PREHISTORIC ARCHAEOLOGICAL LANDSCAPES OF THE MCCAIN VALLEY-JACUMBA-OCOTILLO REGION

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Large-scale CRM studies provide an invaluable opportunity to approach the prehistoric archaeological record from a broad, landscape perspective. Recently, we have been using an assembled GIS site database to look at the McCain Valley-Jacumba-Ocotillo area as an archaeological landscape. We have attempted to tease out the aspects of the natural and human environments that underlay prehistoric decisions concerning the locations for sites, trails, and other features, the functions that would be performed at those locations, and the patterns of regional resource exploitation.

We were given the opportunity to look at the archaeology of eastern San Diego and western Imperial Counties from a broad archaeological landscape perspective. This involved synthesizing empirical archaeological data from both previous and ongoing investigations and examining patterned associations with elements of the natural world, including topography, hydrology, and vegetation (Laylander et al. 2014a, 2014b). These associations were used to test specific hypotheses about prehistoric land use and resource utilization, but also routes of travel, ceremonial associations, and much more.

This approach is one way of applying the concept of an archaeological landscape in order to reconstruct the complex interaction between prehistoric cultures and the natural world, complementing traditional cultural landscape investigations that address what is important for the prehistoric inhabitants' modern descendants. The present article specifically discusses a few of the issues and results that have emerged from applying the power of a geographic information system (GIS) to survey-level archaeological data.

STUDY METHODS

The study region amounts to just over 1,000 km^2, divided into eastern and western halves: the Ocotillo region and the Jacumba/McCain Valley region, respectively (Figure 1). The results discussed here primarily concern the western half, which lies west of the 1,500-ft. elevation contour on the eastern slope of the Peninsular Range. For this western region, we have created a database of records for 1,362 prehistoric archaeological sites and 194 prehistoric isolates (Figure 2).

The sites have been characterized in the GIS in two different ways. One approach was through the application of a typology of 12 site types (Table 1). The type definitions had been developed by Anna Noah (2012) in a regional context document for this region, and they were based in part on a site typology we used for the Chuckwalla Valley area of eastern Riverside County (Schaefer and Laylander 2011). The second approach was based on an array of 32 site attributes (Table 2). These attributes, also developed for the Chuckwalla Valley study, were initially derived from the resource attribute codes used with the California Department of Parks and Recreation's cultural resources primary record form, but they have been elaborated to include more details, as well as quantitative data.

Among other things, we have tested for associations between these archaeological site and isolate variables and variables of the region's natural landscape. As a foundation for addressing biases in the archaeological sample, we used the GIS to generate an array of 6,045 points that are aligned systematically at 300-m intervals throughout the Jacumba/McCain study area (Figure 3). This array served as a representative sample of the characteristics of the region as a whole. Additionally, to take into

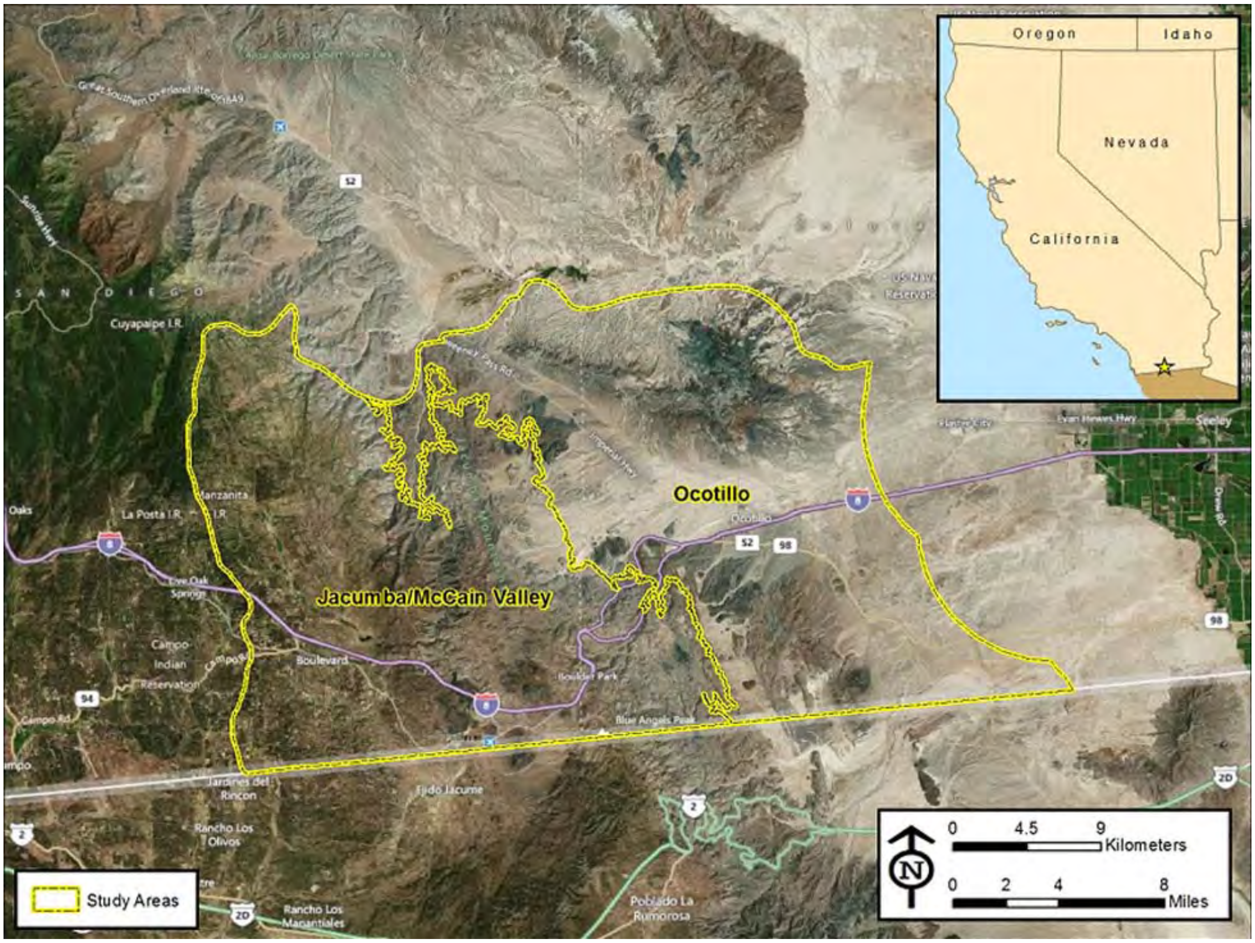


Figure 1. Map of the Jacumba/McCain Valley and Ocotillo study regions.

consideration the effects of uneven archaeological survey coverage in biasing the archaeological site and isolate samples, we distinguished the 1,378 points within the regional sample, amounting to 23 percent of the total, that fall within the boundaries of areas that had been addressed by reports listed in the National Archaeological Data Base (NADB).

The natural environmental variables that were included in the GIS were elevation, slope, aspect, geology, soils, hydrology, and vegetation. Hydrological settings were defined on the basis of distances of locations to mapped springs, perennial drainages, and third-order or higher drainages as defined in the Strahler (1957) classification system (Figure 4). For vegetation, data were consolidated from the application of the Holland (1986) classification system in San Diego County and the California Department of Fish and Wildlife (2014) classification in Imperial County. Those categories were grouped into five major habitat types and 29 vegetation units, reduced from an original 70 units (Table 3; Figure 5).

Statistical analysis was based primarily on Fisher's exact test. This was used to identify associations between archaeological site types or attributes and aspects of the natural environment that were too pronounced to be explicable as mere products of chance.

For purposes of comparison and to evaluate our results within a larger context, we also looked at the findings from several previous investigations that had provided views of landscape archaeology in parts of our study regions or in other nearby regions (Christenson 1990; Cook and Fulmer 1980; Gallegos

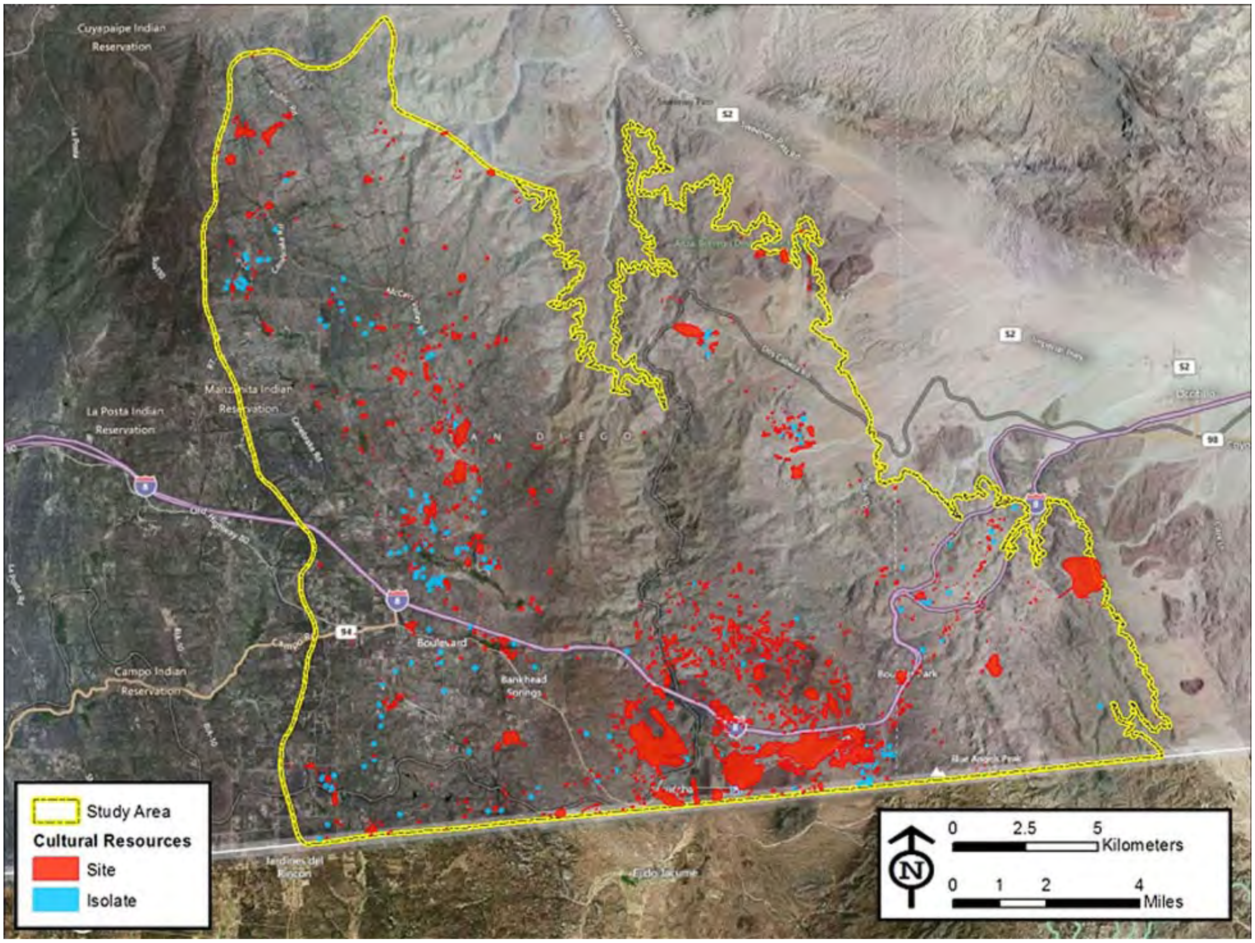


Figure 2. Prehistoric archaeological sites and isolates in the Jacumba/McCain Valley region.

Table 1. Archaeological site types used in the study.

CODE	TYPE DESIGNATION	COUNT OF SITES, BY REGION	
		JACUMBA/MCCAIN VALLEY	OCOTILLO
1	Other	11	12
2	Habitation Base	44	5
3	Temporary Camp	294	95
4	Travel Camp	--	1
5	Biotic Resource Extraction/Processing Site	374	155
6	Lithic Quarry and/or Workshop	54	217
7	Milling Implement Quarry and/or Production Site	--	1
8	Spiritual/Ceremonial Site	20	34
9	Trail	11	61
10	Cleared Circle/Rock Ring Site	7	48
11	Artifact Scatter	494	288
12	Pot Drop	53	40

Table 2. Site attribute codes and their values.

AP1 Unknown (This category is not used.)

AP2 Lithic Scatter (utilitarian stone artifacts, potentially including both tools and manufacturing debris, but excluding special items such as beads and ornaments)

- AP2-a Ground Stone (portable milling items, potentially including hand stones/manos, pestles, milling stones/metates/milling slabs/basins, mortars, and abraders, but excluding percussing stones and nonutilitarian ground artifacts such as ornaments and gaming pieces) – 0 = none observed; 1 = 1 item observed; 2 = 2-5 items observed; 3 = more than 5 items observed; 9 = present, but insufficient information for quantification.
- AP2-b Flaked Stone Tools (excluding cores, debitage, percussing tools, and nonutilitarian items such as ornaments) – 0 = none observed; 1 = 1 item observed; 2 = 2-5 items observed; 3 = more than 5 items observed; 9 = present, but insufficient information for quantification.
- AP2-c Percussing Stones (including hammer stones, choppers, pecking stones, and anvils) – 0 = none observed; 1 = 1 item observed; 2 = 2-5 items observed; 3 = more than 5 items observed; 9 = present, but insufficient information for quantification.
- AP2-d Lithic Waste (including cores, debitage, flakes, shatter, and chunks, but excluding items with evidence of use) – 0 = none observed; 1 = 1-25 items observed; 2 = 26-200 items observed; 3 = more than 200 items observed; 9 = present, but insufficient information for quantification.
- AP2-e Obsidian – 0 = none observed; 1 = 1-25 items observed; 2 = 26-200 items observed; 3 = more than 200 items observed; 9 = present, but insufficient information for quantification.

AP3 Ceramic Scatter (excluding special non-vessel ceramic items, such as pipes, anvils, figurines, miniature vessels, disks, toys, gaming pieces, etc.)

- AP3-a Sherd Count – 0 = none observed; 1 = 1-5 sherds observed; 2 = 6-50 sherds observed; 3 = more than 50 sherds observed; 9 = present, but insufficient information for quantification.
- AP3-b Minimum Number of Vessels – 0 = no vessel sherds observed; 1 = 1 vessel observed; 2 = 2-5 vessels observed; 3 = more than 5 vessels observed; 9 = insufficient information.
- AP3-c Wares Represented – 0 = no ceramics observed; 1 = brownware only observed; 2 = buffware only observed; 3 = both brownware and buffware observed; 9 = insufficient information.

AP4 Bedrock Milling (including mortars, cupules, basins, slicks, rubs, and anvil surfaces)

- AP4-a Bedrock Mortars – 0 = none observed; 1 = 1 mortar observed; 2 = 2-5 mortars observed; 3 = more than 5 mortars observed; 9 = present, but insufficient information for quantification.
- AP4-b Cupules – 0 = none observed; 1 = 1 cupule observed; 2 = 2-5 cupules observed; 3 = more than 5 cupules observed; 9 = present, but insufficient information for quantification.
- AP4-c Other Bedrock Milling (including basins, slicks, rubs, and anvil surfaces) – 0 = not present; 1 = 1 other milling element observed; 2 = 2-5 other milling elements observed; 3 = more than 5 other milling elements observed; 9 = present, but insufficient information for quantification.

AP5 Petroglyphs (including pecked, scratched, or engraved images on bedrock or boulders, but excluding cupules) – 0 = none observed; 1 = 1 panel observed; 2 = 2-5 panels observed; 3 = more than 5 panels observed; 9 = present, but insufficient information for quantification.

AP6 Pictographs (painted image on bedrock or boulders) – 0 = none observed; 1 = 1 panel observed; 2 = 2-5 panels observed; 3 = more than 5 panels observed; 9 = present, but insufficient information for quantification.

AP7 Architectural Features (including rock houses, rock walls, and hunting blinds, consisting of stacked boulders and/or cobbles, but excluding sleeping circles, rock alignments, rock rings, and cairns) – 0 = none observed; 1 = 1 feature observed; 2 = 2-5 features observed; 3 = more than 5 features observed; 9 = present, but insufficient information for quantification.

AP8 Cairns / Rock Features (excluding hearths, earth ovens, milling features, rock art, and architectural features)

- AP8-a Rock Alignments (including some geoglyphs, but excluding trail elements) – 0 = none observed; 1 = 1 feature observed; 2 = 2-5 features observed; 3 = more than 5 features observed; 9 = present, but insufficient information for quantification.
- AP8-b Cairns (including ducks) – 0 = none observed; 1 = 1 feature observed; 2 = 2-5 features observed; 3 = more than 5 features observed; 9 = present, but insufficient information for quantification.
- AP8-c Rock Rings (including some geoglyphs, but excluding earth ovens and architectural features) – 0 = none observed; 1 = 1 feature observed; 2 = 2-5 features observed; 3 = more than 5 features observed; 9 = present, but insufficient information for quantification.
- AP8-d Pavement Clearings (including “sleeping circles” and some geoglyphs, but excluding trails) – 0 = none observed; 1 = 1 feature observed; 2 = 2-5 features observed; 3 = more than 5 features observed; 9 = present, but insufficient information for quantification.

AP9 Burials (including inhumations and cremations, but excluding incidental human remains such as isolated teeth)

- AP9-a Inhumations – 0 = none observed; 1 = 1 feature observed; 2 = 2-5 features observed; 3 = more than 5 features observed; 9 = present, but insufficient information for quantification.
- AP9-b Cremations – 0 = none observed; 1 = 1 feature observed; 2 = 2-5 features observed; 3 = more than 5 features observed; 9 = present, but insufficient information for quantification.

Table 2. Site attribute codes and values (continued).

AP10 Caches – 0 = none observed; 1 = 1 feature observed; 2 = 2-5 features observed; 3 = more than 5 features observed; 9 = present, but insufficient information for quantification.

AP11 Hearths/Pits (including hearths, earth ovens, roasting pits, clean-outs from those features, and scattered fire-affected rocks) – 0 = none observed; 1 = 1 feature observed; 2 = 2-5 features observed; 3 = more than 5 features observed; 9 = present, but insufficient information for quantification.

AP12 Quarries (including locations where lithic raw materials were tested, procured, and potentially subject to initial manufacturing; including outcrops, surface scatters, and excavated pits; including material quarried for flaked lithic tools, ground stone, percussing stone, and nonutilitarian uses) – 0 = none observed; 1 = bedrock/boulder quarry observed; 2 = cobble/pebble quarry observed; 9 = present, but insufficient information for quantification.

AP13 Trails (excluding linear earthworks, walls, and rock alignments) – 0 = none observed; 1 = 1 or more trails observed.

AP14 Rock Shelters/Caves (including overhanging cliffs or boulders, volcanic tunnels, or solution cavities containing evidence of prehistoric human use; excluding small sheltered caches and rock shelter/caves that lack observed evidence of human use) – 0 = none observed; 1 = 1 feature observed; 2 = 2-5 features observed; 3 = more than 5 features observed; 9 = present, but insufficient information for quantification.

AP15 Habitation Debris (This category has not been used.)

AP16 Other

- AP16-a Vertebrate Faunal Remains (excluding human remains or materials interpreted as naturally present) – 0 = none observed; 1 = 1-25 specimens observed; 2 = 26-200 specimens observed; 3 = more than 200 specimens observed; 9 = present, but insufficient information for quantification.
- AP16-b Invertebrate Faunal Remains (including freshwater and marine remains, but excluding materials interpreted as naturally present) – 0 = none observed; 1 = 1 specimen observed; 2 = 2-5 specimens observed; 3 = more than 5 specimens observed; 9 = present, but insufficient information for quantification.
- AP16-c Floral Remains (excluding materials interpreted as naturally present) – 0 = none observed; 1 = unidentified charcoal only; 2 = identified specimens only; 3 = both unidentified charcoal and identified specimens; 9 = present, but insufficient information.
- AP16-d Midden Soil (including soil distinguished as anthropogenic on the basis of a distinctly darker color, greasy texture, or other characteristics, but excluding deposits distinguished as anthropogenic only the basis of the presence of artifacts or faunal remains) – 0 = none observed; 1 = midden soil observed.
- AP16-e Bone Artifacts (including tools such as awls, punches, flaking tools, and fishhooks, but excluding nonutilitarian items such as beads and ornaments) 0 = none observed; 1 = bone artifacts observed.
- AP16-f Special Items (including beads, ornaments, crystals, pipes, effigies, wooden and vegetal artifacts, shaft straighteners, pigments, etc.) – 0 = none observed; 1 = 1 specimen observed; 2 = 2-5 specimens observed; 3 = more than 5 specimens observed; 9 = present, but insufficient information for quantification.

1980; Graham 1981; Laylander and Christenson 1989; May 1980, 1987; Pasahow 1995; Shackley 1980; Tsunoda 2006; Wells 1977).

SOME RESULTS FROM THE GIS ANALYSIS

In this article, we discuss four issues emerging from the GIS analysis of prehistoric archaeological landscapes in the Jacumba/McCain Valley region. Those issues include the effectiveness of site types as categories for analyzing the landscape, the interpretive implications of isolated finds, the problem of chronology, and the interpretation of earth ovens.

Site Types vs. Site Attributes

The first issue concerns the effectiveness of analyzing archaeological landscapes in terms of site types, as against doing so on the basis of site attributes. The use of site types is a well-established archaeological convention, and it can provide a concise way to summarize functional differences between sites. However, there are several significant drawbacks to the reliance on site types in landscape studies, and the present GIS analysis helps to highlight two of those drawbacks.

One problem is the vagueness of the functional boundaries between the site types. For instance, the distinctions that have been drawn between habitation bases on the one hand and temporary camps on the other, or between temporary camps on the one hand and biotic resource extraction processing sites or artifact scatters on the other, have not been very sharply defined or consistently applied (Figure 6). There

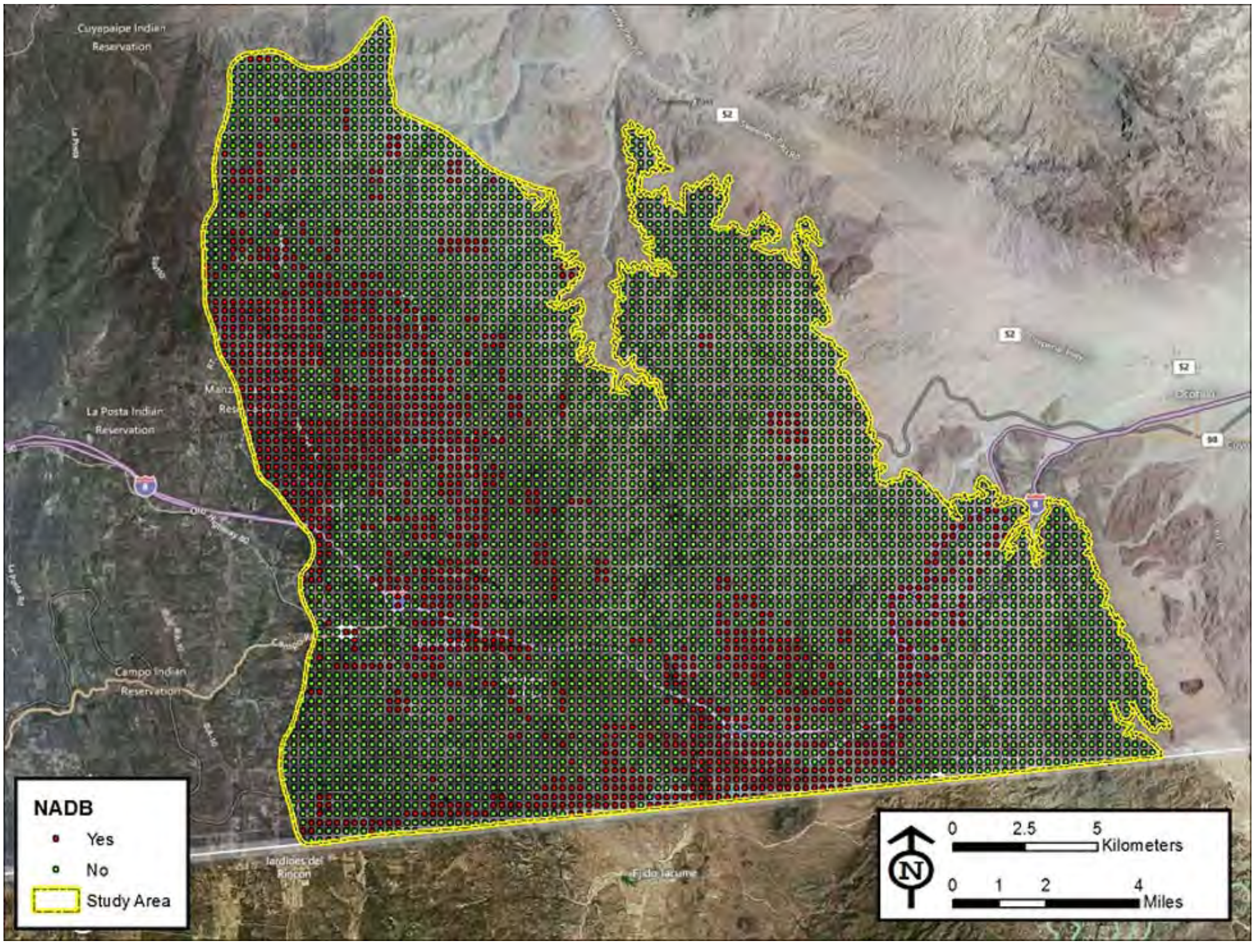


Figure 3. The environmental sample grid of 300-m-interval points in the study region, distinguishing locations that are within and outside of the areas address by NADB reports.

are average differences between the types in such defining attributes as site area, midden, features, and artifact diversity, but there is substantial overlap and no clear indication of bimodality in the distributions. This means that any perceived patterning in the geographical distributions of such site types is likely to be of questionable replicability, and such patterning may be of dubious interpretive significance.

The second problem with types concerns their inadequacy in representing the regional distribution of particular activity sets, which is often what we particularly want to discover in taking a landscape perspective. An attempt might be made to look at the distributions of such interpretively interesting features as rock art, cremations, lithic quarries, trails, cleared circles, and rock rings, using only the distributions of sites that have been assigned to the corresponding site types. However, the results of doing so would provide a very incomplete picture, and probably a biased one. In many cases, a substantial proportion of those features within the region occur within sites that have been assigned to other site types (Figure 7). For example, the GIS findings show that most of the sites recorded as having rock art are classified as habitation sites or temporary camps, and not as spatially discrete and specialized ceremonial sites.

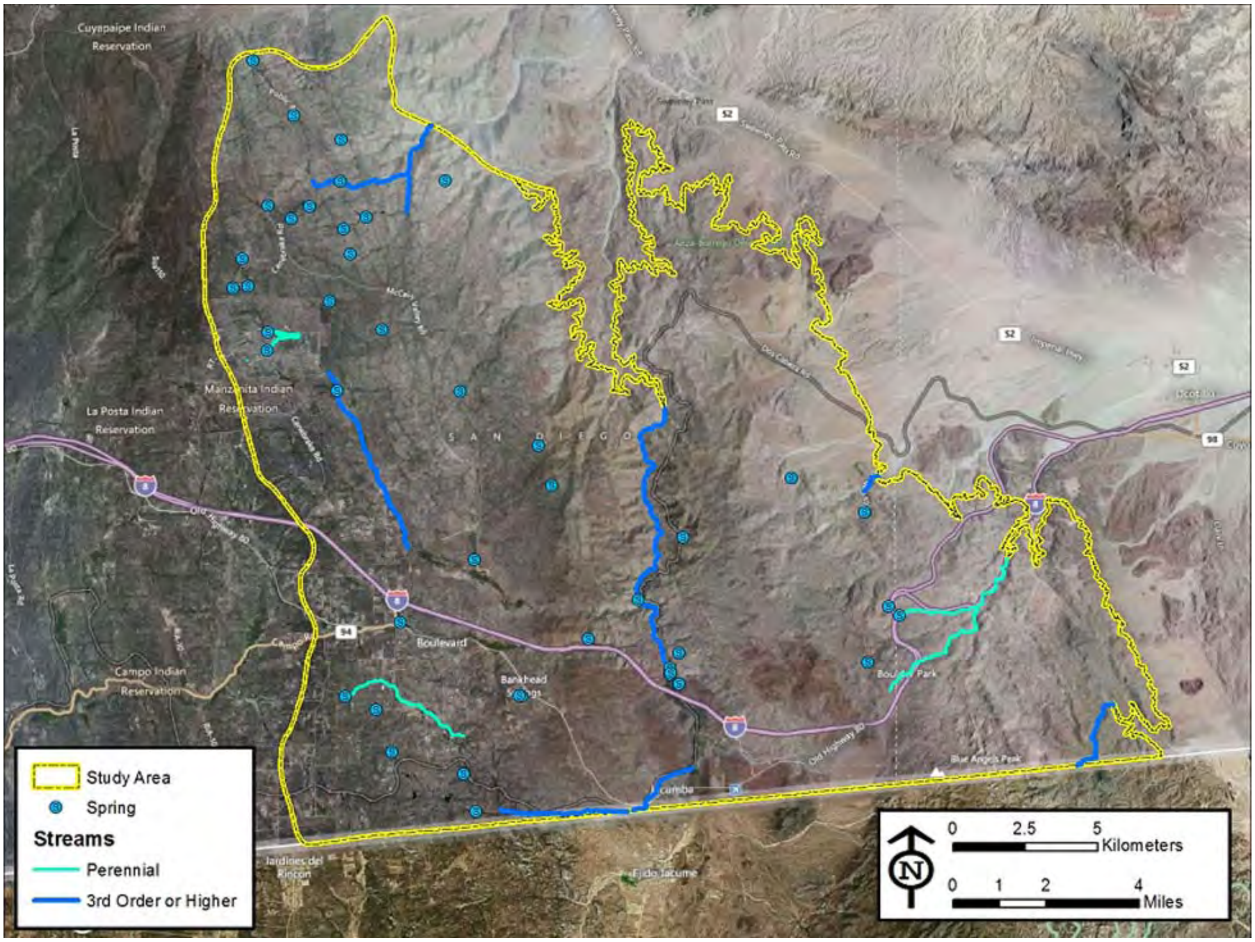


Figure 4. Map of springs, perennial streams, and third-order or higher drainages in the study region.

Table 3. Concordance of vegetation units.

Present Study	Oberbauer et al. (2008)	Keeler-Wolf et al. (1998)
Lower Sonoran Desert Habitats		
Active Desert Dunes	Active Desert Dunes (22100)	
Badlands/Mudhill Forbs	Badlands/Mudhill Forbs (25000)	Barren or Barren/Rock
Desert Saltbush Scrub	Desert Saltbush Scrub (36110) Wildflower Field (42300)	
Mixed Desert Scrub	Mixed Desert Scrub (63700)	
Sonoran Desert (Creosote Bush) Scrub	Sonoran Desert (Creosote Bush) Scrub (33000) Acacia Scrub (33700) Encelia Scrub (33600) Sonoran Desert Mixed Scrub (33200)	Creosote Desert Scrub White Bursage
Cheesebush (Burrowbush)		(Subgroup of Sonoran Desert Scrub)
Sonoran Mixed Woody Scrub	Sonoran Mixed Woody Scrub (33210)	
Sonoran Mixed Woody and Succulent Scrub	Sonoran Mixed Woody and Succulent Scrub (33220)	Desert Succulent Scrub
Southern Riparian Scrub	Southern Riparian Scrub (63000) Mule Fat Scrub (63310) Great Valley Willow Scrub (63410) Tamarisk Scrub (63810)	Colorado Desert Wash Scrub Desert Wash Smoketree-Desert Willow

PRESENT STUDY	OBERBAUER ET AL. (2008)	KEELER-WOLF ET AL. (1998)
Desert Dry Wash Woodland	Sonoran Wash Scrub (33230) Desert Dry Wash Woodland (62200)	
Mesquite Bosque	Mesquite Bosque (61820)	Mesquite
Desert Fan Palm Oasis Woodland	Desert Fan Palm Oasis Woodland (62300)	
Upper Sonoran Desert Habitats		
Mojavean Desert Scrub	Mojavean Desert Scrub (34000) Blackbrush Scrub (34300)	
Pinyon and Juniper Woodland	Pinyon and Juniper Woodland (72000) Peninsular Pinyon and Juniper Woodlands (72300) Peninsular Juniper Woodland and Scrub (72320)	California Juniper Juniper
Sagebrush Scrub	Sagebrush Scrub (35200) Big Sagebrush Scrub (35210)	
Upper Sonoran Subshrub Scrub	Upper Sonoran Subshrub Scrub (39000)	
Chaparral Habitats		
Upper Sonoran Ceanothus Chaparral	Upper Sonoran Ceanothus Chaparral (37800) Interior Live Oak Chaparral (37A00)	
Upper Sonoran Mixed Chaparral	Upper Sonoran Mixed Chaparral (37100) Granitic Northern Mixed Chaparral (37130) Northern Mixed Chaparral (37131)	Mixed Chaparral Montane Manzanita Chaparral
Chamise Chaparral	Chamise Chaparral (37200)	
Granitic Chamise Chaparral	Granitic Chamise Chaparral (37210)	
Red Shank Chaparral	Red Shank Chaparral (37300)	
Semi-Desert Chaparral	Semi-Desert Chaparral (37400)	
Montane Habitats		
Cismontane Alkali Marsh	Alkali Seep (45320)	Cismontane Alkali Marsh
Cismontane Woodland	Cismontane Woodland (71000) Coast Live Oak Woodland (71160) Dense Coast Live Oak Woodland (71162) Open Coast Live Oak Woodland (71161) Coast Live Oak Forest (81310)	
Coastal Scrub	Coastal Scrub (32000) Riversidian Upland Sage Scrub (32710) Flat-topped Buckwheat (32800)	
Wetlands and Meadows	Wetlands and Meadows (45000) Montane Meadow (45100) Freshwater Seep (45400) Freshwater Marsh (52400)	Freshwater
Riparian Forests	Riparian Forests (61300) Southern Coast Live Oak Riparian Forest (61310) Southern Arroyo Willow Riparian Forest (61320)	
Valley Foothill and Grassland	Valley Foothill and Grassland (42000)	
Disturbed		
Disturbed Habitat	Disturbed Habitat (11000) Urban Developed (12000) Field/Pasture (18310) Non-native Grassland (42200) Non-Vegetated Channel, Floodway, Lakeshore Fringe (64200) Eucalyptus Woodland (79100)	Urban

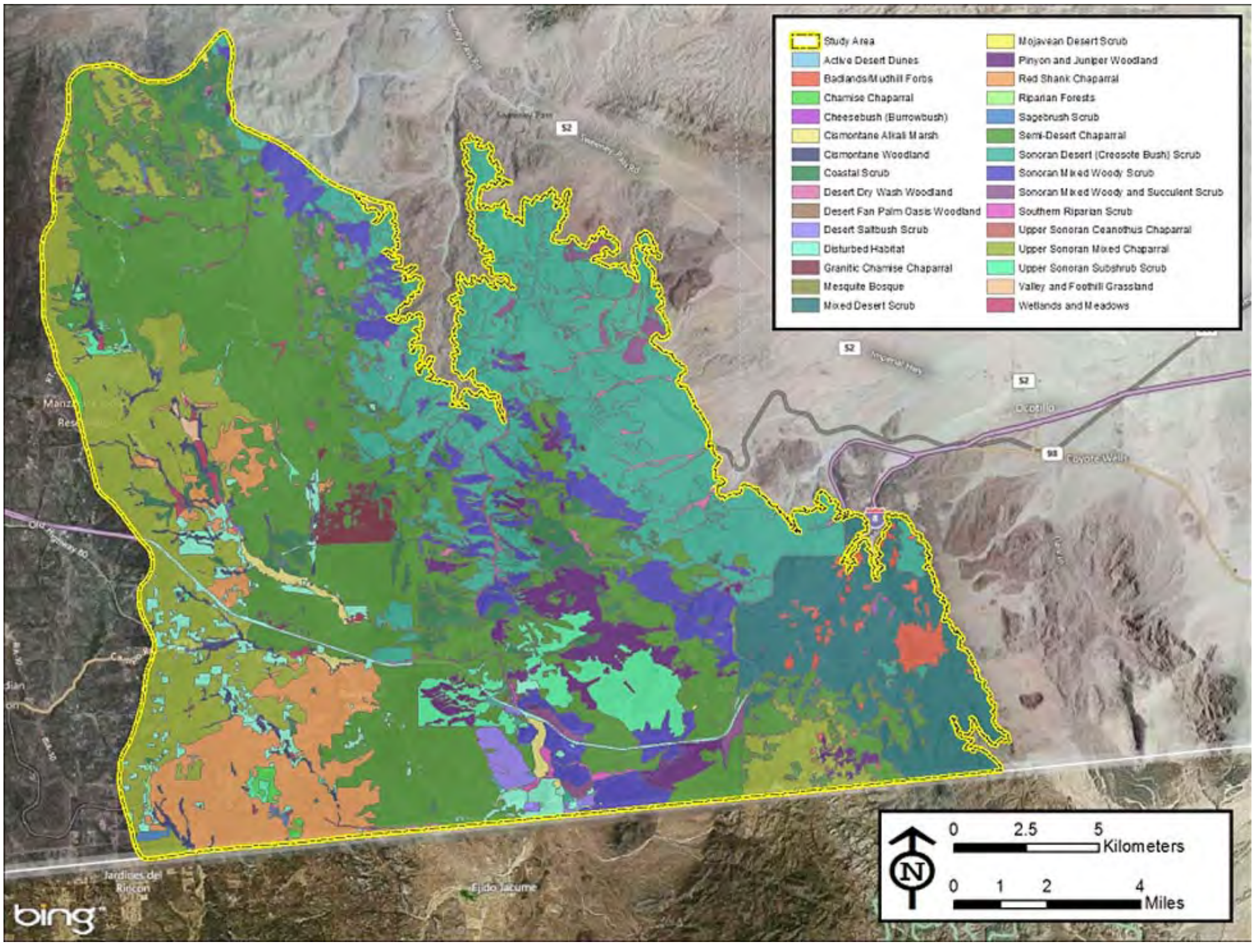


Figure 5. Map of vegetation communities in the study region.

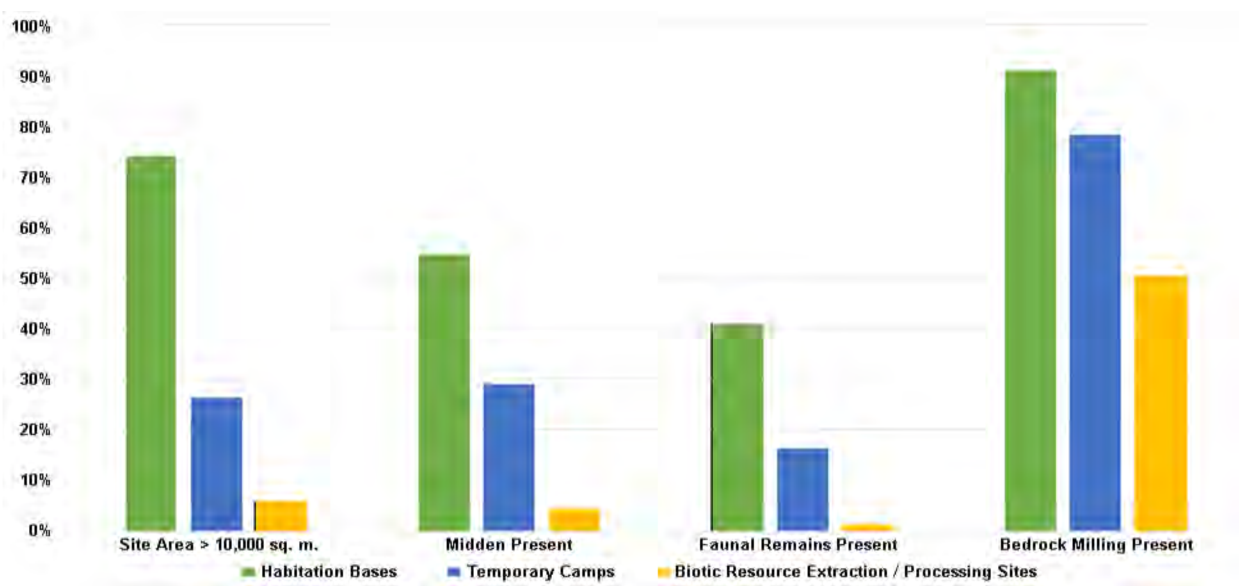


Figure 6. Overlapping attributes of habitation bases, temporary camps, and biotic resource extraction/ processing sites.

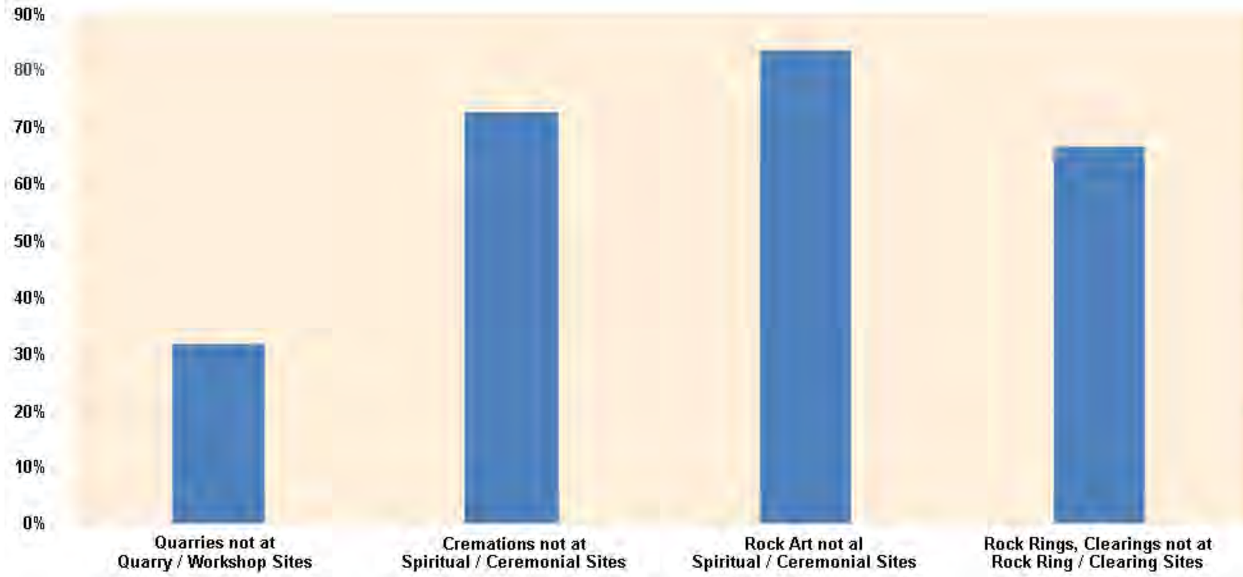


Figure 7. The proportions of special features reported at non-distinctive site types.

Isolates

A second issue concerns the role of isolated finds in the interpretation of prehistoric archaeological landscapes. Does the effort that has gone into the documentation and archiving of information on non-diagnostic isolated finds shed any significant light on prehistoric patterns of activity?

One way to address this question is to consider whether the environmental settings in which isolates have been recorded differ significantly from the characteristics of merely random points. When the region as a whole is considered, the answer is that there are statistically significant differences between the settings of the 194 isolates and the 6,045 systematic sample points in the Jacumba/McCain Valley region. However, when isolate locations are compared with the 1,378 points within those portions of the study region that have been addressed by NADB reports, the characteristics of isolate locations are found to substantially match the characteristics of the random points, which have been addressed by systematic CRM archaeological surveys. At least at this level of analysis, the documentation of isolates does not appear to provide significant information about prehistoric archaeological landscapes.

Chronology

In excess of 10,000 years of prehistory is documented in the study region through radiocarbon dating. However, for a landscape analysis, a large proportion of the Jacumba-McCain Valley sites cannot be directly dated on the basis of what is primarily survey-level information. Radiocarbon dates are not available from the great majority of the sites, and most chronologically diagnostic artifacts, such as projectile points and shell beads, do not occur commonly enough to provide much help in placing the sites chronologically.

The one notable exception is pottery. This material is very common, being reported from 52 percent of the sites in the study region (Figure 8a). It is also chronologically diagnostic, at least on the gross level of distinctions between pre-ceramic and ceramic periods, perhaps corresponding to before and after ca. A.D. 800 (cf. Griset 1996; Waters 198...). The presence of pottery at a site proves that a ceramic-period component is present at the site. It does not necessarily say anything about whether there is or is not an earlier component as well. But can the absence of pottery from some sites be used to say something about archaeological landscapes during the earlier, pre-ceramic period?

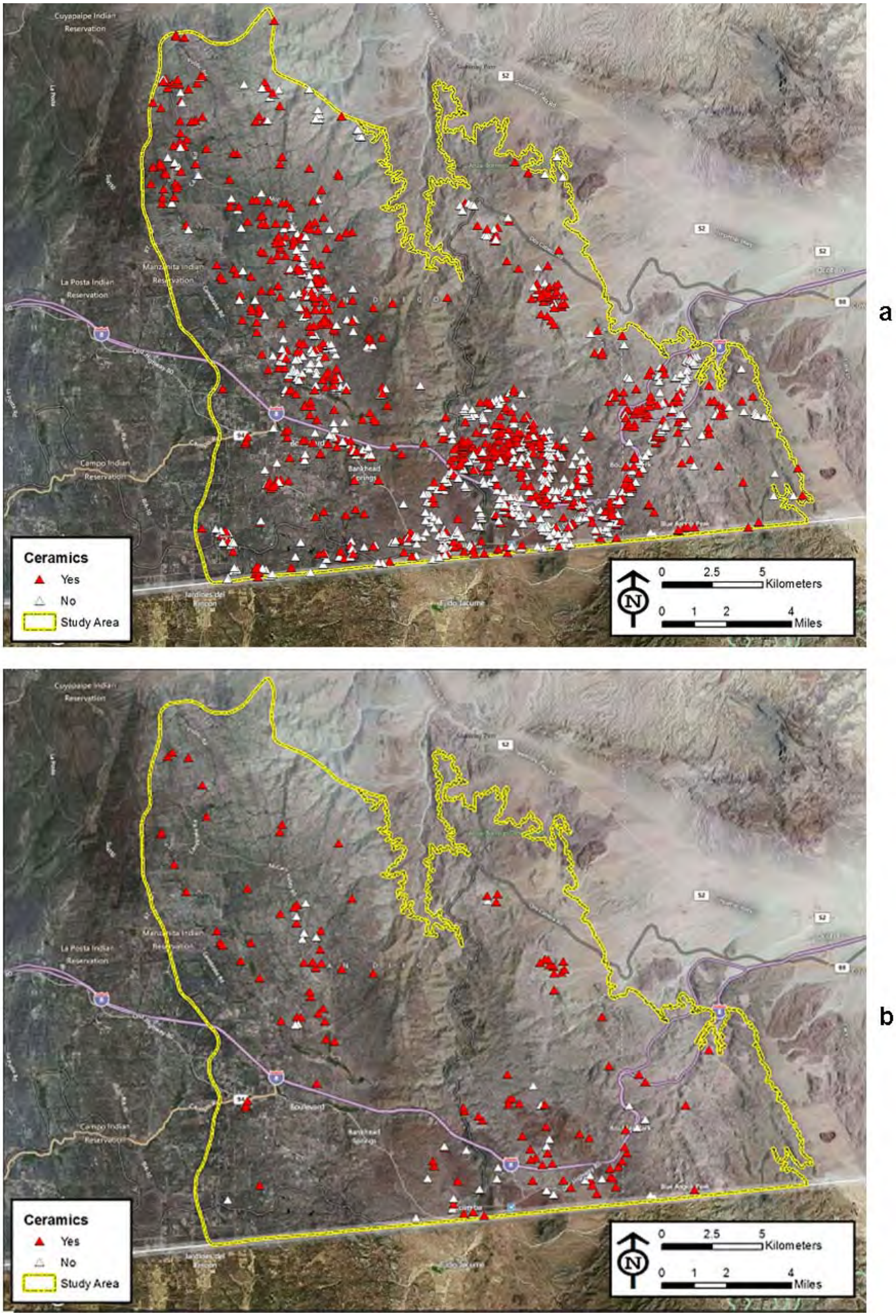
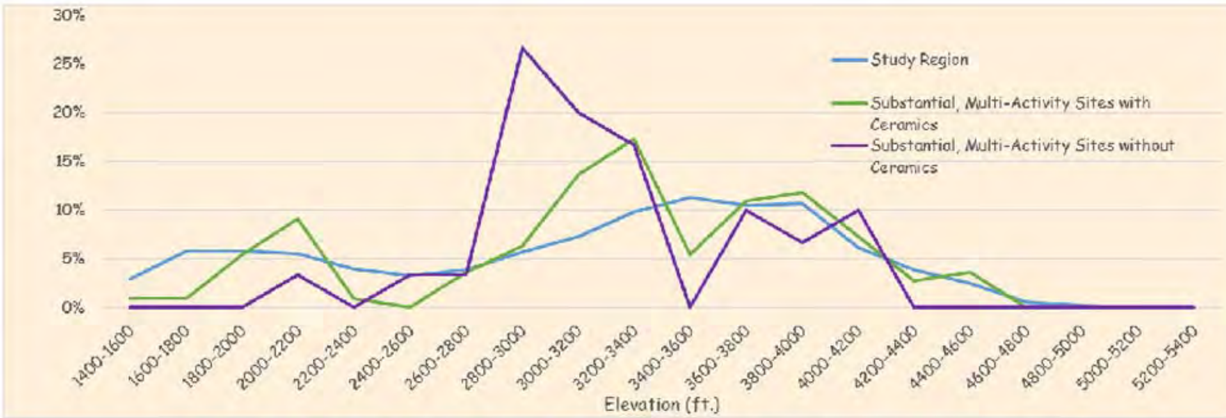


Figure 8. Map showing the presence or absence of pottery (a) at all sites in the study region, and (b) at substantial, multi-activity sites.



Fisher's Exact Test Results for Selected Comparisons between Substantial, Multi-Activity Sites with and without Ceramics

Significant Contrast = < 0.0500

Elevation:	0.3050
Slope:	0.8311
Aspect:	0.4852
Distance to Water:	0.4307

Figure 9. Statistical comparisons of substantial, multi-activity sites with and without pottery.

To test this possibility, we defined a class of substantial, multi-activity sites. This category was based on site records that reported the presence of two attributes: bedrock or portable milling, and lithic scatters including more than 25 pieces of lithic waste. These were considered to be the kinds of sites where there was a reasonably strong likelihood that pottery would have been deposited and would have been recorded archaeologically, if the sites were in use during the ceramic period. That expectation would not be expected to hold true in every individual case, but it may be valid as a statistical generalization. Accordingly, we distinguished two sets of these substantial, multi-activity sites: those with pottery (n = 110), and those lacking pottery (n = 30) (Figure 8b).

If this chronological distinction was valid, it might also be true that there were differences in the archaeological landscapes during pre-ceramic and ceramic periods. Such differences might be rooted in such things as natural changes in climate, hydrology, and vegetation; changes in the available technologies, such as the bow and arrow; and changes in adaptive strategies, such as intensification measures of various sorts.

We looked for statistically significant differences in the associations between these two subsets of sites and environmental variables in the GIS. In comparisons between site types or sets of other attributes, we found many statistically significant contrasts. However, the substantial, multi-activity sites with pottery and those without pottery were found to be very closely similar to each other in their environmental associations (Figure 9).

There may be two explanations to account for this lack of differences between the hypothetically pre-ceramic and ceramic sites. One is that the categories as they were defined here were not very successful in separating out chronologically distinct sets of sites. A second possible explanation is that the prehistoric uses of the regional landscape during the pre-ceramic and ceramic periods were closely similar to each other.

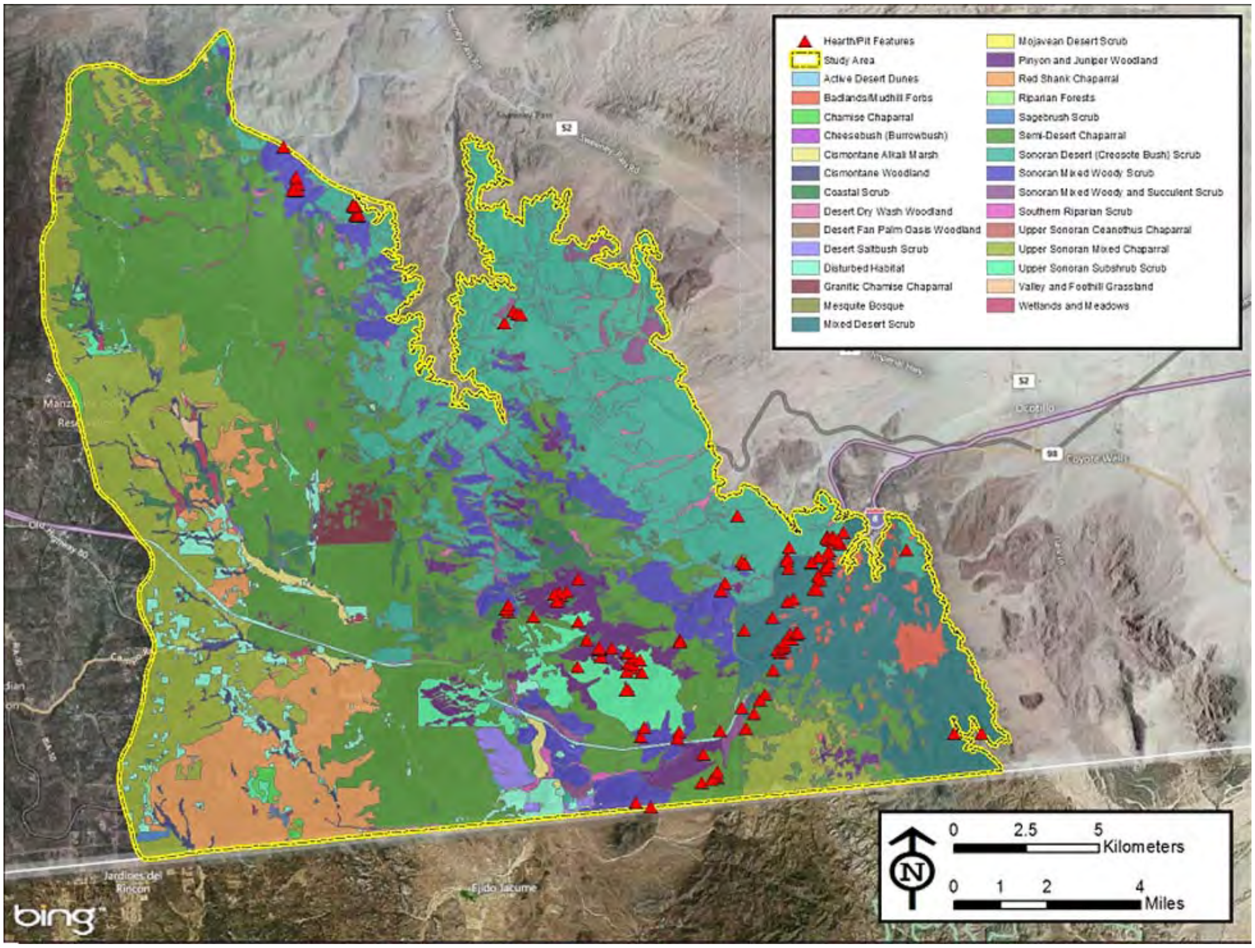


Figure 10. Map of the selected biotic resource extraction sites with hearth/pit features in the study region.

Earth Ovens

A final issue addressed here concerns the functions of prehistoric earth ovens or hot rock cookery features, as suggested by their association with vegetative communities. One specific function for hearth/pit features is suggested by the ethnographic record as having been particularly important in this region: the pit-roasting of agave hearts (e.g., Castetter et al. 1938).

A total of 249 sites in the study region have been reported as containing hearths/pit features. Two factors may help in distinguishing features that may have been used for agave roasting from hearths and pits that were used for other purposes: a scarcity of associated artifacts or features, and the occurrence of the hearth/pit features within modern vegetation units in which agave is a prominent constituent.

Of the sites containing hearth/pit features, 195 were typed as specialized biotic resource extraction/processing sites. Excluding sites that also contain milling features (n = 22) and/or more than 25 pieces of flaked lithic wastes (n = 20), it may be hypothesized that a large proportion of the remaining 157 sites were agave roasting sites.

Figure 10 shows the distribution of these sites in relation to vegetation units. Higher frequencies of the sites than would be statistically expected were found at locations within mixed desert scrub, Sonoran desert (creosote bush) scrub, upper Sonoran subshrub scrub, Sonoran mixed woody scrub, and pinyon/juniper woodland (Table 4). Agave is a notable constituent in all of these units except creosote bush scrub and, in most cases, pinyon/juniper woodland.

Table 4. Percentages of the selected hearth/pit sites and of other locations within vegetation units.

VEGETATION UNIT	SELECTED HEARTH/PIT SITES (N = 157)	ALL SITES (N = 1,362)	REGIONAL SAMPLE POINTS	NADB AREA SAMPLE POINTS
Mixed Desert Scrub	22.3	10.4	7.1	3.3
Sonoran Desert (Creosote Bush) Scrub	19.8	8.4	19.0	4.6
Upper Sonoran Subshrub Scrub	17.2	9.1	2.9	4.4
Semi-Desert Chaparral	14.0	35.5	40.1	36.7
Sonoran Mixed Woody Scrub	12.7	7.3	5.9	5.2
Pinyon/Juniper Woodland	10.2	7.8	2.9	3.4
Coastal Scrub	2.6	2.4	4.0	2.3
Sonoran Mixed Woody and Succulent Scrub	0.6	1.8	0.7	0.9
Disturbed Habitat	0.6	2.0	2.7	4.0

A review of 115 archaeological records from biotic resource extraction/processing sites with earth ovens but in GIS-identified Sonoran desert (creosote scrub) scrub habitat indicates that a large number are located in the ecotone between this habitat and the Sonoran mixed woody and succulent scrub habitat where agave abounds. In fact, agave occurs in patches at this elevation between 800 and 1,000 ft. on the San Diego-Imperial county line, with the plant recorded at some sites but not at nearby sites. At some locations, agave may have been present in prehistoric times but does not occur at present, either due to environmental change, natural species patchiness, or human-induced extirpation. The GIS mapping, however, assigned this area to creosote scrub habitat. At some sites, barrel and cholla cactus occurred without agave, and it may be that the cactus fruit was processed in earth ovens. At other lower elevation sites, especially near Coyote Wash and Coyote Wells, the earth ovens occur in definite creosote scrub habitat with abundant mesquite, another plant whose blossoms or beans might be processed in earth ovens.

CONCLUSION

This article has been able to present only a few preliminary results from the regional syntheses. However, we believe that GIS analysis of prehistoric archaeological landscapes such as those in the Jacumba/McCain and Ocotillo regions will increasingly become interesting and productive approaches to regional archaeological synthesis.

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