad, Idaho, and Black Rock, Utah), then such a pattern would be suggestive of an indirect mode of obsidian acquisition. Furthermore, as Beck and Jones (1990c:294) pointed out, if a well-established trade network allowing indirect acquisition of obsidian was operating, then there would have been little or no compelling reason to use local basalts, unless superior durability played a deciding role in the use of basalt.

Although it cannot be indisputably substantiated, it seems likely that the recovery of used and reworked obsidian projectile points, together with newly made ones of basalt, indicates that Paleoarchaic peoples who at times occupied the Gilbert marshes occasionally visited the Topaz Mountain and Brown's Bench quarries located 100 km. to the southeast and 200 km. to the northwest, respectively (Fig. 11). Because projectile points made of both Topaz Mountain and Brown's Bench obsidian were occasionally recovered from the same sites (e.g., at 42TO847 and 42TO924), it is possible that some groups frequented both source areas, or perhaps more than one group met in the Wildcat Mountain area during the course of their seasonal movements, each depositing exhausted projectile points made from materials previously procured from the Topaz Mountain and Brown's Bench areas. These observations lead us into the realm of speculation, and it is unwise to continue this discussion when available data are insufficient for resolving the problem. Nevertheless, all of these scenarios are plausible, and therefore worth considering.

Just as the issue of how the various obsidian types represented in the UTTR sample were procured must ultimately remain open to various interpretations, so too is it difficult to adequately address one of the most intriguing questions raised by this study: why are so many of the finished UTTR projectile points indicative of an expedient reduction trajectory seldom identified at Great Basin Paleoarchaic sites? The answer does not lie in differential uses of exotic obsidian versus local basalt. Had the latter been characterized by a significantly greater percentage of flake blanks, then this argument would have been an obvious one to propose. But both basalt and obsidian are equally likely to have been manufactured using the flake blank reduction technique.

Hence, there must be other reasons why the people who occupied the greater Wildcat Mountain area during Terminal Pleistocene/Early Holocene times employed a projectile point production technology that is simply not typical for any portion of the Paleoindian/Paleoarchaic time period anywhere on the continent (e.g., see Kelly 1988; Kelly and Todd 1988; Wilke et al. 1991; Beck and Jones 1997). It is well beyond the scope of this article to attempt to unravel this problem, but if the volume of literature devoted to relating bifacial reduction technologies to high Paleoindian mobility and particular land use strategies is any indicator of the importance of the issue, then what is potentially a converse proposition clearly deserves further consideration. One alternative hypothesis in particular that requires explicit testing is that the different reduction strategies represent chronologically different occupations. For example, future work could demonstrate that the more formally flaked Great Basin Stemmed points are systematically older than the more expediently flaked specimens.

The Paleoarchaic sites in the Wildcat Mountain area do allow us to make a few informed propositions regarding Terminal Pleistocene/Early Holocene human adaptive strategies in the Great Salt Lake Desert. It has been posited that Paleoarchaic subsistence systems in the eastern Great Basin emphasized the mixed hunting and gathering of lacustrine resources in lakeside-marsh settings (e.g., Madsen 1982; Simms 1988; Schroedl 1991). The fact that most Great Basin Stemmed point sites within the study area are situated along the main Gilbert Shoreline certainly supports this scenario, indicating that many of the Paleoarchaic groups who frequented this portion of the Great Salt Lake Desert exploited a number of plant and animal foods that occurred in this particular marshland ecosystem. Although various extinct animals still existed within the general study area after initial human colonization (e.g., Beck and Jones 1997), it is quite possible that the subsistence systems of the early inhabitants of the Gilbert Shoreline placed more emphasis on modern species, such as deer, pronghorn, lagomorphs, fishes, migratory waterfowl, and aquatic plants, as opposed to extinct species such as horse, camel, and mammoth. The lack of subsurface archaeological deposits and associated faunal remains at these sites makes it difficult to substantiate this proposition, and future investigations of buried, stratified, and well-preserved Terminal Pleistocene/Early Holocene assemblages are needed to clarify the nature of ancient subsistence regimes associated with the Gilbert stand of Lake Bonneville.

The Gilbert Shoreline sites described above also provide additional data regarding Paleoarchaic settlement patterns, especially in regard to the relative degree of sedentism practiced by groups in lacustrine settings. During Gilbert times, the Wildcat Mountain area seems to have supported a relatively dense human population, and the shoreline zone was characterized by high occupational intensity. The ancient archaeological record associated with this area certainly seems to support Madsen's (1982) position that many Paleoarchaic populations in lacustrine settings were semisedentary. Although some of the Wildcat Mountain Great Basin Stemmed point sites are probably products of short-term usage, others (such as 42TO909) may be associated with seasonally sedentary occupations. Such a scenario could help to explain the observed dichotomy in lithic reduction technologies for the area (e.g., Binford 1973, 1977, 1979; but see Bamforth 1986, 1991).

While many of the Great Basin Stemmed point sites situated along the Gilbert Shoreline probably are the product of a foraging system focused on the exploitation of marsh resources, those stemmed point sites located away from the shoreline zone (such as those in the western portion of the South Knolls Dune Field; see Fig. 2) may be associated with a very different subsistence regime postdating ca. 9,500 RCYBP. The same may be true for those sites containing only Pinto points or those with Great Basin Stemmed and Pinto points, even though some of these sites occur within the general Gilbert Shoreline zone. David Madsen (personal communication 1998) indicated that a marsh was no longer present in the Old River delta after about 9,500 RCYBP. Therefore, many of the Pinto sites in the study area may reflect a foraging system focused on more xeric-affiliated subsistence resources that are commonly found in dune settings and adjacent playa surfaces, such as lagomorphs, Indian rice grass, and pickleweed. Clearly, this is a complex situation, and the lack of buried cultural deposits, preserved faunal and botanical remains, and corresponding absolute dates preclude us from arriving at any solid conclusions regarding subsistence practices associated with these sites.

Interestingly, the heaviest use of Camels Back Cave (located on Dugway Proving Ground four km. southwest of the Old River terminus) occurred between 7,500 and 6,000 RCYBP, and basalt was one of the primary toolstone types used there at that time (D. Madsen, personal communication 1998). Stratum II is the stratigraphic unit associated with this period. During initial testing of the cave, this level yielded a relatively large (n = 274) assemblage of animal bones, with most diagnostic elements being those of lagomorphs (Schmitt et al. 1994:45). So it appears that the more intense occupation of Camels Back Cave occurred during Early Holocene times, relied heavily upon basalt toolstone, and featured a foraging system focused on arid/semiarid resources. It seems quite likely that some of the sites in the study area may also relate to a similar time frame and subsistence orientation.

Historically, marsh ecosystems contained some of the highest known resource densities in the entire Great Basin. If this was the case in Terminal Pleistocene/Early Holocene times, it stands to reason that the settlement systems and subsistence practices of many early human groups would have focused on such a rich and predictable environment. As previously noted by Simms (1988:44), the small sample of Terminal Pleistocene/Early Holocene sites in the Great Basin has precluded the development of informed models concerning Paleoarchaic lifeways. Although this statement is still true today, recent archaeological inventories within the UTTR certainly have improved our understanding of the distribution of Paleoarchaic-aged sites in the Great Salt Lake Desert, and have increased our knowledge of early human settlement systems therein.

CONCLUSION

The Gilbert Shoreline Paleoarchaic sites and the artifacts they contain have provided important additional information regarding early human occupation of the Bonneville Basin. At this point in time, the Wildcat Mountain area contains one of the highest known densities of Western Stemmed Tradition sites in the eastern Great Basin, and future surveys there should result in the discovery of additional Terminal Pleistocene/Early Holocene sites. In many ways, our work supports the findings of other researchers, especially those of Beck and Jones (e.g., 1988, 1990a, 1990c, 1993).

Besides providing additional documentation that Brown's Bench toolstone has been quarried since Terminal Pleistocene times, our study also indicates that the Topaz Mountain, Malad, and Black Rock obsidian sources have a similar history of aboriginal usage. Many of the Gilbert Shoreline sites contain stemmed projectile points that were expediently manufactured from flakes; perhaps this reduction strategy is associated with a more semisedentary settlement mode and close proximity to toolstone quarries, as opposed to the highly mobile lifeway assumed for most western Paleoindian populations. Hopefully, future work will focus on the factors that influence Paleoarchaic chipped stone tool production strategies and expand upon the data base provided by the Wildcat Mountain sites.

In keeping with Simms' (1988) notion that the lifeways of many prehistoric Great Basin peoples were characterized by adaptive variability, perhaps it is best to view the Gilbert Shoreline sites as one example of the diverse environmental settings that were occupied and utilized by Great Basin Paleoarchaic peoples. This portion of the Gilbert Shoreline (which was within the greater Old River delta area) apparently supported a marshland and shallow paleolake ecosystem with emergent aquatic plants such as cattail, bulrush, seasonally abundant waterfowl, several types of fish, and a variety of mammals, and may have been the focus for fall and/or winter residential occupation by Paleoarchaic groups of the central Great Salt Lake Desert region. At the very least, this study has improved our understanding of Paleoarchaic lifeways in the Bonneville Basin, and can serve as a reference point for future work concerning Terminal Pleistocene/Early

Holocene human adaptations in the eastern Great Basin.

ACKNOWLEDGEMENTS

We thank Jack Broughton, Vance Haynes, Joel Janetski, Steven Kuhn, David Madsen, and an anonymous reviewer for their helpful comments and ideas on earlier drafts of this paper. David Madsen's assistance and insights were especially helpful in improving the structure and content of the manuscript. Richard Hughes kindly shared with us his considerable experience regarding the trace element chemistry of eastern Great Basin igneous toolstone sources. James Carter provided us with timely information regarding his recent work within the West Wildcat Dune Field (the TS-5 Target Complex), and shared his thoughts concerning the Paleoarchaic archaeological record of the UTTR. Jack Broughton graciously provided us with unpublished data regarding the terminal Pleistocene ichthyofauna of Lake Bonneville. Debbie Hall, Robert James, and James Van Orman of the Ogden Air Logistics Center at Hill Air Force Base, as well as David Johnson and Gene Mortensen of the Utah State University Research Foundation, provided invaluable administrative, technical, and logistic support for conducting the fieldwork upon which this publication is based.

We also thank Ron Rood, Utah Assistant State Archaeologist, for his kindness in sharing data on file at the Utah Division of State History (and a spare bedroom), and Evie Seelinger, Utah Antiquities Section Preservation Records Manager, who was incredibly patient in locating relevant site forms and other information. This research was financially supported by U. S. Air Force Contract Number F42650-93-D-0053 and by a grant from the National Science Foundation (SBR 9624373). Additional funding from the Marshall Foundation, Tucson, Arizona, and Sigma Delta Epsilon/ Graduate Women in Science (Vessa Notchev Grant Program) is gratefully acknowledged.

REFERENCES

Aikens, C. Melvin
1970 Hogup Cave. University of Utah Anthropological Papers No. 93.

Aikens, C. Melvin, and David B. Madsen
1986 Prehistory of the Eastern Area. In: Handbook of North American Indians, Vol. 11, Great Basin, Warren L. d'Azevedo, ed., pp. 149-160. Washington: Smithsonian Institution.

Amick, Daniel S.
1995 Raw Material Selection Patterns Among Paleoindian Tools from the Black Rock Desert, Nevada. Current Research in the Pleistocene 10:49-51.

Amsden, Charles A.
1937 The Lake Mohave Artifacts. In: The Archaeology of Pleistocene Lake Mohave, Elizabeth W. C. Campbell and William H. Campbell, eds., pp. 51-98. Southwest Museum Papers No. 11.

Arkush, Brooke S.
1997 A Cultural Resources Management Plan for the U. S. Air Force Utah Test and Training Range. Report on file at the Antiquities Section of the Utah Division of State History, Salt Lake City.

1998 Archaeological Investigations at Mosquito Willie Rockshelter and Lower Lead Mine Hills Cave, Great Salt Lake Desert, Utah. Coyote Press Archives of Great Basin Prehistory No. 2.

Bamforth, Douglas B.
1985 The Technological Organization of Paleo-Indian Small-Group Bison Hunting on the Llano Estacado. Plains Anthropologist 30:243-258.

1986 Technological Efficiency and Tool Curation. American Antiquity 51(1):38-50.

1991 Technological Organization and Hunter-Gatherer Land Use: A California Example. American Antiquity 56(2):216-234.

Basgall, Mark E.
1993 The Archaeology of Nelson Basin and Adjacent Areas, Fort Irwin, San Bernardino County, California. Report on file at the San Bernardino County Archaeological Information Center, San Bernardino County Museum, Redlands.

Basgall, Mark E., and M. C. Hall
1994 Perspectives on the Early Holocene Archaeological Record of the Mojave Desert. In: Kelso Conference Papers, 1987-1992, A Collection of Papers and Abstracts from the First Five Kelso Conferences on the Prehistory of the Mojave Desert, G. Dicken Everson and Joan S. Schneider, eds., pp. 63-81. California State University, Bakersfield, Museum of Anthropology Occasional Papers in Anthropology No. 4.

Beck, Charlotte, and George T. Jones
1988 Western Pluvial Lakes Tradition Occupation in Butte Valley, Eastern Nevada. In: Early Human Occupation in Far Western

North America: The Clovis-Archaic Interface, Judith A. Willig, C. Melvin Aikens, and John L. Fagan, eds., pp. 273-302. Nevada State Museum Anthropological Papers No. 21.

1990a The Late Pleistocene/Early Holocene Archaeology of Butte Valley, Nevada: Three Seasons' Work. Journal of California and Great Basin Anthropology 12(2):231-261.

1990b An Obsidian Hydration Chronology of Late Pleistocene-Early Holocene Surface Assemblages from Butte Valley, Nevada. Journal of California and Great Basin Anthropology 12(1):84-100.

1990c Toolstone Selection and Lithic Technology in Early Great Basin Prehistory. Journal of Field Archaeology 17(3):283-299.

1993 The Multipurpose Function of Great Basin Stemmed Series Projectile Points. Current Research in the Pleistocene 10:52-54.

1997 The Terminal Pleistocene/Early Holocene Archaeology of the Great Basin. Journal of World Prehistory 11(2):161-236.

Bedwell, Steven F.

1973 Fort Rock Basin Prehistory and Environment. Eugene: University of Oregon Books.

Benson, Larry V., and Robert S. Thompson

1987 The Physical Record of Lakes in the Great Basin. In: The Geology of North America, Vol. k-3: North America and Adjacent Oceans During the Last Deglaciation, William F. Ruddiman and Herbert E. Wright, Jr., eds., pp. 241-260. Boulder: Geological Society of America.

Benson, Larry V., Donald R. Currey, Yong Lao, and Stephen Hostetler

1992 Lake-size Variations in the Lahontan and Bonneville Basins Between 13,000 and 9000 ^{14}C yr B.P. Palaeogeography, Palaeoclimatology, and Palaeoecology 95:19-32.

Benson, Larry V., Donald R. Currey, Ronald I. Dorn, Kenneth R. Lajoie, Charles G. Oviatt, Stephen W. Robinson, George I. Smith, and Scott Stine

1990 Chronology of Expansion and Contraction of Four Great Basin Lake Systems During the Past 35,000 Years. Palaeogeography, Palaeoclimatology, and Palaeoecology 78: 241-286.

Binford, Lewis R.

1973 Interassemblage Variability—The Mousterian and the "Functional" Argument. In: The Explanation of Culture Change, Colin Renfrew, ed., pp. 257-254. London: Duckworth.

1977 Forty-Seven Trips: A Case Study in the Character of Archaeological Formation Processes. In: Stone Tools as Cultural Markers: Change, Evolution, and Complexity, R. V. S. Wright, ed., pp. 24-36. Canberra: Australian Institute of Aboriginal Studies.

1979 Organization and Formation Processes: Looking at Curated Technologies. Journal of Anthropological Research 35(3):255-273.

Broughton, Jack M., David B. Madsen, and Jay Quade

2000 Fish Remains from Homestead Cave and Lake Levels of the Past 13,000 Years in the Bonneville Basin. Quaternary Research 53:392-401.

Bryan, Alan L.

1979 Smith Creek Cave. In: The Archaeology of Smith Creek Canyon, Donald R. Tuohy and Doris L. Rendall, eds., pp. 164-251. Nevada State Museum Anthropological Papers No. 17.

1980 The Stemmed Point Tradition: An Early Technological Tradition in Western North America. In: Anthropological Papers in Memory of Earl H. Swanson, Jr., Lucille B. Harten, Claude N. Warren, and Donald R. Tuohy, eds., pp. 77-107. Pocatello: Special Publication of the Idaho Museum of Natural History.

1988 The Relationship of the Stemmed Point and Fluted Point Traditions in the Great Basin. In: Early Human Occupation in Far Western North America: The Clovis-Archaic Interface, Judith A. Willig, C. Melvin Aikens, and John L. Fagan, eds., pp. 53-74. Nevada State Museum Anthropological Papers No. 21.

Butler, B. Robert

1964 A Recent Early Man Point Find in Southeastern Idaho. Tebiwa 7(1):39-40.

1965 A Report on Investigations of an Early Man Site Near Lake Channel, Southern Idaho. Tebiwa 8(2):1-21.

Carambelas, K. R., and S. C. Josephson

1996 A Cultural Resource Management Plan for Dugway Proving Ground, Tooele County, Utah. Report on file at the Antiquities Section of the Utah Division of State History, Salt Lake City.

Carter, James A.
1999 TS-5 Target Complex Cultural Resource Inventory, Wendover Air Force Range, Tooele County, Utah. Report on file at the Antiquities Section of the Utah Division of State History, Salt Lake City.

Clewlow, C. William, Jr.
1968 Surface Archaeology of the Black Rock Desert, Nevada. Berkeley: Reports of the University of California Archaeological Survey No. 73.

Cronquist, Arthur, Arthur H. Holmgren, Noel H. Holmgren, and James L. Reveal (eds.)
1972 Intermountain Flora: Vascular Plants of the Intermountain West, USA, Vol. 1. New York: Hafner.

Currey, Donald R.
1980 Coastal Geomorphology of Great Salt Lake and Vicinity. In: Great Salt Lake: A Scientific, Historical, and Economic Overview, J. Wallace Gwynn, ed., pp. 69-82. Salt Lake City: Utah Geological and Mineral Survey Bulletin No. 116.
1990 Quaternary Paleolakes in the Evolution of Semidesert Basins, with Special Emphasis on Lake Bonneville and the Great Basin, U.S.A. Palaeogeography, Palaeoclimatology, and Palaeoecology 76:189-214.

Currey, Donald R., Genevieve Atwood, and Don R. Mabey
1984 Major Levels of Great Salt Lake and Lake Bonneville. Salt Lake City: Utah Geological and Mineral Survey Map 73.

Currey, Donald R., Charles G. Oviatt, and Glenn B. Plyler
1983 Lake Bonneville Stratigraphy, Geomorphology, and Isostatic Deformation in West-Central Utah. Salt Lake City: Utah Geological and Mineral Survey Special Studies No. 62:63-82.

Currey, Donald R., Michael S. Berry, S. A. Green, and Stuart B. Murchison
1988 Very Late Pleistocene Red Beds in the Bonneville Basin, Utah and Nevada. Geological Society of America Abstracts, Program 20:411.

Ellis, Christopher J.
1989 The Explanation of Northeastern Paleoindian Lithic Procurement Patterns. In: Eastern Paleoindian Lithic Resource Use, Christopher J. Ellis and Jonathan C. Lothrop, eds., pp. 139-164. Boulder, CO: Westview Press.

Grayson, Donald K.
1993 The Desert's Past: A Natural Prehistory of the Great Basin. Washington: Smithsonian Institution Press.

Hall, Matthew C.
1993 Archaeology of Seven Prehistoric Sites in Tiefort Basin, Fort Irwin, San Bernardino County, California. Report on file at the San Bernardino County Archaeological Information Center, San Bernardino County Museum, Redlands.

Harrington, Mark R.
1934 American Horses and Ancient Men in Nevada. The Masterkey 8(6):165-169.

Haynes, Gregory M.
1996 Evaluating Flake Assemblages and Stone Tool Distributions at a Large Western Stemmed Tradition Site Near Yucca Mountain, Nevada. Journal of California and Great Basin Anthropology 18(1):104-130.

Hester, Thomas R.
1973 Chronological Ordering of Great Basin Prehistory. Berkeley: Contributions of the University of California Archaeological Research Facility No. 17.

Hintze, Lehi F.
1974 Geologic Map of Utah. Brigham Young University Geology Studies, Special Map No. 2.

Hughes, Richard E.
1997a Geochemical Research Laboratory, Letter Report 97-13. Report on file at the Weber State University Archaeology Laboratory, Ogden, Utah.
1997b Geochemical Research Laboratory, Letter Report 97-96. Report on file at the Weber State University Archaeology Laboratory, Ogden, Utah.

Hutchinson, Phillip W.
1988 The Prehistoric Dwellers at Lake Hubbs. In: Early Human Occupation in Far Western North America: The Clovis-Archaic Interface, Judith A. Willig, C. Melvin Aikens, and John L. Fagan, eds., pp. 303-318. Nevada State Museum Anthropological Papers No. 21.

Jennings, Jesse D.
1957 Danger Cave. University of Utah Anthropological Papers No. 27.

Jones, George T., Charlotte Beck, Fred L. Nials, Joshua J. Neudorfer, Brian J. Brownholtz, and Hallie B. Gilbert
1996 Recent Archaeological and Geological In-

vestigations at the Sunshine Locality, Long Valley, Nevada. Journal of California and Great Basin Anthropology 18(1):48-63.

Kelly, Robert L.
1988 The Three Sides of a Biface. American Antiquity 53(4):717-734.

Kelly, Robert L., and Lawrence C. Todd
1988 Coming Into the Country: Early Paleoindian Hunting and Mobility. American Antiquity 53(2):231-244.

Layton, Thomas N.
1970 High Rock Archaeology: An Interpretation of the Prehistory of the Northwestern Great Basin. Ph.D. dissertation, Harvard University.
1972 Lithic Chronology in the Fort Rock Valley, Oregon: An Obsidian Hydration Study from Cougar Mountain Cave. Tebiwa 15(1):1-21.
1979 Archaeology and Paleo-ecology of Pluvial Lake Parman, Northwestern Great Basin. Journal of New World Archaeology 3(3): 41-56.

Madsen, David B.
1982 Get It Where the Gettin's Good: A Variable Model of Great Basin Subsistence and Settlement Based on Data from the Eastern Great Basin. In: Man and Environment in the Great Basin, David B. Madsen and James F. O'Connell, eds., pp. 207-226. Society for American Archaeology Papers No. 2.

Madsen, David B. (ed.)
2000 Late Quaternary Paleoecology in the Bonneville Basin. Salt Lake City: Utah Geological Survey, Bulletin 130 (in press).

Madsen, David B., and David R. Rhode
1990 Early Holocene Pinyon (*Pinus monophylla*) in the Northeastern Great Basin. Quaternary Research 33:94-101.

Meltzer, David J.
1989 Was Stone Exchanged Among Eastern North American Paleoindians? In: Eastern Paleoindian Lithic Resource Use, Christopher J. Ellis and Jonathan C. Lothrop, eds., pp. 11-39. Boulder, CO: Westview Press.

Mifflin, Martin D., and Margaret M. Wheat
1979 Pluvial Lakes and Estimated Pluvial Climates of Nevada. Reno: University of Nevada, Mackay School of Mines, Nevada Bureau of Mines and Geology Bulletin No. 94.

Moore, William J., and Martin L. Sorensen
1979 Geologic Map of the Tooele 1 Degree by 2 Degrees Quadrangle, Utah. Denver: United States Geological Survey Miscellaneous Investigations Series Map No. I-1132.

Murchison, Stuart B.
1989 Fluctuation History of Great Salt Lake, Utah, During the Last 13,000 Years. Ph.D. dissertation, University of Utah.

Nelson, Fred W., Jr., and Richard D. Holmes
1979 Trace Element Analysis of Obsidian Sources and Artifacts from Western Utah. Salt Lake City: Utah State Historical Society, Division of State History, Antiquities Section Selected Papers 6(15):65-80.

Oviatt, Charles G.
1997 Lake Bonneville Fluctuations and Global Climate Change. Geology 25(2):155-158.

Oviatt, Charles G., Donald R. Currey, and Dorothy Sack
1992 Radiocarbon Chronology for Lake Bonneville, Eastern Great Basin, U.S.A. Palaeogeography, Palaeoclimatology, and Palaeoecology 99:225-241.

Pendleton, Lorann S. A.
1979 Lithic Technology in Early Nevada Assemblages. Master's thesis, California State University, Long Beach.

Rhode, David, and David B. Madsen
1995 Late Wisconsin/Early Holocene Vegetation in the Bonneville Basin. Quaternary Research 44:246-256.

Russell, Dann J.
1993 Running Antelope: A PaleoIndian Site in Northern Utah. Utah Archaeology 6(1):79-86.

Sargeant, Kathryn E.
1973 The Haskett Tradition: A View from Redfish Overhang. Master's thesis, Idaho State University, Pocatello.

Schmitt, Dave N., Monson W. Shaver III, and Jeffrey M. Hunt
1994 From Here to Antiquity: Holocene Human Occupation on Camels Back Ridge, Tooele County, Utah. Utah Archaeology 7(1):35-50.

Schroedl, Alan R.
1991 Paleo-Indian Occupation in the Eastern Great Basin and Northern Colorado Plateau. Utah Archaeology 4(1):1-15.

Shutler, Mary E., and Richard Shutler, Jr.
1963 Deer Creek Cave, Elko County, Nevada.

Nevada State Museum Anthropological Papers No. 11.

Simms, Steven R.
1988 Conceptualizing the Paleoindian and Archaic in the Great Basin. In: Early Human Occupation in Far Western North America: The Clovis-Archaic Interface, Judith A. Willig, C. Melvin Aikens, and John L. Fagan, eds., pp. 41-52. Nevada State Museum Anthropological Papers No. 21.

Simms, Steven R., and La Mar W. Lindsay
1989 42MD300: An Early Holocene Site in the Sevier Desert. Utah Archaeology 2(1):56-66.

Spencer, R. J., Mary Jo Baedecker, Hans P. Eugster, Richard M. Forester, Martin B. Goldhaber, Blair F. Jones, Kerry R. Kelts, J. McKenzie, David B. Madsen, Shirley L. Rettig, M. Rubin, and Carl J. Bowser
1984 Great Salt Lake and Precursors, Utah: The Last 30,000 Years. Contributions to Mineralogy and Petrology No. 86:321-334.

Stokes, William L.
1986 Geology of Utah. Salt Lake City: Utah Museum of Natural History and Utah Geological and Mineral Survey.

Thompson, Robert S., L. J. Toolin, Richard M. Forester, and R. J. Spencer
1990 Accelerator-Mass Spectrometer (AMS) Radiocarbon Dating of Pleistocene Lake Sediments in the Great Basin. Palaeogeography, Palaeoclimatology, and Palaeoecology 78:301-313.

Tuohy, Donald R., and Thomas N. Layton
1977 Towards the Establishment of a New Series of Great Basin Projectile Points. Nevada Archaeological Survey Reporter 10(6):1-5.

Warren, Claude N., and Carl Phagan
1988 Fluted Points in the Mojave Desert: Their Technology and Cultural Context. In: Early Human Occupation in Far Western North America: The Clovis-Archaic Interface, Judith A. Willig, C. Melvin Aikens, and John L. Fagan, eds., pp. 121-130. Nevada State Museum Anthropological Papers No. 21.

Wilke, Philip J.
1991 Lanceolate Projectile Points from Tulare Lake, California. In: Contributions to Tulare Lake Archaeology I, William J. Wallace and Francis A. Riddell, eds., pp. 41-52. Redondo Beach: Tulare Lake Archaeological Research Group.

Wilke, Philip J., J. Jeffrey Flenniken, and Terry L. Ozbun
1991 Clovis Technology at the Anzick Site, Montana. Journal of California and Great Basin Anthropology 13(2):242-272.

Willig, Judith A., and C. Melvin Aikens
1988 The Clovis-Archaic Interface in Far Western North America. In: Early Human Occupation in Far Western North America: The Clovis-Archaic Interface, Judith A. Willig, C. Melvin Aikens, and John L. Fagan, eds., pp. 1-40. Nevada State Museum Anthropological Papers No. 21.

Zier, Christian J.
1984 A Class II Cultural Resource Inventory of the U. S. Army Dugway Proving Ground, West-Central Utah. Report on file at the Antiquities Section of the Utah Division of State History, Salt Lake City.