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Journal of California and Great Basin Anthropology

Title

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Permalink

<https://escholarship.org/uc/item/36z4d465>

Journal

Journal of California and Great Basin Anthropology, 16(1)

ISSN

0191-3557

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Publication Date

1994-07-01

Peer reviewed

The Challenge of Archaeological Research in the Colorado Desert: Recent Approaches and Discoveries

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Colorado Desert archaeological studies over the last 20 years are reviewed to discuss how some of the major research issues pertaining to the region have, or have not, been successfully addressed. Regional culture history and adaptation to environmental change have been the particular focus of many studies that are not widely known outside the local CRM community. Among the key questions are defining an early man phase of occupation, characterizing the Paleoindian and Archaic period occupations, and interpreting Late Prehistoric adaptations to the infilling and final recession of Lake Cahuilla.

HUNTER-GATHERER adaptations to one of the most arid portions of the southwestern desert region have been the subject of extensive archaeological investigations over the last 65 years. Several key research issues involving chronology, adaptations to environmental diversity and change, and material culture studies have been substantially resolved or brought into clearer focus. Among the issues discussed in this paper are the resolution of alleged pre-Paleoindian dates, excavations of rare Archaic Period sites, and evidence for the diversity of adaptive patterns and chronology of occupation during the successive infillings and final desiccation of Lake Cahuilla. As the title implies, the goal here is to highlight some of the advances in and frustrations of doing Colorado Desert archaeology.

The Colorado Desert is actually the northwesternmost portion of the Sonoran Desert Life Zone that extends east into Arizona and Sonora, and south into Baja California (Fig. 1). This 10,000-square-mile area is bordered by the Colorado River to the east, the Gulf of California to the south, the Peninsular Range and Pacific Coastal Plain to the west, and the

Mojave Desert to the north (Jaeger 1965). It is a mistake, however, to view these boundaries as absolute and thereby overlook the considerable cultural ties to each of these neighboring areas. Bisecting the region is the Salton Trough, a great, tectonically active, alluviated rift valley that pushes elevations down to over 82 m. (273 ft.) below sea level. The San Andreas fault runs along the northeast side of the trough and is partly obscured by the great Imperial or Algodones dunes (i.e. the Sand Hills). On the east side, the Chocolate Mountains and related chains form a low-lying basin-and-range province. On the west side, the sharp escarpments of the San Jacinto, Santa Rosa, and Laguna mountains rise to between 2,100 and 3,000 m. (7,000 to 10,000 ft.) above the desert floor and provide the closest access to upper Sonoran and mountain habitats.

Simply put, two dominant environmental elements characterize this low desert area: heat and aridity. The rainshadow effect of the Peninsular Range keeps all but the largest Pacific storms out of the area, and the effects of the Sonoran summer monsoon system are minimal. Due to low elevation and aridity, this

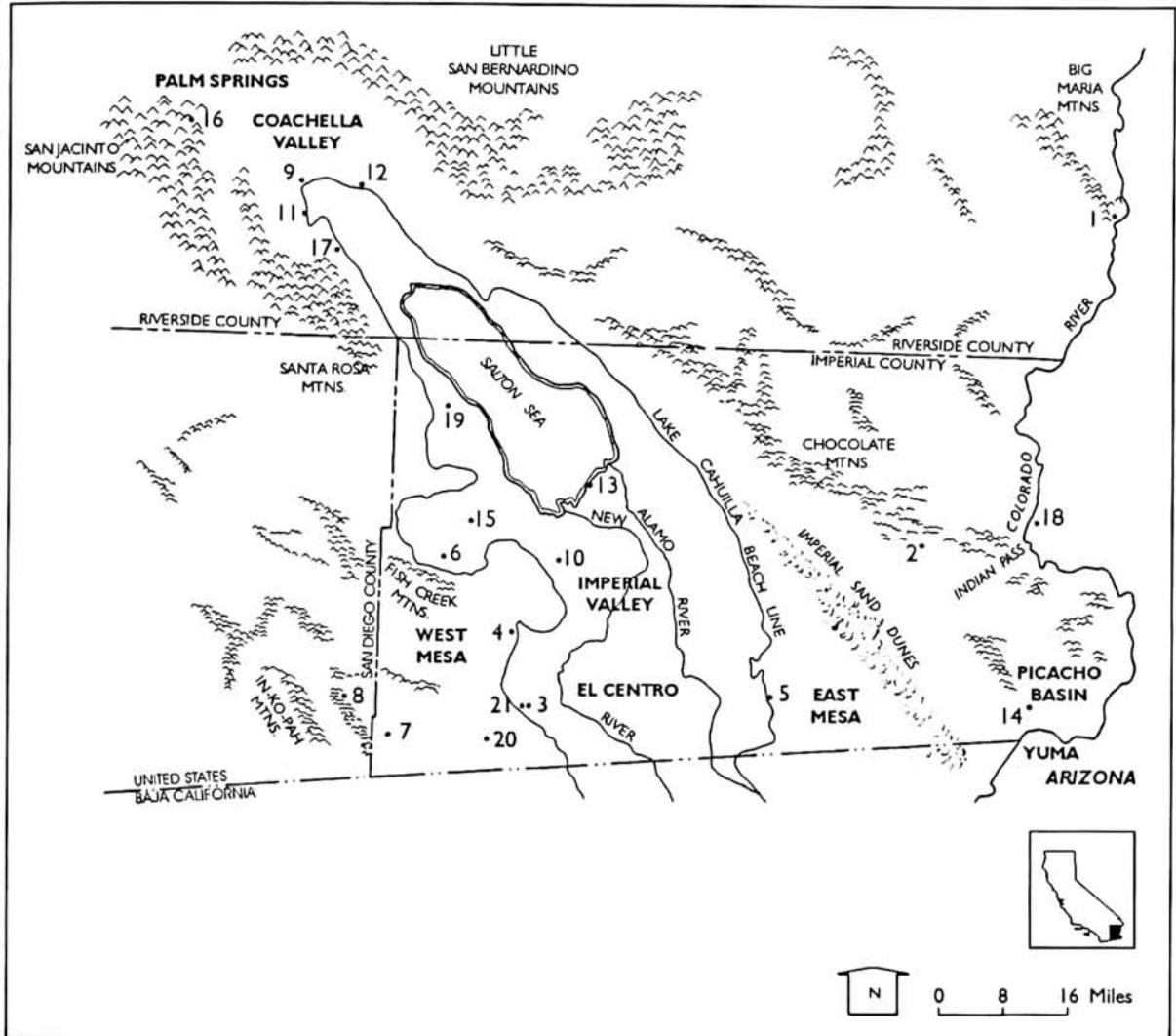


Fig. 1. The Colorado Desert area, with sites discussed in the text: 1) Blyth geoglyphs (Dorn et al. 1992); 2) Chocolate Mountains quarry complex (Schaefer 1986b; Shackley 1988); 3) Dunaway Road site (Schaefer 1986a); 4) Dry Lake (Eighmey and Cheever 1992); 5) East Mesa complex (von Werlhof et al. 1979; Gallegos 1980, 1986; von Werlhof and McNitt 1980); 6) Fish Creek (Clewlow et al. 1992); 7) In-ko-pah Gorge complex (Shackley 1984); 8) Indian Hill rockshelter (Wilke et al. 1986; McDonald 1992); 9) Indian Wells complex (Everson 1992); 10) IT site (Phillips 1982); 11) La Quinta site complex (Sutton and Wilke 1988; Arkush 1990; Yohe 1990; Sutton 1993); 12) Myoma Dunes (Wilke 1978); 13) Obsidian Butte (Dominici 1984; Hughes and True 1985; Hughes 1986); 14) Picacho Basin site complex (Pendleton 1984); 15) San Sebastian marsh complex (von Werlhof 1980; Schaefer et al. 1987); 16) Tahquitz Canyon (Schaefer 1992a, 1992b); 17) Toro Canyon (Ferraro and Schaefer 1990; Schaefer et al. 1993); 18) Trigo Mountains cache (Shelley and Altschul 1989); 19) Truckhaven burial (Taylor et al. 1985); 20) Yuha burial (Childers 1974); 21) Yuha Wash site (Shackley 1984).

is a zone dominated by creosote-bursage scrub and desert riparian habitats that would support

only limited human existence were it not for the life-sustaining waters of the Colorado River, the

intermittent New River and more reliable Alamo River that run through the Imperial Valley, seasonal streams that run out of the Peninsular Range, a number of widely dispersed springs, palm oases, and seasonal tanks, and some ephemeral water sources. This area bears a set of cultural contexts and research domains that were first promulgated by Malcolm Rogers (1939, 1945, 1958, 1966) and in subsequent overviews of the area (Weide and Barker 1974; Crabtree 1981; McGuire and Schiffer 1982; Warren 1984). More than 10,000 years of cultural development are represented in the prehistoric remains of this region, defined by the Paleoindian, Archaic, Late Prehistoric, and Ethnohistoric periods.

Evidence of Pleistocene environmental conditions are very limited. Pollen-bearing stratified deposits from caves or lake beds are not as common or well studied in the Colorado Desert as they are in the Great Basin, where most climatic reconstructions are based. Very recent data, however, indicate that the area was already approaching modern desert conditions by the beginning of the Holocene and the advent of the earliest well-documented cultural remains. Cole (1986) examined radiocarbon-dated *Neotoma* midden deposits along the lower Colorado and Gila rivers at elevations below 30 m. (900 ft.). He found that creosote scrub habitat was established here as early as 14,000 years ago. Additional evidence was derived in 1989 from investigation of a rockshelter cache and *Neotoma* deposits in the Trigo Mountains (Shelley and Altschul 1989). Here, lower Sonoran scrub pollen and macrofloral remains extended back to at least 11,000 years ago. The Trigo Mountain study also demonstrated the presence of important mesquite thickets on the margins of the Colorado River where today none exist. Lower elevations appear to have provided a refugium for Lower Sonoran desert scrub vegetation during the Late Pleistocene. Evidence for an extremely dry Altithermal period is lacking for

the Lower Colorado River. The most important environmental fluctuations for human subsistence therefore centered on precipitation in the Rocky Mountains and Colorado Plateau that produced the life-giving spring floods of the Colorado River. It is thus clear that the prehistoric occupants of the Colorado Desert were confronted with broadly similar climatic and vegetative regimes, as is presently found. What cannot as yet be determined is the degree of microenvironmental variability and the timing of short-term fluctuations in the Prehistoric Period that may have influenced hunter-gatherer settlement and subsistence strategies.

EARLY MAN: A NON-PERIOD?

The issue of a pre-Paleoindian occupation in the Colorado Desert has been largely laid to rest. Very suspect dates of over 23,000 years B.P. were obtained in the 1970s from radiocarbon-dated caliche at the Yuha inhumation and aspartic acid racemization dated bone from the Truckhaven inhumation. Such dates were used by Childers (1974, 1977, 1980) to identify a dubious early man lithic assemblage in the Yuha Desert. Begole (1973, 1981) also attempted to apply Rogers' (1939) Malpais Period construct to similar varnished and crude stone stools, rock rings, and other features in the Anza-Borrego Desert. Begole (1973, 1981) asserted dates of 32,000 to 70,000 years B.P. In a classic case of cloak-and-dagger, before more reliable dating methods could be applied, the Yuha skeleton mysteriously vanished and has never been recovered, despite an FBI investigation. The thieves missed some small fragments, however, that were eventually dated by accelerator mass spectrometry (Taylor et al. 1985). The Yuha inhumation was firmly placed in the Archaic Period at 1,650 to 3,850 years old. The Truckhaven inhumation was found to be less than 500 years old (possibly in error). Numerous other alleged pre-Paleoindian burials from coastal California were similarly re-dated, indicating

that the aspartic acid racimization dating technique on bone is inappropriate or requires new calibration formulae (Bada 1985; Taylor et al. 1985; Taylor 1991). The entire concept of early man in the Colorado Desert thereby remains extremely speculative.

PALEOINDIAN PERIOD: THE NEED FOR CHRONOLOGICAL CONTROL

Efforts to understand the nature of Paleoindian Period occupation, defined in this region as the San Dieguito cultural pattern, has been thwarted by a lack of diagnostic artifacts and reliable dates. Most sites assigned to this period consist of cleared circles, rock rings, some geoglyph types, and heavily varnished simple stone tools (Rogers 1966). All occur on the surface of stabilized desert pavements that offer few opportunities to establish either relative or absolute dates. For stratified Paleoindian deposits, one must go to either coastal San Diego County (Warren 1966; Carrico et al. 1991) or Ventana Cave in Arizona (Haury 1950). To help resolve these basic dating issues, Colorado Desert archaeologists have anxiously observed over ten years of research on cation ratio dating of desert varnish (Dorn and Oberlander 1981; Dorn 1982; Dorn et al. 1986; Watchman 1992). Accelerator radiocarbon dating of minute amounts of organic matter extracted from under the varnish may help to calibrate the cation ratios. The technique was recently applied to the famous anthropomorph and zoomorph Blythe geoglyphs and resulted in plausible dates between $1,060 \pm 65$ and $1,195 \pm 65$ years B.P. (Dorn et al. 1992). Although some recent results in the Mojave Desert and Australia seem promising, the technique is still fraught with problems (Bamforth and Dorn 1988; Nobbs and Dorn 1988; Dorn et al. 1992; Bierman and Gillespie 1994). However, it will continue to be applied at geoglyph sites in the Colorado Desert (Jay von Werlhof, personal communication 1993),

and when extended to trails, cleared circles, rock rings, and lithic scatters on desert pavements, may open a whole new chapter in Colorado Desert research.

Malcolm Rogers (1966) postulated three chronological phases of the San Dieguito Complex in the Central Aspect, that is, the area of the Colorado and Mojave Deserts, and the western Great Basin. Each phase is characterized by the addition of new, more sophisticated tool types in the already existing tool kit. No one, however, has yet substantiated the validity of Rogers' phase designations as chronologically successive changes in the tool kit of a long-lived culture. Begole (1973, 1981) applied Rogers' typology to date rock rings and cleared circles in the Anza Borrego Desert based on associated tools and degree of varnish, but he provided no objective, independent, corroborative evidence, and lengthened the dates of each phase until the San Diego I extended back to 22,000 to 32,000 years B.P. Indeed, these phase distinctions may likely be due to economic specialization at specific site loci, or even due to sampling error whereby later phase diagnostic artifact types are not represented in specific archaeological collections.

For now, the San Dieguito cultural pattern can best be defined as a hunter-gatherer adaptation based on small, mobile bands exploiting small and large game and collecting seasonally available wild plants. The absence of milling equipment from the complex has been seen as reflecting a lack of hard nuts and seeds in the diet, as well as a cultural marker separating the San Dieguito Culture from the later Desert Culture (Rogers 1966; Warren 1967; Moratto 1984). Portable manos and metates are increasingly recognized at coastal sites that radiocarbon date in excess of 8,000 B.P., and in association with late San Dieguito complex assemblages (Kaldenberg 1976; Bull 1984; Gallegos 1987). With regard to the Colorado Desert, Pendleton (1984:68-74) noted that most ethnographically

documented mortars for processing hard seeds, honey mesquite, and screwbeans were made of wood and do not preserve well in the archaeological record, although pestles and manos should be preserved.

Numerous cultural resource management (CRM)-generated settlement pattern studies also indicate some basic elements of what is now imprecisely recognized as the San Dieguito Culture. Sites are characteristically located on flat areas but the largest aggregations occur on mesas and terraces overlooking larger washes. These are zones where a variety of plant and animal resources could be located and where water would at least be seasonally available. Regional climatic reconstructions would cause one to assume that at the beginning of the Holocene, these areas were somewhat more suitable for habitation, although the *Neotoma* midden studies demonstrate that the early San Dieguito inhabitants were already confronted with arid conditions on the Lower Colorado River, although to what extent we do not know.

Pendleton (1984) made a case, based on ethnographic analogy from Colorado River-based tribes, that the San Dieguito occupation in the Colorado Desert was focused on the river floodplain. Surrounding desert areas may have been used only to a limited degree for special resource exploitation within a foraging radius of logistically organized collecting groups. She tested her model with one of the largest investigated arrays of sites and data sets in the Picacho Basin of southeastern Imperial County. Among her findings was the fact that the many cleared circles recorded during the survey phase of the project bear no cultural associations or patterning and may as likely have been produced by wind action on creosote bushes.

ARCHAIC PERIOD: ROCKSHELTER RESEARCH

Implicit in early research into Archaic Period hunters and gatherers was a culture that

evolved from adaptations to a changing environment. The Early Archaic phases (dated to 8,000 to 4,000 B.P. on the San Diego coast) that are well-represented in southwestern California and southwestern Arizona appear to be missing from the Colorado Desert archaeological record. This has led Julian Hayden (1976) and others to cite Antevs' (1948, 1952) Alti-thermal period of a hot, dry climate in the Great Basin and Sonoran Desert as a probable cause. Evidence for severe environmental conditions in the Colorado Desert are lacking. The Early Archaic, as indicated by stone circles and sparse remains on desert pavements, was characterized by very low population density and forager (residential) strategies. This, like the Paleoindian Period before, has left little signature in the archaeological record of the Colorado Desert. During a transitional Middle Archaic in Arizona, population density appears to have increased and there is some indication of mixed forager-collector strategies. Shackley (1986, 1990) concluded from obsidian studies and artifact morphology that territorial ranges of social groups were being defined at this time, possibly as a result of population increase and competition for resources (Wills 1988). The extent to which these concepts are applicable to the Colorado Desert remains to be seen.

The Late Archaic in California (4,000 to 1,500 years B.P), as currently defined by the late Pinto and Gypsum cultural patterns, is represented by remains of diversified hunters and gatherers who adapted to drier and warmer Holocene conditions, specifically at the higher elevations of the Mojave Desert and Great Basin. As reconstructed in these areas, the Archaic pattern focused on the opportunistic exploitation of large and small animals, with a greater emphasis on milling tool food processing technology to exploit seasonally available seeds and nuts. Based on ethnographically derived models, flexibility of group size and mobility were used to schedule activities to take advan-

tage of seasonally abundant resources.

The only well-documented and substantial Archaic Period component in the Colorado Desert derives from Indian Hill Rockshelter in Anza-Borrego Desert State Park, examined by Wallace and Taylor (1960), Wallace et al. (1962), Wilke et al. (1986), and McDonald (1992). The Early Archaic was missing, as usual, but Late Archaic remains were found to a depth of almost 1.5 m. underneath extensive Late Prehistoric Period components. These included 11 rock-lined cache pits, numerous hearths, 21 Elko Eared dart points, other flaked stone and milling stone tools, and three inhumations, one of which was radiocarbon dated to $4,070 \pm 100$ years B.P. The quantity and variety of remains, with evidence of extensive storage, led McDonald (1992:155) to conclude that this was the "home base" or "hunting camp" of late Archaic hunters and gatherers. A rockshelter in Tahquitz Canyon near Palm Springs produced only the second Colorado Desert occurrence of rock-lined cache pits in association with what appear to be cached manos and metates and an array of lithics associated elsewhere with an Archaic occupation, but no temporally diagnostic artifacts or radiocarbon dates (Schaefer 1992a). Low artifact variability and density at Tahquitz Canyon indicate a much less intensive occupation than at Indian Hill. The site was used primarily for caching by people whose residence was located elsewhere, and probably within the context of a very mobile settlement strategy; this is a well-documented pattern throughout the Southwest (Wilke and McDonald 1989). Other inhumations in the Colorado Desert can also be added to the Indian Hill Rockshelter corpus, now that the Yuha cairn burial makes sense. All these remains indicate a low population density of highly mobile hunters and gatherers who shared a tradition of projectile point styles and adaptive strategies that encompassed all of southern California to the coast and western Arizona.

Both Indian Hill and Tahquitz Canyon occur at the juncture between mountain and low desert. So where are the lowland Archaic Period sites? Some are probably masquerading as so-called San Dieguito sites on undatable desert pavements. Some, in optimal habitats of the Imperial Valley and Colorado River Valley, have been either buried under many meters of alluvium or long plowed asunder. Some sites may still be accessible, buried under alluvial fans or in deep rockshelters, but they are largely invisible from the surface. Both Indian Hill and the Tahquitz Canyon rockshelters bore no surface indications of an Archaic component. Another example is a single component, erosion-exposed deposit along San Felipe Creek near the junction of Grapevine Canyon. A radiocarbon date of $4,980 \pm 100$ years B.P. was obtained from that site (McDonald 1992:16).

LATE PREHISTORIC PERIOD: EMERGING APPRECIATION OF HUNTER-GATHERER COMPLEXITY AND FLEXIBILITY

Some of the most productive research has come from the study of Late Prehistoric and ethnohistoric sites associated with Lake Cahuilla and its final recession. A large and well-preserved data base now exists for testing very specific propositions regarding hunter-gatherer adaptation to profound environmental change.

The Patayan cultural pattern in this period is defined by desert and riparian oriented mobile groups living in dispersed seasonal settlements. The pattern first developed on the Colorado River around A.D. 500, presumably from a desert Archaic tradition and influenced by the agricultural-based Hohokam culture on the upper Gila River. The nonperishable Patayan material culture complex includes buff ware ceramics from lowland sedimentary clay sources, micaceous brown wares from upland residual and sedimentary sources, clay figurines and pipes, small triangular, side-notched, and

serrated projectile points, portable stone manos, metates, pestles, and mortars, bedrock grinding slicks and mortars, soapstone arrowshaft straighteners and figurines, pumice abraders, widely traded shell beads, worked bone tools, cremation burials, rock art, and geoglyphs. They erected rock-outlined jacal structures, semi-subterranean earth houses, simple ramadas, or rock-lined brush huts, depending on the season and function of the settlement. Storage was an important aspect in seasonal subsistence strategies. The more sedentary groups also built elevated granaries and all groups cached food and other items in ceramic ollas.

Malcolm Rogers (1945) first defined the pattern as the Yuman complex, dividing it into three chronological phases. Although the assemblage does characterize the probable proto-Yuman ancestors, the pattern was indeed readily adopted or had already been acquired by the Cahuilla (a Takic group) who settled into the Coachella Valley and Santa Rosa Mountains. Ethnographic sources also indicate many shared elements of cosmology and ceremonialism between different groups, probably as a result of trade and cultural interaction. A wide diversity of adaptive patterns and settlement strategies was practiced by peoples who possessed the Patayan material culture assemblage, if the ethnographic present is any indication. Patterns of mobility, degree of reliance on agriculture, nominal size of economic units, kinship systems, alliance patterns, and other social-economic factors between groups varied with habitat range. For example, compare the mobile hunter-gatherer oriented strategy among the Yavapai to the more sedentary, agriculturally oriented Quechan and Mohave. Individual groups also shifted settlement and subsistence patterns to adapt to localized environmental changes. Environmental perturbations might cause larger groups to segment into small economic units, to become more mobile, and in the case of the Colorado River area, to rely

more on wild foods (Castetter and Bell 1951; Hicks 1963). The prehistoric Patayan world was multicultural and inter-cultural, representing many dynamic adaptive strategies and social systems but sharing common elements of technology, material culture, and ideology.

Long-range travel to special resource collecting zones, trading expeditions, and possibly some warfare are reflected by the numerous trail systems throughout the Colorado Desert; trail systems that are associated with accumulated ceramic "pot-drops," trail-side shrines, rock art, and other evidence of transitory activities (Johnston and Johnston 1957; Johnston 1980; Waters 1982a, 1982b; Schaefer 1985; von Werlhof 1988; McCarthy 1993). One of the most impressive trails, currently under investigation by Jay von Werlhof and the Imperial Valley College Museum, is through Indian Pass in the Chocolate Mountains. Malcolm Rogers previously investigated shrines along this trail (Waters 1982c), and it was undoubtedly one of the main routes for people travelling between the Colorado River and Lake Cahuilla. Some of these trails probably were in use well before the Late Prehistoric Period. The widespread occurrence of obsidian from the Obsidian Butte source at the southern end of the Salton Sea is yet another indication of extensive exchange networks (Dominici 1984; Hughes and True 1985; Hughes 1986). Shell beads in the desert from Pacific Coast and Gulf of California sources are yet another indication of established trade systems that extended in all directions.

In periods of Colorado River flood failure or washouts, wild plant and animal resources were relied upon to avoid starvation. Even in the best of times, wild foods are estimated to have accounted for 40 to 70 percent of the diet (Castetter and Bell 1951; Driver 1957; White 1974; Kroeber 1980). The higher elevations served as upland desert resource collection zones for Colorado River and desert-based Patayan groups. Of particular importance were

riparian wash legumes, seed-producing species, plus cactus and yucca. Many Patayan groups in the western Colorado Desert apparently did not adopt agriculture until historic times, except possibly the ancestors of the Kumeyaay (Kamia), who probably maintained cultivated fields in the Imperial Valley after the desiccation of Lake Cahuilla (Gifford 1931). Unfortunately, sites relating to the reoccupation of the Salton Trough along the New and Alamo rivers were destroyed in the great flood of 1905-1906 or by later agriculture. Patayan sites in upland regions consist of caches, rockshelters, open air residential sites, and specialized resource exploitation localities. Territoriality was also a factor in determining adaptive foci. Upland Patayan whose main base camps were not on the Colorado River relied more on wild resources than Lowland Patayan, who spent a greater portion of their schedule on or near the floodplain (Gifford 1931; Hicks 1963). No substantial Late Prehistoric sites have been investigated on the lower Colorado River flood plain because they have all been obscured by alluvium or recent agricultural developments. Investigations have therefore focused on the smaller temporary camps in the desert areas or, more intensively, on Lake Cahuilla-associated sites.

Approximately 1,200 years ago, the Colorado River broke through its natural deltaic cone above the Gulf of California and turned north into the Salton Trough (MacDougal 1914; Sykes 1937). For the next 450 years, the river poured into what is now Imperial and Coachella valleys to produce a 184-km. long, 54-km. wide, and 96-m. deep lake. The present Salton Sea is an artificial, accidentally made, miniature version of what was once one of the largest freshwater lakes in North America. An oasis-like lacustrine environment then developed around the shoreline, at about 12 m. above mean sea level. A string of shoreline marshes and embayments ringed the lake, supporting habitats

for shellfish, fish, waterfowl, cattail reeds, and other economically important resources for the local inhabitants (Wilke 1978). The lakeshore attracted people from the Colorado River, the Mojave Desert, and the Peninsular Range, and they all left their remains on the relic shoreline. There is also evidence that at least four major lacustrine intervals, lasting 100 to 250 years each and separated by very short or incomplete interlacustrine periods in the Late Prehistoric Period, affected human settlement patterns (Waters 1983). The Colorado River finally returned to its original course as a result of tectonic forces, base-level changes accompanied by deltaic alluvial deposition, or a large flood re-routed most of the flow back into the Gulf of California about A.D. 1580 (Waters 1983:375). Evaporation caused the shoreline to gradually recede, drying up the littoral marshes and embayments. By about A.D. 1540 to 1600, the water became too saline to support much wildlife or had dried up entirely, and most of the native human population would have eliminated the lacustrine environment from their seasonal rounds to focus on other parts of their territories in the Peninsular Range and on the Colorado River, or established new settlements along springs, rivers, or walk-in wells in the Imperial and Coachella valleys.

Hundreds of sites remain along the relic beachline at the maximal 12-m. Holocene lake level. Most surface sites have been dated to the final maximal lacustrine interval between about A.D. 1430 and A.D. 1580. Earlier sites from three prior intervals have been found buried in the beach sands and are much less common. Among the most interesting recent finds by Everson (1992) is a Sedentary Period Hohokam jar with crushed phyllite temper, found in a sand dune in Indian Wells, which was radiocarbon dated to 900 ± 80 years B.P. (dendro-calibrated date A.D. 1022 to 1280). The vessel shape conforms to the low-shouldered jars of the Sacatan Phase recorded at Snaketown

(Haury 1976:206). This was precisely the period of increasing westward expansion of Hohokam culture, extending as far as Gila Bend (Vivian 1965; Wasley and Johnson 1965). Recent studies in Arizona have indicated substantial Hohokam-Patayan interaction, much of which may have been in the realm of esoteric knowledge, in addition to utilitarian items and exotic trade goods (Shaul and Andresen 1989). Too few early Patayan sites that predate Lake Cahuilla or identified Hohokam artifacts have been found in the Colorado Desert to adequately assess the extent of cultural interaction or influence that Lake Cahuilla may have had between people on either side. Parallels between Hohokam and Patayan figurine styles provide one research orientation, but this is hampered by the paucity of examples from dated archaeological contexts (Hedges 1973). Some recent finds demonstrate that styles shared by the Patayan and Hohokam, and possibly associated esoteric knowledge, continued well into the 18th and 19th centuries, long after the Hohokam ceased to exist as a cultural entity. Eighmey and Cheever (1992) reported a Hohokam-like steatite reptilian figurine from a cremation burial on a recessional shoreline of Lake Cahuilla that radiocarbon dated to 250 ± 50 years B.P. Schaefer (1992b) documented a cache of figurines, one with Hohokam-like coffee bean eyes and the others of the tubular variety more typical of central California and the Great Basin. All the figurines and the vessels were made from the same unusual clay source and were probably made by a single artisan. They were found in association with miniature vessels in a burnt house in Tahquitz Canyon that dated to the mid-19th century.

Sites can also be found below the 12-m. high stand; remains of camps that followed the receding waters to elevations beyond 240 m. below sea level. At least a dozen major survey and data recovery projects have shed significant light on how Patayan peoples adapted to this

dynamic environmental situation. As one might expect, what was originally developed as a rather simple model has been shown to be much more complex.

The first significant study of prehistoric Lake Cahuilla adaptations was conducted by Wilke (1978). With an explicit focus on paleoecology and diet, Wilke examined floral and faunal remains from midden deposits and well-preserved coprolites at Myoma Dunes, Wadi Beadmaker, and other sites along the north shore of Lake Cahuilla. In what is the most authoritative work on Lake Cahuilla cultural ecology, Wilke (1978) demonstrated that people were exploiting a wide array of lacustrine littoral resources: cattail and bulrush (or tule); aquatic birds, including mudhen and eared grebes; *Anodonta* mussels; and several Colorado River fish species, including humpback sucker, bonytail chub, and striped mullet. Added to this list was the typical array of desert plants and animals, including screwbean, honey mesquite, grass seeds, cactus, lagomorphs, rodents, and desert tortoise. Gobalet (1992) provided a synthesis of fish studies in Lake Cahuilla and suggested that additional species and hybrids may also be detectable.

Wilke (1978) used several lines of evidence to conclude that these sites represented year-round residential bases of Late Prehistoric Period peoples who permanently moved out of the surrounding deserts and mountains to the 12-m. shoreline, although he did not discount the possibility of other settlement types also occurring. Seasonally specific resources appeared to cover almost the entire annual round, although winter resources were definitely under-represented, with the exception of *Dicoria* seeds (Wilke et al. 1979). Stored foods would have supplemented the diet until late spring. Pinyon nut hulls were also found, indicating collecting trips to upland resources, a pattern well-documented for the desert Cahuilla. Furthermore, Wilke (1978) agreed with Aschmann (1959) that

the final recession caused major population adjustments in neighboring areas as the Lake Cahuilla populations established new residential bases in the Peninsular Range foothills, and presumably, along the Colorado River. Wilke (1978) cited reports of increased site density in areas surrounding the Salton Basin, as well as his own collaborative efforts at Perris Reservoir (Wilke 1974:28-29). Applying Weide's (1974) calculated evaporation rates for the Salton Sea and other inland water bodies, Wilke (1978) postulated a rapid and continuous desiccation that lasted some 60 years, with the receding waters eventually becoming too saline to support any aquatic resources, which would have destroyed the optimal marsh habitats at a very early point in the recession.

Wilke (1978:39) used Weide's (1974) calculations of the hydrological regime of Lake Cahuilla to reconstruct a stable lacustrine littoral environment during the high stands at the 12-m. shoreline, which fluctuated only two or three feet. Weide (1974) concluded that with continuous normal Colorado River inputs of 16.96 million acre feet per year, the Salton Basin would have filled to the maximum 12-m. level within four to five years. In addition, a relatively balanced ratio between hydrological input from the Colorado River and output from evaporation would have been attained under conditions of known low inflow. Weide (1974: 15) continued by questioning the stability of Lake Cahuilla shoreline habitats, given expected fluctuations in the shoreline. These were of unknown duration and periodicity but are certainly evidenced by numerous recessional and processional shorelines and by complex beach and lake stratigraphy. Weide (1974) suggested that inland spring-fed streams and desert riparian habitats provided more reliable staple plant resources than the shoreline ever could. Weide and Barker (1974:106-107) continued the argument, suggesting that fluctuating lake levels provided too unstable a habitat to support

sustained permanent habitation or significant permanent population shifts. Only small, seasonal, temporary camps were possible, and the final recession only caused shifts in seasonal scheduling and not wholesale population displacements and re-adaptations.

The debate between Wilke and Weide has greatly influenced the course of subsequent research. Several important advances have been made, particularly with regard to chronology and more explicit definitions of hunter-gatherer settlement and subsistence systems in the Colorado Desert. The first problem was to establish if permanent residential bases actually existed on the Lake Cahuilla shoreline. Wilke (1978) published only the results of the fecal studies, so the range of behavior reflected by his database was very restricted. Fundamental models and observations now have to be made that accurately characterize the seasonality, scheduling strategies, social group size, and range of behavior that the appearance and final recession of Lake Cahuilla affected. This requires explicit and comparable measures for group size, settlement strategies, and duration of occupation. This is a challenging task, as those who have applied forager-collector models to the archaeological record have learned (Binford 1980, 1982). Variables to be considered for determining residential bases include site size, midden thickness or depth, artifact density, artifact variability, presence of multiple cremations or designated cremation grounds, presence of ceremonial artifacts, and variability of features or other evidence of site complexity expected at a residential base of collector-oriented hunters and gatherers. Site morphology should also be compared to ethnographically documented residential base and temporary camp sites. These are often overlooked observations or are not explicitly addressed when assigning site types to surface assemblages and when interpreting both survey and excavation data.

The idea of permanent residential bases on the Lake Cahuilla shoreline would seem intuitively attractive given the large amount of fresh water in the middle of the desert. Surface surveys in the late 1970s and early 1980s by the BLM, Westec Services, the Imperial Valley College Museum, Wirth Associates, Cultural Systems Research, and others in Imperial County showed the pattern is not so simple (see Gallegos 1980). Sites were found to be unevenly distributed along the shoreline, and their geomorphology showed a very diverse range of desert-lacustrine interfaces. Many areas of long, straight beachline with shallow contours would not have been conducive to the development of marshy habitats, and these areas are usually site-poor. Sites instead are concentrated along embayments and sandy spits, where major washes empty into Lake Cahuilla, and where parallel dune areas developed that supported economically important mesquite groves.

Areas where mountains or alluvial fans came abruptly down to the shoreline also offered very different environmental effects from fluctuating lake levels. These zones appear to have the greatest concentrations of fish traps, particularly where alluvial cones extend from nearby canyon mouths to the lakeshore. The areas of Myoma Dunes, Indian Wells, and La Quinta at the northwest end of the lake may appear to contain larger and more densely spaced site clusters, but they in no way characterize much of the south and eastern sides where sites are more widely distributed and typical of seasonal temporary camps. Recent data recovery projects in Riverside and Imperial counties by the University of California, Riverside, and CRM firms have consistently displayed shallow midden development, low artifact quantity, and minimal numbers of cremation burials compared to sites in upland areas (von Werlhof et al. 1979; von Werlhof and McNitt 1980; Gallegos 1984a, 1984b, 1986; Shackley 1984; Sutton and Wilke 1988; Breece

and Rosenthal 1989; Arkush 1990; Ferraro and Schaefer 1990; Goodman 1990; Yohe 1990; Cerreto 1991; Jertberg and Rosenthal 1992; Schaefer et al. 1993).

Ceramic assemblages at a significant number of sites in the La Quinta area and all of the Toro Canyon area are dominated by Tizon Brown Ware, a ceramic type made from residual clays in upland areas. This is very suggestive of a seasonal round from base camps in transitional or upland areas, where the Tizon Brown Ware was made, to temporary camps in the vicinity of Lake Cahuilla, where the pottery was transported, used, and eventually discarded. Cahuilla ethnographic sources also support this model (Schaefer et al. 1993). Of excavated sites, the average midden thickness at Lake Cahuilla sites is only 5 to 10 cm. with artifact densities of 16 to 100 items per m². Compare this to the Tahquitz Canyon residential base where midden thickness is anywhere from 10 to 50 cm. and artifact densities range from 100 to 400 items per m². Rare exceptions occur and these require additional investigations and explanation. Sutton and Wilke (1988) found 30-cm. thick midden deposits extending down to over 50 cm. below the surface at CA-RIV-1179 in La Quinta. This site may have been part of a major residential base complex from which both Lake Cahuilla and terrestrial desert resources were exploited. Yet, based on seasonality of ecofacts, Sutton and Wilke (1988) interpreted the site as a temporary camp and not a permanent village. Sutton (1993) proposed a spring-summer occupation focus based on diet and seasonality inferences from coprolite and midden contents. This conclusion parallels results from Imperial County sites. Sutton suggested a settlement model that is transitional between Wilke's lacustrine-based village model and historic Cahuilla settlements near permanent water, but exploiting terrestrial habitats. Located nearby is a major cairn complex (at CA-RIV-2823) which Sutton and Wilke (1988)

suggested was used to drive bighorn sheep. It is possible that the site also had ceremonial connotations.

Additional evidence that Lake Cahuilla lacustrine resources were not necessarily primary to the Late Prehistoric occupancy was found in excavations at Superstition Mountain (Schaefer 1988). Here, over a mile from the shoreline, was found a large array of temporary camps around ephemeral pans. Radiocarbon dates, fish bone, and ceramic types demonstrated contemporaneity with Lake Cahuilla, but the focus was clearly on the *Atriplex* sp., wolfberry, and other halophytic plants around these seasonal water sources. Among the many hearth features were workshops for the production of sandstone metates, as well as chalcedony, obsidian, quartz, and metavolcanic projectile points. Lake Cahuilla fish bones have also been found at other interior sites, including Indian Hill Rockshelter, Toro Canyon, and Tahquitz Canyon. The shoreline thus was not the only optimal habitat but just one in what was a seasonal round. How the shoreline was scheduled into that round was determined by the culturally relevant topographic associations between desert and lakeshore. On the west side, a more diverse resource base was available due to proximity to the Peninsular Range and the wide variety of elevation-specific resources and riparian habitats within a relatively short distance. On the east side of Lake Cahuilla, no optimal habitats existed on the long trek between the Colorado River and the shoreline. The Imperial Sand Dunes were an obstacle for Colorado River peoples, with only the Glamis and Buttercup passes for access. Passes through or around the Chocolate Mountains were also required, with extensive evidence found of lithic quarrying at the southern end of the Chocolate Mountains, probably conducted within an embedded resource collection strategy of people travelling between the river and Salton Trough (Schaefer 1986b; Shackley 1988).

In a related project undertaken by Schneider (1993), six milling equipment quarries were intensively examined in the Lower Colorado River and Lower Gila River areas. These specialized quarry sites were found within the contexts of both mobile hunters and gatherers and more sedentary mixed horticulturalists. Schneider interpreted these sites as functioning within a primary procurement strategy in her examination of the social, economic, and technological factors of milling tool production and use.

As a result of easier access to more favorable, contiguous, terrestrial habitats, whole families would establish temporary camps on the west and north sides, leaving behind a more varied assemblage of artifacts and features. Sites on the eastern shore, however, contain fewer features and tool types indicative of special purpose visits. These differences are reflected in very different arrays of ceramic types, lithic materials, and flora and fauna that differentiate the north, south, east, and west quadrants of the Lake Cahuilla shoreline. East and west shoreline topography were also quite different. The gradual slope and broad indentations of the west shoreline meant more extreme fluctuations in shoreline location as water levels retreated through evaporation and advanced with flood period recharges. On the east side, prevailing westerly winds, unimpeded by the Peninsular Range, blew the beaches into steeper berms that formed long sand spits and embayments that were less affected by lake level fluctuations (Gallegos 1980, 1986; von Werlhof, personal communication 1993).

A more complex picture has also emerged for the final recession. No longer can a continual, 60-year, linear retreat from the maximum 12-m. shoreline be supported. Excavations at the Dunaway Road site in southeast Imperial County revealed a substantial recessional shoreline site on a 3-m. high beach berm at about sea level elevation (Schaefer

1986a). Thousands of fish bones were found, including the usual suckers, bonytail, and mullet, but also previously unreported specimens of the large machete or tarpon and the Colorado squawfish (Roeder and Salls 1986). Among the striped mullet were many small- and medium-sized examples. Since this species spawns only in the Gulf of California and then returns to the Colorado River, and also fails to reproduce in the Salton Sea, the occurrence of immature mullet suggests that they were washed in from a recharge of the Colorado River and not from a temporary halt in the recession. Large amounts of mesquite pollen also suggest at least a springtime occupation when blossoms were harvested and cooked. This infilling was of sufficient duration to create a 1-m. high beach berm, to put small amounts of cattail pollen into the record, and to provide hunter-gatherer groups with resources to continue an opportunistic lacustrine exploitation. Radiocarbon dates from the site indicate that a fifth partial infilling occurred between 330 ± 60 radiocarbon years B.P. (dendrocalibrated to A.D. 1516 and 1659). Unfortunately, this and other late dates of less than 400 years in age do not carry high confidence levels because of significant natural ^{14}C variations (Taylor 1987:35). Ceramic finds, however, corroborate an intermediate Patayan II-Patayan III date, as does the geographic location of the recessional beachline.

Other recessional shoreline sites at about the same elevation have been excavated by Shackley (1984) at Yuha Wash, by Phillips (1982) at the IT site, and by Clewlow et al. (1992) near Fish Creek and San Felipe Wash. All of these produced evidence of small temporary camps tentatively dated to around A.D. 1600 to 1650, with all the midden characteristics, artifact densities, and artifact diversity typical of the loci of the larger sites on the 12-m. shoreline. On the eastern shore of Lake Cahuilla, Gallegos (1986) also found evidence of continued occupation

along desiccated embayments after A.D. 1500 that may have also been supported by late partial infillings. Recessional beachlines in many areas have been destroyed by natural erosion or agricultural development. In northern San Diego and southern Riverside counties, lines of fish traps remain from continued exploitation of the receding shoreline to an elevation of almost 30 m. below sea level (Wilke 1978:101, 1980). A fifth infilling also may have been of short enough duration to escape notice by the Oñate expedition of 1604 and by Eusebio Kino in 1700 (Bolton 1916, 1948; Hammond and Rey 1958). This infilling, or a similar event, may have been known to some early travellers between 1706 and 1760, and explains why a map published by Rocque from this period shows the combined flow of the Colorado and Gila rivers terminating in an inland sea (Sykes 1914:15; Wilke 1978:53). Smaller seasonal infillings continued to occur during Colorado River flood stages throughout the subsequent centuries (Sykes 1914:19, 1937:39, 43).

Something did happen to the Colorado Desert after A.D. 1600. Many surveys and excavations throughout the western edge of the Colorado Desert have documented high site densities in the Late Prehistoric Period (Wilke and Lawton 1975:19; Wilke 1978:114-119). As predicted, recent excavations at Tahquitz Canyon did indeed show a considerable population influx after this time, but particularly in the 1700s and 1800s, well after the final desiccation (Schaefer 1992a). There also seems to be an intensified use of some resources. For example, Shackley (1984) excavated more than a dozen agave baking pits in the eastern flanks of the Peninsular Range near In-ko-pah Gorge. At least a third of the pits are contemporary with the third or fourth lacustrine intervals, and suggest regular, broad-spectrum subsistence practices in this period, as do the occupational remains from the upper levels of Indian Hill Rockshelter (McDonald 1992). There does

seem to be intensified use of these agave cooking features in post-Lake Cahuilla times, but with the greatest intensification in the 19th and early 20th centuries. A much larger sample and resolution of radiocarbon dating problems will be required, however, to determine if a region-wide intensification actually took place following the final recession. There may well have been significant population growth and concomitant adjustments in settlement and subsistence after A.D. 1600, but what role, if any, the final recession of Lake Cahuilla played in that growth remains unclear. This is certainly an issue requiring additional serious attention.

One of the most impressive and well-documented examples of a major residential base established on the dried bed of Lake Cahuilla after the final recession is the settlement of San Sebastian. It is associated with a complex of springs, marshes, and mesquite dunes on San Felipe Creek (Lebo et al. 1982). Von Werlhof (1980) conducted the first reconnaissance to establish the perimeter of the largest site within the complex. Three sections were later systematically investigated by Schaefer et al. (1987), who found one of the highest site densities documented anywhere in the Colorado Desert. Important descriptions of the settlement were made by several of the Anza expedition members between 1774 and 1776 (Coues 1900; Bolton 1930, 1931). Combined with other ethnohistoric sources, ethnographic literature, and interviews, a very large site complex of seasonal temporary camps was defined, whose population size and demographic composition shifted with the seasons, political conditions, and localized environmental dynamics. Sites were distributed around the largest settlement at the main spring and the adjoining mesquite woodland habitat. A second cluster occurred north of San Felipe Creek and adjacent to mesquite dune fields (Schaefer et al. 1987). Population size increased during late spring and early summer for the mesquite and

Atriplex spp. harvest. In winter, the population shifted to foothill and upland areas for the pinyon harvest and mountain sheep hunts, and in early spring, descended to the foothills for the agave harvest. During the winter and early spring periods, the San Sebastian complex would have been populated only by the old, weak, and others unable to make the ascent to the winter camps. Such a complex may provide a clearer picture of a residential base (i.e., "village") and in comparison may be used to more accurately characterize Late Prehistoric sites, particularly for a more accurate assessment along the Lake Cahuilla shoreline. Similar patterns were also evident at the ethnohistoric Cahuilla settlements at walk-in wells and springs to the north, along the base of the Santa Rosa Mountains, as recently documented by Bean et al. (1991). Changes in the social structure and political affiliation of these communities that resulted from disease-induced depopulation in historic times is poignantly clear from their study, as is the complexity of Cahuilla ethnogeography.

Wilke (1978:8) was indeed careful to point out that a range of settlement modalities probably existed along the shoreline. As more data have accumulated, we have learned that settlement along the Lake Cahuilla shoreline was not uniform, but was quite variable depending on the geographical and ecological relationship of water, marsh, lowland desert, and mountain habitats. As is becoming increasingly obvious in the archaeological record, variability and flexibility in the face of changing circumstances are probably the main principles that governed the Late Prehistoric Period human ecology of the area. Similar conclusions are being derived from the debate between "limnogood" and "limnobad" models of wetland adaptations in the Great Basin (Bettinger 1993).

The key concept characterizing Late Prehistoric adaptations in the Colorado Desert is

flexibility. A diversity of adaptive strategies and settlement patterns typifies Late Prehistoric occupation around Lake Cahuilla. The basic socioeconomic unit was manifested in the seasonal temporary camp, a site type that occurs not only on the maximal shoreline but also on inland and recessional shorelines as people took advantage of short-term habitats wherever they could. The changes that occurred after the final recession thus appear to be more of readjustment than mass exodus.

CONCLUSION

It is clear what challenges lay ahead for investigations of each period of Colorado Desert prehistory. More convincing means of identifying and dating early hunter-gatherer sites will be required to formulate more sophisticated questions and derive more definitive answers into the nature of early settlement and subsistence. Also, for both early and late periods, we need to develop more explicit interpretive models of the relationship between the archaeological record and the human behavior that produced it.

ACKNOWLEDGEMENTS

My thanks to Claude N. Warren, whose invitation to deliver a paper at the session entitled "Archaeology and Prehistory of Western North America," at the Society for American Archaeology annual meeting in St. Louis, culminated in this expanded version. Special thanks are due Jay von Werlhof of the Imperial Valley College Museum. His many thoughtful and informed comments ensured that I said what I meant and meant what I said. Meg McDonald provided both critical peer review and much needed editing. I am also indebted to peer reviewers Philip Wilke and Steven Shackley, whose comments helped me clarify my arguments. Don Laylander of Caltrans, District 11, also provided a critique of Lake Cahuilla chronology, for which I am grateful. Christy Rust and Tom Cherry are credited with deciphering my handwriting to prepare the map. Finally, thanks to Brian F. Mooney Associates and John R. Cook for providing me with the time and facilities to undertake this review.

REFERENCES

- Antevs, Ernst
 1948 The Great Basin, with Emphasis on Glacial and Post-glacial Times, Climatic Changes and Pre-white Man. *Bulletin of the University of Utah* 38(20):168-191.
- 1952 Climatic History and the Antiquity of Man in California. Berkeley: University of California Archaeological Survey Reports 16:23-31.
- Arkush, Brooke S.
 1990 An Archaeological Assessment of 1280 Acres of Land Located South of Indio in Central Riverside County, California. Report on file at the Eastern Information Center, University of California, Riverside.
- Aschmann, Homer
 1959 The Evolution of a Wild Landscape and its Persistence in Southern California. *Association of American Geographers* 40(3):34-57.
- Bada, Jeffrey
 1985 Aspartic Acid Racemization Ages of California Paleoindian Skeletons. *American Antiquity* 50(3):645-647.
- Bamforth, Douglas B., and Ronald I. Dorn
 1988 On the Nature and Antiquity of the Manix Lake Industry. *Journal of California and Great Basin Anthropology* 10(2):209-226.
- Bean, Lowell John, Sylvia Brakke Vane, and Jackson Young
 1991 The Cahuilla Landscape, The Santa Rosa and San Jacinto Mountains. Menlo Park: Ballena Press Anthropological Paper No. 37.
- Begole, Robert S.
 1973 An Archaeological Survey in the Anza-Borrego Desert State Park: 1972 Preliminary Report. *Pacific Coast Archaeological Society Quarterly* 9(2):27-55.
- 1981 1978-1980 Investigations in the Anza-Borrego Desert State Park. *Pacific Coast Archaeological Society Quarterly* 17(4):1-38.
- Bettinger, Robert L.
 1993 Doing Great Basin Archaeology Recently: Coping with Variability. *Journal of Archaeological Research* 1(1):43-66.

- Bierman, Paul R., and Alan R. Gillespie
1994 Evidence Suggesting that Methods of Rock Varnish Cation-Ratio Dating Are Neither Comparable nor Consistently Reliable. *Quaternary Research* 41(1):82-90.
- Binford, Lewis R.
1980 Willow Smoke and Dog's Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* 45(1):4-20.
1982 The Archaeology of Place. *Journal of Anthropological Archaeology* 1(1):5-31.
- Bolton, Herbert Eugene
1916 Spanish Exploration in the Southwest, 1542-1706. New York: Charles Scribner & Sons.
1930 Anza's California Expeditions. Vols. 1-5. Berkeley: University of California Press.
1931 Font's Complete Diary. Berkeley: University of California Press.
1948 Historical Memoir of Pimeria Alta: A Contemporary Account of the Beginnings of California, Sonora, and Arizona, by Father Eusebio Francisco Kino, S. J. Berkeley: University of California Press.
- Breece, William H., and J. Rosenthal
1989 Results of the Phase II Archaeological Program at CA-IMP-6300, Imperial County, California. Report on file at the Southeast Information Center, Imperial Valley College Museum, El Centro.
- Bull, Charles S.
1984 Shaking the Foundations: The Evidence for San Diego Prehistory. San Diego State University, Department of Anthropology: Casual Papers in Cultural Resource Management 3(1):15-64.
- Carrico, Richard L., Theodore G. Cooley, and Joyce M. Clevenger
1991 Archaeological Excavation at the Harris Site Complex. Report on file at the South Coastal Information Center, San Diego State University, San Diego.
- Castetter, Edward F., and Willis H. Bell
1951 Yuman Indian Agriculture. Albuquerque: University of New Mexico Press.
- Cerreto, Richard
1991 Phase III Archaeological Mitigation: Data Recovery at Prehistoric Sites CA-RIV-2199 and CA-RIV-4168, El Mirador Professional Plaza, City of La Quinta, Riverside County, California. Report on file at the Eastern Information Center, University of California, Riverside.
- Childers, W. Morlin
1974 Preliminary Report on the Yuha Burial, California. *Anthropological Journal of Canada* 1(1):2-9.
1977 Ridge-back Tools of the Colorado Desert. *American Antiquity* 42(2):242-248.
1980 Evidence of Early Man Exposed at Yuha Pinto Wash. *American Antiquity* 45(2):297-307.
- Clewlow, C. William, Jr., Theresa A. Clewlow, and Hazel Wald
1992 Final Report for Archaeological Sites CA-IMP-5959, CA-IMP-5961, and CA-IMP-5963, Imperial County, California. Report on file at the Southeast Information Center, Imperial Valley College Museum, El Centro.
- Cole, Kenneth L.
1986 The Lower Colorado River Valley: A Pleistocene Desert. *Quaternary Research* 25(3):392-400.
- Coues, Elliot
1900 On the Trail of a Spanish Pioneer: The Diary and Itinerary of Francisco Garcés in His Travels through Sonora, Arizona, and California, 1775-1776. New York: Frances P. Harper.
- Crabtree, Robert
1981 Archaeology. In: A Cultural Resources Overview of the Colorado Desert Planning Units, by Elizabeth von Till Warren, Robert H. Crabtree, Claude N. Warren, Martha Knack, and Richard McCarty, pp. 25-54. Riverside: Bureau of Land Management Cultural Resources Publications in Anthropology and History.
- Dominici, Debra A.
1984 Calibration of the Obsidian Butte Hydration Rate and Its Implication Regarding Late Prehistoric Exchange. Master's thesis, San Diego State University.
- Dorn, Ronald I.
1982 Observations of the Use of "Desert Varnish" in the Age-determination of Surfaces. El Centro: Imperial Valley College Museum Newsletter 10(2):2-5.
- Dorn, Ronald I., and T. M. Oberlander
1981 Microbial Origin of Desert Varnish. *Science* 213:1245-1247.

- Dorn, Ronald I., Persis B. Clarkson, Margaret F. Nobbs, Lawrence L. Loendorf, and D. S. Whitley
1992 New Approach to the Radiocarbon Dating of Rock Varnish, with Examples from Drylands. *Annals of the Association of American Geographers* 82(1):136-151.
- Dorn, Ronald I., D. B. Bamforth, T. A. Cahill, J. C. Dohrenwend, B. D. Turrin, D. J. Donahue, A. J. T. Jull, A. Long, M. E. Macko, E. B. Weil, D. S. Whitley, and T. H. Zabel
1986 Cation-Ratio and Accelerator Radiocarbon Dating of Rock Varnish on Mojave Artifacts and Landforms. *Science* 231:830-833.
- Driver, Harold E.
1957 Estimation of Intensity of Land Use from Ethnobiology: Applied to the Yuma Indians. *Ethnohistory* 4(2):174-197.
- Eighmey, Jim, and Dayle M. Cheever
1992 Excavations at Dry Lake Sites 4-IMP-5260, 4-IMP-5261, and 4-IMP-5262, Imperial County, California. Report on file at the Southeast Information Center, Imperial Valley College Museum, El Centro.
- Everson, Dicken
1992 Excavations at Archaeological Site CA-RIV-3682, City of La Quinta, Coachella Valley, Riverside County, California. Report on file at the Eastern Information Center, University of California, Riverside.
- Ferraro, David, and Jerry Schaefer
1990 Archaeological Evaluation of Late Period Lake Cahuilla Habitation and Resource Processing Sites Located in Toro Canyon, California. Report on file at the Eastern Information Center, University of California, Riverside.
- Gallegos, Dennis (ed.)
1980 Class II Cultural Resource Inventory of the East Mesa and West Mesa Regions, Imperial Valley, California, Vol. I. Riverside: Bureau of Land Management Cultural Resources Publications in Anthropology and History.
- 1984a Cultural Resource Data Recovery Program for SDG&E's Imperial Valley to La Rosita 230KV Transmission Line. Report on file at the Southeast Information Center, Imperial Valley College Museum, El Centro.
- 1984b West Mesa Cultural Resource Survey and Site Evaluation, Imperial Valley, California. Report on file at the Bureau of Land Management, El Centro.
- 1986 Patayan II and Patayan III Occupation of IMP-4434 and IMP-5167, East Mesa, Imperial County, California. Report on file at the Southeast Information Center, Imperial Valley College Museum, El Centro.
- 1987 San Dieguito-La Jolla: Chronology and Controversy. San Diego County Archaeological Society Research Paper No. 1.
- Gifford, Edward W.
1931 The Kamia of Imperial Valley. *Bureau of American Ethnology Bulletin* 97.
- Gobalet, Kenneth W.
1992 Colorado River Fishes of Lake Cahuilla, Salton Basin, Southern California: A Cautionary Tale for Zooarchaeologists. *Bulletin of the Southern California Academy of Science* 91(2):70-83.
- Goodman, John
1990 Archaeological Investigations at CA-RIV-3793, Located North of Indio in Central Riverside County, California. Report on file at the Eastern Information Center, University of California, Riverside.
- Hammond, George P., and Agapito Rey (ed. and trans.)
1958 Don Juan de Oñate, Colonizer of New Mexico. Albuquerque: University of New Mexico Press.
- Haury, Emil W.
1950 The Stratigraphy and Archaeology of Ventana Cave. Tucson: University of Arizona Press.
- 1976 The Hohokam: Desert Farmers and Craftsmen. Excavations at Snaketown 1964-1965. Tucson: University of Arizona Press.
- Hayden, Julian D.
1976 Pre-Altithermal Archaeology in the Sierra Pinacate, Sonora, Mexico. *American Antiquity* 41(3):274-289.
- Hedges, Ken
1973 Hakataya Figurines from Southern California. *Pacific Coast Archaeological Society Quarterly* 9(3):1-40.
- Hicks, Frederick
1963 Ecological Aspects of Aboriginal Culture

- in the Western Yuman Area. Ph.D. dissertation, University of California, Los Angeles.
- Hughes, Richard E.
1986 Trace Element Composition of Obsidian Butte, Imperial County, California. *Bulletin of the Southern California Academy of Sciences* 85(1):35-45.
- Hughes, Richard E., and Delbert L. True
1985 Perspective on the Distribution of Obsidian in San Diego County, California. *North American Archaeologist* 6(4):325-339.
- Jaeger, Edmund C.
1965 *The California Deserts* (fourth edition). Stanford: Stanford University Press.
- Jertberg, Patricia, and Jane Rosenthal
1992 Archaeological Test Investigation: CA-RIV-150, USGS La Quinta Quadrangle, La Quinta, California. Report on file at the Eastern Information Center, University of California, Riverside.
- Johnston, Francis J.
1980 Two Southern California Trade Trails. *Journal of California and Great Basin Anthropology* 2(1):88-96.
- Johnston, Francis J., and Patricia H. Johnston
1957 An Indian Trail Complex of the Central Colorado Desert: A Preliminary Survey. Berkeley: University of California Archaeological Survey Reports 37:22-34.
- Kaldenberg, Russell L.
1976 Paleo-technological Change at Rancho Park North, San Diego County, California. Master's thesis, San Diego State University.
- Kroeber, Clifton B.
1980 Lower Colorado River Peoples: Hostilities and Hunger, 1850-1857. *Journal of California and Great Basin Anthropology* 2(2):187-198.
- Lebo, Andrew, Leslie Nitikman, and Charles Salmen (eds.)
1982 San Sebastian Marsh. Environmental Field Program, University of California, Santa Cruz, Publication No. 9.
- MacDougal, D. T.
1914 *The Salton Sea: A Study of the Geography, the Geology, the Floristics, and the Ecology of a Desert Basin*. Washington: The Carnegie Institution of Washington Publication 193.
- McCarthy, Daniel
1993 Prehistoric Land-Use at McCoy Spring. An Arid-Land Oasis in Eastern Riverside County, California. Master's thesis, University of California, Riverside.
- McDonald, Alison Meg
1992 Indian Hill Rockshelter and Aboriginal Cultural Adaptation in Anza-Borrego Desert State Park, Southeastern California. Ph.D. dissertation, University of California, Riverside.
- McGuire, Randall H., and Michael B. Schiffer
1982 *Hohokam and Patayan: Prehistory of Southwestern Arizona*. New York: Academic Press.
- Moratto, Michael J.
1984 *California Archaeology*. Orlando: Academic Press.
- Nobbs, Margaret F., and Ronald I. Dorn
1988 Age Determination for Rock Varnish Formation within Petroglyphs: Cation-Ratio Dating of 24 Motifs from the Olary Region, South Australia. *Rock Art Research* 5(2):108-146.
- Pendleton, Lorann
1984 Archaeological Investigations in the Picacho Basin. Report on file at the Southeast Information Center, Imperial Valley College Museum, El Centro.
- Phillips, Roxana
1982 Archaeological Data Recovery Program: Northern Portion of IT Corporation Imperial Valley Site. Report on file at the Southeast Information Center, Imperial Valley College Museum, El Centro.
- Roeder, Mark, and Roy Salls
1986 Fish Remains From the Late Prehistoric Dunaway Road Site, Imperial County, California. In: *Late Prehistoric Adaptations During the Final Recessions of Lake Cahuilla: Fish Camps and Quarries on West Mesa, Imperial County, California*, by Jerry Schaefer, pp. 105-118. Report on file at the Southeast Information Center, Imperial Valley College Museum, El Centro.
- Rogers, Malcolm J.
1939 Early Lithic Industries of the Lower Basin of the Colorado River and Adjacent Desert Areas. San Diego Museum of Man Papers No. 3.

- 1945 An Outline of Yuman Prehistory. *Southwestern Journal of Anthropology* 1(2): 167-198.
- 1958 San Dieguito Implements from the Terraces of the Rincon-Pantano and Rillito Drainage System. *Kiva* 24(1):1-23.
- 1966 Ancient Hunters of the Far West. San Diego: The Union-Tribune Publishing Company.
- Schaefer, Jerry
- 1985 Cultural Resources Along a Major Trail in the Big Maria Mountains, Riverside County, California. Report on file at the Bureau of Reclamation, Boulder City, Nevada.
- 1986a Late Prehistoric Adaptations During the Final Recessions of Lake Cahuilla: Fish Camps and Quarries on West Mesa, Imperial County, California. Report on file at the Southeast Information Center, Imperial Valley College Museum, El Centro.
- 1986b Hunter-Gather Adaptations to a Marginal Desert Environment: Subsistence Practices and Lithic Production in the Chocolate Mountains, Imperial County, California. Report on file at the Southeast Information Center, Imperial Valley College Museum, El Centro.
- 1988 Lowland Patayan Adaptations to Ephemeral Alkali Pans at Superstition Mountain, West Mesa, Imperial County, California. Report on file at the Southeast Information Center, Imperial Valley College Museum, El Centro.
- 1992a The Chronology and Distribution of Site Types at Tahquitz Canyon. Paper presented at the annual meetings of the Society for California Archaeology, Pasadena.
- 1992b Ceramic Vessels, Figurines, Pipes, and Disks from Tahquitz Canyon. Paper presented at the annual meetings of the Society for California Archaeology, Pasadena.
- Schaefer, Jerry, Lowell J. Bean, and C. Michael Elling
- 1987 Settlement and Subsistence at San Sebastian: A Desert Oasis on San Felipe Creek, Imperial County, California. Report on file at the Bureau of Reclamation, Boulder City, Nevada.
- Schaefer, Jerry, Drew Palette, and Lowell J. Bean
- 1993 Archaeological Investigations of Two Cahuilla Sites in the Toro Canyon Area, Riverside County, California. Report on file at the Eastern Information Center, University of California, Riverside.
- Schneider, Joan S.
- 1993 Aboriginal Milling-Implement Quarries in Eastern California and Western Arizona: A Behavioral Perspective. Ph.D. dissertation, University of California, Riverside.
- Shackley, M. Steven
- 1984 Archaeological Investigations in the Western Colorado Desert: A Socio-ecological Approach. Report on file at the Southeast Information Center, Imperial Valley College Museum, El Centro.
- 1986 Lithic Technology and Mobility Strategies at Picacho. In: *Prehistoric Hunter-Gatherers of South Central Arizona: The Picacho Reservoir Archaic Project*, F. E. Bayham, D. H. Morris, and M. S. Shackley, eds., pp. 109-156. Tempe: Arizona State University Anthropological Field Studies 13.
- 1988 Prehistoric Lithic Technology and Production in the Southern Chocolate Mountains: Data Recovery and Analysis at Mesquite Mine, Imperial County, California. Report on file at the Southeast Information Center, Imperial Valley College Museum, El Centro.
- 1990 Early Hunter-Gatherer Procurement Ranges in the Southwest: Evidence from Obsidian Geochemistry and Lithic Technology. Ph.D. dissertation, Arizona State University.
- Shaul, David Leedom, and John M. Andresen
- 1989 A Case for Yuman Participation in the Hohokam Regional System. *Kiva* 54(2): 105-126.
- Shelley, Steven D., and Jeffrey H. Altschul
- 1989 Paleoenvironments and Archaeology of the Trigo Mountains. Data Recovery in the Hart Mine and Cibola Quarry Areas, Yuma County, Arizona. Tucson: Gray Literature Press.
- Sutton, Mark Q.
- 1993 Midden and Coprolite Derived Subsistence Evidence: An Analysis of Data from the La Quinta Site, Salton Basin,

- California. *Journal of Ethnobiology* 13(1):1-15.
- Sutton, Mark Q., and Philip J. Wilke (eds.)
 1988 Archaeological Investigations at CA-RIV-1179, CA-RIV-2823, and CA-RIV-2827, La Quinta, Riverside, California. Coyote Press Archives of California Prehistory No. 20.
- Sykes, Godfrey
 1914 Geographical Features of the Cahuilla Basin. In: *The Salton Sea: A Study of the Geography, the Geology, the Floristics, and the Ecology of a Desert Basin*, by D. T. MacDougal, pp. 13-20. Washington: Carnegie Institution of Washington Publication 193.
- 1937 *The Colorado Delta*. Washington: Carnegie Institution of Washington Publication 460.
- Taylor, R. E.
 1987 *Radiocarbon Dating*. Orlando: Academic Press.
- 1991 Frameworks for Dating the Late Pleistocene Peopling of the Americas. In: *The First Americans: Search and Research*, Tom D. Dillehay and David J. Meltzer, eds., pp. 77-111. Boca Raton: CRC Press.
- Taylor, R. E., L. A. Payen, C. A. Prior, P. J. Slota, Jr., R. Gillespie, J. A. J. Gowlett, R. E. M. Hedges, A. J. T. Jull, T. H. Zabel, D. J. Donahue, and R. Berger
 1985 Major Revisions in the Pleistocene Age Assignments for North American Skeletons by C-14 Accelerator Mass Spectrometry: None Older than 11,000 C-14 Years B.P. *American Antiquity* 50(1):136-140.
- Vivian, R. Gwinn
 1965 An Archaeological Survey of the Lower Gila River, Arizona. *Kiva* 30(4):95-146.
- von Werlhof, Jay
 1980 An Archaeological Overview of San Sebastian Village, Imperial County, California (4-IMP-1141). Report on file at the Southeast Information Center, Imperial Valley College Museum, El Centro.
- 1988 Trails in Eastern San Diego County and Imperial County: An Interim Report. *Pacific Coast Archaeological Society Quarterly* 24(1):51-75.
- von Werlhof, Jay, and Karen McNitt
 1980 Archaeological Examinations of the Republic Geothermal Field, East Mesa, Imperial County. Report on file at the Southeast Information Center, Imperial Valley College Museum, El Centro.
- von Werlhof, Jay, Sherilee von Werlhof, Karen McNitt, and Lorraine Pritchett
 1979 Archaeological Investigations of the Magma Site, East Mesa. Report on file at the Southeast Information Center, Imperial Valley College Museum, El Centro.
- Wallace, William J., and Edith S. Taylor
 1960 The Indian Hill Rockshelter: Preliminary Investigations. *The Masterkey* 34(2):66-82.
- Wallace, William J., Edith S. Taylor, and George Kritzman
 1962 Additional Excavations at the Indian Hill Rockshelter, Anza-Borrego Desert State Park, California. In: *Archaeological Explorations in the Southern Section of the Anza-Borrego Desert State Park*, W. J. Wallace, ed., Part IV. California Department of Parks and Recreation Archaeological Report 5.
- Warren, Claude N.
 1966 The San Dieguito Type Site: Malcolm J. Rogers' 1938 Excavation on the San Dieguito River. *San Diego Museum Papers* No. 5.
- 1967 The San Dieguito Complex: A Review and Hypothesis. *American Antiquity* 32(2):168-185.
- 1984 The Desert Region. In: *California Archaeology*, by Michael J. Moratto, pp. 339-430. Orlando: Academic Press.
- Wasley, William W., and Alfred E. Johnson
 1965 *Salvage Archaeology in Painted Rocks Reservoir, Western Arizona*. Tucson: Anthropological Papers of the University of Arizona No. 9.
- Watchman, Alan
 1992 Investigating the Cation-Ratio Calibration Curve: Evidence from South Australia. *Rock Art Research* 9(2):106-110.
- Waters, Michael R.
 1982a The Lowland Patayan Ceramic Typology. In: *Hohokam and Patayan: Prehistory of Southwestern Arizona*, Randall H. McGuire and Michael B. Schiffer, eds., pp. 537-570. New York: Academic Press.

- 1982b Ceramic Data From Lowland Patayan Sites. In: Hohokam and Patayan: Prehistory of Southwestern Arizona, Randall H. McGuire and Michael B. Schiffer, eds., pp. 571-580. New York: Academic Press.
- 1982c Trail Shrines at Site SDM C-1. In: Hohokam and Patayan: Prehistory of Southwestern Arizona, Randall H. McGuire and Michael B. Schiffer, eds., pp. 533-535. New York: Academic Press.
- 1983 Late Holocene Lacustrine Chronology and Archaeology of Ancient Lake Cahuilla. *Quaternary Research* 19:373-387.
- Weide, David
- 1974 Regional Environmental History of the Yuha Desert Region. In: Background to Prehistory of the Yuha Desert Region, by Margaret L. Weide and James P. Barker, Philip J. Wilke, ed., pp. 4-15. Riverside: Bureau of Land Management. (Reprinted by Ballena Press 1976).
- Weide, Margaret L.
- 1974 Archaeological Potential of the Yuha Area. In: Background to Prehistory of the Yuha Desert Region, Philip J. Wilke, ed., pp. 103-107. Riverside: Bureau of Land Management. (Reprinted by Ballena Press 1976).
- Weide, Margaret L., and James P. Barker
- 1974 Background to Prehistory of the Yuha Desert Region, Philip J. Wilke, ed. Riverside: Bureau of Land Management. (Reprinted by Ballena Press 1976).
- White, Chris
- 1974 Lower Colorado River Area. Aboriginal Warfare and Alliance Dynamics. In: 'Antap, California Indian Political and Economic Organization, Lowell J. Bean and Thomas F. King, eds., pp. 111-136. Ramona: Ballena Press.
- Wilke, Philip J.
- 1974 Settlement and Subsistence at Perris Reservoir: A Summary of Archaeological Investigations. In: Perris Reservoir Archaeology: Late Prehistoric Demographic Change in Southeastern California, James F. O'Connell, Philip J. Wilke, Thomas F. King, and Carol L. Mix, eds., pp. 20-30. Sacramento: Department of Parks and Recreation.
- 1978 Late Prehistoric Human Ecology at Lake Cahuilla, Coachella Valley, California. Berkeley: Contributions of the University of California Archaeological Research Facility No. 38.
- 1980 Prehistoric Weir Fishing on Recessional Shorelines of Lake Cahuilla, Salton Basin, Southeastern California. In: Proceedings of the Desert Fishes Council, Vol. XI, pp. 101-102. The Desert Fishes Council, Bishop, California.
- Wilke, Philip J., and Harry W. Lawton
- 1975 Early Observations on the Cultural Geography of Coachella Valley. Ballena Press Anthropological Papers No. 3(1):9-43.
- Wilke, Philip J., and Meg McDonald
- 1989 Prehistoric Use of Rock-Lined Cache Pits: California Deserts and Southwest. *Journal of California and Great Basin Anthropology* 11(1):50-73.
- Wilke, Philip J., Mary DeDecker, and Lawrence E. Dawson
- 1979 *Dicoria canescens* T. & G., an Aboriginal Food Plant in the Arid West. *Journal of California and Great Basin Anthropology* 1(1):188-192.
- Wilke, Philip J., Meg McDonald, and L. A. Payen (eds.)
- 1986 Excavations at Indian Hill Rockshelter, Anza-Borrego Desert State Park, California, 1984-1985. Report on file at the Archaeological Research Unit, University of California, Riverside.
- Wills, W. H.
- 1988 Early Prehistoric Agriculture in the American Southwest. Santa Fe: School of American Research Press.
- Yohe, Robert M., II
- 1990 Archaeological Investigations at Five Sites Located at One Eleven La Quinta Center in the City of La Quinta, Central Riverside County, California. Report on file at the Eastern Information Center, University of California, Riverside.

