NORTH AMERICAN ARCHAEOLOGIST, Vol. 28(2) 87-112, 2007

EARLY HOLOCENE LANDSCAPE ARCHAEOLOGY IN THE COSO BASIN, NORTHWESTERN MOJAVE DESERT, CALIFORNIA

JELMER W. EERKENS
University of California Davis

JEFFREY S. ROSENTHAL

D. CRAIG YOUNG

JAY KING

Far Western Anthropological Research Group, Davis, California

ABSTRACT

Early Holocene adaptations are still poorly understood in North America. The archaeological record of this period is often difficult to access and most studies have taken a site-based approach, focused on a small number of well-excavated sites. The archaeological record of the Coso Basin in the northwest Mojave Desert provides the unique opportunity to approach adaptations from a landscape, rather than a site-based, perspective. Large sections of land that were formed during the Pleistocene and Early Holocene, the landforms on which Early Holocene hunter-gatherers lived, are still exposed and easily accessible today. Previous studies have significantly under-represented these landforms in regional survey and excavation. Our analyses suggest that Early Holocene people made use of a wide range of environments, not primarily lakes and wetlands as has commonly been suggested. Furthermore, there is little indication that populations were more residentially mobile and lived in lower population densities than later in time. After accounting for survey, geological, and temporal biases, it is apparent that site densities equal or exceed those of later periods in time. These findings should challenge archaeologists to reconsider certain notions about the Early Holocene in the desert west and to, when possible, take a landscape approach in reconstructing prehistoric lifeways.

doi: 10.2190/NA.28.2.a
http://baywood.com

INTRODUCTION

How people in North America adapted to a rapidly changing landscape following the close of the last major glacial epoch has been a topic that has captured the interest and imagination of both archaeologists and the general public. Unfortunately, the rarity of well-preserved archaeological sites dating to the Early Holocene has made the pursuit of answers to this question rather elusive (and perhaps thereby more attractive in some senses). For a variety of reasons, most Early Holocene sites in North America are not easily accessible. As sea levels rose throughout the Early Holocene, rivers in many areas deeply incised their channels and either eroded existing sites or deeply buried others under alluvium. Most Early Holocene sites have been discovered archaeologically through happenstance, such as chance discovery during excavation of later-period sites, during construction, or because a watercourse has recently eroded through such sediments, exposing sites in a cut bank (e.g., Erlandson, 1994).

This article summarizes recent research on Early Holocene sites in the Coso Basin of southeastern California in the northwest corner of the Mojave Desert (see Figure 1). Early Holocene sites were regularly encountered during systematic survey and excavation in the region. Due to the lack of widespread sediment deposition in Coso Basin, sites were generally found on the surface of ancient landforms on desert pavement, making them easily visible and accessible to archaeologists. Although organic remains were not preserved, the nature of these sites and the research program allowed us the opportunity to examine the distribution of Early Holocene sites, and hence use of the region, at a landscape rather than site-specific scale. In particular, we consider whether Early Holocene sites are truly rare, relative to other time periods, or whether their rarity is largely due to visibility. We also examine the types of environments in which these sites occur and the nature of residential mobility during this time period compared to later ones.

COSO BASIN

Coso Basin is a small internally-flowing basin with a dry lake surrounded by low-lying hills on the south (White Hills), and small mountain ranges (ca. 1500-2500 m) to the west and northwest (Coso Range) and east (Argus Range). Just to the west, the Sierra Nevada Mountains (ca. 4000 m +) define the western edge of the larger Mojave Desert. China Lake basin, which has been the subject of more archaeological research due to the presence of fluted points (e.g., Byrd, 2006; Davis, 1978), lies just to the south and has been separate from Coso Basin since at least the late Pleistocene.

Modern Environment

This arid region is characterized by hot summers (greater than 40°C) and cool winters (<15°C), with prevailing winds blowing in a southwesterly direction.

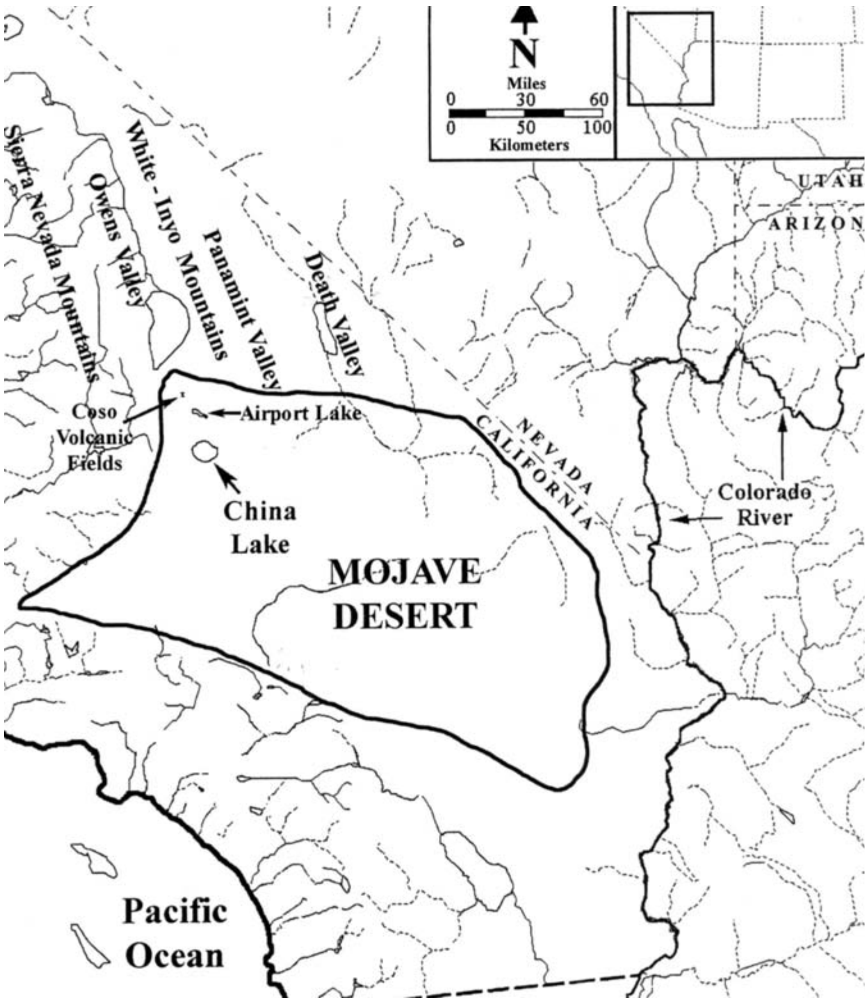

Figure 1. Map of southwest California, Airport Lake, and places mentioned in the text.

The rain-shadow of the Sierra Nevada allows little precipitation to reach Coso Basin, with annual rainfall typically between 5 and 10 cm. Higher elevations surrounding the valley receive light snowfall from November through April, which generally dissipates within a few days. Springs and small seeps provide the primary surface water in the larger valley, but during rare periods of intense rain, playas in both China Lake and Coso basins hold up to several inches of water. Although surface flows are infrequent, Coso Wash, which drains an extensive area north of Airport Lake Playa, delivers the primary in-flow to the Coso Basin. Not a single perennial stream currently exists within easy walking distance of the Coso Basin.

The area currently supports typical desert scrub vegetation. Creosote bush (*Larrea tridentata*) tends to form large homogenous tracts, frequently with its principle associate white bursage (*Ambrosia dumosa*), in coarse, well-drained soils on alluvial fans bordering the Coso Basin. Saltbush Scrub plant communities are found on low-lying fans adjacent to the playa that support a number of seed-bearing plants, principally those in the goosefoot family (Chenopodiaceae). A low density of fauna is found in the region. Among these species are a range of small mammals such as ground squirrels (*Spermophilus* spp.), woodrats (*Neotoma* spp.), black-tailed jackrabbit (*Lepus californicus*), and desert cottontail (*Sylvilagus audubonii*). In addition, a small number of larger mammals such as coyote (*Canis latrans*), desert kit fox (*Vulpes macrotis*), badger *(Taxidea taxus*), ringtail cat (*Bassariscus astutus*), bobcat (*Lynx rufus*), mountain lion (*Felis concolor*), mule deer (*Odocoileus hemionus*), and desert bighorn sheep (*Ovis canadensis nelsoni*) can be found, and may have co-occurred prehistorically with pronghorn (*Antilocapra americana*).

Paleoenvironment

It is almost cliché that a discussion of Early Holocene archaeology in North America includes a section outlining paleoclimate and environment. By discussing paleoclimate, we do not imply that environment is a determinant or predictor of prehistoric lifeways. Environment is just one of a number of factors that can affect the range of choices individuals have in terms of what they choose to eat, the kinds of raw materials they have to make tools, and the like. Moreover, in an environment that today is among the most extreme in North America, it is particularly poignant to relate how different Early Holocene environments likely were.

However, there continues to be disagreement about environmental conditions that prevailed from the late Pleistocene to the middle Holocene in the Mojave Desert. Stemming from that, the degree to which environmental fluctuations during the Holocene affected patterns of human land use and subsistence throughout the Great Basin has been continually debated (cf. Baumhoff and Heizer, 1965; Bettinger, 1975, 1978, 1991; Cleland and Spaulding, 1992; Elston, 1982; Grayson, 1991, 1993; Jennings and Norbeck, 1955; Madsen, 1982, 1999; Thomas, 1972, 1973, 1988). Much of the discussion revolves around whether or not fresh-water lakes and associated marsh and grassland habitats persisted into the Holocene (cf. Basgall and Hall, 1992; Cleland and Spaulding, 1992).

For example, Basgall and Hall (1992) argue that these lacustrine environments may have disappeared quite early in the closed basins of the Mojave Desert, like Coso Basin, resulting in arid environmental conditions, more like the present. Whereas, Warren (1986) and others (Cleland and Spaulding, 1992; Warren and

Crabtree, 1986; Warren and True, 1961) characterize the early Holocene (what has been termed the Lake Mohave Period, ca. 10,000 to 7000 BP) as a time when warmer post-Pleistocene temperatures and still-thriving pluvial lakes resulted in highly productive ecosystems.

Most considerations of paleoenvironment in the Coso Basin region have also focused on pluvial lake histories, particularly fluctuations in the adjacent China Lake basin. The latter, was once part of an inter-connected system of rivers and lakes extending from Owens Valley on the north, to the Searles basin on the south. Most paleoenvironmental reconstructions have assumed that this larger pluvial lake system was active during the terminal Pleistocene and perhaps, periodically into the early Holocene (e.g., Rosenthal et al., 2001; Warren, 2000). However, recent examination of a large body of paleoenvironmental evidence from Owens Lake indicates that this drainage network ceased to exist during the late Pleistocene, after 15,000 cal BP (Bacon et al., 2006). As a result, it seems the main source of water supporting pluvial lakes in China Lake Basin and the subsidiary, Searles Lake basin, was cut-off well before humans first occupied the northwestern Mojave Desert. The distribution of Clovis points and crescents along the modern playa in China Lake Basin supports the notion that the earliest occupation of this region occurred at a time when China Lake was essentially dry (Rosenthal et al., 2001; Warren, 2000). The same is true in Coso Basin, where several early Holocene stemmed points and site deposits occur adjacent to the level of the modern playa, indicating that the basin probably never supported a significant body of water since the late Pleistocene.

Preliminary observations based on modern hydrological patterns seem to suggest that early Holocene habitats within Coso Basin and the adjacent China Lake Basin were neither the xeric nor verdant environments portrayed by other researchers. Increased precipitation and/or reduced evapotranspiration rates may have supported dispersed spring-marshes, periodic playa-lakes, wet meadows, and more frequent surface flows along the washes and other now-dry water courses. These conditions would have resulted in a greater mosaic of both plant and animal resources than exist today (Rosenthal et al., 2001).

EARLY HOLOCENE SITES

Prehistoric sites of all ages in the Coso Basin are dominated by flaked stone, almost all of it obsidian. The Coso Volcanic Fields lie just to the north and northwest of the basin and natural obsidian cobbles up to 10 cm in diameter can be found in Coso Wash. However, while these cobbles appear to be eroding from the less commonly used Joshua Ridge subsource, most obsidian in the region still derives from the Sugarloaf and West Sugarloaf subsources, suggesting most of the obsidian in the basin was brought in from the north (for recent discussions of Coso obsidian see Eerkens and Rosenthal, 2004; Ericson and Glascock, 2004; Gilreath and Hildebrandt, 1997).

Dating Sites

The high density of obsidian is a blessing for archaeological studies, for it provides the opportunity to date sites even when there is no carbon or organic materials (e.g., for radiocarbon dating), or temporally sensitive artifacts (e.g., projectile points, pottery). This turns out to be the case for nearly every Early Holocene site. A sample of 10-20 obsidian artifacts were analyzed for hydration bands from all sites in the study area. Although much less accurate than radiocarbon, hydration is commonly used in eastern California and has been shown to be a reliable means of dating sites to general periods of time (e.g., Ericson, 1989; Hughes, 1988; Hull, 2001; Meighan, 1983; Rogers, 2007).

At the same time, because many of the Coso Basin sites have been exposed on the surface for thousands of years, artifacts are often highly sandblasted which poses a problem for hydration dating. Such sandblasting can be extreme, completely removing all traces of dorsal flake scars, and more importantly, removing the associated hydration band. Because of this issue, we settled on an alternative to traditional hydration dating by choosing to date artifacts with hinge, step, or other types of fractures. This works when air could reach the surface, but the resulting flake had not been completely removed, thereby protecting part of the artifact from sandblasting. Figure 2 illustrates our sampling method for such sandblasted artifacts.

Hydration results are shown in Table 1 for 11 Early Holocene sites or site loci that were surface collected and excavated in the Coso Basin by Rosenthal and Eerkens (2003). In previous work it has been shown that a hydration band of 11.4 microns converts to an age estimate of about 7000 BP (Gilreath and Hildebrandt, 1997; Table 1; see also Rosenthal and Eerkens, 2003). In all but one of our 11 cases average hydration readings exceed 12.5 microns, indicating ages exceeding 7000 BP. In the final case (CA-INY-5012B), only one artifact produced a visible hydration reading at 6.0 microns (about 1500 BP). However, five additional readings produced diffuse hydration bands indicating a more ancient age, and other factors, such as the degree of sandblasting and the nature of the debitage assemblage strongly suggest an Early Holocene age. Table 1 also gives the density of tools and cores and debitage on the surfaces at these sites.

Artifacts Recovered

Early Holocene sites are characterized by fairly low surface densities of artifacts. As shown in Table 1, controlled surface collections resulted in densities ranging between .01 and .98 artifacts per square meter, the majority of this debitage. Tool and core densities are even lower, ranging only between .001 and .03 per square meter. Obsidian accounts for over 98% of the artifacts, with trace amounts of quartzite, basalt, chert, and other local toolstone materials. Figure 3 presents examples of the types of artifacts recovered at Early Holocene sites.

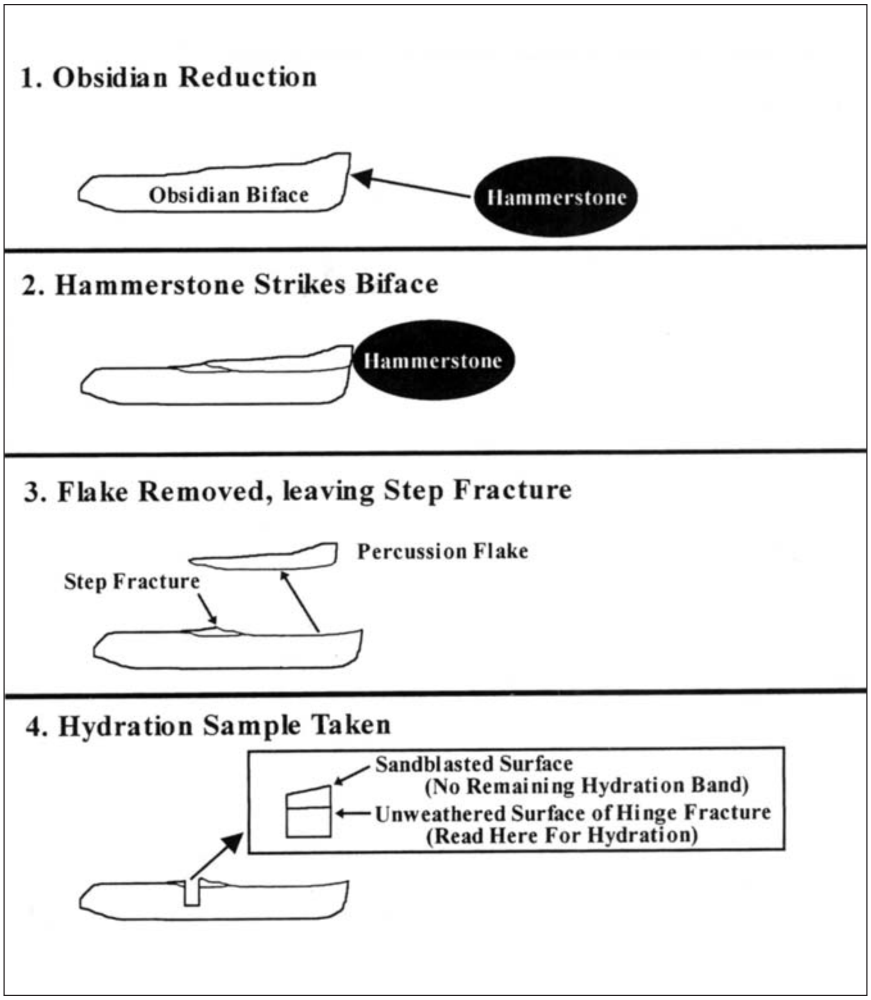

Figure 2. Sampling hinge fractures for hydration.

As seen in Table 2, by far the most numerous tools are bifaces (65%), found in almost every Early Holocene component. Most (88%) are early-stage rough-outs, and over 90% were broken, many as a result of either manufacturing errors (25%) or structural flaws (11%). The low proportion of finished tools (i.e., stages 4 and 5 bifaces; see Callahan, 1979) indicates that small-scale biface production took place at these sites. Cortical remnants were rarely identified, suggesting that most specimens were initially reduced elsewhere and further worked on-site. XRF analysis on seven of the Early Holocene bifaces confirmed that all

Table 1. Early Holocene Flaked Stone Tool and Debitage Densities

	Avg. hyd	Number hyd	Number diffuse	Cores & tools	Cores & tools per m^2	Debitage	Debitage per m^2
5012A	20.1	2	0	—	0.000	57	0.253
5012B	6.0	1	5	2	0.009	22	0.098
5830B	16.1	3	3	5	0.011	11	0.024
5840B	13.9	16	4	15	0.033	128	0.284
5840C	13.3	6	2	8	0.015	158	0.287
5841	13.7	4	11	16	0.021	131	0.169
5828	12.5	6	4	1	0.001	42	0.062
5830A	13.8	13	3	6	0.003	96	0.048
5835	14.8	5	5	1	0.003	65	0.200
5845	14.1	6	10	2	0.006	318	0.978
5846	13.0	9	0	1	0.002	131	0.238
Total				57	0.009	1,159	0.177

originated from Coso quarries; four from the local Joshua Ridge, two from Sugarloaf Mountain, and one from West Sugarloaf.

Cores account for 16% of the non-debitage artifacts at these sites. Cores average 14.7 grams, and only about 36% retain any cortex. Most are moderately worked and show at least two or more non-contiguous flake removal platforms (71%). Again, this suggests that these items are often being brought to the region after being initially worked elsewhere.

Projectile points account for an additional 6% (*n* = 5) of the non-debitage artifacts. Points include three Great Basin stemmed points (Lake Mohave and Silver Lake; two obsidian one basalt) and two Pinto forms (both obsidian and collected from a single site). Although traditional interpretations of Pinto points place them later in time, during the Middle Holocene, recent research in the Coso Volcanic Field (Gilreath and Hildebrandt, 1997) and at Fort Irwin (Basgall, 1993; Basgall and Hall, 1994a:32) shows considerable overlap in the spatial and temporal distribution of Pinto and earlier stemmed points in the Mojave Desert, suggesting that these forms are partly coeval (Basgall and Hall, 2000). Unfortunately, both the Pinto points returned diffuse hydration readings, but all available evidence indicates they are Early Holocene in age. XRF analyses

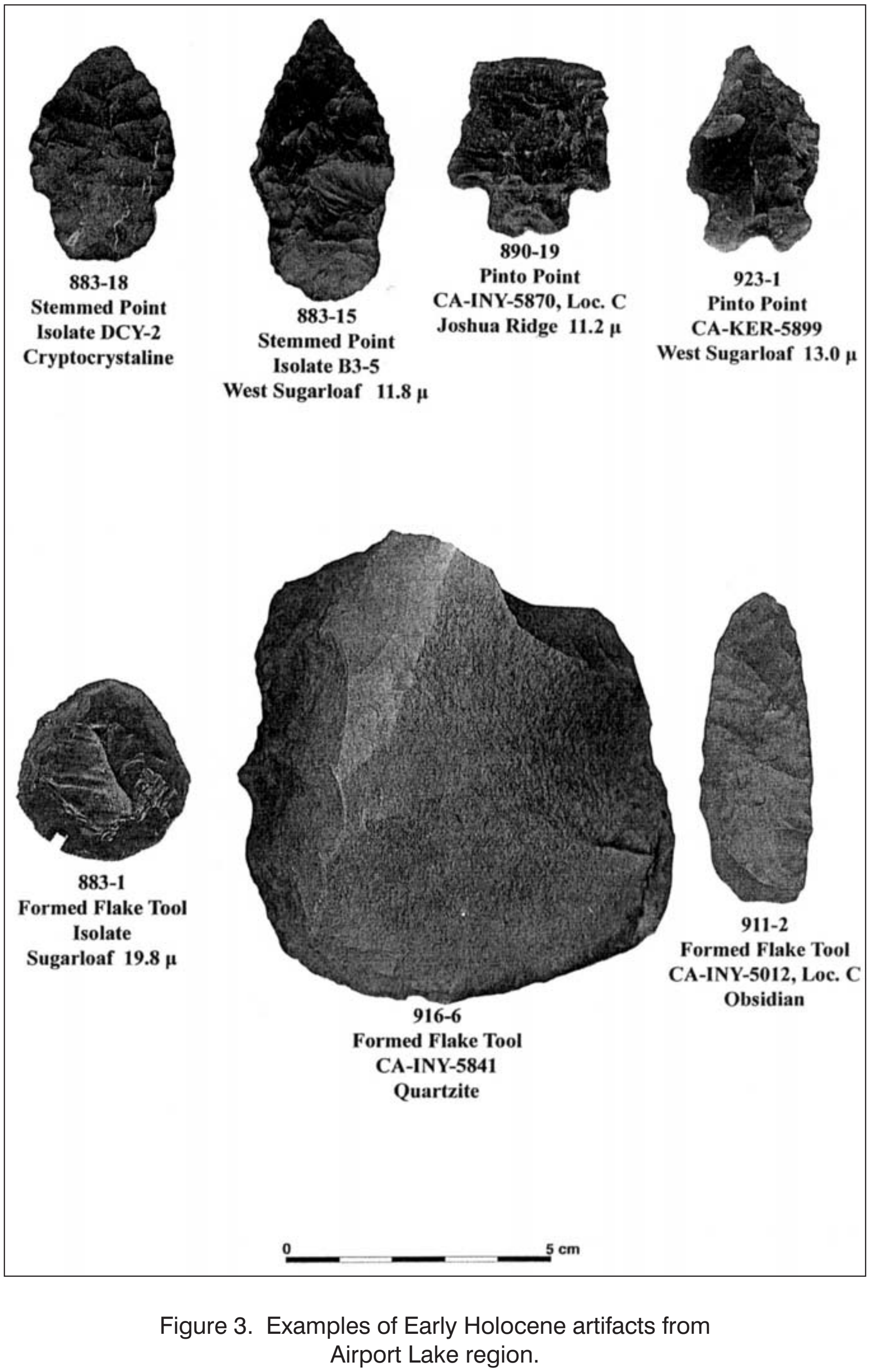

Figure 3. Examples of Early Holocene artifacts from Airport Lake region.

Table 2. Assemblage Summary from Early Holocene Components

	Bone	Biface	Core	Flake tool	Formed flake tool	Projectile point	Debitage	Cobble tool	Anvil	Hand-stone	Total
Generalized Camps											
5012A	—	—	—	—	—	—	60	—	—	—	60
5012B	—	4	1	2	1	—	24	—	—	—	32
5830B	—	4	—	—	—	1	13	—	—	1	19
5840B	—	13	4	2	—	1	184	—	—	—	204
5840C	—	16	5	2	—	2	167	1	—	—	193
5841	—	9	4	1	1	1	137	—	1	—	154
Specialized BFT Camps											
5828	—	1	—	—	—	—	47	—	—	—	48
5830A	14	5	—	1	—	—	110	—	—	1	131
5835	1	1	—	—	—	—	73	—	—	—	75
5845	—	2	—	—	—	—	333	—	—	—	335
5846	—	1	—	—	—	—	133	—	—	—	134
Total	15	56	14	8	2	5	1,281	1	1	2	1,385

indicate that all four obsidian points were made from Sugarloaf ($n = 3$) and West Sugarloaf ($n = 1$) obsidian.

Simple flake tools (9%; $n = 8$), formed flake tools (2%; $n = 2$), and a single angular, quartzite cobble-tool with extensive crushing/rounding along a single margin account for the remaining non-debitage flaked stone artifacts. The flake tools, all obsidian, tend to be quite large, averaging 52 × 30 × 11 mm, and display a range of use-wear patterns (e.g., bifacial micro-chipping, edge grinding), indicating they were probably used for a variety of purposes. Given the limited sample size, it is difficult to generalize about the formed flake tools. However, in the nearby Volcanic Field Gilreath and Hildebrandt (1997) found these artifacts to be exclusively associated with Early Holocene sites.

Only two sites produced artifacts other than flaked stone. Two handstones from one site, and a tabular cobble with central pecking, interpreted as an anvil, from another, were discovered. While milling tools are known from Early Holocene assemblages in the region (e.g., Basgall, 1993; Delacorte, 1999; Gilreath and Holanda, 2000), the site with the handstones also contained two geophyte cooking features radiocarbon dated to after 1000 BP (Eerkens and Rosenthal, 2002). Thus, it is possible the handstones date to this later use of this particular site. In any case, none of the other Early Holocene components produced milling gear. If milling was part of the Early Holocene repertoire, it was a minor and ephemeral component of the range of behaviors.

Debitage Assemblages

A total of 1281 pieces of debitage was collected from Early Holocene components, 99% of it obsidian. Early and late-stage biface thinning debris makes up almost 70% of the assemblage, with only slightly over 30% characteristic of core reduction (i.e., simple interior flakes, complex interior flakes, and shatter). During laboratory analysis, it became evident that there were two types of assemblages represented, those that seemed to contain primarily core reduction debris and those containing primarily biface thinning debris. A more detailed individual flake-based analysis reveals these differences quantitatively. Figure 4 plots the average width vs. the average thickness of a sample of flakes from each of the Early Holocene components, with the two assemblage types labeled accordingly. One core reduction component could not be plotted due to a very small sample of measurable flakes ($n = 2$). Hydration profiles for the two debitage assemblage types completely overlap, indicating that the differences are not related to temporal patterns.

These differences suggest that two types of reduction activities were taking place at Early Holocene sites, and that these activities were spatially segregated. One of these reduction strategies involved secondary reduction of cores into more versatile shapes, while the other involved biface production. Consistent with debitage profiles, all the cores recovered from Early Holocene sites are associated

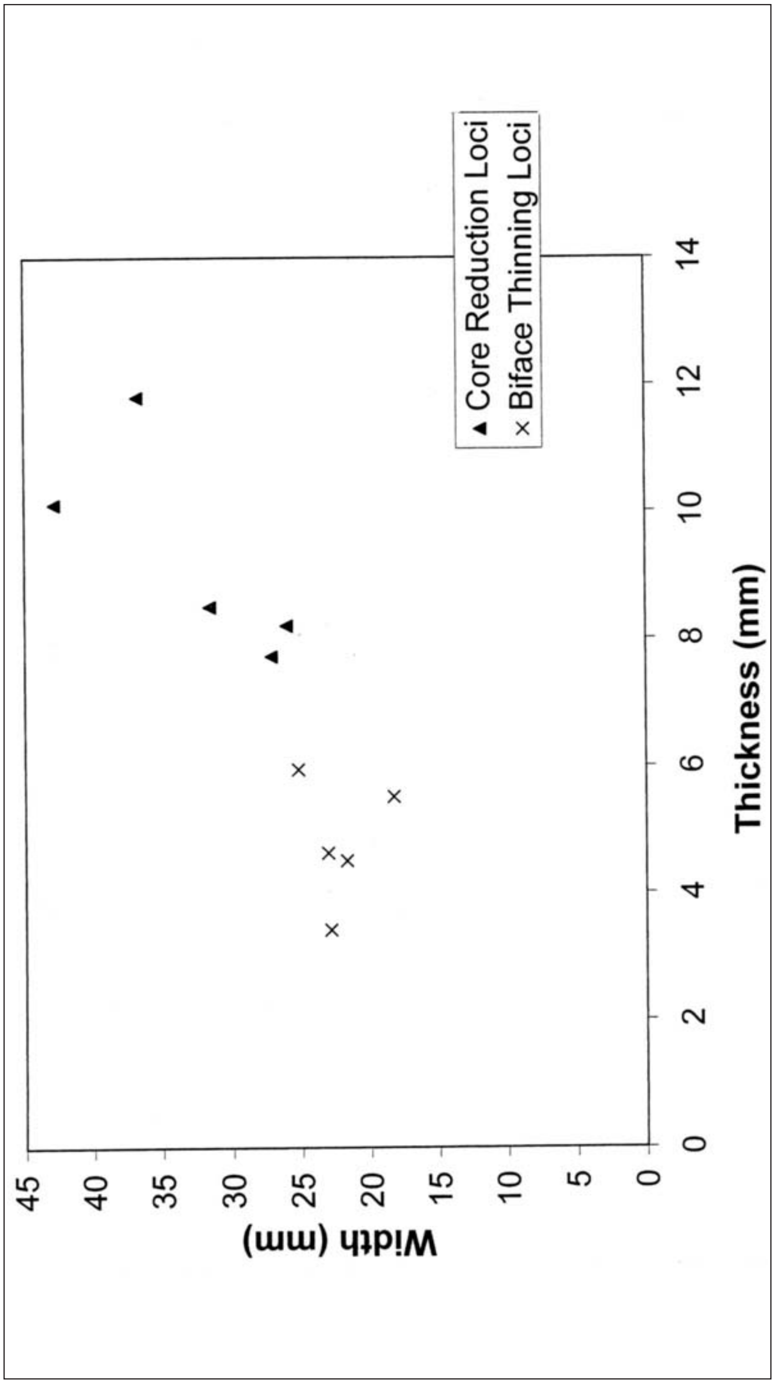

Figure 4. Average width and thickness measurements for Early Holocene debitage assemblages showing difference between generalized camps (core reduction loci) and specialized workshops (biface thinning loci).

with core reduction sites. Indeed, an examination of the range of tools present at these types of sites suggests they are much more generalized. All the projectile points, nearly two-thirds of the bifaces, and all but one of the simple and formed flake tools are found at these sites. On the other hand, outside of one simple flake tool, broken bifaces are the only tool found at the more specialized biface reduction sites. Thus, it appears that individuals discarded their broken or no-longer-serviceable points and most of their cutting implements (i.e., flake tools) at places where they reduced cores, but not at places where they were producing new ones (e.g., thinning bifaces).

We also note that these patterns are not due to differences in the intensity of investigation at these different sites. An examination of the relationship between sample size and artifact diversity shows virtually no relationship, producing a linear regression coefficient of $r = 0.004$ and a nearly flat slope. Even some of the smallest assemblages produced comparatively diverse tool assemblages, a characteristic of early assemblages throughout the broader region that has been noted by others (Basgall, 1993:382; Delacorte, 1999:362; Gilreath and Holanda, 2000).

LANDSCAPE PATTERNS

Having described the characteristics of Early Holocene sites in the Coso Basin, we now turn to the spatial distribution of those sites relative to geologic landforms. We begin with the Quaternary surface geology mapped by Moyle (1962) and augmented by Rosenthal and Eerkens (2003), which was digitized into a Geographical Information System (GIS) for analysis. Because we examine here only the distribution of dated sites (all by hydration), not the nature of sites based on excavation data, we are able to expand the database of sites plotted onto these geological maps from those discussed above by including several others from survey reports. In addition to those discussed above from Rosenthal and Eerkens (2003), the analysis also includes survey results from Hildebrandt and Jones (1995, 1997), King (2004), Tetra Tech and Far Western (1999), and Rosenthal et al. (2001). These survey studies cover just over 14,000 acres.

A total of 158 sites were recorded in these 14,000 acres, of which 82 were dated. For the purposes of this analysis, site polygons were reduced to center points, a simplification that is warranted given the coarse resolution of the geologic data set and the small size of most sites. The database does not include isolates, including isolated hearths, milling features, and pot drops, as well as sites lacking significant amounts of obsidian that would render them undatable by hydration means. Based on previous investigations (Eerkens and Rosenthal, 2002) the majority of such isolates and sites likely reflect the more ephemeral remains of late prehistoric activities dating after 1500 BP (e.g., Eerkens, 1999). Thus, the database certainly underestimates the importance of late prehistoric landscape use. Because of this, we confine our analyses to time periods predating 1500 BP for which we feel there are fewer obvious biases.

The results show several important trends for understanding Early Holocene landscape use. First, as seen in Table 3 there is significant sampling bias in the surveyed areas with respect to geologic units: younger fan deposits dating to the Middle and Late Holocene are heavily overrepresented relative to their extent in the study area as a whole (34% of total acreage vs. 63% of surveyed acreage). By contrast, older Late Pleistocene and Early Holocene fan deposits around the margins of the basin, precisely where we would expect to find most Early Holocene sites, are underrepresented (37% of total area vs. 20% of survey coverage). Figure 5 shows the distribution of landform types, grouped by age and the range of systematic surveys done. As seen, land around Airport Lake accounts for a significant fraction of the survey undertaken. These landforms tend to be young in age.

Second, with exception of the dune fields which account for more sites (9%) than survey acreage (4%), the density of sites within different geologic units closely tracks the distribution of survey acreage, indicating that surface geology, at least at the scale mapped by Moyle (1962), is a poor predictor of *overall* site density.

Third, as seen in Table 4, there is a strong correlation between landform age and site age. Using the GIS, we can account for the biased survey coverage by calculating the expected number of sites in different landforms, assuming they were randomly distributed, and compare that to the observed number of sites. Such an analysis indicates that Early Holocene sites are differentially found on Pre- and Early Holocene landforms, especially fans, and that in spite of the small sample size (n = 16 sites), this difference is statistically significant. On the other hand, Middle Holocene sites were found in roughly the proportions expected, indicating a more-or-less random distribution across the geologic landforms. Late Holocene sites are found on Late Holocene landforms, and are particularly dense in the Late Holocene dune sands; although the level of statistical significance is lower than for the Early Holocene sites.

Fourth, Early Holocene sites are found in a variety of older geologic contexts, including pre-tertiary piedmont, alluvial fans (that were relatively young at the time these sites were deposited), and within fields comprised of Quaternary volcanic rocks. Although no Early Holocene sites were found directly on older lake deposits (indeed, such contexts may have been under water periodically during the Early Holocene), several sites are found on the edge of the playa. This indicates that Early Holocene populations were making use of a broad range of environmental settings for undertaking various activities. There is no obvious landscape patterning to the two types of Early Holocene sites identified above, as the specialized use camps occur across the same suite of environments as the general-use camps.

Table 3. Distribution of Archaeological Sites by Landform

Landform	Total acreage	Total acreage (as %)	Surveyed acreage	Surveyed acreage (as %)	Number of sites	Number of sites (as %)
Pre- to Early Holocene						
pTu – pre-Tertiary basement	1,978	3	393	3	1	1
Qv – Volcanic rocks	6,530	11	679	5	11	7
Qls – Older lakeshore deposits	34	0	0	0	0	0
Qof – Older fan deposits	22,852	37	2,847	20	37	23
Qol – Older lacustrine deposits	4,032	7	414	3	2	1
Qos – Older dune sands	499	1	11	0	0	0
Middle to Late Holocene						
Qp – Playa deposits	2,496	4	422	3	0	0
Qyf – Younger fan deposits	20,989	34	8,843	63	93	59
Qds – Dune sands	2,617	4	527	4	14	9
Total	62,028	100	14,135	100		158

DISCUSSION

The excavation and survey results discussed above have implications for two important areas of research in the Early Holocene, population mobility and density. Although not completely at odds with previous research, the Coso Basin sites suggest alternative viewpoints and add important detail to existing models.

Population Mobility

Early Holocene assemblages investigated in the Coso Basin are, for the most part, in keeping with models that view Early Holocene foragers as small, wide-ranging, highly mobile family-bands (Basgall, 1993; Basgall and Hall, 1992; Delacorte, 1999; Gilreath and Holanda, 2000). The small sites evoke an impression of one or a few brief episodes of occupation, during which a number of subsistence-related and tool maintenance and production activities took place. Consistent debitage profiles indicate that core preparation and some early biface thinning/shaping occurred at general-use camps, perhaps an indication of gearing-up to leave the Coso Basin with newly fashioned tools or the continued exploitation of local ones. The presence of various flake-based processing implements (i.e., simple and formed flake tools), the regular occurrence of projectile points, and perhaps, the occasional piece of groundstone, imply a broad range of subsistence activities were staged from these localities. As general-use camps were identified near the playa edge, along Coso Wash, and on the surrounding

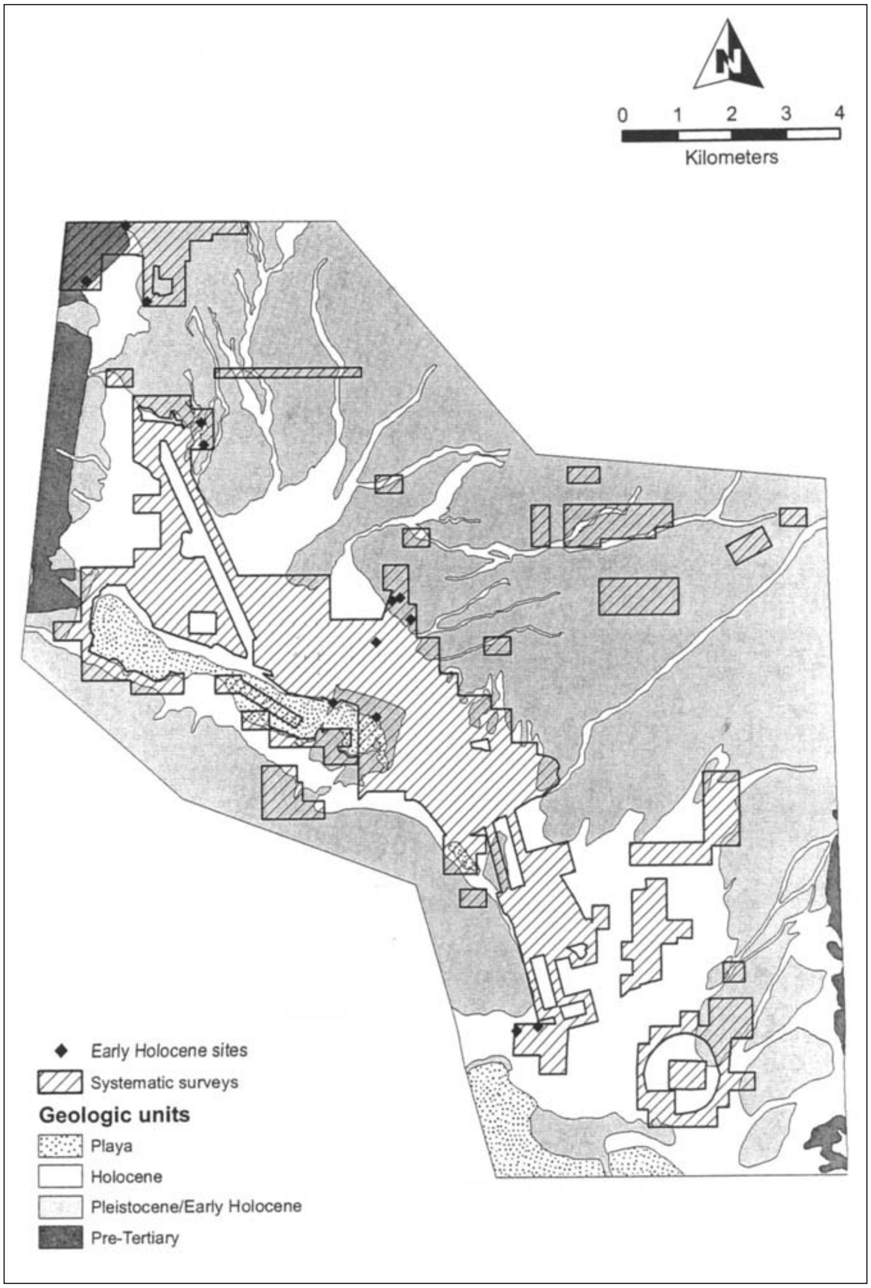

Figure 5. Landforms and coverage of systematic survey in Chine Lake region showing bias toward younger land surfaces.

Table 4. Distribution of Dated Components by Landform

	Period							
	Early Holocene		Middle Holocene		Late Holocene: Newberry		Total	
Landform	Obs	Exp	Obs	Exp	Obs	Exp	Obs	Exp
Pre-Holocene								
pTu – pre-Tertiary basement	1	.5	—		—		1	4.5
Qv – Volcanic rocks	2	.8	1	1	4	2.1	7	7.6
Qof – Older fan deposits	9	3.2	3	3.6	4	8.4	16	30.4
Qol – Older lake deposits	—		1	.5	1	1.3	2	4.6
Holocene								
Qyf – Younger fan deposits	4	10.1	10		25	26.5	39	95.8
Qds – Dune sands	—		3		8	1.7	11	6.1
Total	16		18		42		76	

piedmont, subsistence activities do not seem to have simply focused on the most productive lakeshore or marsh-side habitats (cf. Warren, 1984, 1986).

Special-use camps identified in Coso Basin occur across the same suite of environmental settings as the general-use camps, but their assemblages are much more attenuated consisting of discarded biface fragments, debitage, and little else. An absence of other tool types might suggest that these sites were occupied more briefly. As noted above, however, it is not the amount of stoneworking, but rather the nature of those activities that vary. The much higher proportions of biface thinning debris overall, and the larger amount of late biface thinning debris in particular, further suggest that activities at the special use camps included higher incidences of maintenance and final shaping of existing bifacial implements. The need for cores and their derivative flake tools seems to have been low at these locations, perhaps suggestive of specialized biface workshops or alternatively, hunting camps. That such segregated localities exist at all seems somewhat contrary to the notion that adaptive strategies of early foragers included little occupational differentiation, typically viewed as a matter of degree, rather than kind (Basgall, 1993:381; Delacorte, 1999:363). The Coso Basin components indicate that at least some settlement variability can be recognized, if only representing brief stopping places included in short forays from the more general-use camps.

At the same time, toolstone variability at Early Holocene sites in the Coso Basin is relatively low, with obsidian making up almost 99% of these assemblages recovered during excavation (see Table 5). High toolstone diversity during

Table 5. Material Composition of Early Holocene Flaked Stone Assemblages

	Basalt	Rhyolite	Other igneous	Obsidian	Chert	Quartzite	Total
Biface	—	—	—	56	—	—	56
Cobble tool	—	—	—	—	—	1	1
Core	—	—	—	11	—	3	14
Debitage	4	1	2	1,279	1	11	1,298
Flake tool	—	—	—	8	—	—	8
Formed flake tool	—	—	—	1	—	1	2
Projectile point	1	—	—	5	—	—	6
Total	5	1	2	1,360	1	16	1,385

the Early Holocene has been argued in other nearby regions to be an indication of artifact curation and broad territorial ranges. That this variability is not well represented in the Coso Basin sample is perhaps surprising, given the strength of this pattern elsewhere (see Basgall, 1993; Basgall and Hall, 1992; Delacorte, 1999).

On the other hand, compared to overall patterns, variability in toolstone is slightly higher among Coso Basin projectile points, which are typically thought to be the most highly curated tool type. The projectile point data shown in Table 6 are drawn from a larger sample than shown in Table 5, and includes both survey and excavation data. Twenty-four percent of Middle and Early Holocene point types (Pinto, Fish Slough, and Great Basin Stemmed) are fashioned from non-local materials (e.g., non-Coso). Yet, 20% of Late Holocene points (Rose Spring, Saratoga Spring, Elko, Humboldt), when populations were presumably larger and less mobile, are also non-local. Eerkens and Rosenthal (2004:24) document the same pattern across an even larger sample of projectile points in the broader China Lake region.

If evidence of expansive residential mobility during the Early Holocene is as pervasive as has been portrayed, we would have expected a higher percentage of highly-curated and spent tools to be made of extra-local obsidian or other materials (e.g., chert, basalt). This does not appear to be the case in assemblages from Coso Basin or even from those Early Holocene components in the nearby quarry zone (Gilreath and Hildebrandt, 1997). Moreover, if mobility patterns had changed significantly over time, with later populations less mobile than their ancestors, we would have expected significant differences in the percentage of local vs. non-local toolstone over time. This pattern did not emerge either, suggesting either that

Table 6. Projectile Points by Material Type from Coso Basin

	Igneous			Obsidian			
	Basalt	Rhyolite	Chert	Saline Range	Casa Diablo	Coso	Total
Late Holocene							
Rose Spring	—	—	—	1	—	6	7
Saratoga Spring	—	—	1	—	—	1	2
Elko	—	—	—	—	—	2	2
Humboldt	1	—	—	—	—	3	4
Middle and Early Holocene							
Pinto	—	—	—	—	—	6	6
Fish Slough	—	1	—	—	—	—	1
Great Basin Stem	1	—	1	—	1	7	10
Total	2	1	2	1	1	25	32

late populations were highly residentially mobile (e.g., Eerkens, 1999) or Early Holocene ones were less so. Additional research is needed to address this issue.

That Coso obsidian makes up a significant portion of early assemblages in nearby regions (e.g., Basgall, 1993; Delacorte, 1999; Gilreath and Holanda, 2000), indicates that the movement of toolstone was largely one-way. Thus, the presence in Coso Basin of Early Holocene sites dominated by obsidian bifaces and thinning debris, but containing virtually no other tool types as we see at the special use camps, may allude to the logistical procurement of obsidian during the Early Holocene, perhaps staged from localities more distant than is traditionally acknowledged for this time interval.

Population Density

It is true overall that Early Holocene sites are less common, in an absolute sense, than sites dating to the ensuing two time periods. This might be taken as evidence to support the common notion that such sites are rare and population densities must have been low. However, it is also clear that 1) we would not expect Early Holocene sites to be found in a large fraction of the land surfaces investigated because they were formed after the Early Holocene, and 2) those landforms where we would expect to find them are greatly under-represented in regional studies.

As shown in Table 7, the density of Early Holocene sites on Early Holocene landforms, at least those that are still exposed today, is approximately .003 sites per acre. This is equal to the density of sites in the Late Holocene Newberry Period and about three times higher than the density of sites during the Middle Holocene period. People living during the latter periods would have had access to nearly

Table 7. Density of Sites by Time Period, Accounting for Survey and Temporal Biases

	No. of site components	Duration of time period in years	Sites per acre	Sites per acre-year (*100,000)
Early Holocene	12	3,000	.003	.10
Little Lake	18	3,500	.001	.03
Newberry	42	2,000	.003	.15

all of the landforms visible today. If we further adjust for the length of time each cultural period represents, expressed as the number of sites per acre-year (last column in Table 7; multiplied by 100,000 to bring the significant digits forward), we see that Early Holocene sites are much denser than Middle Holocene sites (over three times), and slightly less dense than Newberry aged sites from the Late Holocene.

In other words, when we account for survey biases *and* temporal factors, Early Holocene site are not at all rare. The density of these sites is much higher than Middle Holocene sites and nearly as high as those dating to one of the most archaeologically visible periods in the region, the Newberry period. If we take site density as a proxy measure of population density, Early Holocene populations were just as dense and large as later ones. Of course, site density is affected by factors other than population density, such as residential mobility (greater mobility may produce greater densities of sites) and group size (larger aggregations of people may leave behind similar numbers of sites despite higher population density). In the Coso Basin, however, there is no indication that mobility and group size differed over time. As discussed above, there is little evidence for change in mobility over time and site sizes are similar across time. Thus, we believe that site density is a fairly reliable indication of population density. This method of estimating population density avoids many of the problems noted by Surovell and Brantingham (2007), such as tabulating radiocarbon dates.

CONCLUSIONS

Early Holocene components from Coso Basin have the advantage of being in close proximity to the Coso obsidian source and thus provide consistent samples for hydration dating—a situation that does not prevail in more central portions of the Mojave Desert. In these latter settings, many similar flaked stone deposits that may be early go undated (Basgall, 1991, 1993:366), likely contributing to the misconception that Early Holocene sites are rare and/or focused on lacustrine environments. Our ability to ascribe age assignments to even the most unobtrusive flaked stone scatters in Coso Basin, provides a more detailed understanding of Early Holocene settlement variability and land use. This is supported by the recognition of at least two separate types of functional assemblages in Coso Basin, thought to represent different aspects of Early Holocene land use.

Early Holocene sites are found throughout the study area wherever older landforms are present at or near the surface. These deposits are all comparatively sparse surface accumulations composed almost entirely of obsidian debitage and a few tools. Unlike traditional characterizations of Early Holocene land use which emphasize occupation in pluvial lake/marshland habitats, components identified in Coso Basin occur across a range of geomorphic settings. In addition to occurring in "magnet" locations on or near the playa edge, where traditional interpretations of Early Holocene lifeways would place them, these components are found in comparatively high frequency on the broad piedmonts and on the inter-fluvial ridges and terraces along Coso Wash, well away from the basin bottom. This diversity speaks to the range of subsistence and technological activities these populations were involved in.

Evidence suggests that Early Holocene sites are just as common, and in some cases more so (as in the comparison to the Middle Holocene), than later ones. Yet, comparatively we know much more about later populations than earlier ones. For example, the Newberry-period is well studied and, although there is still much to learn, we have a firm understanding of general human adaptations. Hundreds of sites dating to this period have been excavated and studied, a time when obsidian tool production in the region reached its peak (Gilreath and Hildebrandt, 1997). Our analysis indicates that although the *overall* number of Early Holocene sites on the surface today is lower, they can be found in high densities if one looks in the right places. Thus, there are plenty of opportunities to study lifeways during this time period. Much of our bias against a greater understanding of Early Holocene lifeways, at least in the Mojave Desert, derives from a lack of obsidian to date sites (about which archaeologists can do little) and a general focus on the wrong types of landforms (about which we can). In other areas of western North America, the additional issue of Early Holocene landscape accessibility and visibility is also a problem (about which archaeologists can sometimes do something; Erlandson, 1994). Accessing such landscapes may require more careful geomorphological research and/or probing or digging through younger strata, a potentially costly undertaking.

Unlike many previous studies, which have often focused on single sites (e.g., Basgall and Hall, 1993, 1994b; Gilreath and Holanda, 2000), we were able to examine Early Holocene lifeways at a broader landscape level. The research indicates that populations in the Coso Basin were just as residentially mobile and just as dense as later ones. This finding challenges the traditionally-held notion that populations in the desert west gradually and more-or-less consistently grew over time and that such population increases elicited gradual reductions in the scale of residential mobility. Our research suggests a more nuanced picture of population change, with relatively high population densities during the Early Holocene, followed by an apparent population decline in the Middle Holocene as the climate warmed and available surface water declined. Only later, during the early part of the Late Holocene (3500-1500 BP), did populations expand again as people adapted technologically and socially to these new conditions.

Finally, we did not discuss what happened in the Coso Basin during the second half of the Late Holocene, after 1500 BP. The main reason for this omission is that our means of tracking human behavior, focused on sites containing lithic refuse, and dating using obsidian hydration, is significantly biased against the archaeological record post-dating 1500 BP. Although it is beyond the scope of this article, it is clear that the nature of the archaeological record changes significantly around this time. The remnants of human behavior after 1500 BP are most often marked by isolated cooking features, pottery, and grinding stones (e.g., Eerkens, 2004; Eerkens and Rosenthal, 2002), all made out of non-obsidian materials. In this respect, ethnographic hunter-gatherers in the Mojave Desert do not seem to make good analogues for pre-1500 BP groups.

ACKNOWLEDGMENTS

We thank Amy Gilreath and Bill Hildebrandt for reading earlier drafts of this article and Tammara Norton for drafting the figures. We also thank Naval Air Weapons Station China Lake, Jan Jacobson, and Russell Kaldenberg for their continued support of archaeological research and stewardship of the past. This work would not have been possible without their support.

REFERENCES CITED

BACON, STEVEN N., RAYMOND M. BURKE, SILVIO K. PEZZOPANE, and ANGELA S. JAYKO

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

BASGALL, MARK E.

1991 *The Archaeology of Nelson Basin and Adjacent Areas, Fort Irwin, San Bernardino County, California, Volume I,* Far Western Anthropological Research Group, Inc., Davis, California.

1993 *The Archaeology of Nelson Basin and Adjacent Areas, Fort Irwin, San Bernardino County, California,* Far Western Anthropological Research Group, Inc., Davis, California.

BASGALL, MARK E. and MATHEW C. HALL

1992 Fort Irwin Archaeology: Emerging Perspectives on Mojave Desert Prehistory, *Society for California Archaeology Newsletter, 26*:5, pp. 1-7.

1993 *Archaeology of the Awl Site, CA-SBR-4562, Fort Irwin, San Bernardino County, California,* Far Western Anthropological Research Group, Inc., Davis.

1994a *Status Report on Cultural Resources Management at the National Training Center, Fort Irwin, 1993-1994: An Addendum to the Fort Irwin Historic Preservation Plan,* Archaeological Research Unit, University of California, Riverside, California.

1994b *Archaeological Investigations at Goldstone (CA-SBR-2348): A Middle Holocene Occupation Complex in the North-Central Mojave Desert, California,* Archaeological Research Unit, University of California, Riverside.

2000 Morphological and Temporal Variation in Bifurcate-Stemmed Dart Points of the Western Great Basin, *Journal of California and Great Basin Anthropology, 22,* pp. 237-276.

BAUMHOFF, MARTIN A. and ROBERT F. HEIZER

1965 Postglacial Climate and Archaeology in the Desert West, in *The Quaternary of the United States*, H. E. Wright, Jr. and D. E. Frey (eds.), Princeton University Press, Princeton, New Jersey, pp. 697-707.

BETTINGER, ROBERT L.

1975 *The Surface Archaeology of Owens Valley, Eastern California: Prehistoric Man-Land Relationships in the Great Basin,* Ph.D. dissertation, University of California, Riverside.

1978 Alternative Adaptive Strategies in the Prehistoric Great Basin, *Journal of Anthropological Research, 34,* pp. 27-46.

1991 Aboriginal Occupations at High Altitude: Alpine Villages in the White Mountains of Eastern California, *American Anthropologist, 93,* pp. 656-679.

BYRD, BRIAN F.

2006 *Archaeological Survey of 2,760 Acres of Target Buffer Zones in the Baker, Charlie, and George Ranges, NAWS China Lake, Inyo and Kern Counties, California,* Far Western Anthropological Research Group, Inc., Davis.

CALLAHAN, ERRETT

1979 The Basics of Biface Knapping in the Eastern Fluted Point Tradition: A Manual for Flintknappers and Lithic Analysts, *Archaeology of Eastern North America, 7,* pp. 1-180.

CLELAND, JAMES H. and W. G. SPAULDING

1992 An Alternative Perspective on Mojave Desert Prehistory, *Society for California Archaeology Newsletter, 26*:5.

DAVIS, EMMA. L. (editor)

1978 *The Ancient Californians: Rancholabrean Hunters of the Mojave Lakes Country,* Natural History Museum of Los Angeles County, Los Angeles.

DELACORTE, MICHAEL G.

1999 *The Changing Role of Riverine Environments in the Prehistory of the Central-Western Great Basin: Data Recovery Investigations at Six Prehistoric Sites in Owens Valley, California,* Far Western, Davis Anthropological Research Group, Inc., California.

EERKENS, JELMER W.

1999 Common-Pool Resources, Buffer Zones, and Jointly-Owned Territories: Hunter-Gatherer Land and Resource Tenure in Fort Irwin, Southeastern California, *Human Ecology, 27,* pp. 188-213.

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

EERKENS, JELMER W. and JEFFREY S. ROSENTHAL

2002 Transition from Geophyte to Seed Processing: Evidence for Intensification From Thermal Features near China Lake, Northern Mojave Desert, *Pacific Coast Archaeological Society Quarterly, 38,* pp. 19-36.

2004 Are Obsidian Subsources Meaningful Units of Analysis? Temporal and Spatial Patterning of Subsources in the Coso Volcanic Field, Southeastern California, *Journal of Archaeological Science, 31,* pp. 21-29.

ELSTON, ROBERT G.

1982 Good Times, Hard Times: Prehistoric Culture Change in the Western Great Basin, in *Man and Environment in the Great Basin*, D. B. Madsen and J. F. O'Connell (eds.), Society for American Archaeology, Washington, D.C., pp. 186-206.

ERICSON, JONATHON E.

1989 Toward Flow-Specific Obsidian Hydration Rates: Coso Volcanic Field, Inyo County, California, in *Current Directions in California Obsidian Studies*, R. E. Hughes (ed.), Contributions of the University of California Archaeological Research Facility No. 48, pp. 13-22.

ERICSON, JONATHON E. and MICHAEL D. GLASCOCK

2004 Subsource Characterization: Obsidian Utilization of Subsources of the Coso Volcanic Field, Coso Junction, California, USA, *Geoarchaeology*, *19*, pp. 779-805.

ERLANDSON, JON M.

1994 *Early Hunter-Gatherers of the California Coast,* Plenum Press, New York.

GILREATH, AMY J. and WILLIAM R. HILDEBRANDT

1997 *Prehistoric Use of the Coso Volcanic Field,* Contributions of the University of California Archaeological Research Facility 56, University of California, Berkeley.

GILREATH, AMY J. and KIM L. HOLANDA

2000 *By the Lake By the Mountains: Archaeological Investigations at CA-INY-4554 and CA-INY-1428: 09-INY-395, P.M. 41.3 to 45.6 (KP 66.5 to 73.4),* report submitted to California Department of Transportation, District 09, Bishop, Far Western Anthropological Research Group, Inc., Davis, California.

GRAYSON, DONALD. K.

1991 Alpine Faunas from the White Mountains, California: Adaptive Change in the Late Prehistoric Great Basin, *Journal of Archaeological Science*, *18*, pp. 483-506.

1993 *The Desert's Past: A Natural Prehistory of the Great Basin,* Smithsonian Institution Press, Washington, D.C.

HILDEBRANDT, WILLIAM R. and DEBORAH A. JONES

1995 *The JSOW Archaeological Survey and Site Evaluation Project, Naval Air Weapons Station, China Lake, Inyo County, California,* Far Western Anthropological Research Group, Inc., Davis, California.

1997 *The JSOW Archaeological Survey, Site Evaluation and Data Recovery Project, Naval Air Weapons Station, China Lake, Inyo County, California, Volume I,* Far Western Anthropological Research Group, Inc., Davis, California.

HUGHES, RICHARD E.
1988 The Coso Volcanic Field Reexamined: Implications for Obsidian Hydration Dating, *Geoarchaeology, 3,* pp. 253-265.
HULL, KATHLEEN L.
2001 Reasserting the Utility of Obsidian Hydration Dating: A Temperature-Dependent Empirical Approach to Practical Temporal Resolution with Archaeological Obsidians, *Journal of Archaeological Science, 28,* pp. 1025-1048.
JENNINGS, JESSE D. and EDWARD NORBECK
1955 Great Basin Prehistory: A Review, *American Antiquity, 21,* pp. 1-11.
KING, JAY
2004 *Archaeological Survey of 5,004 Acres of Target Area Buffer Zones in the Coso, Airport Lake, George, and Armitage Airfield Ranges, NAWS China Lake, Inyo and Kern Counties, California,* Far Western Anthropological Research Group, Inc., Davis, California.
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*, D. B. Madsen and J. F. O'Connell (eds.), Society for American Archaeology, Washington, D.C., pp. 207-226.
1999 Environmental Change During the Pleistocene-Holocene Transition and its Possible Impact on Human Populations, in *Models for the Millennium: Great Basin Anthropology Today*, C. Beck (ed.), University of Utah Press, Salt Lake City, pp. 75-82.
MEIGHAN, CLEMENT W.
1983 Obsidian Dating in California, *American Antiquity, 48,* pp. 600-609.
MOYLE, WILLIAM R.
1962 *Data on Water Wells in Indian Wells Valley Area, Inyo, Kern, and San Bernardino Counties, California,* California Department of Water Resources Bulletins 91-9.
ROGERS, ALEXANDER K.
2007 Effective Hydration Temperature of Obsidian: A Diffusion Theory Analysis of Time-Dependent Hydration Rates. *Journal of Archaeological Science*, *34*, pp. 656-665.
ROSENTHAL, JEFFREY S., KIM L. CARPENTER, and D. CRAIG YOUNG, JR.
2001 *Archaeological Survey of Target Area Buffer Zones in the Airport Lake, Baker, and George Ranges, Naval Air Weapons Station China Lake, Inyo and Kern Counties, California,* Far Western Anthropological Research Group, Inc., Davis.
ROSENTHAL, JEFFREY S. and JELMER W. EERKENS
2003 *The Archaeology of Coso Basin: Test Excavations at 28 Sites Located in the North Ranges Complex, NAWS China Lake,* Far Western Anthropological Research Group, Inc., Davis.
SUROVELL, TODD A. and P. JEFFREY BRANTINGHAM
2007 A Note on the Use of Temporal Frequency Distributions in Studies of Prehistoric Demography, *Journal of Archeaological Science, 34,* pp. 1868-1877.

TETRA TECH AND FAR WESTERN
1999 *Archaeological Sample Survey of the Inner Ranger, North Range Complex Naval Air Weapons Station, China Lake, California,* Tetra Tech, Inc., San Bernardino, California; and Far Western Anthropological Research Group, Inc., Davis, California.

THOMAS, DAVID H.
1972 Western Shoshone Ecology: Settlement Patterns and Beyond, in *Great Basin Cultural Ecology: A Symposium*, D. D. Fowler (ed.), Desert Research Institute Social Sciences and Humanities Publications 8, University of Nevada, Reno, pp. 135-153.
1973 Testing Steward's Great Basin Shoshonean Subsistence Patterns, *American Antiquity, 38,* pp. 155-176.
1988 *The Archaeology of Monitor Valley 3: Survey and Additional Excavations,* American Museum of Natural History, New York.

WARREN, CLAUDE N.
1984 The Desert Region, in *California Archaeology*, Michael J. Moratto (ed.), Academic Press, Orlando, pp. 339-430.
1986 *Early Holocene Cultural Adaptation in the Mojave Desert, California,* manuscript in possession of author.
2000 *The Age of Clovis Points at China Lake,* paper presented at the 27th Great Basin Anthropological Conference, Ogden, Utah.

WARREN, CLAUDE N. and ROBERT H. CRABTREE
1986 Prehistory of the Southwestern Area, in *Great Basin*, Warren L. d'Azevedo (ed.), Handbook of North American Indians 11, W. C. Sturtevant, general editor, Smithsonian Institution, Washington, D.C., pp. 183-193.

WARREN, CLAUDE N. and DELBERT L. TRUE
1961 The San Dieguito Complex and Its Place in California Prehistory, *University of California, Los Angeles, Archaeological Survey Annual Report*, *1960-1961*, pp. 246-338.

Direct reprint requests to:

Jelmer W. Eerkens, Ph.D.
Department of Anthropology
University of California, Davis
One Shields Avenue
Davis, CA 95616
e-mail: jweerkens@ucdavis.edu