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Edited by Jon M. Erlandson and Michael A. Glassow

*with contributions by*

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Institute of Archaeology, University of California, Los Angeles

❀ PERSPECTIVES IN CALIFORNIA ARCHAEOLOGY, VOLUME 4

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# Preface

THE CHAPTERS IN THIS VOLUME were first presented in the symposium "The Archaeology of the California Coast during the Middle Holocene," at the Society for California Archaeology Annual Meeting at Asilomar in 1993. We organized that symposium to provide a forum for archaeologists actively working on the California coast to discuss their recent research on Middle Holocene (6650 to 3350 RYBP) sites located along various parts of the California littoral. Later, additional manuscripts were solicited from a few people not involved in the symposium. One of these was a paper on Baja California, a project Jerry Moore ultimately concluded was not advisable given the limited data available from Middle Holocene sites at the time.

A volume dedicated to areal summaries for a particular time period and a region corresponding to a modern political boundary risks a provincialism that could lose sight of broader trends in the prehistory of California and surrounding regions. However, this volume is an outgrowth of an earlier book, *Hunter-Gatherers of Early Holocene Coastal California* (Erlandson and Colten 1991) published by The UCLA Institute of Archaeology. In the next few years, we hope to publish a third volume focused on California's maritime cultures of the last thirty-five hundred years, completing a trilogy that chronicles the origins and development of California's remarkable coastal societies over the pas ten thousand years.

To minimize the problems of provincialism, we have also written introductory and concluding chapters that place discussions of Middle Holocene cultural and environmental changes along the California coast within a broader framework of similar or contrasting developments in adjacent coastal or interior regions. Finally, we have encouraged individual authors to place their research within the context of a regional synthesis and to look for connections with both surrounding areas and earlier or later time periods.

In putting this volume together, we tried to cover the entire California coast. Inevitably, however, the volume is weighted heavily towards the Southern and Central California coasts. This reflects both the greater intensity of archaeological investigations conducted in these areas and the very small number of Middle Holocene coastal sites documented north of Monterey Bay. Until more intensive research is conducted on the coast of Northern California—and additional Early and Middle Holocene coastal sites are found—any treatment of the early phases of California's coastal prehistory will remain unbalanced.

This volume would never have come to fruition without the hard work and dedication of the individual authors, as well as many colleagues who shared data, reviewed manuscripts, inspired ideas, or constructed the scholarly foundations on which we have built. We also deeply appreciate the encouragement, support, and advice of Marilyn Beaudry-Corbett and Jeanne Arnold at The UCLA Institute of Archaeology, as well as the production and editing expertise of the Institute's publications staff. Ultimately, of course, the volume never would have happened without the archaeological record left behind by California's remarkable coastal tribes, a record of ingenious adaptations that spans ten thousand years. To those diverse and fascinating peoples of the past, as well as to their many living descendents, we respectfully dedicate this volume.

JON M. ERLANDSON
MICHAEL A. GLASSOW

CHAPTER 1

# The Middle Holocene along the California Coast

*Jon M. Erlandson*

FROM THE FRIGID SHORELINES of the arctic to the cool rainforests of the Northwest Coast and the arid landscapes of the Baja California littoral, native peoples of the Pacific Coast of North America occupied a diverse array of environments. Many of these coastal hunter-gatherers are renowned for their artistic and technological traditions, dense and sedentary populations, and economic and sociopolitical complexity. Despite the diversity of the environments they occupied and the variety of ethnic or linguistic stocks they originated from, the Native societies of the Pacific Coast shared many traits because of their common reliance on a broadly similar suite of marine resources, especially fish, shellfish, and sea mammals (Moss and Erlandson 1995).

Because it has been one of the archaeologically most intensively studied coastal areas in the world, we know that the Pacific Coast was occupied at least nine thousand years ago, although significant gaps still exist in the distribution of early sites (Erlandson and Moss 1996; Lightfoot 1993). General cultural patterns for the Early Holocene and Late Holocene are relatively well known for much of the Pacific Coast, but in most areas Middle Holocene developments are poorly understood (Moss and Erlandson 1995:33). This volume examines cultural and environmental developments along the coast of California during the Middle Holocene. When Europeans first explored the California coast during the 1500s and 1600s, they encountered some of the most populous, prosperous, and complex hunter-gatherer societies on earth. Many of California's Indian tribes are well known among anthropologists for achieving a degree of economic and sociopolitical complexity unusual among nonagricultural peoples. After European contact, Native Californians were devastated by foreign diseases, dispossession, and often violent persecution. A great deal of traditional information was also lost. Fortunately, a vast store of information about more than ten thousand years in the development of California's coastal societies is contained in sites that have been—and will be—excavated and studied.

In California, cultural complexity and population densities peaked among maritime and riverine tribes. The coastal Chumash Indians of Southern California, for example, lived in towns of as many as one thousand people. Chumash society was organized hierarchically, with governing secular and religious councils, inherited leadership roles, and intervillage alliances or federations (J. Johnson 1988; C. King 1990). Economically, the Chumash had specialized craft guilds and manufacturing sites, elaborate and highly artistic technological traditions, and extensive trade networks facilitated by the use of shell bead money (Arnold 1992; C. King 1971). To one degree or another, signs of societal complexity are found archaeologically among virtually all of California's coastal tribes.

The complexity of California's maritime societies has been clearly established, but the process by which these complex cultures developed is much less well understood. The rich cultural traditions and archaeological sites of California's coastal tribes have attracted scientific attention for over a century. Working with California Indian descendants and with materials recovered from the scientific investigation of their ancestral sites, we have learned much about how Native Californians lived, the dynamic environments they adapted to, how their cultures changed through time, and the historical development of their cultural diversity and complexity. We now know people have lived along the California coast for at least ten thousand years and that their ancestors migrated from Asia to North America millennia before that. There is much to be learned, however, about how and when these people first arrived on the California coast, the nature of their technologies and economies at various points in time, and their interactions with the natural environment and neighboring groups.

In particular, we know relatively little about the Middle Holocene of California prehistory—the time between about 6650 and 3350 radiocarbon years before present (RYBP).[1] During this transitional period, the earliest cultures of the area developed into—or were replaced by—many of the diverse and distinctive tribes that occupied the California coast during late prehistoric and historic times. Over the years, archaeologists working on the California coast have focused most of their efforts on the more glamorous excavation of late prehistoric and historic villages or on the more dramatic search for the earliest occupants. We seem to know more about the more ancient cultural developments of the Early Holocene than we do about those of the Middle Holocene.

In the eleven chapters of this volume, archaeologists actively engaged in research on the California coast examine the archaeological and environmental records of the Middle Holocene—addressing issues ranging from chronology building to the causes of culture change. Reflecting the history of California archaeology and the nature of the coastal archaeological record itself, common themes are found among individual chapters: the identification of changes in the natural environment, human technology, settlement patterns, subsistence, and societal organization, as well as the search for explanations for the changes observed in Middle Holocene cultures. Explanations as diverse as environmental change, population growth or decline, intrusive ethnic migrations, and the regional interaction of peoples trading goods and ideas, attempt to account for the variability observed in the archaeological record. Finally, more or less explicitly, all consider the excavation and interpretation of shell middens, the cultural ecology of maritime peoples, and the evolution of coastal adaptations.

## CALIFORNIA COASTAL ENVIRONMENTS

As the crow flies, the California coast extends for almost 1300 km from northwest to southeast, spanning ten degrees of latitude (between about 32° N and 42° N) and a variety of marine and terrestrial environments. Following the more circuitous shoreline itself, however, the California coast stretches for almost 2000 km, not counting the coastlines of offshore islands.

The differential distribution, productivity, and accessibility of various resources along the California coast had a major influence on where people settled and when, what they ate, what tools they made, how their population density changed, and how they interacted with their neighbors. California's coastal environments were not stable through time, either, but often changed dramatically over the millennia. To understand the origins and development of California's diverse coastal cultures, therefore, we must understand the nature of environmental variation through space and time. At any given point in time, the cultural effects of such environmental variation were expressed on a variety of spatial levels, from localized differences in habitat availability to broad regional patterns in the productivity of various food classes (see chapter 10).

Like most coastlines of the Pacific Rim, the California coast is mountainous and tectonically active. Its geology is complex and relatively recent. Much of California's modern coastal landscape is the result of erosional processes that modified sedimentary and volcanic formations of predominantly marine origin. Tectonic processes related to the subduction of the oceanic Pacific Plate beneath the continental North American Plate have welded a diverse array of rock formations to the continental margin. Many of these coastal formations—tilted, deformed, or otherwise modified by tectonic forces—are rich in sandstones, cherts, siliceous shales, basalts, as well as serpentines, steatites, and similar rock types, which were widely used by California's coastal tribes. Recent vulcanism is limited largely to more interior areas, however, from which obsidian and other materials were obtained by coastal tribes through trade.

Along much of the coast, formidable mountains rise relatively rapidly from the sea. Compared to many parts of the world, California's coastal plains and continental shelves are generally narrow. The juxtaposition of the mountains and the sea often stacks a variety of ecological habitats within a short distance of the coast. This variety encouraged sedentary lifestyles, relatively high population densities, and the development of a complex material culture. In many areas, however, the available living space was wedged between land and sea, a situation termed *environmental circumscription* by anthropologists.

Marine productivity along much of the California coast is fed by the upwelling of cool nutrient-rich currents and oceanic mixing with productive estuarine habitats. The nutrients from such sources supported relatively dense accumulations of marine phytoplankton and zooplankton. These, in turn, fed a diverse food chain that includes over five hundred species of marine fish (Miller and Lea 1972), as many as thirty-four species of sea mammal (Burt and Grossenheider 1976), numerous shore and sea birds, and a variety of productive shellfish beds. California's diverse terrestrial habitats are also relatively productive. Various species of oak trees are available up and down the coast, and these produce prodigious quantities of edible acorns. Other seed producers and edible plants are available in coastal scrub, chaparral, grassland, riparian, and marsh communities. Such habitats also support a variety of land mammals, reptiles, birds, amphibians, and other organisms.

[1] Ages in this volume are given in either uncorrected RYBP or in calibrated calendar years before present (CYBP). See Stuiver and Reimer (1993).

Despite general similarities in the geography of the California coast, there are significant ecological variations as well. California's diverse coastal environments range from the wet coniferous rainforests of the north coast to the arid shores of northern Baja California, and from calm and protected salt marshes to rocky shores regularly hammered by heavy surf. Although a number of plant and animal species or genera are common to much of the California coast, major biogeographic boundaries divide both the terrestrial and marine components of the coast. Point Conception marks a general boundary between northern cool-water biota and southern warm-water biota, for instance, with the Santa Barbara Channel a transitional zone. The coastal region can be divided into three provinces of roughly equal length: the north, central, and south coasts (fig. 1.1).

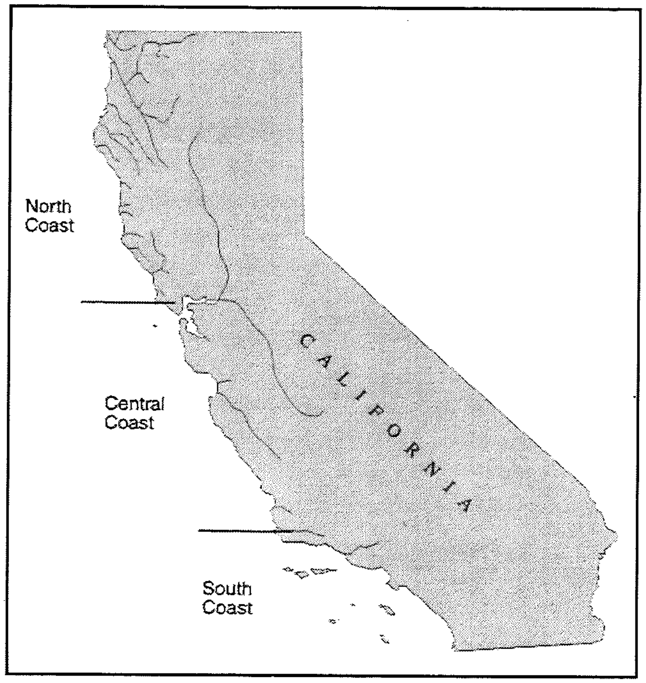



FIGURE 1.1 The California coast

Extending from the Oregon border to Point Reyes, most of the north coast is rough and rugged. The Klamath Mountains and Coast Ranges rise rapidly from the sea to elevations of up to three thousand meters or more. Relatively abundant rainfall supports lush forests along much of this coast, primarily redwood and other coniferous forests, but oak woodlands, grasslands, and mosaic communities are also found. Higher rainfall also feeds a number of relatively large and perennial rivers that dissect the mountains of the north coast, including the Klamath, Eel, and Russian rivers. Many rivers of the north coast teem seasonally with salmon, sturgeon, and other anadromous fish. River valleys also provide habitat for a variety of land mammals, including such economically important species as elk and deer. Except for such occasional protected features as Humboldt Bay or smaller river mouths and estuaries, most of the west-facing north coast is exposed to the brunt of high winds and surf associated with winter storms. In many areas, such storms significantly limited access to intertidal and nearshore resources from late fall to early spring. Rocky stacks or small islets are common along parts of the north coast, some containing sea mammal rookeries or seabird colonies, but no substantial islands are found offshore.

From San Francisco Bay to Point Arguello, the central coast encompasses the San Francisco Bay area and the predominantly exposed coasts to the south. The vast San Francisco Bay was once a virtually continuous network of rich estuarine and freshwater marsh habitats (see chapter 9), all protected from the ocean swells that batter much of the California coast seasonally. Offshore rocks or islets are common in many outer-coast areas, but the Farallons off San Francisco Bay are the only substantial islands off the central coast. Much of the coast south of San Francisco Bay is exposed and dominated by rocky shore habitats. Monterey Bay, Morro Bay, and a number of smaller bays or estuaries, however, contain more protected habitats (chapter 8). Anadromous fish runs are much less productive south of San Francisco Bay, rainfall is highly seasonal, and the landscape becomes increasingly arid. Coniferous forest habitats are increasingly replaced by oak woodland, grassland, chaparral, and coastal scrub communities. Elk, deer, and a variety of other land mammals were once found through much of this area, but the productivity of elk probably declined towards the southern limit of their coastal range.

Along the south coast, from Point Arguello to the Mexican border, shoreline orientation and islands provide some protection from Pacific swells. Much of the coast from Point Arguello to Long Beach faces south, protected from the prevailing northwesterlies by Point Conception, Point Dume, or the Palos Verdes Peninsula. Several large and productive estuaries once punctuated this coast, including the Goleta Slough, El Estero, and Mugu Lagoon (see chapter 6). Most of the coast between Long Beach and San Diego faces southwest and also contains lagoons like Newport Bay, Batiquitos Lagoon, and San Diego Bay (see chapters 2, 4). The coast of Southern California is also protected by the eight Channel Islands. The Northern Channel Islands of Anacapa, Santa Cruz, Santa Rosa, and San Miguel are tightly clustered off the Santa Barbara coast and shelter the Santa Barbara Channel. The southern Channel Islands of San Clemente, Santa Catalina, San Nicolas, and Santa Barbara are more widely dispersed off the coast from Los Angeles to San Diego (see chapter 3). Vegetation communities are increasingly arid in character, dominated by coastal scrub and chaparral habitats. Oak woodland, grassland, riparian, and marsh communities are widely distributed, however, and scattered relict stands of pine forests are also found in this area. Except for a few small steelhead runs, anadromous fish are not present.

Deer, bear, and a variety of small and medium mammals are found but no elk.

## ENVIRONMENTAL CHANGES THROUGH TIME

Along with the ecological variability typical of historic times, many of California's coastal environments have changed dramatically over the millennia. The transition from glacial to interglacial climates between about seventeen and eight thousand years ago, for instance, had profound effects on the distribution and productivity of animal and plant communities, on global sea levels, and on the location and conformation of the California coast (see Bickel 1978; Erlandson 1994; Moratto 1984:223). Most environmental changes over the last eight thousand years have been less dramatic, but California's coastal environments have continued to respond to short- and long-term climatic and other geographic trends.

In coastal areas, one of the most important contributors to landscape evolution is change in sea level. Between seventeen and seven thousand years ago, glacial melting caused global sea levels to rise rapidly from about 120 m to about 10 m below present (Inman 1983:8–9). This flooded large tracts of California's coastal lowlands and formed numerous bays and estuaries as coastal canyons were flooded (Bickel 1978; chapter 2). During the Middle Holocene, the rise in sea level slowed dramatically, but many coastal habitats remained in a state of constant flux. In most outer-coast areas, coastal plain habitats continued to be lost to shoreline transgression caused by gradual coastal erosion. As sea levels stabilized, many coastal bays and lagoons filled with sediment and were reduced in size, were periodically cut off from oceanic circulation, or disappeared altogether. As coastal estuaries filled, more sediment reached the outer coast, often transforming rocky shorelines into sandy beach or mosaic habitats (see chapter 7). Some estuaries even appear to have been transformed into freshwater lakes, as sand dunes blocked the mouths of some coastal drainages. Other bays and estuaries remained open and productive during the Middle Holocene, and some may even have been newly formed by tectonic subsidence, erosion, or fluctuations in river mouths.

As several of the chapters in this volume illustrate, the effects of these changes on coastal geography and resource productivity were complex and varied from place to place. During the Early Holocene, marine transgression generally reduced the extent and productivity of terrestrial coastal plain habitats and increased the extent of productive estuarine and other intertidal habitats. During the Middle Holocene, estuarine infilling generally had the opposite effect, although the cutting of shallow nearshore platforms may have increased the productivity of kelp beds and other shallow outer-coast habitats (Yesner 1980).

Another major source of environmental change through time is long-term fluctuations in postglacial climates. The Middle Holocene roughly corresponds to a general trend towards climatic warming in western North America (and beyond), an interval called the Altithermal (Antevs 1955). As originally defined, the Altithermal spanned the period from about 7000 to 4000 RYBP, a warmer and drier interval when many pluvial lakes in the Great Basin disappeared and xeric plant communities expanded their range in much of California (Axelrod 1967). California climates probably varied significantly through both space and time during the Altithermal (Moratto 1984:548; Moratto, King, and Woolfenden 1978), but the general concept of a Middle Holocene warm interval has gained considerable support and acceptance. Because of its maritime character and equability, however, it seems likely that the California coast was affected less dramatically by the Altithermal than many interior areas. Nonetheless, significant changes in the character of coastal plant and animal communities, as well as the availability of freshwater, may have occurred during the Middle Holocene.

## ARCHAEOLOGICAL SETTING: THE FIRST CALIFORNIANS

The California coast encompasses portions of both the Northwest Coast and California culture areas. Researchers have drawn the boundaries between these two culture areas differently (see Suttles 1990:9–12). Aside from a greater emphasis on riverine and coniferous forest resources, the coast of Northern California is clearly transitional. It is more similar in many ways to the California culture area than the classic Northwest Coast cultures to the north.

Study of California shell middens began in the late 1800s (see Schumacher 1875), but stratigraphically controlled excavations began in the early 1900s, with Uhle (1907) and Gifford's (1916) work in San Francisco Bay shell mounds. Over the years, archaeologists studying California have played a key role in the development of methods and theories for the study of shell middens and coastal adaptations (for example, Arnold 1992; Botkin 1980; Cook and Treganza 1947; Erlandson 1988a; Glassow and Wilcoxon 1988; Gould 1966; Hildebrandt and Jones 1992; Jones 1991; Lambert 1993; Meighan 1959). The past twenty-five years have seen a great increase in the amount of archaeological research in California because of federal, state, and local laws that require the investigation of archaeological sites threatened by development. Effective synthesis of the massive amounts of data resulting from this growth is one of the keys to further progress in understanding cultural developments along the California coast.

The long history of archaeological research on the California coast and the provincialism of many local researchers has led to a confusing morass of local phase, horizon, or period designations (see Moratto [1984:xxxii] for a small sample of these). This terminological scramble makes comparing cultural and environmental changes over a broad area unwieldy and needlessly complex. I simply divide the ten thousand years of the Holocene defined by geologists into three parts (see Erlandson 1988b). Although arbitrarily defined (fig. 1.2), the Terminal Pleistocene, Early Holocene, Middle Holocene, and Late Holocene epochs roughly correspond to some general developments important in California coastal prehistory.

**Terminal Pleistocene (ca. 12,000 to 10,000 RYBP)**

Available evidence suggests that this is probably the time that Paleo-Indian peoples first settled the California coast. Isolated Clovis-like points from the Santa Barbara area (Erlandson, Cooley, and Carrico 1987), the Mendocino County coast (Simons, Layton, and Knudson 1985), and the southern Oregon coast (Erlandson and Moss 1996) suggest that people had arrived in these areas between about 10,500 and 11,500 RYBP. Unfortunately we know very little about how coastal Paleo-Indian peoples lived or where they came from. At present, for instance, it is not known whether early Paleocoastal peoples (Moratto 1984) used marine resources, how much they depended on plant foods, or whether their economies were based primarily on the hunting of large land mammals.

Evidence for the occupation of the northern Channel Islands between 10,000 and 11,000 RYBP comes from Daisy Cave on San Miguel Island and the Arlington Springs skeleton on Santa Rosa Island (Erlandson 1994; Erlandson et al. 1996; Orr 1962, 1968). The colonization of the Channel Islands, like the roughly contemporaneous settlement of the Alexander Archipelago in Southeast Alaska, required the use of relatively seaworthy boats. A thin brown cave soil at Daisy Cave (SMI-261) contains a diffuse scatter of chipped-stone artifacts, red abalones, and other marine shells that appear to have been left behind by humans as much as 10,300 years ago (Erlandson 1993; Erlandson et al. 1996).

**Early Holocene (10,000 to 6650 RYBP)**

More definitive evidence for the occupation of the California coast is present at several sites dated to about 9000 RYBP or slightly earlier (see Connolly, Erlandson, and Norris 1995; Erlandson and Colten 1991a; Glassow 1991:115–116; Greenwood 1972; Moriarty 1967; Orr 1968; Warren 1967). These include both mainland and Channel Island localities that appear to lack handheld mullers (manos) and grinding stones (metates) used by later peoples to grind small seeds and other foods. Altogether, more than eighty-five coastal sites in California have been dated between about 7000 and 10,000 RYBP (Erlandson 1994; Jones 1991; Moss and Erlandson 1995), but only one of these is located north of Monterey Bay (see Schwaderer 1992). The number of coastal sites rises dramatically between 9000 and 8000 RYBP, a period when sites from the early Milling Stone appear along much of the southern and central California coast. These sites typically contain numerous manos and metates, hammerstones, and flaked cobbles. Leaf-shaped bifaces and bone tools are present in many sites from the early Milling Stone but are rare. The presence of obsidian artifacts (mostly debitage) suggests that early peoples participated in long-distance trade networks, but evidence for craft specialization or other indicators of cultural complexity are rare. On the mainland coast, economies of the early Milling Stone appear to have been quite eclectic, but shellfish and edible seeds appear to have been dietary staples (Erlandson 1991a, 1994; Warren 1968).

Off the coast of Southern California, most of the Channel Islands have now produced evidence for Early Holocene occupation. Unlike most mainland coastal sites dated from about 9000 to 6700 RYBP, milling stones appear to be rare or absent in early island sites. Daisy Cave on San Miguel Island, with occupational strata dated between about 8000 and 9400 RYBP, contains the most remarkable record of early island adaptations. These deposits contain dense layers of shellfish interspersed with the bones of fish, birds, and sea mammals. Bipointed bone fish gorges are relatively common, as are spire-ground *Olivella biplicata* beads, but bifaces and other formal chipped-stone tools are relatively rare. Chipped-stone tools are common, but they are dominated by expedient retouched and utilized flakes. The most remarkable aspect of the Early Holocene assemblage at Daisy Cave is the presence of twined sea-grass basketry and cordage (Connolly, Erlandson, and Norris 1995).

**Middle Holocene (6650 to 3350 RYBP)**

During the Middle Holocene, there continues to be a disparity in the distribution of coastal sites in California, with scores of examples documented for the south and central coast, but few examples documented north of Monterey Bay (see chapters 9 and 10). Whether the dearth of Middle Holocene shell middens and other coastal sites along the north coast is a true cultural pattern, a reflection of the lower intensity of archaeological research in the area, or the result of such environmental biases as coastal submergence or erosion is uncertain. In general, there appear to be too few data to talk confidently about broad Middle Holocene adaptations along the Northern California coast. Chapter 10, however, presents the first truly coherent argument that intensive and widespread coastal adaptations may not have existed in this area during the Middle Holocene—at least along the outer coast.

Elsewhere, the Middle Holocene is a period of considerable technological innovation along the California coast, even though archaeological assemblages in some areas continue to reflect lifestyles of the Milling-Stone period similar

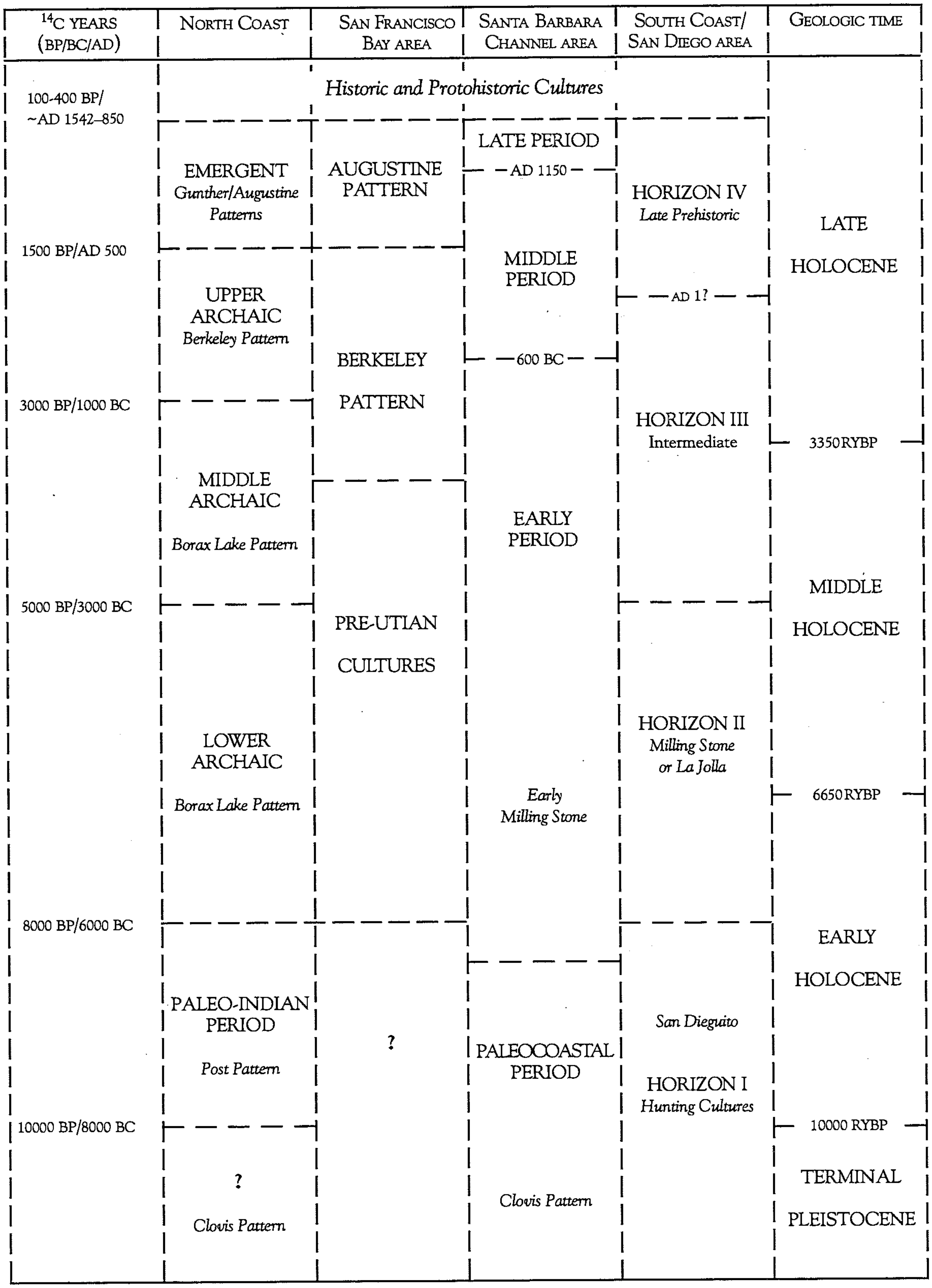



FIGURE 1.2 Some chronological sequences for California coast. All dates are in uncorrected radiocarbon years. *Adapted from Frederickson 1984, Moratto 1984, C. King 1990, Wallace 1955, M. Rogers 1929, and Erlandson 1988b.*

to Early Holocene patterns. During the Middle Holocene, the first widespread use of mortars and pestles takes place along the California coast. This has long been assumed to signal the first systematic use of acorns, but Glassow (chapters 6, 11) argues the early use of mortars and pestles may have been for root processing. New types of large dart points (similar to Elko series points widespread in western North America)—side-notched varieties and then contracting-stem types—also seem to first appear during the Middle Holocene, and projectile points are generally more abundant than in Early Holocene sites. Notched stone sinkers or net weights are almost certainly associated with innovations in fishing technology and circular shell fishhooks may also appear in some areas during the later Middle Holocene (Salls 1991; Strudwick 1985). The earliest reasonably secure evidence for asphaltum basketry impressions and tarring pebbles seems to date to roughly 4000 RYBP (Bleitz 1991; Connolly, Erlandson, and Norris 1995; chapter 7), suggesting that bitumen-sealed containers also first appear during the Middle Holocene. New types of shell beads also appear in the Middle Holocene (see C. King 1990), innovations that may represent simple stylistic changes, changes in social structure, or the development of distinct interaction spheres based on socioeconomic, political, or ethnic affiliations (Howard and Raab 1993; chapter 3). Finally, the earliest wood-stake fishing weirs on the Northwest Coast now date to between about 3500 and 4500 RYBP (Moss 1994; Moss and Erlandson 1996; Moss, Erlandson, and Stuckenrath 1990), and weir fishing along the coast of Northern California may have a similar antiquity.

Many of these technological developments seem to be related to a progressive diversification in human subsistence along the California coast during the Holocene. Since at least the 1920s, California archaeologists have recognized a general trend towards the diversification of coastal hunting and fishing technologies. This pattern is correlated with the increasing abundance of mammal, fish, and bird remains in Middle Holocene archaeological sites (D. Rogers 1929; Wallace 1955, 1978c; Warren 1968; and others). Much remains to be learned, however, about the timing, meaning, and causes of these and other Middle Holocene technological developments (see Glassow, chapter 11).

A number of researchers have implicated population growth or resource stress as agents of Middle Holocene culture change along the California coast (for example, Glassow, Wilcoxon, and Erlandson 1988). On both the south and central coasts, for instance, the number of radiocarbon dated archaeological sites generally increases until at least 6000 RYBP (Erlandson 1994:257; Glassow, Wilcoxon, and Erlandson 1988:69), suggesting that human populations were growing. In some areas, however, the number of dated sites decreases during the early Middle Holocene suggesting that population levels may have declined during certain periods (see chapter 6). Whether variations in the raw numbers of radiocarbon-dated sites actually reflect past population levels is uncertain, however, and more refined methods of estimating past population levels (see chapter 7) are needed to assess the specific role that population fluctuations played in various cultural developments.

Studies of California's linguistic prehistory suggest that at least two key migrations may have taken place along the California coast during the Middle Holocene. Moratto (1984:529–574) suggests that two primary linguistic groups lived along the California coast between ten thousand and six thousand years ago: Hokan (or proto-Hokan) peoples from the San Francisco Bay area southward, and Yukian (proto-Yukian) peoples farther north. Sometime during the Middle Holocene—the precise times are widely debated, it appears that Penutian speakers moved into the San Francisco Bay area, and that Uto-Aztecan (Shoshonean) peoples moved from the Great Basin to the Los Angeles coast and southern Channel Islands. These intrusions are most often seen as reaching the central and southern California coasts during the late Middle Holocene, between about 3000 and 4000 RYBP. It is worth considering, however, whether the Shoshonean intrusion may not have occurred somewhat earlier, as data presented by Raab (chapter 3) and Vellanoweth (1996) might suggest. Whenever such migrations reached the coast, they undoubtedly stimulated considerable culture change, affecting the sociopolitical and economic patterns of the newcomers, the people they displaced, and their neighbors.

### Late Holocene (3350 to 0 RYBP)

Archaeologically, the Late Holocene is the first period for which a substantial record of occupation is found throughout coastal California, including the north coast (see Elsasser 1978). This is the period when many of the distinctive features of California's complex maritime societies fully developed for the first time (Chartkoff and Chartkoff 1984). In general, archaeological sites appear to be both larger and more numerous than in earlier periods. In many areas, village sites are associated with large cemeteries, which suggest both large and sedentary populations (for example, Martz 1992). The archaeological record of the Late Holocene is also marked by generally increasing elaboration and sophistication of coastal subsistence and technology, greater emphasis on aesthetic decoration of functional tool classes, increasing evidence for craft specialization (see Arnold 1987, 1992), more intensive trade, and increases in religious behavior, sociopolitical ranking, stress-related diseases, warfare, and interpersonal violence (Lambert and Walker 1991; Walker 1989). In most areas, the first evidence for fully developed fishing and sea mammal hunting economies appear during this period. The linkage between greater socioeconomic and technological complexity and such indicators of societal stress as violence and disease strongly suggest that many of California's maritime societies had reached a state of "territorial circumscription" (see Carneiro 1970) by the Late Holocene, leading to economic intensification and increased competition.

These developments were probably fueled by a combination of population growth, the amplified effects of environmental perturbations on people living at or near the carrying capacity of their local environments, and resource stress. Once again, however, population movements may have played a major role in initiating culture changes. During the Late Holocene, for instance, Penutian and Shoshonean peoples seem to have expanded their central and south coast territories, and Algic- and Athapaskan-speaking peoples probably first moved into new territories along the coast of Northern California (Moratto 1984). Late Holocene migrations and territorial expansion must have affected the ethnic composition of California's coastal societies, altered social and economic interaction spheres, and influenced the developmental trajectories of cultures on both local and regional scales.

In short, the Late Holocene encapsulates the progressive cultural elaboration and diversification that led to the diverse and complex cultures typical of the California coast at the time of European contact (see Heizer 1978). Tragically, within a few decades after European colonization, virtually every component of those sophisticated cultures was devastated by the combined effects of foreign diseases, ethnic discrimination, and political disenfranchisement (Castillo 1978). Although some anthropologists have described various California Indian tribes as extinct, many descendants of these first Californians not only survived to the present but also managed to do so with remnants of their traditional cultures intact.

## SOME RESEARCH THEMES FOR THE MIDDLE HOLOCENE

Some of the major issues relevant to studying Middle Holocene (and other) cultural developments on the California coast, addressed in one way or another by chapters in this volume, include reading the archaeological record, environmental reconstructions, shifts in settlement and subsistence strategies, technological change, and the evolution of coastal adaptations. Specific aspects of some of these issues are also discussed by Michael Glassow in chapter 11.

### Reading the Archaeological Record

Many problems in archaeology today revolve around issues of reading, or deciphering, the archaeological record. In California, for instance, the burrowing of gophers and other animals has severely disturbed the stratigraphy of most mainland sites. Research has shown that artifacts of various sizes may be moved downward through site soils under some conditions, whereas under others they are moved upward (Erlandson and Rockwell 1987; D. L. Johnson 1989; Wood and Johnson 1978). Since multicomponent sites are common along the California coast, this disturbance affects the interpretation of site chronologies, the materials associated with various strata, and the temporal range of key artifact types.

In any given area, the investigated archaeological sites may or may not represent the full range of sites (and human behaviors) left behind by past peoples. For example, the antiquity of California's coastal sites generally declines to the north. Early and Middle Holocene coastal sites—abundant from Monterey Bay to the south—are rare from San Francisco Bay northward. This pattern continues along the coasts of Oregon and Washington, before early coastal sites once again become relatively common in British Columbia and Southeast Alaska (Erlandson 1994; Lightfoot 1993; Lyman 1991; Moss and Erlandson 1995). For northern California, the dearth of early sites has been attributed to the differential effects of the rise in sea level (Bickel 1978:10), the declining intensity of archaeological research from south to north, and the lack of research in productive estuarine settings (Jones 1991). Others have suggested that the lower number of coastal sites to the north may be related to real differences in the antiquity of coastal adaptations, based on the differential productivity or accessibility of marine and terrestrial resources (Hildebrandt and Levulett, chapter 10; Lightfoot 1993; Lyman 1991).

For years, my experience in Southern California and southeast Alaska led me to believe the small number of early coastal sites in Northern California, Oregon, and Washington is probably owing to preservational or investigative biases. Only ten years ago, there were no coastal sites in this area that were known to have been occupied before about 3000 RYBP. During the last decade, several Middle and Early Holocene coastal sites have been found in the area (Connolly 1992; Minor 1991; Minor and Toepel 1986; Moss and Erlandson 1995; Schwaderer 1992; Tasa and Connolly 1995). Even so, Early and Middle Holocene sites along the Northern California, Oregon, and Washington coasts remain widely scattered. Only further research will determine whether the dearth of ancient sites is owing to variation in the age of widespread coastal adaptations or to biases in the archaeological record.

### Environmental Reconstructions

As noted earlier, California's coastal environments have changed dramatically during the Holocene. These changes range from fluctuations in the location and conformation of the coastline related to changes in sea level (Inman 1983; Masters and Gallegos, chapter 2), to variation in the types and productivity of coastal habitats available, to shifts in temperatures on the sea surface and coastal upwelling that may have affected general marine productivity (Arnold 1992; Raab et al. 1995a), to climatic changes that affected the flora, fauna, and hydrology of terrestrial, marine, and riverine environments. Because hunter-gatherers so intimately interact with their natural environment, a major task for archaeologists working on the California coast is to understand the environmental contexts of cultural changes observed in the archaeological record. Deciphering these relationships relies on a combination of ecological data from archaeological sites themselves, and other data from geological, climatic, or other sources. As the chapters in this volume show, considerable amounts of paleoenvironmental data have accumulated for parts of the California coast. Major gaps remain in the distribution and types of data available, however, and poor chronological resolution inhibits precise correlation between environmental and cultural events.

**Shifts in Settlement and Subsistence**

The subsistence and settlement strategies of hunter-gatherers are closely related to the distribution of resources and neighboring peoples in the surrounding landscape. Since those landscapes have changed dramatically during the last 10,000 years, so too has human settlement and subsistence. For decades, the study of changes in diet and settlement among coastal hunter-gatherers has been a central focus of California archaeologists. Specific changes in settlement and patterns of animal exploitation are often closely linked to changes in coastal environments (see chapters 2, 4, 7, and 8). Much of the interest in subsistence is owing to the excellent preservation of faunal remains (shell and bone) in coastal shell middens, to the ecological emphasis of American archaeology, and to broader questions about the nature of maritime cultural ecology and the evolution of coastal adaptations. Fundamental questions remain about the antiquity and intensity of sedentism among coastal peoples in various areas, however, as well as the timing and meaning of subsistence shifts.

**Technological Changes and their Causes**

Changes in human subsistence are intimately linked to questions about the development of new technologies or artifact forms along the California coast. When and where did key technological developments—the appearance of mortars and pestles, circular shell fishhooks, fish weirs or traps, for instance—first occur and when and how did they spread into surrounding areas? What do the appearance of new technologies or artifact forms tell us about changes in human behavior? Are such developments local innovations designed to help people better adapt to localized changes in the natural or cultural environment? Are certain technological attributes related to distinct ethnic or linguistic cultural patterns and can they be used to reconstruct patterns of migration, changing tribal territories, or cultural interaction?

This last question is fundamental to a variety of issues in studying the archaeology of the Middle Holocene on the California coast. In 1964, Harrison explained the appearance of large side-notched points and other so-called new cultural traits in the Santa Barbara area as a migration of "Hunting People" (as coined by D. Rogers 1929) down the Pacific Coast from ancestral homelands in west-central Alaska (see Glassow, chapter 6). At the time, most American archaeologists saw migration, invention, and diffusion as the three primary causes of prehistoric culture change. Today, we know that very similar styles of large side-notched points are found in Middle Holocene sites across a vast area of North America, from central Alaska, to New England, to the Great Basin, to the coast of Southern California. In fact, from the terminal Pleistocene on, there are broad technological similarities among archaeological assemblages over much of western North America. Some of these similarities appear to result from the exchange of ideas within and between a number of extensive "interaction spheres" (see chapter 3).

It is always tempting to look for relatively direct explanations for the appearance of technological or cultural traits in research areas. I myself have relied heavily upon local evidence for environmental change, population pressure, or resource stress (Hayden 1981) to explain changes in diet and subsistence technology in the Santa Barbara Channel area. Declining shellfish productivity on the Santa Barbara coast, however, cannot explain the roughly synchronous appearance of large side-notched points—or many other distinctive artifact styles—in widely separate coastal and interior areas of the western United States. Since the 1960s, the use of diffusion as an explanation for culture change has been out of favor, but broad patterns need to be considered in explanations of culture change. Technological and other organizational changes in prehistoric societies are not solely responses to local population growth or environmental changes. Surely local changes stimulated local responses on the part of prehistoric peoples, but such people were connected into large interactive networks for thousands of years. Recognizing this fact—attested to by the presence of obsidian and other exotic materials in Early, Middle, and Late Holocene sites across much of California—allows us to see seemingly local or regional developments as integrated changes involved in the exchange of goods and ideas over vast areas of California, western North America, and perhaps beyond.

**Evolution of Coastal Adaptations**

Almost twenty years have elapsed since Osborn (1977) proposed that the exploitation of marine resources was a relatively inefficient mode of making a living and that humans did not adapt to the sea until relatively late in prehistory. This idea has been challenged repeatedly (see Perlman 1980; Quilter and Stocker 1983; Yesner 1980; and others), often with data on early subsistence patterns along the California coast (Erlandson 1988a, 1991a, 1994; Glassow and Wilcoxon 1988; Jones 1991; chapter 3). Most archaeologists would now agree that the relative productivity of marine vs. terrestrial habitats varies locally and regionally, that changes in human technology greatly affected the productivity and accessibility of various food resources, and that the relative importance of various marine and terrestrial foods varied considerably along the California coast through space and time.

While many of California's coastal peoples seem to have relied heavily on shellfish and plant foods during the Early Holocene, the intensity of marine fishing, sea and land mammal hunting, and plant food collecting all appear to have increased during the Middle and Late Holocene. Within this general pattern, however, there is a tremendous amount of detail—and probably variation on the local and regional levels—that remains to be sorted out. In years to come, some of the major tasks faced by California's coastal archaeologists will be to flesh out such generalities, to identify variations or exceptions in the archaeological record of coastal subsistence, and to explore the relationships between environmental variation, human population levels, developments in maritime (and other) technologies, and societal organization. The Middle Holocene appears to bracket much of the transition from the predominantly littoral economies of the Early Holocene to the fully maritime economies of the Late Holocene. Consequently, dietary reconstructions for Middle Holocene sites in a variety of habitats along the southern, central, and northern coastlines are essential to understanding the development of maritime adaptations along the California coast.

## SUMMARY AND CONCLUSIONS

The story of California archaeology is one of remarkable cultural and ecological diversity (see Chartkoff and Chartkoff 1984; Moratto 1984). At the time of European contact, population densities, sociopolitical complexity, and material culture traditions varied substantially up and down the California coast. These differences are just as interesting as the broad adaptive similarities among California's maritime peoples. Both the similarities and differences hint at the close relationships between environmental variation and human adaptations among hunter-gatherers. The linguistic and cultural diversity found along the California coast resulted from the long history of occupation of the region, local adaptations to a variety of marine and terrestrial environments, the intrusive migrations of later peoples, and the amalgamation of cultural traits as diverse peoples exchanged ideas and goods across tribal boundaries. Neighboring groups from very different cultural and linguistic backgrounds (that is, the Tongva [Gabrieliño] and the Chumash) developed very similar adaptations to similar environmental conditions. This adaptive convergence is further evidence of the strong influence the environment wields over hunter-gatherer societies, but it also testifies to the often porous nature of tribal territories to the exchange of goods, technologies, and ideas.

With one of the oldest and best-documented coastal archaeological sequences in the Americas, California is an excellent place to examine issues related to the origins of coastal adaptations, long- and short-term changes in maritime cultural ecology, the evolution of cultural complexity among hunter-gatherers, and the causes of culture change. Over the years, in fact, considerable research has been devoted to the study of such issues by archaeologists working on the California coast. In the chapters that follow, these and other issues are explored as we examine the archaeological record of the California coast during the Middle Holocene.

**Acknowledgments.** I am indebted to Michael Glassow and anonymous reviewers for carefully reading this chapter and providing comments that improved it significantly. My thanks also to Marilyn Beaudry-Corbett for her encouragement and patience, the staff of the Institute of Archaeology for their editorial and production assistance, and to countless colleagues who have shared their knowledge and discussed these issues with me over the years.

# Environmental Change and Coastal Adaptations in San Diego County during the Middle Holocene

*Patricia M. Masters and Dennis R. Gallegos*

CHANGES IN COASTAL HABITATS influenced prehistoric subsistence and settlement patterns in the San Diego region throughout the Holocene. Before urbanization, the remnant lagoons of the county were bordered by numerous shell middens, which contained environmental evidence of earlier estuarine habitats and paleodietary information. The degradation of these early bay or estuarine environments by infilling sediments as sea level approached its present position has been given as the cause of coastal abandonment in the second half of the Holocene (Shumway, Hubbs, and Moriarty 1961; Warren 1964; Warren, True, and Eudey 1961). Based on forty-two radiocarbon dates from coastal sites, Warren and Pavesic (1963) suggested that a hiatus in coastal occupation occurred between about 3000 and 1600 RYBP.

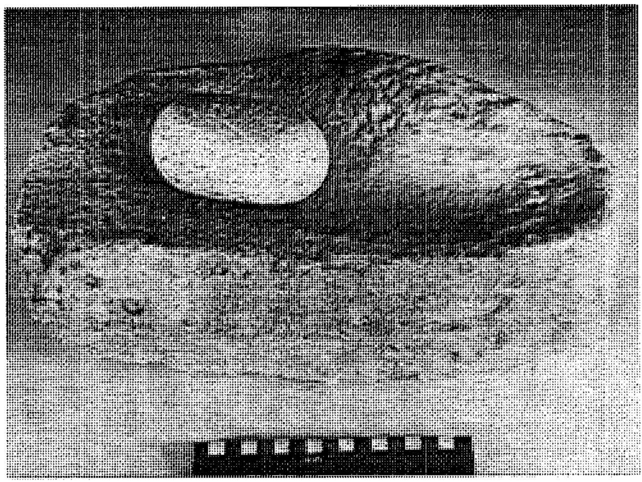
Archaeological research suggests that maritime adaptations in the San Diego area date to more than 9000 RYBP (Gallegos 1991; Koerper, Langenwalter, and Schroth 1991; Moriarty 1967). The stability of this coastal adaptation is now well established in sites dated from the Early to the Late Holocene (Breschini, Haversat, and Erlandson 1992; Gallegos 1992). During the Middle Holocene, a diversified maritime economy developed at the Ballast Point site on San Diego Bay, resembling the intensification in fishing and hunting of sea mammals seen in the Santa Barbara Channel area to the north (Gallegos and Kyle 1988).

An expanded data base of radiocarbon dates (from the numerous archaeological studies completed over the past thirty years) allows us to propose settlement patterns and maritime and inland adaptations to environmental change for the people who occupied San Diego County during the Middle Holocene. Sedimentation changes in lagoon habitats as well as productivity were previously postulated on the basis of archaeological evidence. In this chapter, a paleocoastline reconstruction, developed independently of archaeological data, helps to clarify the environmental changes occurring not only within the lagoons but also in nearshore waters during the Middle Holocene. Studies of molluscan remains from selected middens are compared with the paleocoastline reconstruction to examine the effects of coastal habitat changes on subsistence patterns. Archaeological evidence from kelp beds and shallow rocky-reef habitats indicates that offshore fishing and watercraft building were more widespread during the Middle Holocene. Finally, we explore the environmental factors associated with the persistence of this maritime adaptation into the Late Holocene on San Diego Bay and at Los Peñasquitos Lagoon.

## CULTURAL SEQUENCE

The traditional cultural sequence for San Diego County (M. Rogers 1929, 1945; Warren 1968) begins with the San Dieguito complex (9000 to 7500 RYBP), followed by the La Jolla complex or Encinitas tradition (7500 to 2000 RYBP) and, finally, the Yuman complex (1300 RYBP to present). Rogers, Warren, and others characterized the San Dieguito complex as an inland hunting culture on the basis of the assemblage from the Harris site. The La Jolla complex—with milling stones and abundant shell middens—was seen as an unelaborated gathering culture. Given the wealth of information compiled since 1968 and the continuous record of human occupation throughout the Early and Middle Holocene, the recent trend is to subsume the San Dieguito and La Jollan complexes into the Early or Archaic period followed by the Late period (Erlandson 1994:204–205; Erlandson and Colten 1991a; Gallegos 1987; Koerper, Langenwalter, and Schroth 1991).

Coastal occupation sites clearly date from the Early Holocene and persist throughout the Middle Holocene. Milling tools (fig. 2.1a)—such as trough-shaped grinding stones (metates) and handheld mullers (manos)—indicate that sub-



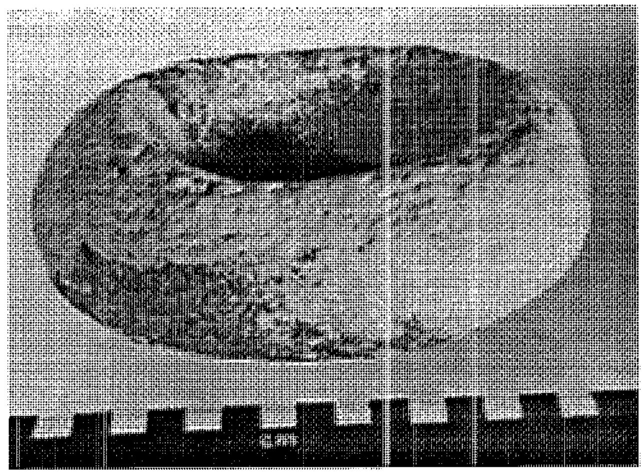


FIGURE 2.1 *a (left)*, Milling tools: grinding stone (metate) and muller (mano) from SDI-525; *b (right)*, granitic cobble mortar from a kelp bed off the coast of La Jolla

sistence was based on seed processing; abundant shell middens demonstrate reliance on marine shellfish (Erlandson 1994; Warren 1968). Mortars and pestles are generally rare in San Diego County coastal sites, but small cobble mortars (fig. 2.1b) are the most prevalent artifacts recovered from underwater sites off the coast. Inland Middle Holocene occupation sites have been reported in transverse valleys and sheltered canyons and termed the Pauma complex. These sites show a predominance of grinding implements (manos and metates), have a greater diversity of tool types, lack shellfish remains, emphasize both gathering and hunting, and are thought to represent more sedentary occupation (Meighan 1954; True 1958; Warren, True, and Eudey 1961). Rather than proposing a separate component of the La Jolla tradition, we view these interior sites as inland manifestations of the coastal La Jolla complex occupied by peoples having a diversified resource base.

The Late Holocene occupation in San Diego County is the Yuman complex (Warren 1968), a late prehistoric people known at the time of Spanish contact as the Diegueño. These Yuman-speaking people, also referred to as Kumeyaay, are characterized in the archaeological record by small projectile points, pottery, obsidian from Obsidian Butte, and cremation burial. These Late Holocene traits are present on sites dated post 1300 RYBP.

## SETTLEMENT PATTERN

> It is now well established that the most powerful class of data in sociocultural explanations is settlement pattern. This may be taken as a material manifestation of the entire mode of production, and . . . social and political organization (Bunimovitz 1995:324).

The importance of the coastal zone to Middle Holocene people can be seen from the density of dated cultural deposits on the coast. Using radiocarbon dates assembled by Breschini, Haversat, and Erlandson (1992), we investigated the geographical distribution of prehistoric sites and changes in this distribution over time. Within San Diego County 145 sites with $^{14}C$ dates have been tabulated, including 53 dated to the Middle Holocene (fig. 2.2). The number of dates throughout the Middle Holocene is fairly stable, but there is a marked decline in dates after 3350 RYBP. Mapping the 53 sites identified by Breschini, Haversat, and Erlandson (1992), along with 11 other known Middle Holocene sites, shows that they are found predominantly near lagoons and on the open coast (fig. 2.3). The remaining sites occur primarily along stream valleys.

Cultural material from Middle Holocene sites within the coastal zone reflects maritime adaptations to river valleys, lagoon margins, and coastal waters. Lagoon and open coast sites contain large amounts of shell, milling tools, and burned rock. Faunal remains include fish, bird, and small to medium mammals. Large mammal bone is present but not common. In addition to numerous milling tools, Middle Holocene lagoon sites such as SDI-603, SDI-10672, SDI-5130, and SDI-525 contain doughnut stones, discoidals, stone balls, Elko points and knives, angular choppers, hammerstones, scrapers, cores, Coso obsidian, worked bone, beads (shell, bone, and stone; fig. 2.4), flexed burials, and stone features (Crabtree, Warren, and True 1963; Moratto et al. 1994; Schroth, Schilz, and Cooley 1990; Shumway, Hubbs, and Moriarty 1961).

## PALEOENVIRONMENTS

This early coastal adaptation undoubtedly was owing to the formation of estuaries and other productive nearshore habitats by the rapid rise in sea level occurring at the end of the Pleistocene. Rise in sea level, which followed the last glacial maximum around eighteen thousand years ago, drove a number of environmental and geographical changes during the Holocene. Between nine and ten thousand years ago—

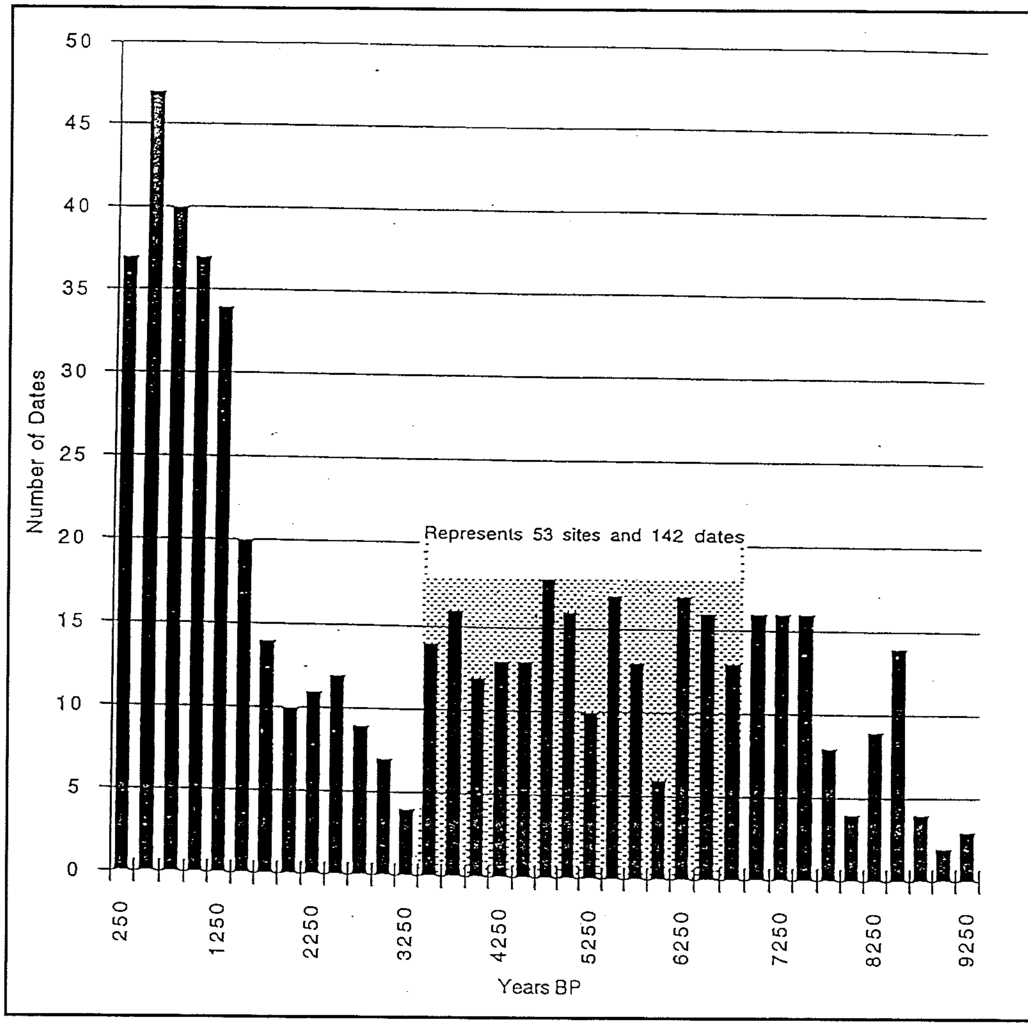



FIGURE 2.2 Graph of 145 $^{14}C$ dated sites and 595 dates from San Diego County. Shaded area represents the Middle Holocene. *Adapted from Breschini, Haversat, and Erlandson 1992*

the time of the earliest recorded occupations in San Diego County, sea level stood about 20 m below present sea level, with a shoreline 2 to 6 km farther seaward than today's coast. This Early Holocene shoreline was retreating rapidly eastward in response to a rapid rise in sea level of around 1 m per century. The flooding stream valleys of this time were highly productive estuarine environments that attracted early settlement and maritime adaptations. By 6000 RYBP, the rate of rise in sea level had slowed to about 10 cm per century and continues at this rate to the present day. The shoreline was transgressing from about the present 6 m isobath, and any prehistoric sites on the exposed shelf would have been within 200 m of today's beach. In fact, the greater geographic stability of the outer coast, as the rise in sea level slowed, resulted in the preservation of sites on the sea cliffs and lagoons of San Diego County.

Regarding paleoclimates of coastal Southern California, pollen studies show that the predominant climate pattern since the last glaciation has been the Mediterranean type. Heusser (1978) reported on a twelve thousand year record of marine sediments from the Santa Barbara Basin, noting that the cooler, moist habitats of the Early Holocene (conifer zone) were replaced by warmer, drier climate and open habitats between about six and three thousand years ago (oak and Asteraceae zone), with an optimum between about fifty-seven hundred and forty-three hundred years ago. On the Orange County coast, Davis (1992) analyzed pollen from a 7000-year record in a core from the San Joaquin Marsh on Newport Bay. From 7000 to 4500 RYBP, pollens indicate a freshwater marsh. After 4500 RYBP, marine organisms and halophytic species point to a saltwater marsh as sea level approached its present position. Between 3800 and 2800 RYBP, flooding events were indicated by increases in freshwater and/or grassland pollens.

Although little palynological work has been done in San Diego County, the existing reports from Middle Holocene archaeological sites indicate the presence of coastal sage scrub and chaparral communities much like the present flora but with some possible local increase in oak (Gallegos and Kyle 1988; Kyle, Schroth, and Gallegos 1989) and grassland (Carrico, Cooley, and Clevenger 1993; Vanderpot, Altschul, and Grenda 1991) habitats. Similar pollen profiles are reported from Early Holocene sites (Gallegos 1991; Koerper, Langenwalter, and Schroth 1991) near Agua Hedionda La-

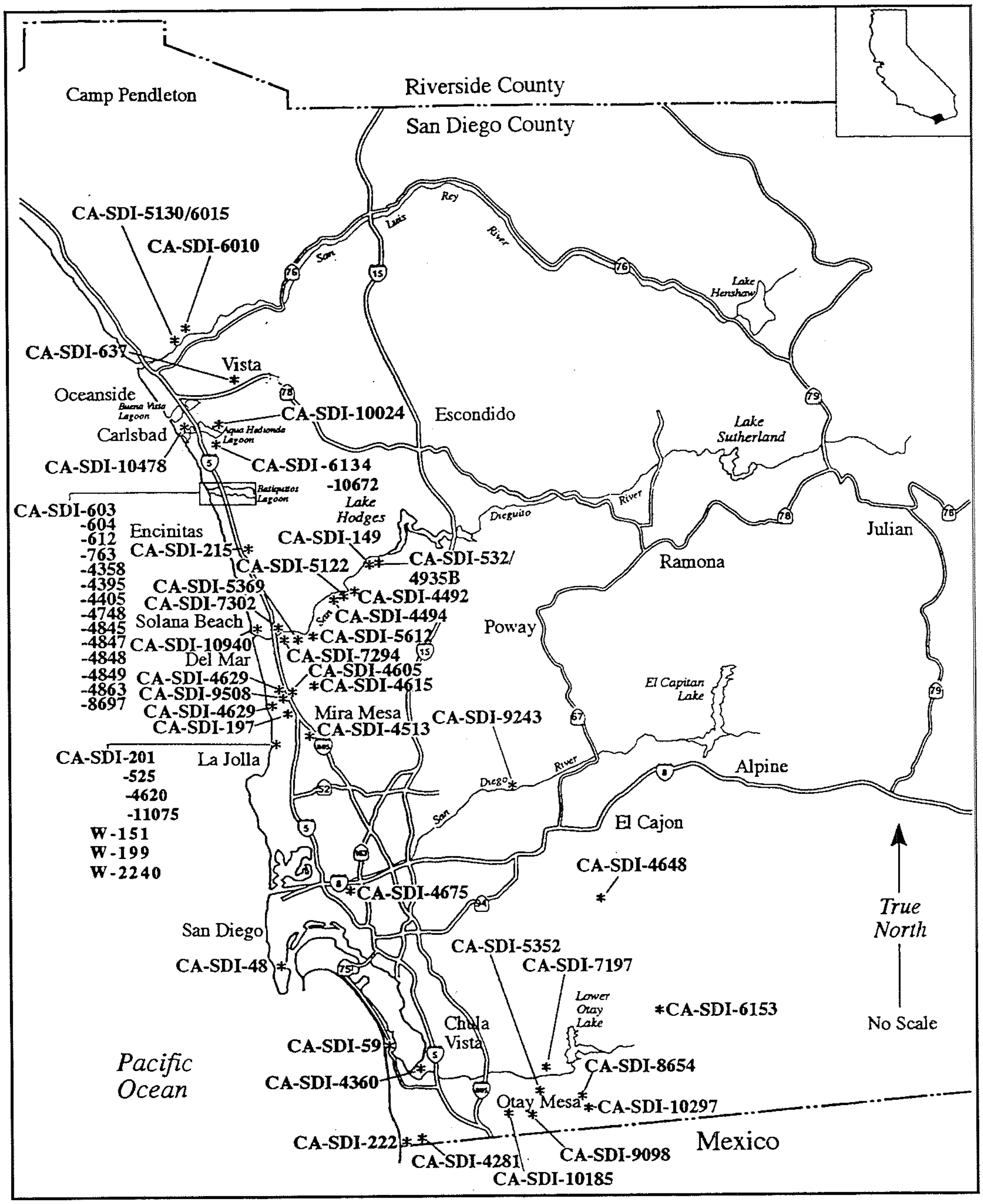



FIGURE 2.3 Middle Holocene sites of San Diego County

goon. It appears that the semiarid open environments of western San Diego County were established very early and have changed little throughout the Holocene. What small shifts may have occurred are in the distribution of the types of plant communities found here today.

When we look at the environmental effects of rise in sea level and of sedimentary regimes, however, we find that these processes were far more significant than the modest fluctuations in surface climate and vegetation in this area during the Holocene. Sediment type and rate of deposition induced major changes in the outer coast and within the estuaries, altering both the habitats and productivity of the coastal zone. To understand these environmental changes, one must understand the processes that have shaped the San Diego coastline. Inman's (1983) synthesis of information on coastal geomorphology, the dynamics of change in sea level, and types of sediment deposition provide a paleocoastline reconstruction for the San Diego region during the Holocene. The marine resources and subsistence options available to prehistoric coastal peoples can thereby be reconstructed.

In Inman's model, as sea level falls, water courses cut valleys into the exposed continental shelf and eventually carve deep valleys into former flood plains. Because of the steeper gradient between the earlier watershed and the lowered sea level, streams had more energy and moved coarser materials, such as cobbles or boulders, along with finer sediments to the regressive coast. Waves spread the cobbles along the shelf.

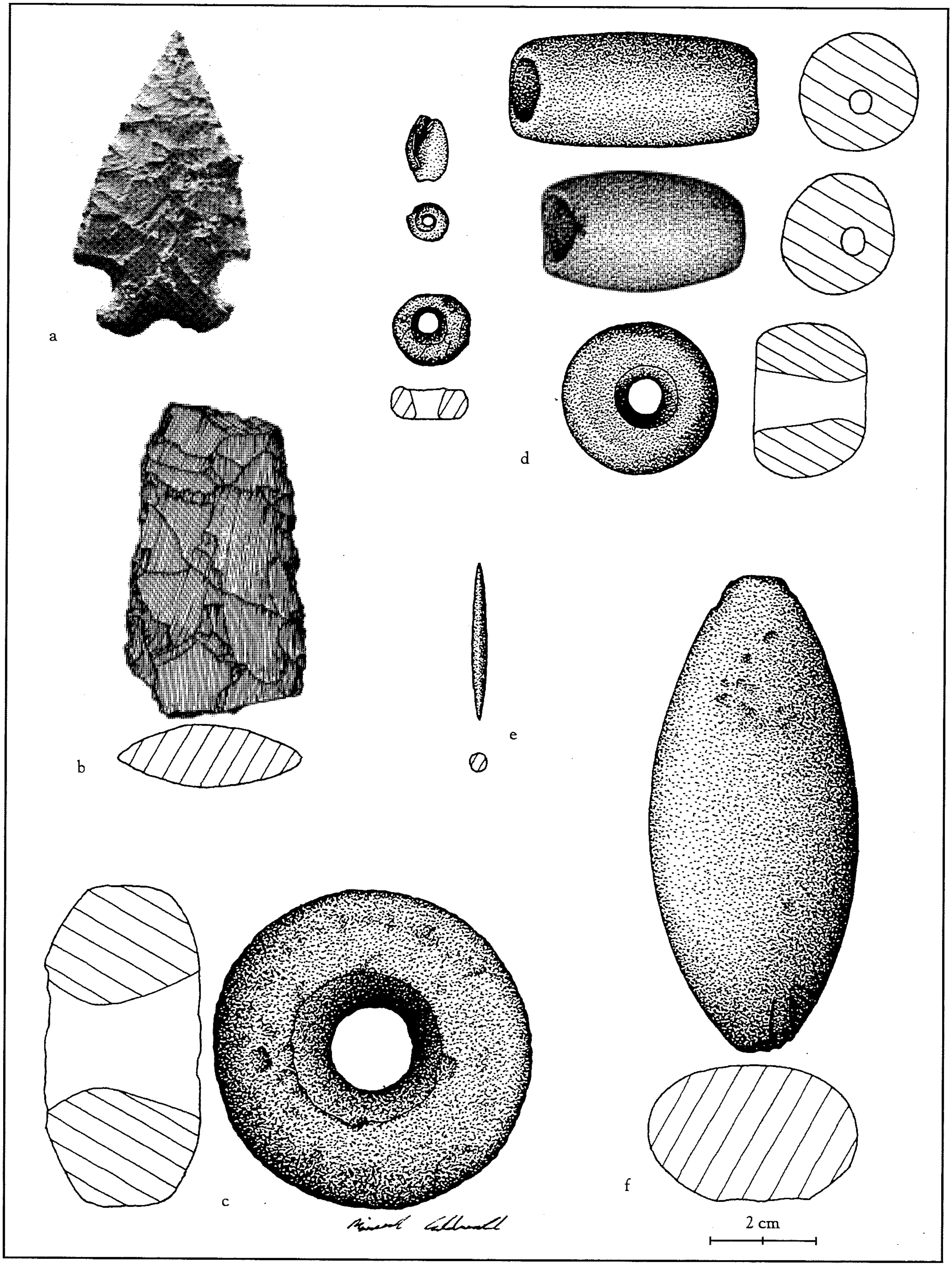



FIGURE 2.4 *a*, Elko point from SDI-149 *(Rogers et al. 1966)*; *b*, biface knife; *c*, doughnut stone; *d*, beads; *e*, bone gorge; *f*, plummet stone. *(Schroth, Schilz, and Cooley 1990)*

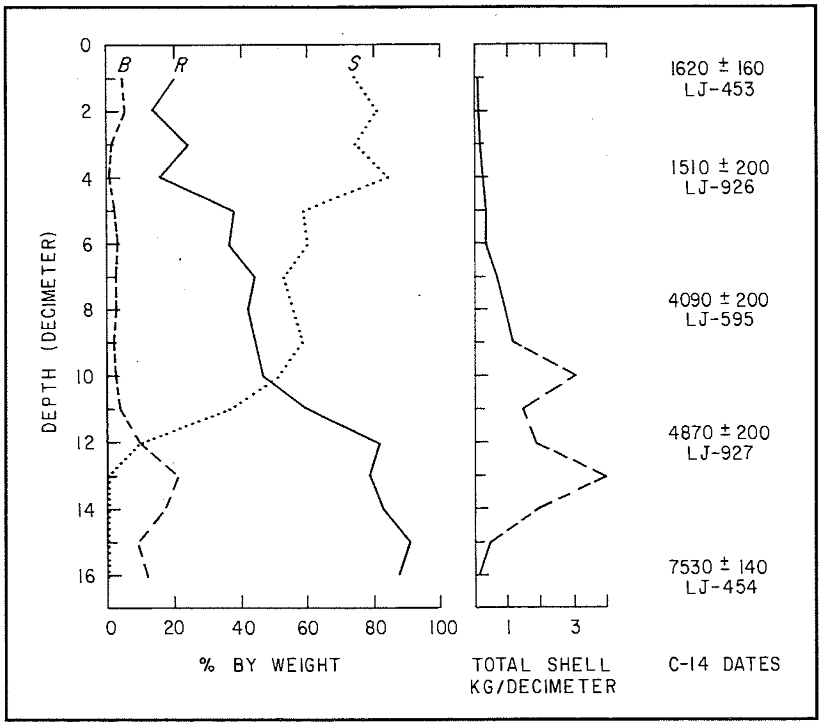



FIGURE 2.5 Fluctuations in molluscan remains, grouped as bay (B), rocky-coast (R), and sandy-beach (S) species, from the open-coast site SDI-11075. *Masters, Sussman, and Lippold* N.D.; *Hubbs* N.D.

When sea level began to rise at the beginning of the Flandrian transgression, the newly incised valleys were flooded and became estuaries. Streams deposited sediments at the heads of the estuaries, which left the outer coast deficient in sediments for replenishing beaches. Yet storms continued to erode the coast, transporting finer sediments out of the area and leaving behind coarser materials such as cobbles. These materials were worked into steep cobble beaches that would have been prevalent during the Terminal Pleistocene and Early Holocene in Southern California. Nearshore areas probably had little or no sand cover, and so shallow rocky reefs would have been more abundant. As sea level rose further, waves formed cobble spits at the mouths of the estuaries and transformed them into tidal lagoons. After rise in sea level and transgression slowed about six thousand years ago, stream-borne sediments more rapidly infilled the lagoons, eventually closing them to the ocean. Concurrently, fine sandy sediments were brought to the coast by floods, and the rocky coast was transformed to sandy beaches beginning about five thousand years ago.

Changes in sedimentation along the coast during periods of rising sea level significantly altered the ecology not only of the lagoons but also of the open coast. The diversity and biomass of marine fish and invertebrates depend on the physiographic characteristics of open coast and estuarine shorelines. Nearshore rocky reefs are excellent fishing areas, and rocky wave-cut terraces at greater depths can support kelp forests with abundant fish. Estuaries and tidally flushed lagoons, having a variety of substrates and sheltered water, were probably the most productive coastal habitats for molluscs, fish, and waterfowl. After sediments filled lagoons and spits closed them to the sea, productivity declined. On the outer coast, shallow rocky reefs were blanketed with sand, reducing this productive area as well. Farther offshore, the formerly extensive kelp beds were restricted to rocky headlands.

## INVERTEBRATE FAUNA AND SEDIMENTATION

Evidence of these coastline changes during the Middle Holocene can be found in faunal analyses of open coast and lagoon sites. Changes in mollusc species over time support the concept that sediment deposition increased through the Middle Holocene. Early studies (Shumway, Hubbs, and Moriarty 1961; Warren and Pavesic 1963) noted the discrepancy between modern sandy coastlines and middens containing predominantly rocky-coast mollusc remains. Indeed many archaeological sites along the California coast show shifts in the pattern of shellfish remains that correspond to sea-level rise and substrate changes (Bickel 1978; Colten 1989; Erlandson 1985; Gallegos 1985; Greengo 1951; Nelson 1909; Rudolph 1985; Wojdak 1993).

A 2-m deep shell midden (SDI-11075) on a sea cliff at La Jolla provides a record of marine resource use from 7530 to 1510 RYBP (fig. 2.5). Rocky-coast species predominate until 5000 to 4000 RYBP, then sandy beach species (*Donax* and *Tivela*) begin to displace the mussels and rock oysters. In the uppermost levels, dated to about 1500 RYBP, marine invertebrates are almost exclusively represented by *Donax* and *Tivela*. On the sea cliffs north of SDI-11075, analyses at SDI-4620 (Roth N.D.) again show a heavy reliance on rocky-coast species 8000 to 6000 RYBP. Sandy beach species make a significant contribution only in the uppermost level, dated to

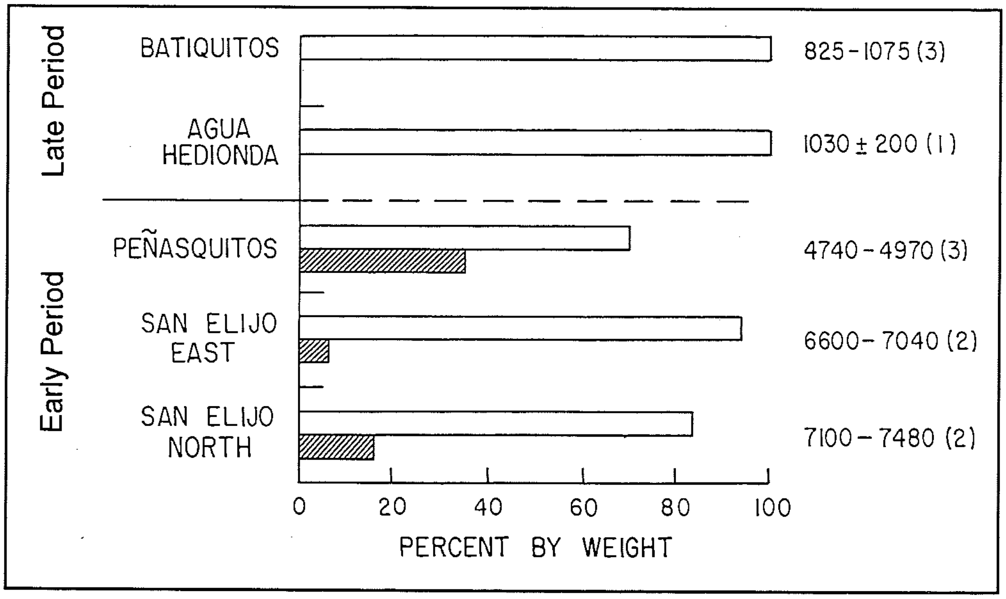



FIGURE 2.6 Proportions of bay (open) and rocky-coast (hatched) shellfish species from five lagoonal middens (Miller 1966). Radiocarbon dates are listed as ranges with number of dates per site in parentheses. Assumed site numbers based on latitude-longitude information are Batiquitos (SDI-12810), Agua Hedionda (no record), Peñasquitos (SDI-1603), San Elijo East (SDI-6853), San Elijo North (no record).

1300 RYBP. At the nearby Scripps Estate site (SDI-525), dated between 7500 and 5500 RYBP (Shumway, Hubbs, and Moriarty 1961), approximately 80 percent of the molluscan remains are derived from rocky-coast habitats and 10 to 20 percent from bays.

At lagoon sites such as SDI-603 on Batiquitos Lagoon, Warren and Pavesic (1963) attributed the displacement of *Mytilus* by bay species between 7000 and 6000 RYBP to estuarine development and increased sedimentation. Middle Holocene dates of 6000 to 4000 RYBP coincide, however, with remains of bay species at SDI-6015 on San Luis Rey Lagoon (Gallegos and Schroth 1991) in northern San Diego County and at SDI-4360 near the south end of San Diego Bay (Carrico and Ainsworth 1980). Both of these localities are several kilometers upstream from their bay mouths and suggest extensive sand and mudflat development in this time range.

In test units from five lagoonal middens (Miller 1966), each representing isochronous deposits (fig. 2.6), bay species always predominate, but rocky species are observed until 5000 to 4000 RYBP. Although the lagoons could have been closed to the sea any time after about 4000 RYBP because of attainment of near-present sea level, two Yuman complex middens reflect the gathering solely of bay species. The bay molluscs from Late Holocene sites at Batiquitos and Agua Hedionda Lagoons, as well as at other lagoons along the Southern California coast, may indicate intervals of higher annual rainfall, perhaps associated with cold intervals, when lagoons can be reopened to the sea.

Therefore the types of mollusc species represented in both open-coast and lagoon middens during the Middle Holocene coincide with Inman's predicted transition from rocky open coast to infilled lagoons and sandy beaches. After about 5000 RYBP, rocky open-coast species begin to decrease relative to sandy beach molluscs. In some lagoon sites, rocky attached species are found around 5000 RYBP, but bay species predominate during the Middle Holocene. The transition in species proportions in open-coast middens signals an environmental shift from rocky to sandy beaches and coincident infilling of the lagoons after about 5000 RYBP.

A radiocarbon dated core from Batiquitos Lagoon (Miller 1966; Gallegos 1985) gives some insight into the rate of Middle Holocene lagoonal sedimentation. The core sampled 10 m of lagoon sediments deposited over the last six thousand radiocarbon years. Overall, the rate of sedimentation averages about 16 cm per 100 years, roughly coinciding with the rate of the rise in sea level over this period (Inman 1983:10). This rate compares with averages of about 10 cm per 100 years for three other Southern California lagoons during precontact times (Mudie and Byrne 1980). However, about 3500 RYBP, nearly 2 m of sediments were deposited at Batiquitos, indicating increased stream flow and runoff associated with flooding events.

Enzel et al. (1992) detected the formation of Holocene lakes in the Mojave River drainage basin at about 3500 RYBP, which supports the notion of higher precipitation at that time. They attributed these short-duration lakes to neoglacial episodes and a higher frequency of winter storms in the southwestern states. Cole and Liu (1994) also found evidence of increased precipitation on Santa Rosa Island beginning about 3250 RYBP. Davis (1992) interpolated a date of 3800 RYBP for a freshwater event at San Joaquin Marsh.

Substrate changes do not appear to have adversely affected lagoonal productivity until about 3500 RYBP. The radiocarbon dates plotted in figure 2.2 suggest that population density on the coast remains fairly constant despite the initial buildup of fine sediment in the lagoons. The sand and mudflats developing in the lagoons by 5000 RYBP may have provided more diversified mollusc resources, not a net loss in productivity of the lagoon environment. However, the

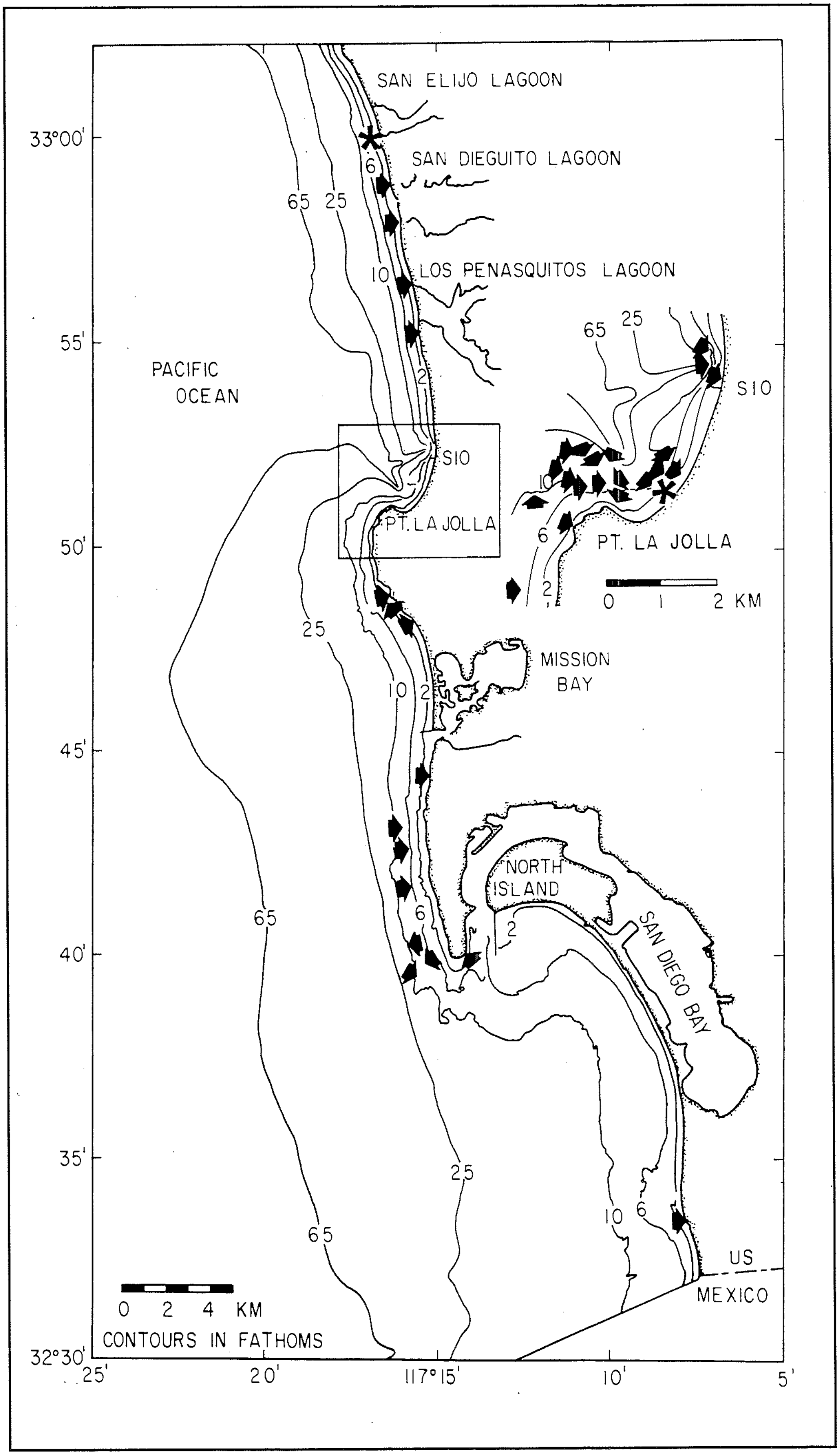



FIGURE 2.7 Underwater artifact sites off the San Diego County coast. Hundreds of cobble mortars have been reported from the La Jolla Shores and Solana Beach sites (marked by ∗) since 1950. *Adapted from Masters 1985*

abrupt drop in number of dates after 3500 RYBP coincides with catastrophic sedimentation, the final infilling of the lagoons, and transport of sand along the outer coast. Sand was deposited on the shelf out to a depth of about 10 m, causing the loss of productive shallow rocky reef habitats as well as the intertidal areas of the open coast and lagoons. This habitat loss was sufficiently severe to prompt an adjustment in coastal adaptation by prehistoric populations. As a result, archaeological evidence for occupation of the coastal zone decreases after 3500 RYBP.

## INTENSIFICATION OF MARITIME ADAPTATIONS

A pattern of intensified maritime fishing and hunting of sea mammals has been described for the Santa Barbara Channel area and the southern Channel Islands in the Middle Holocene. Until recent work at the Ballast Point site (SDI-48) on San Diego Bay, this pattern had not been documented in the San Diego region. SDI-48 was occupied as early as 6600 RYBP (Gallegos and Kyle 1988), around the time the bay itself was created by a rise in sea level and sand transport northward from the Tijuana River delta (Masters 1988). This site is a deep shell midden with rich and diverse faunal remains and hearth features. The faunal assemblage includes the remains of sixty-four shellfish species, numerous fish, land mammals, birds, and reptiles, as well as sea otter, sea lion, southern fur seal, and harbor seal. The site is unique for San Diego County in that the large mammal remains are predominantly marine rather than terrestrial. Terrestrial resources, however, were also an important part of the diet as suggested by numerous milling tools and the bones of small land mammals. Artifacts also include cobble tools, biface tools, *Olivella* beads, and twenty-eight bone tools. The bone tools provide additional evidence of marine fishing activities as they include gorges, composite fishhooks, and awls or needles. The resource areas exploited by the inhabitants of SDI-48 were the bay, the rocky intertidal and shallow rocky reef zone of Ballast Point, the kelp beds off Point Loma, and terrestrial habitats.

Intensification of offshore fishing during the Middle Holocene is also indicated by the number of underwater artifacts reported for coastal waters of San Diego County. Cobble mortars are the most frequently reported artifact type from submerged localities (Hudson 1976; Marshall and Moriarty 1964; Masters 1983, 1985; Tuthill and Allanson 1954). More than forty intertidal and submerged artifact localities have been recorded for San Diego County, and similar mortars are reported from submerged localities along the coastline of the Southern California bight and Channel Islands (Masters 1985). In the San Diego area, artifacts occur primarily in two locales: nearshore rocky reefs or bars between 2 and 5 m deep and kelp beds off Point Loma and Point La Jolla 10 to 20 m deep (fig. 2.7). Hundreds of mortars have been reported at the La Jolla Shores site (Marshall and Moriarty 1964; Tuthill and Allanson 1954) and Solana Beach site (SDMM-W-312, Thornburgh 1956). Shallow rocky reefs and kelp beds are productive habitats for fishes, and the same species are found in both habitats (Allen 1985).

Mortars and pestles from inland sites are widely thought to signify a technological advance in processing pulpy seeds such as acorns, but the small cobble mortars from submerged contexts are distinct from the bedrock mortars or large portable mortars of inland San Diego County sites. Mortars similar to the submerged cobble mortars appeared in datable terrestrial sites on the coast of Santa Barbara and Los Angeles Counties circa 5000 RYBP, and they are common in underwater localities in the Santa Barbara Channel area (Hudson 1976:45).

Evidence of a Middle Holocene age for these submerged artifacts is seen at the La Jolla Shores site (SDI-39). The underwater component of this site consists of a 2-m to 5-m deep cobble bar paralleling the shore. A sample of subtidal peat from 2-m deep inshore of the cobble bar was dated to 4230 RYBP (Hubbs et al. 1962). In the onshore component of the site, dates range from 3190 RYBP to 4770 RYBP (Hubbs, Bien, and Suess 1962:235; 1963). The hundreds of mortars from the submerged cobble bar and the fact that the mortars are made from sandstone and metavolcanic cobbles common to the bar suggest that the bar served as a factory site for manufacturing mortars about 4000 RYBP. At that time, sea level was about 2 m lower than present, and the bar formed a spit at the mouth of the small lagoon (Inman 1983). By about 1300 RYBP, the cobble bar would have been submerged.

The dates of the kelp-bed artifacts appear to correspond with the date of about 4200 RYBP for the spit at the La Jolla Shores site. At 4000 RYBP, the Point Loma and La Jolla kelp beds would have approximated their modern locations and depths. The association of mortars with the kelp beds can be explained by human transport from nearby onshore sites using watercraft (Masters 1983).

The Ballast Point, La Jolla Shores, and Solana Beach sites, therefore, provide further insight into Middle Holocene maritime adaptations in San Diego County. These were characterized by the fishing of the kelp beds and nearshore rocky reefs from boats, by the fishing and shellfish collecting in the intertidal reefs and the lagoons, and by the procurement of sea mammals. The prevalence of small cobble mortars in the Point Loma and La Jolla kelp beds suggests that they played some role in fishing activities. The Ballast Point site yielded the largest assemblage of fish bone from any Middle Holocene site in San Diego County. The La Jolla Shores site was located at the head of the La Jolla Submarine Canyon, which would have brought a highly productive, upwelling environment close to shore (see Vetter 1994 for highly productive detrital mats in the head of La Jolla Submarine Canyon) and provided a low-wave boat launch for access to the offshore reefs and kelp beds. The Solana Beach site occurs within an extensive shallow rocky-reef complex at the mouth of San Elijo Lagoon.

Despite the number of coastal sites, it should be emphasized that a broad terrestrial resource base was also exploited. In the interior, Middle Holocene river valley sites demonstrate the diversity of these subsistence activities. SDI-9243 (Carrico and Cooley 1992), SDI-8654 (Kyle, Schroth, and Gallegos 1989), SDI-7197 (Pigniolo and Gallegos 1990), and SDI-6153 (Christenson 1981) are all within 32 km of the ocean. Although faunal remains are usually poorly preserved in inland San Diego County sites, a large number of faunal elements were recovered at SDI-9243 (Carrico and Cooley 1992). This site is situated about 16 km east of San Diego Bay, near the San Diego River channel. The lower site deposit has been dated between about 2340 and 5400 RYBP. Artifacts include a number of milling tools, cores, cobble tools, biface knives, and two Elko series points (Carrico and Cooley 1992). Consistent with its inland location, faunal remains for SDI-9243 were dominated by small mammal bone followed by medium to large mammal bone, marine fish bone, and shellfish remains.

## SUMMARY AND CONCLUSIONS

Maritime adaptations developed early on the San Diego County coast, beginning about 9000 RYBP. Middle Holocene economies in the area were characterized by kelp-bed and nearshore rocky-reef fishing, shellfish collecting, hunting and fishing in lagoons, terrestrial hunting, and gathering and milling of seeds. Populations focused on lagoonal resources, but they also moved up and down the river valleys exploiting a variety of inland and coastal resources. The distribution of radiocarbon dates suggests that the coastal adaptations and a sustainable population density were established by 7500 RYBP and persisted until 3500 RYBP.

This coastal adaptation was an optimal response to the numerous lagoons of the Early Holocene. San Diego County is unique in having a larger number of substantial lagoon habitats than any other comparable length of coastline in the Southern California bight. Along the 115 km of the county's outer coast today, there are eleven modern and three relict lagoons. There would have been a rich, diversified bay habitat about every 8 km along this coast during the first half of the Middle Holocene. Using a conservative estimate of 5 to 10 km of shoreline per lagoon at 6000 RYBP, the length of productive bay shoreline would have been in the range of 70 to 140 km, roughly doubling the length of the modern coastline.

In addition, during the first half of the Holocene, the outer coast consisted primarily of rocky shoreline. Shallow rocky reefs and kelp beds were more extensive than today and supported diverse fisheries. These habitats account for the greatest species diversity of nearshore marine fishes in the bight. The same species of fish are found in both habitats (Allen 1985), but boats had to be used to fish the kelp beds.

The best evidence for the use of watercraft is the presence of cobble mortars in the kelp beds. A date of about 4000 BP for the mortars manufactured at La Jolla Shores is consistent with a sea level 2 m below today's level and with the present location of the kelp beds off La Jolla and Point Loma. These kelp beds would have been productive fishing areas four thousand years ago, and transporting the mortars out to the kelp beds required the use of watercraft. Grooved stones thought to be net weights also have been reported from two of these underwater localities (Masters 1983).

The occurrence of small mortars in kelp beds and shallow rocky reefs suggests that these tools had some role in fishing activities. The function of the mortars, however, remains a matter of conjecture. Possible uses include grinding chum, baiting fish traps, and/or preparing fish poison (Hoover 1973). In any case, it is important to emphasize the distinctness of the underwater mortars from milling tools used in acorn processing. These cobble mortars were too small and shallow to be useful in grinding large seeds. Their distribution in kelp beds and shallow rocky reefs is also inconsistent with the processing of plant food. Whatever their role in fishing activities, they are reported in nearshore areas of the northern part of the bight and from some of the Channel Islands as well (Hudson 1976; Masters 1985).

Kelp-bed fishing and hunting marked an intensification of the San Diego maritime pattern in the Middle Holocene. The prehistoric inhabitants of Ballast Point appear to have obtained the larger portion of their subsistence from marine rather than terrestrial resources. In addition to shellfish and fish, marine mammal remains outnumbered terrestrial mammal bones. The evidence—from dietary analyses and such fishing tools as gorges and composite fishhooks and the implied use of boats—points to a maritime adaptation resembling the Santa Barbara Channel maritime tradition. The lack of clear seasonality indicators at Ballast Point suggests the development of maritime sedentism at San Diego Bay, achieved with the use of watercraft to exploit offshore fisheries and rookeries (Jones 1992) and supplemented with terrestrial plant foods and small to medium game.

The lagoons and the heads of submarine canyons provided the safest and most convenient watercraft access to the offshore reefs and kelp beds. From Ballast Point, fishermen would have paddled along the shoreline of Point Loma possibly using an ebb tide, out the mouth of San Diego Bay, and directly into the kelp beds. The lagoon at the La Jolla

Shores site opened into the head of the La Jolla Submarine Canyon, which brought deep water close to shore and reduced wave heights. The locality is still used today as a boat launch. In the early part of the Holocene, Agua Hedionda Lagoon would have provided similar watercraft access to the Carlsbad Submarine Canyon.

Submarine canyons also contribute to the productivity of San Diego's coastal waters. Upwelling environments at the heads of the submarine canyons bring nutrient-rich waters close to shore and can produce hot spots of benthic production (Vetter 1994) within the canyon heads that support fish and invertebrate populations. Upwelling also occurs off the headlands of Point Loma and Point La Jolla and supports the growth of kelp forests on those shelves.

Some coastal localities remained productive after 3500 RYBP. San Diego Bay, because of its configuration (Masters 1988), amplifies the tidal range at its head, and the resultant vigorous flushing has helped maintain it as an open, saltwater lagoon with productive habitats into the historic period. Ballast Point yielded five radiocarbon dates between 3510 and 2360 RYBP. At Chollas Creek on the eastern shore of San Diego Bay, a midden extending into the intertidal zone yielded dates of 2100 and 1450 RYBP (Hubbs, Bien, and Suess 1960). Upstream in the San Diego River Valley, SDI-9243 dates to 2340 RYBP.

Among the lagoons of northern San Diego County, Los Peñasquitos Lagoon was slower to infill because two valleys come together there forming a large lagoon relative to the sediment yield from its small drainage basins. SDI-4609, located on the southern shoreline of the lagoon, was occupied from about 2890 RYBP to the historic period as documented by thirty-one $^{14}C$ dates (Breschini, Haversat, and Erlandson 1992). Dates for SDI-4629, on the north side of Los Peñasquitos Lagoon, range from about 7000 to 2355 RYBP. Reefs and kelp beds were accessible from the lagoon. When lagoon productivity dropped, the site inhabitants could therefore still fish on the outer coast (Salls 1988). Also, SDI-11075, on the sea cliff above a reef complex that is still a rocky intertidal habitat today, has dates of 1500 to 1600 RYBP in the uppermost levels (fig. 2.5).

With a few exceptions, therefore, the model of environmental change on the coast at the close of the Middle Holocene, as proposed by Shumway, Hubbs, and Moriarty (1961), Warren, True, and Eudey (1961), and Miller (1966), continues to serve San Diego County well. The cultural response to declining coastal productivity at the end of the Middle Holocene remains an issue for continuing research. Did coastal populations intensify use of inland resources to replace lagoonal resources? Or did they migrate out of the region or suffer population collapse? Datable stream valley sites (SDI-9243 and others) indicate occupation continued there into the Late period, with no hiatus circa 3500 RYBP. Further archaeological research in the stream valleys should be able to resolve the issues of inland resource intensification and cultural continuity into late prehistoric times.

The apparent shift in settlement pattern after 3500 RYBP relies, of course, on how representative the sample of dated sites (fig. 2.3) is of total Middle Holocene sites. As inland sites rarely have datable materials, they tend to be underrepresented in this sample. On the other hand, a greater proportion of coastal sites may have been lost to rising sea level and early, unmitigated development. Where a nearly complete record of sites exists at Batiquitos Lagoon, the archaeological evidence supports the model of environmental and settlement pattern changes at the end of the Middle Holocene.

One cultural response Middle Holocene coastal peoples did not develop was a specialized mainland-island maritime adaptation, as seen in the Santa Barbara Channel area. Both the distance and unfavorable currents would have discouraged southern Channel Island access from the San Diego coast. San Clemente Island lies 96 km west of La Jolla, and seafaring between the San Diego mainland and San Clemente or Santa Catalina Islands would require cross-current travel. Both islands were also long occupied by people associated with the Orange County coast (see chapter 3).

Maritime adaptations in the Southern California bight during the Holocene were as diverse as local environments. Where offshore fisheries and rookeries in the Santa Barbara Channel area provided the impetus, specialized maritime technology such as harpoons and plank boats arose. The San Diego County coastline, with its concentration of lagoon habitats, favored adaptation to estuarine and nearshore reef and kelp-bed fishing. With the collapse of the north county lagoon ecosystems about 3500 RYBP, the San Diego maritime tradition survived and continued into the Late Holocene in two very different localities, San Diego Bay and Los Peñasquitos Lagoon, both remaining tidally flushed lagoons with access to offshore fisheries.

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# The Southern Channel Islands during the Middle Holocene
## *Trends in Maritime Cultural Evolution*

*L. Mark Raab*

THE CHANNEL ISLANDS OF CALIFORNIA are usually described in northern and southern groups (Power 1980:3). The northern group, extending from the Santa Barbara coast to beyond Point Conception, consists of Anacapa, Santa Cruz, Santa Rosa, and San Miguel Islands (fig. 3.1). The more widely dispersed southern group, including Santa Catalina, San Clemente, and San Nicolas Islands, is located off Los Angeles, Orange, and San Diego counties. Owing to its central location, Santa Barbara Island's place in this scheme is more ambiguous but it is often included with the southern islands (Power 1980:3).

The Channel Islands' numerous, well-preserved archaeological sites attracted considerable attention from American and European artifact collectors during the last century (Moratto 1984:121–123). Scientific research replaced relic collecting during this century, but archaeological knowledge has not advanced in a uniform way for all the islands. Investigation of the Santa Barbara Channel region, including northern islands such as Santa Rosa and Santa Cruz, resulted in a comparatively large and coherent body of research (Arnold 1992; Connolly, Erlandson, and Norris 1995; Glassow 1977, 1980; C. King 1971, 1990; Orr 1968; D. Rogers 1929). Research in the southern islands lagged. For the last thirty-five years, a single journal publication, Meighan's (1959) pioneering study of prehistoric maritime cultural ecology at the Little Harbor site, Santa Catalina Island, was the most widely cited source of information on the southern Channel Islands.

The halting advance of archaeological research in the southern islands followed from efforts that simply were too eclectic and episodic. Fortunately, in the last decade, long-term, cooperative research programs launched on San Clemente and San Nicolas Islands, both administered by the United States Navy, resulted in a wealth of new data and will no doubt continue to be productive (Raab, Bradford, and Yatsko 1994; Raab et al. 1995a; Raab and Yatsko 1990; Schwartz and Martz 1992). Basic archaeological research on Santa Catalina Island and contract studies on the mainland also added significantly to the data base of the southern islands region, including new insights into the period of the Middle Holocene (Erlandson 1988b; Erlandson and Colten 1991b:1–2).

My approach to this information is comparative, treating the southern Channel Islands as a cultural area. This approach seems appropriate, in that distinct southern and northern interaction spheres were discernible in the Channel Islands during the era of early European contact (ca. AD 1542 to 1769). The northern sphere, occupied by Chumash Indian groups (Landberg 1965), appears to have origins deep in the Holocene (Connolly, Erlandson, and Norris 1995; C. King 1990; Moss and Erlandson 1995). To the south, Santa Catalina and San Clemente Islands, and probably San Nicolas Island as well, were occupied at the time of European contact by populations with cultural affiliations to the Gabrieliño (Tongva) Indians (Bean and Smith 1978; J. Johnson 1988b; Johnston 1962). Recent evidence suggests that this southern interaction sphere extends at least as far back as the Middle Holocene. Los Angeles, Orange, and San Diego counties, immediately adjacent to the southern Channel Islands, are logical components of this sphere, but there is not space here to include them (see Gallegos 1992; Moratto 1984:120–165; see also chapters 2, 4, and 5). Island data is my topic here, and I will draw on mainland information only to illuminate regional cultural trends and connections.

So far, the antiquity of settlement on Santa Barbara Island has been determined for only the last four thousand years (Erlandson, Glassow et al. 1992). Its small size (about

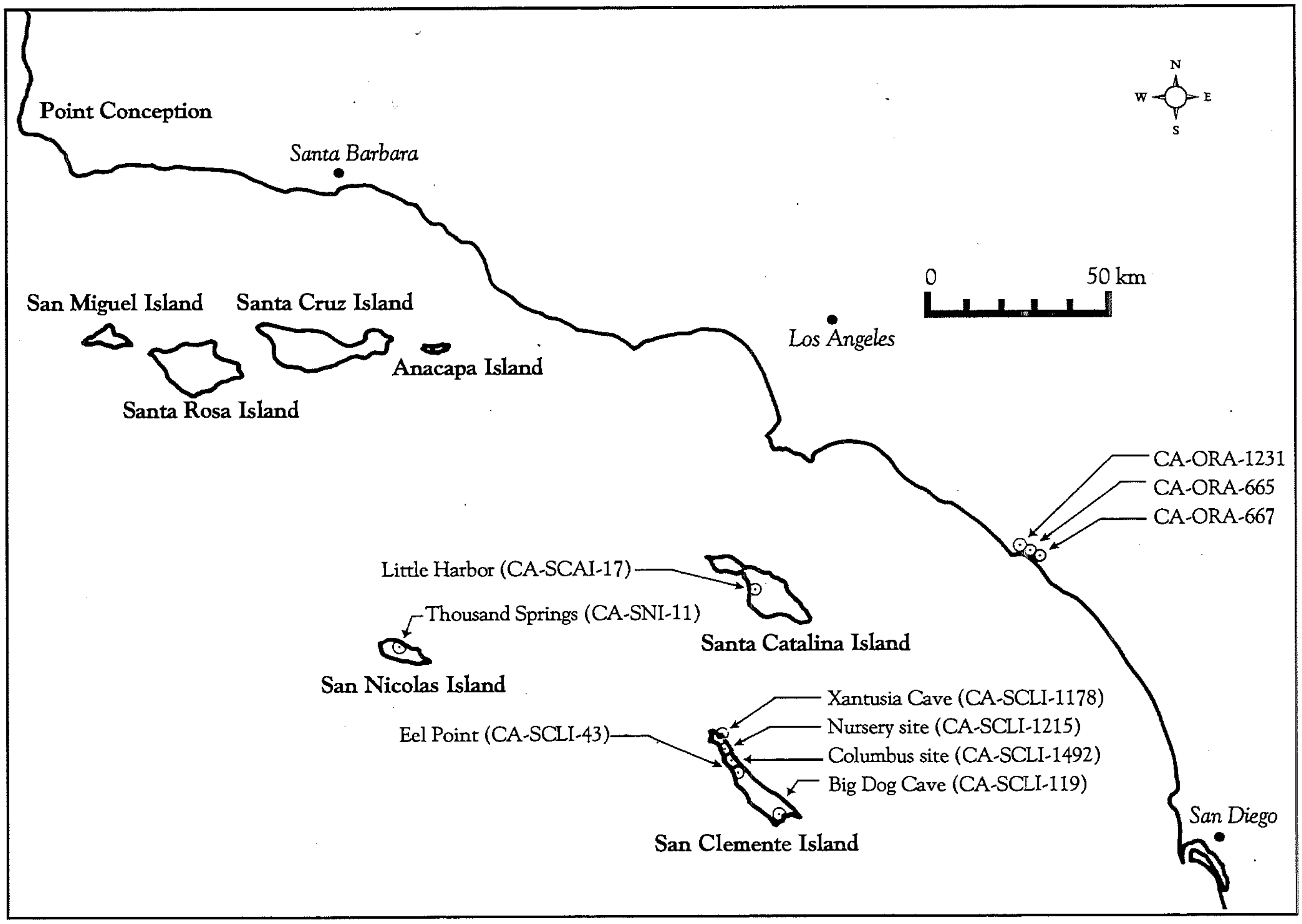



FIGURE 3.1 Sites on the Channel Islands

2.6 km²), rugged coastline, and lack of perennial water appear to have discouraged substantial prehistoric settlement (Glassow 1977:21–48). Because the Middle Holocene record is limited, this island is not discussed here.

Demonstrably important to maritime cultural evolution, paleoenvironmental factors receive only brief consideration in this chapter, owing to limitations of space (see Arnold 1992; Carbone 1991; Glassow, Wilcoxon, and Erlandson 1988; Glassow et al. 1994; Raab, Bradford, and Yatsko 1994; Raab et al. 1995a).

Radiocarbon-based cultural chronologies for the southern islands have expanded greatly in the last decade. Citing dates that are critical to establishing regional cultural trends, with particular reference to dates obtained in the last few years, I have used an illustrative rather than encyclopedic approach. Because we don't know how some dates were processed in the radiocarbon laboratory, the dendrocalibration results presented in table 3.1 should be regarded as an approximation subject to revision on the basis of additional information. Where a date is known to be adjusted for fractionation by the laboratory or where such an adjustment may be appropriately estimated, table 3.1 presents the uncorrected and $^{13}C$ adjusted age of the sample. Dendrocalibrated ages are presented in CYBP. As presented in table 3.1, correction of shell dates for the so-called reservoir effect involved two components: a time-dependent global ocean correction (-402 years) incorporated into the Calib 3.0.3 marine calibration curve, and an additional local ocean offset of -225±35 years for Southern California (Erlandson 1994:61–62; Stuiver and Braziunas 1993:138; 155–156; Taylor 1987:129).

## SETTLEMENT CHRONOLOGY

Sites dating between 8000 and 9000 RYBP have been known from the Southern California coast for more than twenty years, leading Moratto (1984:104–108) to suggest that Early Holocene coastal occupation might be accounted for in terms of a paleocoastal tradition. Even so, many continued to defend the position that real maritime adaptations did not appear before the Middle Holocene—indeed, perhaps not until late in prehistory (see Chartkoff and Chartkoff 1984:128–129; Moratto 1984:144–146; Yesner 1987). This discussion defines maritime adaptation as one in which the bulk of calories or protein comes from the sea (Yesner 1980:728). Current evidence, including advances in coastal chronology building, suggests that such adaptations emerged during the Early Holocene in Southern California and were well

TABLE 3.1 Radiocarbon chronology for key Middle Holocene sites of southern Channel Islands

| $^{14}$C LAB NO. | PROVENIENCE | $^{14}$C AGE[1] | $^{13}$C/$^{12}$C ADJUSTED AGE | MATERIAL | CALENDER AGE(BP)[2] |
|---|---|---|---|---|---|
| *SCAI-17, Little Harbor, Santa Catalina Island* | | | | | |
| M-434[3] | Unit 8, 61 cm | 3880 ± 25 | —[4] | Charcoal | 4180(4330)4400 |
| Beta-47277[5] | Unit 33W, 40–50 cm | 4620 ± 80 | 5070 ± 80 | Shell | 4980(5120)5270 |
| Beta 47275[5] | Unit 2.5N, 30–40 cm | 4760 ± 90 | 5200 ± 90 | Shell | 5220(5300)5440 |
| UCLA-1880B[6] | Unit 1, 50 cm | 4780 ± 60 | —[4] | Shell | 5220(5290)5340 |
| Beta-47273[5] | Unit 1, 50–60 cm | 4890 ± 80 | 5340 ± 80 | Shell | 5330 (5460)5570 |
| UCLA-1928A[6] | Unit 1, 40 cm | 4980 ± 60 | —[7] | Shell | 5440 (5540)5590 |
| Beta-47274[5] | Unit 1, 50–60 cm | — | 5105 ± 60[8] | Charcoal | 5750 (5890)5920 |
| Beta-47278[5] | Unit 83W, 40–50 cm | 6860 ± 190 | 6880 ± 190 | Charcoal | 7530 (7650)7890 |
| *SCLI-43B, Eel Point, San Clemente Island* | | | | | |
| LJ-4130[9] | "Foxhole," 51–66 cm | — | 8180 ± 110 | Shell | 8280(8360)8470 |
| UCLA-2758E[9] | Unit 3, 250–260 cm | 9655 ± 325 | —[4] | Charcoal | 10,300(10,900)11,200 |
| UCLA-2758C[9] | Unit 3, 140–160 cm | 9775 ± 165 | —[4] | Charcoal | 10,630(10,980)11,070 |
| UCLA-2758D[9] | Unit 3, 180–190 cm | 9870 ± 770 | —[4] | Charcoal | 10,030(11,000)12,570 |
| Beta-75092[10] | Unit 3, 250–260 cm | 5060 ± 50 | 5510 ± 50 | Shell | 5580(5630)5700 |
| Beta-75555[10] | Unit 3, 250–260 cm | 5470 ± 160 | 5500 ± 160 | Charcoal | 6060(6290)6440 |
| Beta-75093[10] | Pit A, 150–160 cm | 7490 ± 70 | 7910 ± 70 | Shell | 7990(8100)8160 |
| Beta-76021[10] | Pit A, 150–160 cm | 8120 ± 310 | 8110 ± 300 | Charcoal | 8550(8990)9430 |
| *SCLI-1178, Xantusia Cave, San Clemente Island* | | | | | |
| LJ-4169[11] | 90 cm | — | 4950 ± 90 | Shell | 4830(4940)5050 |
| UCLA-255[11] | Burial, 90–105 cm | 5130 ± 55 | —[4] | Bone | 5080(5290)5300 |
| LJ-4168[12] | 90 cm | — | 6300 ± 90 | Shell | 6390(6480)6620 |
| *SCLI-1215, Nursery Site, San Clemente Island* | | | | | |
| UCLA-2568[12] | Feature 27, House pit 1 | 3750 ± 35 | —[4] | Charcoal | 3990(4090)4150 |
| Beta-66816[13] | S23/W10, 10–20 cm | 450 ± 70 | 450 ± 70 | Charcoal | 470(510)530 |
| Beta-66817[13] | Floor, House pit 3 | 4360 ± 70 | 4790 ± 70 | Shell | 4640(4800)4840 |
| Beta-69355[13] | Feature 3, House pit 2 | 4370 ± 70 | 4820 ± 80 | Shell | 4700(4810)4860 |
| Beta-71853[10] | Floor, House pit 4 | — | 4510 ± 60 | Charcoal | 5000(5130)5300 |
| *SNI-11, Thousand Springs Site, San Nicolas Island* | | | | | |
| UCLA-2559D[14] | — | 5955 ± 120 | —[4] | Charcoal | 6670(6780)6900 |

1. Radiocarbon years before present, uncorrected for isotopic fractionation; 2. Dendrocalibrated age in years before the present(present = AD 1950), with 1 sigma age range and mean intercept in parenthesis, calculated by Calib 3.0.3(Stuiver and Reimer 1993); 3. From Meighan 1959; 4. Not known if sample was $^{13}$C adjusted; 5. From Raab et al. 1995b; 6. From Kaufman 1976; 7. Date not $^{13}$C adjusted in the lab; marine carbonate $^{13}$C value estimated at 0 ± 2(after Table 1 of Calib 3.0.3); 8. Small sample converted to AMS date(ETH-8620); 9. From Salls 1988, Breschini et al. 1992; 10. Date on file, Northridge Center for Public Archaeology, California State University, Northridge; 11. From Foley 1987; 12. From Rigby 1985; 13. From Raab, Bradford, and Yatsko 1994; 14. From Schwartz and Martz 1992.

established by the Middle Holocene (Erlandson 1994; Erlandson and Colten 1991b; T. Jones 1991, 1992; Moss and Erlandson 1995).

Recent syntheses of California maritime prehistory (Erlandson 1988d; 1994; Erlandson and Colten 1991a; T. Jones 1991) identify perhaps ten coastal or pericoastal sites dated to between 9000 and 10,500 RYBP. Four sites in this time span are reported from the California Channel Islands (Erlandson 1991b; T. Jones 1991). Scores of sites are currently known with ages between 8000 and 9000 RYBP (Erlandson 1994; Erlandson and Colten 1991b; T. Jones 1991: 427–428, 1992). At least seventy-five sites with ages between 7000 and 8000 RYBP have been reported on the central and southern coast of California (Erlandson 1994; Erlandson and Colten 1991b:2; T. Jones 1992).

On the southern Channel Islands, the Eel Point site (SCLI-43) on San Clemente Island is currently the earliest reported occupation (Erlandson 1994:214–216; Erlandson and Colten 1991b:9; T. Jones 1991:427–428; Raab, Bradford, and Yatsko 1994). Eel Point contains three defined archaeological loci (A, B, C), with a total area of at least 2 ha (Salls 1990). Twenty-four $^{14}$C dates were reported by Salls (1988:361, 372) from loci B and C. Salls' dates from locus C range between 1080±25 and 4500±350 RYBP. The most recent date for locus B reported by Salls is 3125±85 RYBP, whereas the three earliest dates from this locus set initial human occupation of Eel Point between approximately 9000 and 10,000 RYBP (table 3.1). Recent work, however, calls the validity of these early dates into serious question. The basal stratum of the excavation pit that produced the earliest of Salls' dates (unit 3) was subjected to a new round of radiocarbon dating, with the result that this stratum produced two dates that range from 5630 to 6290 CYBP (Raab, Bradford, and Yatsko 1994; Raab et al. 1995b). Additional dates (LJ-4130, Beta-75093, and Beta-76021) tend to confirm Erlandson's (1994:214) assessment that the initial occupation of Eel Point took place between about 7900 and 8500 CYBP.

Recent excavations (Raab, Bradford, and Yatsko 1994) demonstrate an extensive Middle Holocene occupation of Eel Point, with eleven radiocarbon dates ranging from 3320±110 to 5780±90 RYBP (3510 CYBP to 5920 CYBP; see Raab et al. 1995b for a complete listing). These levels contained abundant faunal remains, including sea mammals, birds, fish, and shellfish (Porcasi 1995). Significantly, at Eel Point single-piece circular shell fishhooks appear for the first time at 3320±110 RYBP, or 3510 CYBP (charcoal date, Beta-76151, Raab et al. 1995b).

Middle Holocene occupations of the other southern islands and adjacent mainland coast are also evident. The oldest date currently known from Santa Catalina Island derives from the Little Harbor site (SCAI-17). A date of 6880±190 RYBP (7650 CYBP) was obtained from a possible hearth feature at the base of the site's midden deposits (Raab et al. 1995a).

Little Harbor is one of the most extensively researched Middle Holocene sites in the southern islands. Meighan's excavations between 1953 and 1955 established Little Harbor as a landmark in the study of prehistoric maritime cultural ecology and produced perhaps the first radiocarbon date from a California coastal site (Meighan 1959). A single date of 3880±250 RYBP (M-434; Meighan 1959:384) from Little Harbor was cited for many years as one of the earliest for a Pacific Coast maritime cultural component (see Moratto 1984:160–161). Current evidence suggests, however, that this date is spurious, reflecting a mixture of charcoal from differing cultural components (Raab et al.1995a).

Recent investigation of the site contributed six new radiocarbon dates (table 3.1) as part of a study of the impact of marine paleotemperature on the site's faunal assemblage and identified five possible prehistoric cultural components at the Little Harbor site (Raab et al. 1995a). The most important of these to the present discussion is component 2, the site's most extensive Middle Holocene cultural deposit. The weighted average of six component 2 radiocarbon dates is 5270 CYBP. Although these dates make the site older than previously estimated, Little Harbor is by no means an anomaly either in relation to its age or the maritime character of its economy.

Foley (1987:3) reports a radiocarbon date of 6300±90 RYBP (6480 CYBP) from the base of archaeological deposits in Xantusia Cave (also called North End shelter, SCLI-1178) on San Clemente Island. This sea cave, with a floor area of about 18 x 9 m, was nearly filled with a midden of pink abalone (*Haliotis corrugata*) shells and little else. Two other dates, 4950±90 and 5130±55 RYBP, the latter from a human burial in the abalone shell deposit, were also obtained from this midden (Foley 1987:11). These dates produce mean ages of 4940 and 5290 CYBP, close to the age of component 2 at Little Harbor.

At 5955±120 RYBP (4835 CYBP), the earliest reported San Nicolas Island date is younger than the basal dates of Xantusia Cave and Little Harbor but older than component 2 of the Little Harbor site. This date is the oldest of thirteen reported from SNI-11, the Thousand Springs site (Schwartz and Martz 1992:3).

The Nursery site (SCLI-1215) on San Clemente Island, named for a nearby native plant nursery, contains an important Middle Holocene record of occupation. At least eighteen house pits and a large shell-bearing midden are sheltered in the lee of a fossilized dune (Salls, Raab, and Bradford 1993). Four prehistoric house pits, all dating to the Middle Holocene, have been investigated to date. In some instances, the houses built in these pits had whale jaws, scapulae, and ribs as roof members. Radiocarbon dates confirm a Middle Holocene age for these structures, although it seems likely that the site was occupied at least intermittently until the time of European contact (most recent date is 510 CYBP, or ca. AD 1450).

Excavation at the Nursery site during 1984 by archaeologists from the University of California, Los Angeles, revealed the first evidence of house pits and related features (Rigby 1985). The first of these structures to be discovered, designated here as house pit 1, was a saucer-shaped depression filled with shell midden. Features were encountered on the floor, including a mold impression of a center support post and hearths containing large amounts of burned sea mammal bone and charcoal (Rigby 1985:9). Charcoal from one of these hearths (feature 27) yielded a $^{14}C$ date of 3750±35 RYBP (4090 CYBP).

During the summer of 1990, an archaeological field school directed by the author and A. Yatsko excavated house pit 2 (Salls, Raab, and Bradford 1993). Constructed in a circular pit 4.5 m wide and about 50 cm deep, whalebone roof members were set in holes between 10 and 30 cm in diameter at the floor perimeter. Quantities of whalebone were found on the floor, including large bone masses at the east and west periphery. After a description of this structure went to press, abalone shells from a storage pit (feature 3) in the floor of house pit 2 produced a date of 4820±80 RYBP or 4810 CYBP.

Other house pits at the Nursery site were partially excavated by the members of a 1993 field school conducted by the author and A.Yatsko. Remnants of whalebone roof members, floor surfaces with artifacts, hearths, storage cysts, and postoccupational refuse deposits were found. House pit 3 produced a date of 4790±70 RYBP (4800 CYBP). This date is derived from a basket load of shells (*Tegula* sp.) thrown into house pit 3 not long after its abandonment. An AMS date of 4510±60 RYBP (5130 CYBP) was obtained from a charcoal sample taken from the floor of house pit 4.

## ECONOMIC PATTERNS

Given the settlement chronology presented earlier, maritime economies of the Middle Holocene clearly did not spring into existence de novo. Our understanding of Early Holocene antecedents on the Channel Islands is sketchy, however, owing to the small number of early sites investigated. In some cases, this paucity of information will only permit extrapolation of Early Holocene economic patterns from more recent cases. Erlandson, for example, suggests that SCRI-109 on Santa Cruz Island may be indicative of early northern Channel Islands subsistence patterns:

> California mussel dominates the shellfish remains, with only small amounts of bone recovered. Estimates of the protein yield of the recovered faunal remains . . . suggest that Early Holocene site occupants depended heavily on shellfish (90.8%), supplemented by fish (5.4%), and sea mammals (3.8%). . . . (1991b:110)

The small proportion of sea mammals in this assemblage is surprising, perhaps, in light of reports of the hunting of sea mammal on the northern Channel Islands between 6000 and 9000 RYBP (Hildebrandt and Jones 1992:386). This reconstruction also provides an interesting contrast with the results of recent research at the Eel Point site on San Clemente Island.

Salls (1988:636) noted several years ago that abalones (*Haliotis corrugata* and *H. fulgens*) and fish appeared to form the economic base of the Early Holocene occupation at Eel Point. This observation could only be regarded as anecdotal, however, since bones of sea mammal apparently were not collected (Hildebrandt and Jones 1992:386).

The economic picture at Eel Point is now a good deal clearer (Raab, Bradford, and Yatsko 1994; Raab et al. 1995b). These studies, bolstered by thirty new radiocarbon dates, revealed cultural deposits spanning an age range from as much as nine thousand years ago until about AD 1400. Based on this research, Porcasi (1995) demonstrates a number of interesting trans-Holocene shifts in the species composition and intensity of pinniped, dolphin and sea otter hunting. Although this research shows that sea mammals were always a mainstay of the Eel Point diet, hunting of sea mammal contrasts sharply with fishing in certain respects. At Eel Point, fishing was of negligible importance during the Early Holocene, presenting a pattern similar to the one described earlier by Erlandson (1991b:110). Substantial quantities of fish do not appear in the assemblage until after about 5000 RYBP; indeed, fishing shows no clear tendency toward intensification until after 3320 RYBP with the appearance of shell fishhooks. From this point until the close of the Holocene, fishing shows an exponential increase in importance (Raab et al. 1995b).

Maritime subsistence patterns in the southern Channel Islands and adjacent mainland come into considerably sharper focus after about 5000 RYBP. Faunal data show that shellfish and sea mammals remained important dietary components from Early Holocene times, and fishing became a significant economic pursuit. Three economic patterns from the southern islands and mainland illustrate the procurement tactics employed during the Middle Holocene: hunting of sea mammal and fishing on Santa Catalina and San Clemente Islands, abalone collecting on San Clemente Island, and the sheephead fishery of the mainland coast and San Clemente Island.

### Hunting of Sea Mammal and Fishing

The subsistence economy of the Little Harbor site was diverse and clearly maritime in orientation, including shellfish, fish, birds, and sea mammals (Bradford 1994; Kaufman 1976; Meighan 1959; Porcasi 1994; Salls 1988). The latter accounted for 97 percent of the mammalian bones obtained from Meighan's excavations (Meighan 1959:400); 81 percent of these were cetaceans (dolphins and porpoises), and the remaining 16 percent were pinnipeds (nearly all sea lions). The important role of sea mammals in the Little Harbor economy is reinforced by recent research. In 1991, my colleagues and I excavated 2.5 m$^3$ of midden from three pits at the site (Raab et al. 1995a). When the faunal elements from this sample were analyzed, dolphin (*Delphinidae*) bones representing five species and members of the genus *Stenella* were identified. The blue or white dolphin (*Stenella coeruleoalba*) is of particular interest both as an indicator of past marine conditions and in relation to tuna fishing at Little Harbor. This species is rarely seen today in California waters, given that Baja California is typically the northern limit of its range. This species has been sighted as far north as British Columbia in warm-water years but is a resident of the tropics or subtropics, as are all members of this genus. These warm-water animals, in concert with other lines of evidence, point to warmer-than-present sea temperatures during the occupation of component 2 at the Little Harbor site (Raab et al. 1995a). Porcasi (1994) also reports bones of sea lion (*Zalophus californianus*) and fur seal (*Arctocephalus townsendi*) from this sample.

Fish bones are also abundant at Little Harbor. The most extensive study to date of fish remains is Salls' (1988:405–412) analysis of Meighan's (1959) bone assemblage. A number of fish species were identified, but perhaps the most striking aspect of Salls' study (1988:731) was the number of tunas and other large, pelagic warm-water species. It is difficult to determine the relative importance of large species in Meighan's fish-bone assemblage because screens were not used during the 1950s excavations. Even so, tuna skeletal elements account for 53 percent (NISP=895; Salls 1988:408, 731) of all fish bones at Little Harbor, by far the highest absolute number of tuna elements observed in the fish-bone assemblages of twenty-three coastal sites examined by Salls.

Dolphins of the genus *Stenella* are normally oceanic, infrequently venturing close to land. How were these animals taken? This question is particularly puzzling in light of the fact that the Little Harbor site reveals no evidence of elaborate hunting or fishing technology (Meighan 1959:402). The association of tunas and dolphins in the same assemblage may offer a key to understanding this intriguing problem. Cultural component 2 at Little Harbor predates the appearance of shell fishhooks but bone gorges are common (Meighan 1959), a trait that marks Early and Middle Holocene cultural components of the southern islands. At least some of the smaller tunas could be caught with such equipment (Salls 1989). On the other hand, Salls' (1988:411) suggestion that tunas may have been taken at Little Harbor with nets is interesting in light of Perrin's (1975) report that *Stenella* often account for most dolphins killed in the nets of modern tuna boats—because these dolphins tend to swim above schools of tuna. As air-breathers, dolphins drown when they become entangled in fishing nets. This mode of capture would obviate the need for subduing these relatively large, powerful animals. The small MNI of dolphins (N=9) in our sample, however, may suggest occasional catches incident to net fishing, or even occasional stranded animals, rather than a dolphin fishery.

Salls (1988:194–197) noted that the two sites containing the largest numbers of tuna elements in his study, Little Harbor and site VEN-110 near Point Mugu, Ventura County are both located at the heads of submarine canyons known to bring pelagic species virtually to shore. This is a provocative observation. The Little Harbor site takes its name from the bowl-shaped basin of Little Harbor, which forms the head of the Catalina Submarine Canyon (Salls 1988:197). A concentration of fish in this canyon would logically attract predators such as sea lions and dolphins. Sea mammal haulouts or breeding rookeries in the area would also be vulnerable to attacks with clubs and spears (Hildebrandt and Jones 1992:364). The large projectile points in the Little Harbor artifact assemblage are interesting when viewed in this light, particularly since no indigenous terrestrial mammal existed on the southern Channel Islands larger than the Channel Islands fox (*Urocyon litoralis*), which is the size of a house cat. Indeed, Hildebrandt and Jones (1992:364–365) suggested that the Channel Islands were attractive for precisely this type of shore-based hunting during the Early and Middle Holocene. These observations suggest that Little Harbor may have enjoyed a strategic location for exploiting marine resources.

Strong evidence for shore-based sea mammal hunting also exists on San Clemente Island. Porcasi shows that at the Eel Point site sea mammal hunting "pulsed" (1995:13) within remarkably constrained limits across the Holocene; that is, the proportion of sea mammals in the faunal assemblage shows a regular rising and falling pattern but never exceeded certain limits. The species composition of the marine mammal assemblage suggests an explanation for this pattern. As much as 46 percent of the marine mammal assemblage (NISP) consists of pinnipeds (Porcasi 1995:14). Significantly, 31 percent of these pinnipeds are juveniles (Porcasi 1995:17). Since the island's rookeries are occupied largely by seals and sea lions who come ashore to give birth to their pups, this pattern strongly indicates predation on rookeries as the dominant hunting mode. Clubbing is an effective killing technique under these conditions. The virtual absence of harpoons, large bone barbs, or other gear clearly connected with the hunting of sea mammals at Eel Point also points to attacks on rookeries as the main hunting technique.

**Abalone Collecting**

In sharp contrast to the diverse Little Harbor and Eel Point economies, the inhabitants of Xantusia Cave (SCLI-1178) on San Clemente Island focused their foraging efforts on abalone collecting. Studies of prehistoric abalone collecting on San Clemente and Santa Catalina Islands show that comparatively small intertidal black abalones (*Haliotis cracherodii*) typically constitute more than 90 percent of abalone shells in middens, with the remainder consisting of larger subtidal pink (*H. corrugata*) and green (*H. fulgens*) abalones (Bradford 1994; Raab 1992; Raab et al.1995a). A midden composed of 90 percent or more of pink abalone shells in Xantusia Cave is a striking reversal of this pattern. As far as I am aware, no other midden in the southern islands duplicates this pattern.

Foley (1987:10–11) also reports stable isotope values (per mil) from the human burial at Xantusia Cave of -12.58 for $^{13}C$ and + 22.14 for $^{15}N$. These values are indicative of a diet heavily dependent on marine foods; indeed, these values suggest an even greater reliance on marine foods than shown by the Late period dwellers of the northern Channel Islands documented by Walker and DeNiro (1986:55). Evidence of this kind should help resolve any lingering doubts about whether Middle Holocene islanders were really maritime in economic orientation.

**Sheephead Fishery**

Archaeological evidence shows that the California sheephead (*Semicossyphus pulcher*, formerly *Pimelometopon pulchrum*) was one of the most important teleost (bony) fish species in the prehistoric fishing economies of Southern California. Several of the sites examined earlier contain evidence of sheephead fishing.

The Eel Point site provides particularly important data on sheephead fishing. A sample of 7.97 $m^3$ of midden containing 1,618 fish elements (30 percent random sample of all excavated faunal material) was analyzed from locus B. A sample of 33 $m^3$ of midden containing 20,665 fish elements (30 percent random sample of all excavated faunal material) was analyzed from locus C (Salls 1988:357–382). One of the most interesting results of these studies is the high proportion of sheephead in the Eel Point fish-bone assemblages over the span of the site's occupation (Salls 1988:209–220, 357–382). Sheephead account for 72 percent of the identifiable teleost elements at Eel Point, locus B, and nearly 58 percent at locus C.

Other sites on San Clemente Island also contain high percentages of sheephead bones. To the nearest whole percent, these are: SCLI-119 (Big Dog Cave) 53 percent; SCLI-1215 (Nursery site) 70 percent; SCLI-1492 (Columbus site) 78 percent. The large representation of sheephead in these fisheries is also apparent despite Salls' identification of a total of forty-one genera or species of teleosts at Eel Point locus C (Salls 1988:725–727), twenty-six genera or species at Eel Point locus B (Salls 1988:724), twenty-six genera or species at the Nursery site (Salls 1988:729), twenty-four genera or species at SCLI-119 (Salls 1988:730), and thirteen genera or species at SCLI-1490 (Salls 1988:728). These figures do not take into account size and meat yield of various species, seasonal availability, relative difficulty of exploiting various marine habitats, gear required for capture, and other factors that influenced food yields. Moreover, the sites listed above contain cultural components of various ages. These data suggest, however, that sheephead supplied a major proportion of food obtained from fish species by San Clemente Island dwellers, including those of the Middle Holocene.

Fish-bone assemblages of Middle Holocene age have recently been reported from the three Orange County sites. In these sites, percentages of sheephead bones among identified teleosts range from slightly more than 9 percent (ORA-1231) to a little more than 35 percent (ORA-665). This range may be at least partially attributable to sampling errors arising from comparatively small bone samples. This possibility acknowledged, sheephead nonetheless were an important target of anglers on the Orange County coast. Among the Orange County sites, Langenwalter (1992:210) identifies a total of sixteen teleost genera or species, and Bonner (1992:101–111) reports a total of seventeen teleost genera and species. As in the case of San Clemente Island, apparently no other single fish species made a larger contribution to the fishing economy.

The intensive exploitation of *S. pulcher* was influenced by two factors: its comparative vulnerability as a prey species and principles of optimal foraging. The sheephead is territorial and readily drawn to all types of invertebrate baits, such as crushed sea urchins or other shellfish (Ames 1972; Eschmeyer and Herald 1983:237; Fitch and Lavenberg 1971:88), at which time it is vulnerable to spears, hook and line, nets, and traps. The dietary breadth of human hunter-gatherer-fishers is viewed by some researchers as the outcome of ecological constraints that shape the feeding behavior of all predators (Yesner 1981:150). Based on these dynamics, one might conclude that sheephead fishing was more productive in relation to its energy costs than the available alternatives. This interpretation is not consistent, however, with certain interpretations of sheephead fishing. In assessing the fish-bone data from site ORA-667, Bonner concluded that procurement of sheephead and other kelp bed species was relatively "expensive" (1992:109, 113) in that it would have required considerable labor and equipment, including boats.

If this conclusion is valid, one might ask why bay and estuary and open-coast species are not more prominent in the fish-bone assemblages. Elasmobranch (shark and ray) elements in the Orange County sites range from about 1 percent to 6 percent of total fish elements (Langenwalter 1992). Bottom-dwelling sharks and rays taken from bay, estuary, and sandy-bottom, open-coast habitats account for most of these elements (Bonner 1992; Langenwalter 1992). Why do elasmobranchs represent such comparatively small percentages of these assemblages, if offshore species were more expensive to obtain?

Perhaps offshore fishing was not as expensive as some researcher might suppose. Bonner's interpretation appears to rest on the assumption that sheephead and other species were exploited with elaborate fishing tackle and watercraft. Sheephead and many other teleost species found in fish-bone assemblages do inhabit kelp beds and offshore rocky reefs. And there can be little doubt that kelp beds were productive fishing habitats. Glassow and Wilcoxon (1988:44–45) report that fish biomass ranges from 383.6 kg/ha over sandy-bottom habitats to 859 kg/ha in kelp beds (rocky substrates). The potential subsistence rewards of the latter may have justified the costs involved in fishing from boats. On the other hand, shore-based fisheries employing only simple techniques and gear may also be highly productive in relation to sheephead fishing—note the large numbers of sheephead taken at Eel Point millennia before the appearance of the first shell fishhooks. A shore-based fishery on the mainland coast, where rocky shorelines are interspersed with sandy beaches and bays, might result in an optimal dietary breadth that includes a high proportion of sheephead but a variety of other teleosts and elasmobranchs as well. Within this economic calculus, the higher proportions of sheephead and negligible numbers of elasmobranchs in the San Clemente Island sites would be attributable to the fact that most of the shoreline of that island is rocky, with few sandy-bottom habitats (Salls 1988; Raab and Yatsko 1990). The productivity of sheephead fishing, much like hunting of sea mammal, appears to have resulted from targeting specific habitats and prey behavior rather than reliance on elaborate technology.

## SOUTHERN ISLANDS INTERACTION SPHERE

Beyond economy and technology, recent research provides an intriguing glimpse into socioeconomic linkages between the inhabitants of the southern Channel Islands in the Middle Holocene (Howard and Raab 1993). This insight is afforded by the distribution of *Olivella* Grooved Rectangle (OGR) beads, a rare type made from the purple olive shell (*Olivella biplicata*). OGR beads have been found in cultural deposits of similar age at Little Harbor, in coastal Orange County sites, and in sites on San Clemente and San Nicolas Islands.

Bennyhoff and Hughes assign OGR beads to their Class N, defined as "rectanguloid to oval bead with ground edges and an elongate perforation formed by a central groove transverse to the long axis of the shell" (1987:141–142). Bennyhoff and Hughes subdivide OGR beads into large (N1) and small (N2) varieties, which are quite distinctive and not easily mistaken for any other type.

Few of these beads appear in reports (<250?), but examples are known from ORA-368, ORA-665, ORA-667 in Orange County (C. King 1990:111; Mason et al. 1992a:168, 1992b:94); LAN-361 and LAN-43 in Los Angeles County (C. King 1990:111); SCAI-17 on Santa Catalina Island (C. King 1990:111); SNI-161 on San Nicolas Island (Vellanoweth 1996); SBA-119 in southern Santa Barbara County (Harrison 1964:147, 179; a single bead); the western Great Basin sites of Lovelock Cave (Bennyhoff and Heizer 1958:69, 75), Hidden Cave, Kramer Cave, Shinners site F, and Stillwater Marsh (Bennyhoff and Hughes 1987:141–142); and a northern Great Basin site in the Fort Rock Valley of south-central Oregon (Jenkins and Erlandson 1996).

Ten OGR beads were recovered from the Little Harbor site, nine from cultural component 2 (Howard and Raab 1992). Recent excavations at two Orange County sites of similar age produced six OGR beads (see chapter 4). The Orange County sites are somewhat problematic, however, since these sites, like many on mainland Southern California, reveal the pervasive effects of faunalturbation and other problems of stratigraphic interpretation. Nevertheless, one OGR specimen was recovered from ORA-665 (Gibson 1992a), a site with eight $^{14}$C dates ranging between 4590±80 and 5010±90 RYBP (chapter 4).

Five specimens were recovered from ORA-667 (Gibson 1992c). Contexts near the excavation unit from which these beads were recovered produced seven dates ranging from 4800±65 to 5025±60 RYBP. An additional sixteen $^{14}$C dates from this site have a similar time range (chapter 4). Sites ORA-665 and ORA-667 thus have cultural components of closely similar ages about one to two centuries younger than component 2 at Little Harbor. These differences may result from statistical variation inherent in radiocarbon dates. A larger sample of dated sites from the islands and mainland could conceivably reflect valid time trends in the regional distribution of this bead type.

House pit 2 from the Nursery site on San Clemente Island, with an age of 4810 CYBP, contained OGR beads in refuse thrown onto the floor soon after the house was abandoned. As noted earlier, house pit 3 produced a date of 4800 CYBP from a basket load of *Tegula* shells containing OGR beads (Raab, Bradford, and Yatsko 1994).

Vellanoweth (1996) reported OGR beads and bead-making debris from SNI-161 on San Nicolas Island. Nine $^{14}$C dates, including an AMS date on an OGR bead, cluster circa 5000 RYBP, which is consistent with the age of OGR beads found on the mainland and the other southern islands.

OGR beads appear to be most numerous on the southern Channel Islands (Santa Catalina, San Clemente, San Nicolas), adjacent portions of the mainland coast, and the western Great Basin. Their currently known distribution does not extend to the northern Channel Islands. Intriguingly, C. King notes that

> On the basis of present information, it appears that beads with grooved holes were used at the end of the Early period or at the beginning of the Middle period mainly in areas where the historical native people spoke Uto-Aztecan languages. (1990:111)

The origins of these people is an enduring problem in Southern California prehistory, generally subsumed under the rubric of the Shoshonean Wedge hypothesis. The bearing of the OGR bead data on this hypothesis is beyond the scope of the present discussion but is considered elsewhere (Howard and Raab 1992). It seems reasonable to suggest, however, that a Middle Holocene sphere of socioeconomic interaction, marked by the presence of OGR beads, existed between Santa Catalina, San Clemente, and San Nicolas Islands and adjacent portions of the mainland between about 4500 and 5100 CYBP.

## RETHINKING CHANNEL ISLANDS PREHISTORY

When information from Little Harbor was published more than thirty-five years ago (Meighan 1959), many archaeologists believed that the earliest Californians were essentially, if not exclusively, terrestrial hunter-gatherers. This interpretation was consistent with prevailing models of New World prehistory, but it left the question of maritime cultural origins unresolved. It was by no means obvious when or how land-based groups developed the maritime adaptations apparent on the Southern California coast during late prehistory. This challenge was met by characterizing Middle Holocene coastal occupations such as Little Harbor as experiments or discoveries that gradually led to fully developed maritime adaptations. In various forms, this model has enjoyed remarkable popularity in archaeological thinking. This durability was no doubt enhanced by periodic revisions that brought the model into line with prevailing theoretical approaches. Osborn (1977), for example, cast the problem of maritime origins in ecological terms, suggesting that ancient peoples turned to marine foods only under conditions of dwindling terrestrial food supplies. More recently, Yesner advanced a similar "calorie-free sea" hypothesis (see Moseley and Feldman 1988:126) as an explanation of the apparently "late" occupation of the California Channel Islands:

> If . . . one of the best indicators of population pressure is the increasing use of more marginal habitats, then . . . continued population growth and pressure on resources have been occurring since mid-Holocene times. This expansion involves the use of microenvironments with less species diversity, such as straighter, less complex (and hence less biotically diverse) coastlines, as well as areas with lower species abundance, such as small, offshore islands. . . . Even for North America as a whole, it is possible to show that areas such as the California Channel Islands or the Florida Keys *were occupied relatively late in the prehistoric record* . . . . (Yesner 1987:300–301; emphasis added)

Models of this kind are behind the curve of Southern California coastal research. Viewing the path of coastal cultural evolution in this region in relation to separate terrestrial and maritime paths is justified only by ignoring research advances of the last decade. Recent syntheses show that maritime adaptations, combining terrestrial and marine resources, have existed on the mainland coast since Early Holocene times (for example, Erlandson 1991a, 1994; Erlandson and Colten 1991b; Gallegos 1991; Glassow 1991; T. Jones 1991, 1992; Moss and Erlandson 1995). Even more intensively maritime economies existed on the Channel Islands in a comparable time span.

## MIDDLE HOLOCENE CULTURAL TRANSITIONS

It is now apparent that maritime hunter-gatherers occupied the Southern California coast and Channel Islands at least as early as 9500 RYBP, and probably a millennium earlier (Erlandson 1994; Moss and Erlandson 1995). The antiquity of these developments should not be surprising. It would be more astonishing for any ecological niche to be ignored by human predators equipped to exploit it. In fact, I believe the prehistoric occupation of California's Channel Islands, including its southern members, can be viewed as a long-term niche-filling process. In this regard, earlier researchers were not entirely off the mark in viewing the Middle Holocene as a time of critical change. Widespread settlement of the Channel Islands and well-developed maritime economies are two important trends that mark this time period. Recent studies show that these occupations were not experimental or pioneering steps in a gradual technoeconomic shift from the land to the sea. Instead, important changes in Middle Holocene economy, technology, settlement patterns, demography, and social organization have their roots in Early Holocene occupations, and these middle Holocene trends in turn set the stage for continuing maritime cultural change in the Late Holocene.

An important challenge in understanding patterns of maritime cultural change during the Holocene is explaining how forager lifeways of the Early Holocene gave rise to the sedentism, accelerating population growth, intensification of economic production, and technological innovations that mark later time periods. Middle Holocene archaeological data play a crucial role in understanding this transition. The Nursery site pit house community, for instance, seems to reflect many of these critical changes. The degree of residential permanence suggested by this community stands in sharp contrast to the highly mobile settlement-subsistence dynamics generally attributed to Early Holocene coastal groups. In terms of the settlement-subsistence model popularized by Binford (1980), it appears that Early Holocene foragers were replaced, at least in some instances, by collectors operating out of permanent or semipermanent residential bases such as the Nursery site by about 5000 RYBP.

It may be worth noting that California is not a unique instance in which some degree of Middle Holocene sedentism emerged in a zone of high marine productivity. Moseley notes that between five thousand and sixty-five hundred years ago houses were being constructed on the Peruvian coast. These are described as "dome-shaped houses, more than 50 examples of which have been excavated. Providing about 11 sq m of floor space, the structures were built in shallow, flat-bottomed pits roughly 40 cm deep" (Moseley 1992:103). The age and construction style of these houses are remarkably similar to those at the Nursery site.

Middle Holocene cultural transitions involve processes that have interesting empirical and theoretical dimensions. Contrary to earlier models of maritime cultural development, which generally viewed marine foods as second-rate resources, Middle Holocene occupations in the southern islands appear to have enjoyed a high degree of marine resource productivity and reliability. An interesting aspect of these economies is the general absence of technological elaboration. It appears that elaborate technologies were not required to cope with seasonal or temporal scarcity in resource availability. In fact, technological elaboration is not clearly evident in the southern islands data until the close of the Middle Holocene or later. One of the most dramatic technological innovations of the Middle Holocene, the appearance of circular shell fishhooks mentioned earlier, did not occur until the close of this period (ca. 3330 RYBP). Similarly, despite the demonstrable importance of the hunting of sea mammal during the Early and Middle Holocene (Porcasi 1995), there currently is no evidence from the southern islands of harpoons or other specialized gear related to this activity (see Hildebrandt and Jones 1992; Porcasi 1995). Middle Holocene subsistence security appears to have been achieved by targeting comparatively large, abundant or easily exploited species in flexible, shore-based patterns that "mapped onto" (see Binford 1980) particularly productive habitats or ecological circumstances. The most valuable tool in this connection was probably a practiced knowledge of resource potentials rather than elaborate hunting and fishing gear.

The productivity of this strategy is difficult to measure precisely, but the available data point to substantial subsistence yields. Salls (1988:408), as noted earlier, remarks on the comparatively large number of tunas or tuna-like species at Little Harbor. Even though this sample may be biased in favor of larger species (Salls 1988:408), it is difficult to escape the conclusion that fishing was an appreciable economic pursuit. Clearly, sea mammals also were an important dietary component. Porcasi (1994:227–228) estimated a total sea mammal meat yield of 1,045 kg from an MNI of nine dolphins and four pinnipeds in the approximately 2.5 $m^3$ of midden deposits excavated at Little Harbor in 1991 (Raab et al. 1995a). From the same deposits, Bradford (1994:218) reconstructed a total yield of 15.9 kg of shellfish meat.

Shell hooks and exponential intensification of fishing both have their origin about seventeen hundred years after the appearance of the Middle Holocene house pit community at the Nursery site. Early attempts to explain communities of this type (for example, Beardsley et al. 1956) posited high mobility and a lack of residential permanence as hallmarks of hunting and gathering, reserving sedentism for food producers. These distinctions are increasingly suspect, however, as researchers recognize that some North American hunter-gatherers achieved appreciable degrees of sedentism by the Middle Holocene (for example, Brown and Vierra 1983; Charles and Buikstra 1983). Today, many agree that sedentism does not result from a specific type of economy but from the productivity and reliability of food resources. Marine resources, as pointed out by Yesner (1987), may offer both of these advantages; indeed, such advantages appear to have been important in the economies of the southern islands during the Middle Holocene.

## A MIDDLE HOLOCENE MARITIME OPTIMUM?

What factors explain the timing of Middle Holocene cultural developments and what were the consequences of these changes for later cultural development? Despite recent research advances, our understanding of southern islands cultural evolution remains sketchy, and it will be some time before explanations of the region's prehistoric cultural patterns can be accepted with a high degree of confidence. Just the same, it may be useful to advance a few working hypotheses.

Many will no doubt be tempted to attribute cultural change in the Middle Holocene to coastal population growth. One might argue, for example, that after thousands of years of island occupation, Middle Holocene populations were pressing the limits of growth that could be sustained by littoral foraging. Packing of coastal resource zones, particularly in the Channel Islands, could have led to increasingly constrained resource territories and perhaps an increasing tendency toward residential permanence (see Glassow, Wilcoxon, and Erlandson 1988). Subsequent cultural changes, including technological innovation and economic intensification, might then be viewed as responses to mounting environmental circumscription.

While this demographic argument has plausible aspects, it does not seem an adequate explanation for Middle Holocene cultural patterns on the southern islands. At present, radiocarbon dates, despite many acknowledged limitations, offer perhaps the best proxy measure of prehistoric population growth on the coast of Southern California (Breschini, Haversat, and Erlandson 1992; Glassow, Wilcoxon, and Erlandson 1988; T. Jones 1992; Moss and Erlandson 1995; Raab et al.1995b). These data suggest that coastal populations began to expand relatively rapidly between about eighty-five hundred and fifty-five hundred years ago (Erlandson 1994:257; T. Jones 1992:20). An equally important issue, however, is whether there is any evidence that population growth led to more stressful conditions for coastal populations. It is not population expansion per se but environmental circumscription resulting from it that is generally credited with driving cultural change. The logical outcome of this scenario is increasing resource scarcity and biocultural stress.

Based on current evidence, these stresses do not appear to characterize the Middle Holocene on the southern islands. To the contrary, viewed in relation to long-term cultural trends within the Channel Islands region, one can hypothesize that the southern islands at mid-Holocene may actually reflect a kind of Middle Holocene Maritime Optimum (MHMO) for hunter-fishers.

Data on island subsistence economies certainly are too limited at present to draw firm conclusions about relative degrees of subsistence productivity across large spans of time. Even so, Late Holocene midden deposits in the southern islands, like other Channel Islands locations (Arnold 1992), reveal impressive densities of bone (fish, sea mammals, and birds), shell, and other marine food items—perhaps on the order of 50,000 to 500,000 bone elements per $m^3$ in some cases (Porcasi 1995; Raab et al. 1995a, b). Do such densities imply, however, that Late Holocene coastal economies were more advanced or productive than those of the Middle Holocene?

Any answer to this question should consider several factors. Although Late Holocene middens may contain dense deposits of food items, the per capita yield of these remains has to be viewed against the likelihood of larger coastal populations than during the Early and Middle Holocene. The comparatively elaborate hunting and fishing gear on which Late Holocene economic production depended may well have imposed a greater labor burden than during the Middle Holocene (Glassow 1991; Raab et al. 1995b). Late Holocene economic intensification appears to have exacted an environmental cost, as faunal data from this period point to overexploitation of several classes of coastal resources, including sea mammals, fish, birds, and shellfish (Bradford 1994; Hildebrandt and Jones 1992; Moss and Erlandson 1995; Porcasi 1995; Raab 1992; Raab et al. 1995b). At the same time, human osteological data describe a long-term decline in the health of Channel Islands populations, becoming particularly acute in the Late Holocene (Lambert 1993; Raab, Bradford, and Yatsko 1994). Negative long-term health trends, increasing labor burdens, and resource depletion all arguably add up to a loss of foraging efficiency similar to that described by Broughton (1994a, b) for other regions of California during the Late Holocene (Raab et al. 1995b).

Compared to these Late Holocene trends, then, Middle Holocene islanders may have enjoyed comparatively high levels of health, low labor burdens, and relatively sustainable levels of resource consumption. For purposes of archaeological model building, this hypothesis presents an alternative to existing reconstructions of Southern California coastal prehistory based on theories of progressive cultural evolution (see Fagan 1995:248–256; C. King 1971, 1990). The simplistic tendency of the latter to equate coastal economic and technological elaboration with improved or more successful cultural adaptations is increasingly questionable in light of recent research advances (Raab et al. 1995c).

## MARINE ENVIRONMENTAL CHANGE

Current data, admittedly limited at present, hint that changes in the marine environment may have played a role in the productivity of Middle Holocene coastal environments. For the last two decades, coastal researchers have sought to link changing sea temperature to cultural change. At present, the fate of this marine paleotemperature model appears to be in flux (Raab et al. 1995a). It seems likely that at least some interpretations based on this model will be discarded in light of new data on sea temperature presently being developed for the Santa Barbara Channel (Kennett 1995). One trend that appears to rest on increasingly solid evidence, however, is a general cooling of sea temperatures and intensification of marine upwelling in the Santa Barbara Channel region between about 5900 and 4500 RYBP (Glassow et al. 1994). It may be more than coincidence that the cultural developments described in this chapter emerged in this time interval. It is not clear at present how these data may relate to possible periods of ocean warming, such as conditions indicated at Little Harbor during the Middle Holocene (Raab et al. 1995a). Even so, the possibility should be considered that prolific kelp forests—rich biological communities that flourish in cooler waters—took hold for the first time in this interval. One wonders what the outcome might be if small populations of proficient coastal foragers had encountered the resources of increasingly abundant kelp communities during the Middle Holocene. Low initial population densities and an expanding, easily exploited food supply might well have served as kickers in the creation of a MHMO for coastal hunter-fishers—an inviting hypothesis for future research.

## MIDDLE HOLOCENE LEGACIES

Did population growth stemming from something like an MHMO create fertile conditions for economic intensification, technological innovation, and high coastal population densities during the Late Holocene? This question takes us outside the temporal and topical scope of this chapter, but is worth considering because it suggests two points of interest for future research. First, Middle Holocene cultural developments in the southern islands are clearly more complex than many anticipated only a few years ago. Some of these developments, such as the appearance of sedentism and a regional cultural interaction sphere, were once viewed as Late Holocene developments. It is now clear that late prehistoric cultural patterns will not be satisfactorily understood without reference to Middle Holocene antecedents. More research is needed on the timing and interaction of Middle Holocene marine environmental change, technological innovation, subsistence practices, and settlement patterns, and how these developments are connected to Late Holocene coastal occupations. Second, Middle Holocene cultural developments may have set coastal populations on developmental trajectories that were influenced to an increasingly greater extent by cultural reactions to population growth, economic intensification, and resource scarcity. The cultural and environmental consequences of these trends within the constraints of littoral ecosystems, particularly those of small islands, seems a particularly promising path for future research (Raab, Bradford, and Yatsko 1994; Raab et al. 1995b). In all, then, research in the southern Channel Islands is revealing a more complex and interesting picture of Middle

Holocene maritime cultural development than many might have expected. This research may also prove to be an important catalyst in rethinking the evolutionary potentials of coastal adaptations generally.

**Acknowledgments.** I thank Jon Erlandson, Mike Glassow, and anonymous reviewers for their help in preparing this chapter. The impact of Jon and Mike's scholarship is apparent, although I am of course solely responsible for any errors of fact or interpretation. I also owe an immense debt to scores of colleagues, friends, and students in collecting the information presented here, far too many to acknowledge by name. Paramount among these was my late colleague, Roy Salls. I must also thank Andy Yatsko, staff archaeologist, Natural Resources Office, Naval Air Station North Island, and the NASNI command for their generous support of our San Clemente Island research. I am indebted to Steve Schwartz, staff archaeologist, Point Mugu Naval Air Weapons Center, and Pat Martz, Department of Anthropology, CSU Los Angeles, for sharing their knowledge of San Nicolas Island archaeology. Doug Propst and Misty Gay, Catalina Island Conservancy, have my sincere gratitude for assisting our Santa Catalina Island research. I thank Bill Howard for leading the way in researching the OGR beads. My wife and colleague, Katherine Bradford, has been a great help in things large and small connected to this research.

# Middle Holocene Adaptations on the Newport Coast of Orange County

*Roger D. Mason, Henry C. Koerper, and Paul E. Langenwalter II*

EXCAVATION OF SEVERAL SITES located on marine terraces just south of Corona Del Mar in Orange County provided information about settlement and subsistence on the Newport coast during the Middle Holocene. These investigations were part of a larger Newport Coast Archaeological Project (NCAP) undertaken between 1988 and 1991 to mitigate the impact of development on thirty-seven prehistoric archaeological sites, most dating to the Late Holocene (Mason et al. 1991a; Mason and Peterson 1994). The project area included both marine terraces near the Pacific Ocean shoreline and ridge and canyon systems in the San Joaquin Hills that rise to a maximum elevation of 355 m within 4.3 km of the coast (fig. 4.1).

Six of the NCAP sites appear to have been occupied only during the Milling-Stone period, ranging in Orange County from about 8000 to 3000 RYBP (Mason and Peterson 1994:57–59). The sites discussed in this chapter date primarily to the middle of this period, between about 5800 and 4650 BP, although some of the sites also have produced calibrated radiocarbon dates from the early and late Milling-Stone subperiods. The Milling-Stone sites are all located within 1.2 km of the coast, and the Late Prehistoric (1350 to 200 BP) sites are almost all located in the ridge and canyon systems of the adjacent San Joaquin Hills.

Two relatively undisturbed Milling-Stone sites, ORA-665 and ORA-667 (Mason et al. 1992a, b), have well-preserved burned-rock features and contain abundant fish and terrestrial animal bone, as well as marine shell. Along with these two, data from four other NCAP Milling-Stone sites contribute to an understanding of coastal settlement and subsistence during the Middle Holocene. These four sites are less informative, however, because they have been more heavily disturbed by agricultural activities (ORA-928 and ORA-929) or they produced lower densities of cultural material (ORA-660 and ORA-664). The sites with exclusively Middle Holocene radiocarbon dates have already proved valuable for a study of Orange County projectile point morphology, chronometrics, and time-space systematics (Koerper, Schroth, and Mason 1994).

Considering the wider regional context, the NCAP Milling-Stone sites are located between 6 and 10 km southeast of the mouth of Newport Bay, a large estuarine bay and marsh complex that extends over 8 km inland. The large number of archaeological sites around Newport Bay, dated as early as 8500 RYBP and as late as 200 BP, indicates that the bay was a focus of settlement during all time periods. Analysis of NCAP settlement systems suggests that Late Prehistoric settlement in the San Joaquin Hills represents an expansion of population from the Newport Bay area into the hills (Mason and Peterson 1994). The appearance of Milling-Stone sites on the marine terraces southeast of Newport Bay may represent a similar process of expansion, but of more mobile groups with lower population densities than those of the Late Prehistoric period.

Using data from these sites, we can consider such questions as these: Do dietary reconstructions using the NCAP data support the generally held view of a reliance on shellfish and plant foods, particularly hard seeds, by Milling-Stone coastal dwellers (for example, Erlandson 1994), or have the contributions of terrestrial and marine vertebrates been underestimated (see Koerper 1981; Drover, Koerper, and Langenwalter 1983)? Does paleodemographic information from the Orange County coast indicate significant population increase during the Early to Middle Holocene (Basgall 1987; Erlandson 1994:258; Glassow, Wilcoxon, and Erlandson 1988; T. Jones 1991:435)? Does a transition in settlement and other adaptive strategies occur at the end of the Middle Holocene? Might such a change in settlement be reflected by a shift to more permanently occupied sites? If so, did changes in climate and biogeography cause such shifts? The Middle

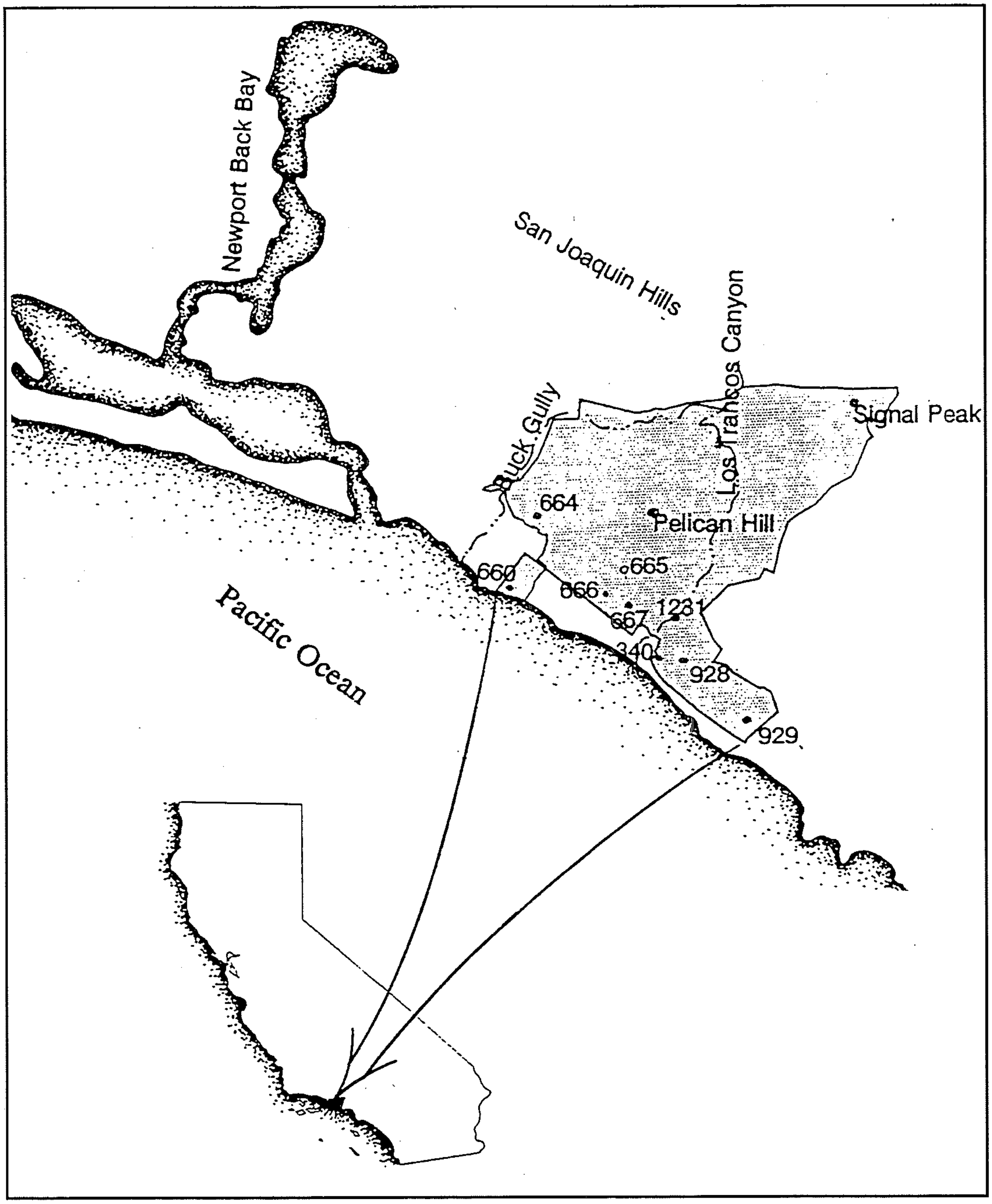



FIGURE 4.1 Location of Newport Coast Archaeological Project and Middle Holocene sites

Holocene sites also provide data relevant to issues of prehistoric lithic trade, but first we'll present the ecofactual and artifactual remains from ORA-665 and ORA-667.

## HABITAT AND BIOME

The Middle Holocene Newport coast sites are all located at the western base of the San Joaquin Hills within 1.2 km of the ocean. Site elevations range between about 21 m and 91 m above sea level. The surrounding area provided access to a number of marine and terrestrial habitats and plant communities. The offshore kelp beds are among the most productive of all ecosystems and shelter at least 111 species of fish (Bonner 1991), among them the California sheephead (*Semicossyphus pulcher*), an important food resource for prehistoric humans. Adult sheephead reach lengths of almost a meter and weigh up to 9 kg (Salls 1988:597–598). Other fish found in and around the kelp beds include jack mackerel, señorita, kelp bass, blacksmith, and giant kelpfish. Line and gorge fishing or diving and spearing may have been used to catch kelp bed fish. Using nets would have been difficult in the kelp, but they may have been used around the kelp beds. Immediately offshore is a shallow rocky reef with more than sixty species of rockfish. Boats or rafts probably would have been needed to reach the reef for line, net, or spear fishing. In nearshore and surf zones, nets could have been used by wading from shore to catch surfperch, pacific mackerel, jacksmelt, and croaker.

The coast is characterized by several rocky headlands connected by bluffs that rise about 15 m above the beach. The headlands provided a variety of shellfish that could be collected at low tide. The most important was the mussel (*Mytilus californianus*), but barnacles, abalones, chitons, and many small marine gastropods were also available.

Terrestrial plant communities include the coastal strand, coastal sage scrub, grassland/herbland, chaparral, riparian, and southern oak woodland (Klug and Koerper 1991). Most of the marine terraces and hills near the coast were covered by coastal sage scrub and grassland/herbland. The presence of at least some grassland near the Middle Holocene sites is supported by the faunal remains. While most rabbit remains identified belong to the genus *Sylvilagus*, up to 20 percent are *Lepus* or jackrabbit, which prefers open grassy areas. Coastal sage scrub provided a variety of seeds, the most important from the sage genus (*Salvia*). Of the three sage species, chia (*S. columbariae*) has the highest protein content and all three yield about 400 kcal per 100 g (Gilliland 1985). Other major seed producers in the coastal sage scrub community are California buckwheat and California goosefoot. The grassland/herbland community also provided edible seeds from a variety of native grasses as well as California goosefoot.

In the project area, the chaparral community—with sages, woody shrubs, and small trees such as scrub oak, California holly, lemonadeberry, and sugarbush—is limited to north-facing slopes of canyons. Southern oak woodland is a minor plant community in the coastal hills, but small oak groves occur at the heads of major canyons. Riparian woodlands occur in narrow bands in the drainages of the small canyons and contain sycamore trees, elderberry, tule, and sedge.

The most important land animals were deer, rabbits, rodents, and such carnivores as bobcat, badger, fox, dog, and coyote. Most terrestrial animals were widely distributed in a variety of different vegetation communities throughout the coastal hills.

Marine mammals, including seal, sea lion, and sea otter, were less widely distributed, generally in kelp bed and open-water habitats accessible by raft or boat. Occasionally, marine mammals may have been taken on the beach.

We assume the faunal and floral associations were similar to the present during the Middle Holocene, although the spatial extent and relationships between microenvironments would have fluctuated through time. There is little detailed paleoenvironmental information specific to the Orange County coast, except for Davis' (1992) study of pollen cores from the San Joaquin Marsh at the upper end of Newport Bay. During the early Middle Holocene, the San Joaquin freshwater marsh was retreating with the advance of a saltwater environment as sea level rose. Until 4500 BP, a salt marsh environment prevailed at the present upper extension of Newport Bay. During several subsequent cool/wet episodes during the Late Holocene, the marsh reverted to fresh water. The Middle Holocene period in general may have been somewhat warmer than the Early or Late Holocene, as indicated by climatic data from the Sierra and White Mountains (Moratto, King, and Wolfenden 1978) and by pollen cores from the Santa Barbara Channel (Heusser 1978). No information that would confirm this trend for coastal Orange County is available.

## ORA-665

ORA-665 is a 1225 m$^2$ midden situated at an elevation of 90 m on a marine terrace below the frontal slopes of Pelican Hill. There are small drainages on each side of the terrace. Twenty-one 2 x 2 m units were excavated at 7 m intervals in the core of the site, and additional units were excavated at wider intervals in the southwestern periphery, where an agricultural ditch and berm had disturbed the site. Cultural deposits were an average of 40 cm deep. Twelve burned-rock features and a double burial were found at ORA-665.

**Site Structure and Age.** The burned-rock features varied from a few scattered rocks, which may be the result of hearth cleaning and dispersal of hearth rocks, to concentrations of hundreds of rocks, which may represent large hearths or stockpiles of rock for making hearths or for stone boiling. Most of the artifacts associated with the features are scrapers, ground-stone fragments, angular hammers, cores, and core fragments. The ground-stone fragments, cores, and core fragments may represent secondary refuse, and their presence in these features may represent reuse as hearth rocks.

The spatial distribution of artifacts and faunal remains indicates that most activities were carried out around the burned-rock features. There is no spatial patterning of functional artifact categories to suggest that different activities were conducted in different parts of the site.

The only burial feature encountered consisted of a double inhumation of two juveniles, both supine and flexed with torso and legs turned to their left sides. The older individual was aged 8 to 15 at death, and the younger died between age 5 and 9 (Cerreto 1994a).

Eight calibrated radiocarbon dates from ORA-665 put occupation between about 5740 and 5140 CYBP (table 4.1; Mason and Peterson 1994:Appendix I–D). All but one of thirteen analyzed obsidian specimens came from the Coso area and three debitage specimens yielded substantial hydration values (table 4.2). These facts are consistent with a Milling-Stone age (Koerper et al. 1986; Ericson et al. 1989), as is the presence of a variety of projectile points (fig. 4.2) resembling Elko side-notched (c-e), Northern side-notched (a), as well as large triangular points (b) (see Koerper, Schroth, and Mason 1994).

Time-sensitive beads suggest occupation during C. King's (1990) late Early period or early Middle period (Gibson 1992a;

TABLE 4.1 Radiocarbon dates from ORA-665

| LAB NO. | UNIT | LEVEL | $^{14}$C AGE (RYBP) | $^{13}$C/$^{12}$C ADJUSTED AGE | CALIBRATED AGE (BP) |
|---|---|---|---|---|---|
| Beta-35427 | 169 | 30–40 | 4800 ± 70 | 5220 | 5440 ± 80 |
| Beta-35428 | 237 | 30–40 | 4980 ± 70 | 5400 | 5630 ± 80 |
| Beta-35429 | 245 | 30–40 | 4880 ± 90 | 5300 | 5550 ± 95 |
| Beta-42027 | 241 | 10–20 | 5010 ± 90 | 5430 | 5650 ± 95 |
| Beta-42028 | 249 | 30–40 | 4730 ± 80 | 5150 | 5320 ± 85 |
| Beta-42029 | 261 | 30–40 | 4870 ± 80 | 5290 | 5540 ± 85 |
| Beta-42030 | 1023 | 27–42 | 4910 ± 90 | 5330 | 5570 ± 95 |
| Beta-42031 | 968 | 7–18 | 4590 ± 80 | 5010 | 5230 ± 85 |

Note: All dates are from aggregate shell samples except Beta-42031, a single *Mytilus* valve from feature 3. Calibration follows Stuiver, Pearson, and Braziunas 1986, using a locally derived correction factor (Delta-R) for the reservoir effect (Mason and Peterson 1994).

TABLE 4.2 ORA-665: obsidian source and hydration data

| CATALOG NO.* | INAA NO. | HYDRATION MEASURE | MN (PPM) | NA (% WT.) | K (% WT.) | DY (PPM) | SOURCE |
|---|---|---|---|---|---|---|---|
| 20023 | 610 | | 242.32 | 3.26 | 3.08 | 7.49 | Coso |
| 20022 | 611 | | 266.95 | 3.41 | 4.49 | 7.11 | Coso |
| 20072 | 612 | | 315.32 | 3.85 | 6.15 | 6.53 | Coso |
| 20176 | 613 | | 246.84 | 3.35 | 4.53 | 8.12 | Coso |
| 13475 | 614 | | 224.50 | 3.06 | 3.10 | 6.76 | Coso |
| 13660 | 615 | | 249.97 | 3.38 | 5.22 | 8.20 | Coso |
| 22205 | 616 | 6.4 ± 0.2 | 238.97 | 3.24 | 3.47 | 7.51 | Coso |
| 30278 | 617 | | 262.55 | 3.33 | 4.35 | 9.13 | Coso |
| 31220 | 618 | | 398.46 | 3.86 | 3.59 | 23.79 | Obsidian Butte |
| 31208 | 619 | 8.0 ± 0.4 | 239.49 | 3.26 | 3.46 | 8.15 | Coso |
| 31209 | 620 | 8.5 ± 0.2 | 252.80 | 3.39 | 4.00 | 8.02 | Coso |
| 31248 | 621 | | 317.99 | 4.32 | 5.00 | 10.93 | Coso |

| CATALOG NO. ** | RB (PPM) | SR (PPM) | ZR (PPM) | TOTAL | RB (%) | SR (%) | ZR (%) | SOURCE |
|---|---|---|---|---|---|---|---|---|
| 00200 | 219.34 | 4.66 | 147.78 | 371.78 | 59.00 | 1.25 | 39.75 | Coso |

*Neutron activation analysis of debitage done at the UC Irvine reactor (Ericson 1994). **X-ray fluorescence analysis of single projectile point done by Bouey 1993.

see also Bennyhoff and Hughes 1987), possibly somewhat later than the radiocarbon chronology alone suggests. The *Olivella* spire-removed oblique bead recovered from ORA-665 is of a type used in quantity during the later part of the Early period in most of the Chumash territory, in Central California, and in the western Great Basin (Gibson 1992a, 1992b). However, in the Santa Barbara Channel region the type is common in early Middle period contexts, between about 2550 and 1750 RYBP (Gibson 1992a, 1992b). An *Olivella* grooved rectangle bead was also recovered from ORA-665. Similar beads have been recovered from Middle Holocene contexts at the Little Harbor site on Catalina Island, the Nursery site on San Clemente Island, and SNI-161 on San Nicolas Island (chapter 3; Howard and Raab 1993; Vellanoweth 1996). The occurrence of this bead type on the islands, at ORA-665 and ORA-667, and at other sites on the south coast suggests an interaction sphere between the mainland and islands operated during the Middle Holocene (Howard and Raab 1993).

**Vertebrate Remains.** The vertebrate faunal sample from ORA-665 consists of 3,786 specimens from five 1 x 1 m units in the densest part of the midden (table 4.3). This sample does not include 368 specimens, primarily rodents and their predators, thought to be of natural origin. All specimens came from material remaining in $^{1}/_{8}$-inch screens.

Given the configuration of the coastline adjacent to the NCAP, most of the identified fish specimens at ORA-665 came from in and around the kelp bed habitat. Of the 263 specimens identified at least to family level, 167 (63%) are sheephead. There are smaller numbers of kelp bass and señorita, also associated with the kelp bed habitat. Small numbers of rockfish specimens imply that the shallow rocky-reef habitat along the adjacent coast was also fished. Other fish ordinarily found in nearshore habitats include Pacific mackerel, croakers, midshipmen, sharks, and rays. The few duck and pinniped (seal) specimens in the collection probably came from animals procured from the same habitat.

Although a much lower proportion of specimens was identifiable, terrestrial animals at ORA-665 nevertheless seem to have been less important than fish. No deer bones and only forty-nine rabbit bones were identified. Carnivores included one bone each from dog or coyote, bobcat, and weasel. Rodents were rarely found. Land animals seem to have provided much less biomass than marine fauna.

**Shellfish Remains.** Shellfish remains from ORA-665 were recovered from thirty 2 x 2 m hand-excavated units or the equivalent of 55.6 m$^2$. A total of 13,066 hinges and apices were identified to genus or species and accounted for an MNI estimate of 7,158 individuals distributed among thirty-eight taxa (table 4.4); (Peterson 1992a). California mussel ac-

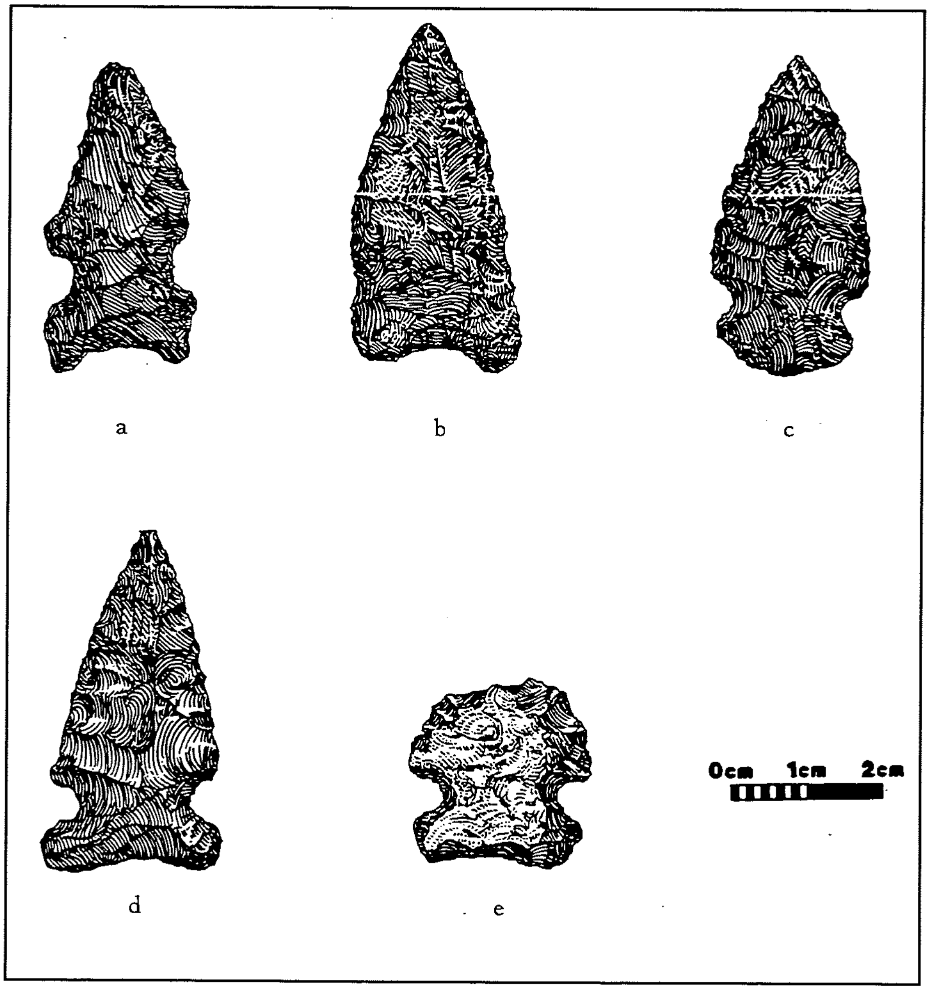



FIGURE 4.2 Projectile points from ORA-665: *a*, Northern side-notched; *b*, large triangular; *c-e*, Elko side-notched.

counted for 80 percent of the total shellfish MNI, and over 95 percent came from the rocky-shore habitat. Other rocky-shore dwellers included gooseneck barnacle (*Pollicipes polymerus*) (7%), limpet (*Acmaea* sp.) (3.5%), platform mussel (*Septifer bifurcatus*) (2%), and twenty-one minor contributors that were probably collected incidentally with mussels. Shellfish found along the outer coast and in bays included oysters (*Ostrea lurida*) and Venus clams (*Chione* sp.), but such taxa comprise only 3 percent of the MNI. The presence of scallops (*Argopecten* sp.) (1% of MNI) may indicate that there were limited bay or estuary habitats at the mouths of nearby canyons (Peterson 1992a).

**Flora.** Plant foods available within about 1.5 km of ORA-665 have been arranged into a seasonal timetable (Klug 1992). Grass seeds and wildflower bulbs could have been procured in spring, along with leaves of herbaceous plants. During summer, tarweed, sunflower, clover, sage, and buckwheat seeds were possible food fare. Between summer and early fall, fruits from elderberry, lemonadeberry, toyon, and prickly pear cactus could have been gathered. Acorns from coast live oaks could also have been collected in the fall. It is not clear, however, whether acorns were a feature of Middle Holocene subsistence. The absence of mortars and pestles in local Milling-Stone sites suggests that people were not yet leaching tannic acid from the bitter acorn. During winter, toyon berries, buckwheat shoots, cattail roots, and the roots and leaves of some wildflowers were available (Klug 1992).

Few carbonized native seeds were recovered from the flotation samples taken from eleven features and two midden deposits. Because of the small sample size and the intrusion of modern uncarbonized seeds into the archaeological deposits, it was not possible to confidently attribute any of the seeds to prehistoric use of the site (Klug 1992). Pollen and phytolith analysis was also generally ambiguous, but slightly elevated goosefoot/amaranth and grass pollen frequencies on a metate fragment associated with a rock scatter from feature 13 may indicate aboriginal processing of these plants (Cummings 1991).

**Seasonality.** Seasonality evidence for ORA-665 was limited to a single chameleon rockfish (*Sebastes phillipsi*) otolith. Analyzed by Richard Huddleston, the otolith in the collection indicates a middle to late summer capture. Analysis of otoliths from other NCAP Middle Holocene sites suggests that nearshore fishing took place predominantly between May and October. Three white croaker (*Genyonemus lineatus*) otoliths from ORA-666 and three ORA-928 otoliths

TABLE 4.3 ORA-665: vertebrate taxa

| COMMON NAME | SCIENTIFIC NAME | NISP | MNI | WEIGHT |
|---|---|---|---|---|
| Horn shark | *Heterodontus francisci* | 1 | - | 0.03 |
| Leopard shark | *Triakis semifasciata* | 1 | - | 0.56 |
| Smoothhound shark | Triakidae | 2 | - | 0.08 |
| Pacific angel shark | *Squatina californica* | 1 | - | 0.06 |
| Guitarfish | *Rhinobatos productus* | 2 | - | 0.04 |
| Thornback | *Platyrhynoides triserata* | 1 | - | 0.13 |
| Bat ray | *Myliobatis californica* | 7 | - | 0.22 |
| Unidentifiable shark/ray | Elasmobranchii | 16 | - | 0.65 |
| Midshipman | *Porichthys* sp. | 1 | - | 0.02 |
| Lingcod | *Ophiodon elongatus* | 3 | - | 0.19 |
| Rockfish | *Sebastes* sp. | 38 | - | 2.62 |
| Rockfish, genus unknown | Embiotocidae | 8 | - | 0.23 |
| Cabezon | *Scorpaenichthys marmoratus* | 1 | - | 0.03 |
| Kelp bass | *Paralabrax clathratus* | 3 | - | 2.30 |
| Jack mackerel | *Trachurus symmetricus* | 3 | - | 0.13 |
| Spotfin croaker | *Roncador stearnsii* | 2 | - | 0.06 |
| Croaker, genus unknown | Sciaenidae | 1 | - | 0.02 |
| Señorita | *Oxyjulis californica* | 1 | - | 0.03 |
| Sheephead | *Semicossyphus pulcher* | 167 | - | 24.59 |
| Pacific bonito | *Sarda chiliensis* | 2 | - | 2.60 |
| Pacific mackerel | *Scomber japonicus* | 3 | - | 1.19 |
| Unidentifiable bony fish | Teleostei | 239 | - | 8.57 |
| Unidentifiable fish | Pisces | 8 | - | 0.37 |
| Unidentifiable duck | Anatidae | 3 | - | 1.08 |
| Unidentifiable bird | Aves | 9 | - | 0.73 |
| Rabbits | *Sylvilagus* sp. | 24 | 4 | 1.90 |
| Black-tailed jackrabbit | *Lepus californicus* | 14 | 2 | 2.36 |
| Unidentifiable rabbit | Leporidae | 11 | - | 0.56 |
| Pocket gopher | *Thomomys bottae* | 1 | 1 | 0.02 |
| Unidentifiable rodent | Rodentia | 1 | - | 0.03 |
| Dog or coyote | *Canis* sp. | 1 | 1 | 0.13 |
| Long-tailed weasel | *Mustela frenata* | 1 | 1 | 0.10 |
| Bobcat | *Felis rufus* | 1 | 1 | 0.29 |
| Seal or sea lion | Pinnipedia | 1 | - | 0.30 |
| Unidentifiable carnivore | Carnivora | 3 | - | 0.84 |
| Unidentifiable mammal | Mammalia | 91 | - | 25.67 |
| Unidentifiable vertebrate | Vertebrata | 3114 | - | 121.31 |
| TOTAL | | 3786 | | 200.04 |

Note: Given in aggregate by total specimens (NISP), minimum number of individuals (MNI), and weight (Weight).

from three different species all fall within the early- to mid-summer range. Thirty-four otoliths from nine species recovered at ORA-929 fall within the mid-May to mid-October range. A single yellowfin croaker (*Umbrina roncador*) otolith found at ORA-1231, a very early Middle Holocene site, also has a late summer reading. The early to late summer concentration of readings is typical of Orange County coastal archaeological sites.

Since almost all otoliths from these Newport coast sites are from nearshore fish, these seasonality data pertain only to nearshore fishing. Otoliths from sheephead and other kelp bed species are either too small or too fragile to be recovered in 1/8-inch screens. Thus, it cannot be determined whether the fishing schedule varied between habitats.

In this pattern there is likely a continuity from Early Holocene times. Excavation at ORA-378, a research project of the Cypress College Archaeology Program (CCAP), recovered more than two hundred otoliths, thirty-nine of which have been read for seasonality and AMS dated. Two of three Early Holocene otoliths are from late-summer fishing activities, but one is a mid- to late-winter specimen (Koerper et al. 1996). Richard Huddleston's analysis of two spotfin croaker (*Roncador stearnsii*) otoliths from SDI-9649, a San Dieguito-La Jollan Transition site, indicated summer procurement (Koerper, Langenwalter, and Schroth 1991:51).

The pattern of predominant summer fishing as revealed by otolith analysis is sustained in the Late Holocene during both the Intermediate period (Koerper et al. 1996) and the Late Prehistoric period (Koerper, Langenwalter, and Schroth 1988).

**Technomic Artifacts.** The technomic artifacts reflect a wide range of extraction and maintenance activities, as indicated by significant quantities of most functional tool types within each functional category (fig. 4.3) and by other technomic artifacts such as cores, biface preforms, and retouched flakes (listed under "Other" in fig. 4.3). All artifacts discussed here are from hand-excavated units.

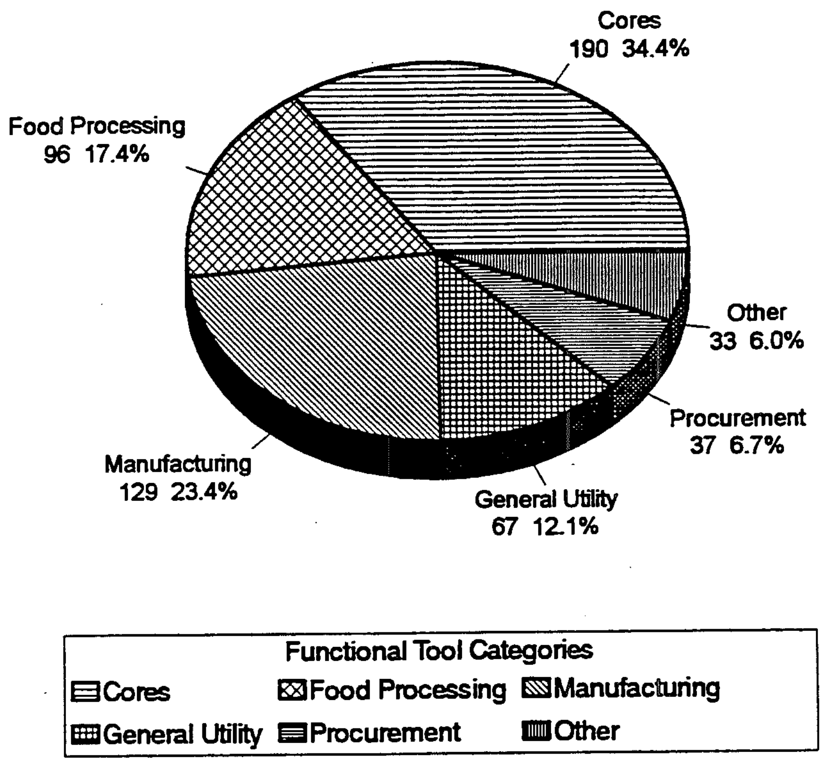
TABLE 4.4 ORA-665: MNI and weight of shellfish remains by habitat and species

| | MNI | % | WEIGHT (G) | % |
|---|---|---|---|---|
| *Rocky shore/Outer coast* | | | | |
| *Acanthina spirata* | 10 | 0.14 | 2.59 | 0.04 |
| *Acmaea* sp. | 253 | 3.69 | 8.56 | 0.13 |
| *Anomia peruviana* | 1 | 0.01 | 14.76 | 0.23 |
| *Astraea undosa* | 1 | 0.01 | 9.65 | 0.15 |
| *Balanus* sp. | 56 | 0.81 | 174.20 | 2.76 |
| *Cancer* sp. | 0 | * | 0.25 | * |
| *Chama pellucida* | 4 | 0.05 | 1.34 | 0.02 |
| *Chiton* sp. | 8 | 0.11 | 5.09 | 0.08 |
| *Crepidula* sp. | 19 | 0.27 | 2.58 | 0.04 |
| *Crepipatella* sp. | 3 | 0.04 | 0.24 | * |
| *Crucibulum* sp. | 1 | 0.01 | 0.09 | * |
| *Fissurella volcano* | 21 | 0.30 | 1.78 | 0.02 |
| *Haliotis* sp. | 23 | 0.33 | 1672.59 | 26.54 |
| *Hinnites multirugosus* | 1 | 0.01 | 129.17 | 2.05 |
| *Hipponix antiquatus* | 3 | 0.04 | 0.34 | * |
| *Littorina* sp. | 1 | 0.01 | 0.06 | * |
| *Lottia gigantea* | 4 | 0.05 | 1.14 | 0.01 |
| *Megathura crenulata* | 0 | * | 3.09 | 0.04 |
| *Mytilus* sp. | 5743 | 83.90 | 4138.24 | 65.68 |
| *Pollicipes polymerus* | 500 | 7.30 | 50.95 | 0.80 |
| *Pseudochama exogyra* | 23 | 0.33 | 27.90 | 0.44 |
| *Serpulorbis squamigerous* | 0 | * | 2.56 | 0.04 |
| *Septifer bifurcatus* | 168 | 2.45 | 51.70 | 0.82 |
| *Tegula* sp. | 1 | 0.01 | 1.19 | 0.01 |
| *Thais* sp. | 1 | 0.01 | 0.10 | * |
| SUBTOTAL | 6845 | 95.63 | 6300.16 | 92.71 |
| *Sandy beach* | | | | |
| *Donax* sp. | 4 | 100.00 | 0.24 | 100.00 |
| SUBTOTAL | 4 | 0.05 | 0.24 | 0.35 |
| *Bay/Lagoon/Estuary* | | | | |
| *Argopecten* sp. | 73 | 98.64 | 162.45 | 99.63 |
| *Cerithidea californica* | 1 | 1.35 | 0.11 | 0.06 |
| *Tagelus* sp. | 0 | * | 0.48 | 0.29 |
| SUBTOTAL | 74 | 1.03 | 163.04 | 2.40 |
| *Offshore/Deep water* | | | | |
| *Pododesmus cepio* | 15 | 100.00 | 3.99 | 100.00 |
| SUBTOTAL | 15 | 0.20 | 3.99 | 0.05 |
| *Bays/Outer coast* | | | | |
| *Chione* sp. | 36 | 16.36 | 147.45 | 45.00 |
| *Laevicardium elatum* | 0 | * | 9.08 | 2.77 |
| *Ocenebra poulsoni* | 4 | 1.81 | 1.56 | 0.47 |
| *Olivella biplicata* | 5 | 2.27 | 4.03 | 1.23 |
| *Ostrea lurida* | 171 | 77.72 | 53.71 | 16.39 |
| *Polinices* sp. | 0 | * | 2.70 | 0.82 |
| *Saxidomus nuttalli* | 2 | 0.90 | 106.83 | 32.60 |
| *Tresus nuttalli* | 2 | 0.90 | 2.27 | 0.69 |
| SUBTOTAL | 220 | 3.07 | 327.63 | 4.82 |

*Less than 0.01%. Percentages of species are relative to habitat. Percentages in subtotals are proportion of aggregate site sample.

Animal procurement is represented by projectile points (fig. 4.2), gorges (fig. 4.4a,b), and a single net weight (fig. 4.4c). One artifact listed as a projectile point was reworked and used as a drill (fig. 4.5a). Processing of plant food (mostly hard seeds) is represented by manos, metates, and a single cobble proto-pestle. General utility tools, which could have been employed in both food processing and manufacturing, are represented by scrapers, knives (fig. 4.5b-c), and prismatic blades.

Manufacturing tools are the most diverse category, including bone awls (probably used in basket making); angular hammers and abraders used to make ground-stone tools; spherical hammers used to make chipped stone tools; drills (fig. 4.5d,e); reamers; and small ground slabs that were per-




| *Cores* | |
|---|---|
| Core fragments | 136 |
| Cores | 54 |

| *Manufacturing Tools* | |
|---|---|
| Angular hammers | 46 |
| Awls | 45 |
| Faceted abraders | 9 |
| Reamers | 7 |
| Spherical hammers | 6 |
| Small ground slabs | 5 |
| Grooved stones | 4 |
| Drills | 3 |
| Tarring pebbles | 3 |
| Utilitarian incised stone | 1 |

| *Procurement Tools* | |
|---|---|
| Projectile points | 31 |
| Gorges | 5 |
| Net weight | 1 |

| *General Utility Tools* | |
|---|---|
| Retouched flake scrapers | 33 |
| Utilized flake scrapers | 14 |
| Knives | 9 |
| Core scrapers | 8 |
| Prismatic blades | 3 |

| *Food Processing Tools* | |
|---|---|
| Manos | 50 |
| Shallow basin metates | 36 |
| Slab metates | 9 |
| Cobble proto-pestle | 1 |

| *Other* | |
|---|---|
| Biface preforms | 17 |
| Retouched flakes | 11 |
| Abraded stones | 3 |
| Chipped-stone tool fragments | 2 |

FIGURE 4.3 Frequencies of functional tool types from ORA-665. *After Singer 1992a*

haps used as working surfaces. Utilitarian incised stones functioned as cutting surfaces, and grooved stones may have been used to manufacture stone, bone, or wood tools. Tarring pebbles were used to apply asphaltum to make baskets watertight.

A number of other artifacts were not categorized as to function, including biface preforms, retouched flakes whose function could not be identified, abraded stones that may have served as pigment sources, and two possible scraper fragments.

The 190 cores and core fragments and 12,492 pieces of debitage recovered indicate intensive stone knapping. By material, quartz constitutes 56 percent and Monterey chert comprises 36 percent, contrasted with Late Prehistoric middens, where chert and chalcedony waste flakes are far more frequent than quartz debitage. Only two other materials, felsite and metachert, comprise more than 1 percent of the sample. Obsidian is present in only trace amounts: twelve of the specimens analyzed came from the Coso source and one from Obsidian Butte. Tertiary flakes make up 90 percent of the debitage. The high percentage (8%) of decortication flakes suggests that primary lithic reduction was important at ORA-665. Biface thinning flakes account for 1 percent of the debitage.

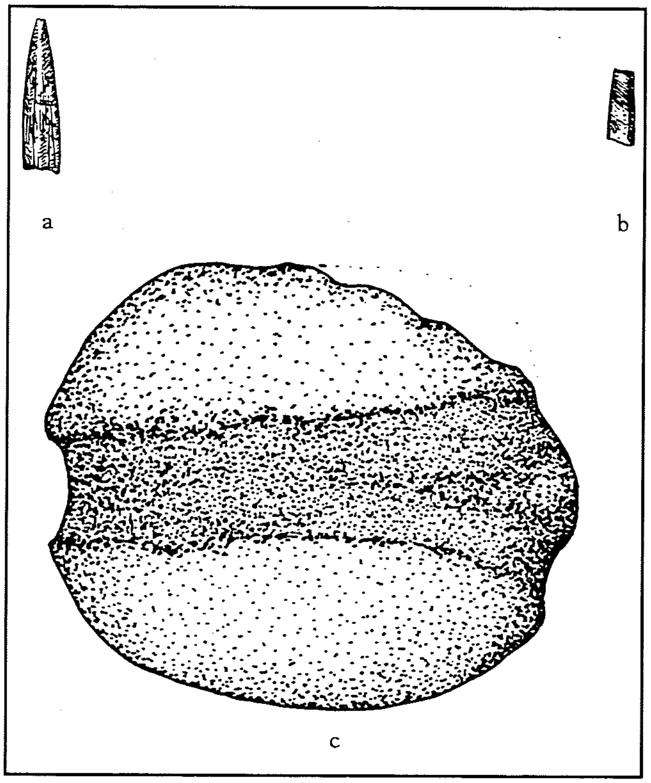



FIGURE 4.4 Fishing equipment from ORA-665: *a-b*, gorges; *c*, net weight (all shown actual size).

**Sociotechnic and Ideotechnic Artifacts.** Ceremonial/social artifacts from ORA-665 include four shell beads (fig. 4.6a-d), one possible bone bead, one eccentric crescent (fig. 4.6e), one stone pendant (fig. 4.6f), twelve patterned incised stones, one patterned grooved stone, and lumps of ocher. Two connected hexagonal crystals and a multipointed triangular crystal cluster may have been magico-religious items, so-called shaman's crystals.

Four *Olivella* shell beads were recovered. Three were nearly complete shells with the spires removed, two perpendicular to the long axis of the shell and one oblique. The fourth shell bead was the *Olivella* grooved rectangle discussed earlier. The possible bone bead is a small fish vertebra with a smooth round hole.

Patterned incised stones and patterned grooved stones may have been associated with shamanistic curing behavior (Hurd 1991). The incised artifacts are made from soft materials: sandstone, shale, and siltstone. The single grooved artifact is of sandstone.

### ORA-667

ORA-667 is a 3400 m$^2$ midden with an average depth of 40 cm, situated 50 m above sea level on a marine terrace between two drainages. A total of 110 2 x 2 m units was excavated on a systematic grid at 6-m intervals. Large faunal and artifactual assemblages were recovered, and twenty burned-rock features and one burial feature were identified.

**Site Structure and Age.** The burned-rock features at ORA-667 were clusters and scatters containing from eleven to eighty-five rocks. Most features had associated ground-stone tools, angular hammers, cores, and debitage. In general, features with scattered rock had more associated tools, shell, bone, and debitage, suggesting that these areas were used more often. Discrete features may have been used for shorter periods and then abandoned, resulting in the feature remaining intact (Chatters 1987). If the ground-stone tools were used by women to process plant foods and the cores and debitage were produced by men making chipped-stone tools, it seems likely that both sexes worked around the burned-rock features.

The spatial distribution of cultural material and features shows that there were three discrete areas, each containing burned-rock features and associated food refuse. In one of these areas, several excavation units each produced more than 2000 g of burned rock, but no defined features. Large quantities of scattered burned rock were probably reused and recycled in hearths and for stone boiling. Large amounts of shell, animal bone, and debitage were associated with the burned-rock features. There was no separate dump area as there was at ORA-665.

The burial consisted of the partial remains of one individual, possibly a young adult female (Cerreto 1994b). No artifacts could be securely associated with the burial, but three abalone shells were found nearby. One green abalone (*Haliotis fulgens*) shell was radiocarbon dated to 5440±80 CYBP (UCI-228).

The twenty-five calibrated $^{14}$C dates (table 4.5) indicate two principal occupations: 5720 to 4750 CYBP and 4450 to 4170 CYBP. One date suggests occupation circa 3600 CYBP.

Fifty-seven beads of eight types were recovered at ORA-667 (Gibson 1992c). The complete absence of *Olivella* cup beads or lipped beads indicates no occupation during C. King's (1990) Late period. Two *Olivella* wall disc beads and one *Mytilus* disc bead may date to a late Middle period component, and five *Olivella* oblique spire-removed beads, five *Olivella* grooved rectangle beads, and four *Olivella* barrel beads suggest an Early period or early Middle period occupation. The grooved rectangle beads are consistent with the Middle Holocene radiocarbon chronology for the site.

Five obsidian debitage specimens and the midsection of an obsidian projectile point or knife were sourced (table 4.6). Three specimens attributed to the Coso source and one to the Casa Diablo source are consistent with a pre-Late Prehistoric time placement, as are the two hydration measurements of 6.6 microns and 6.0 microns on the two pieces of Coso debitage (Koerper et al. 1986; Ericson et al. 1989). Also consistent with a pre-Late Prehistoric time placement is the variety of projectile points (fig. 4.7) (Koerper, Schroth, and Mason 1994). Two pieces of Obsidian Butte debitage were

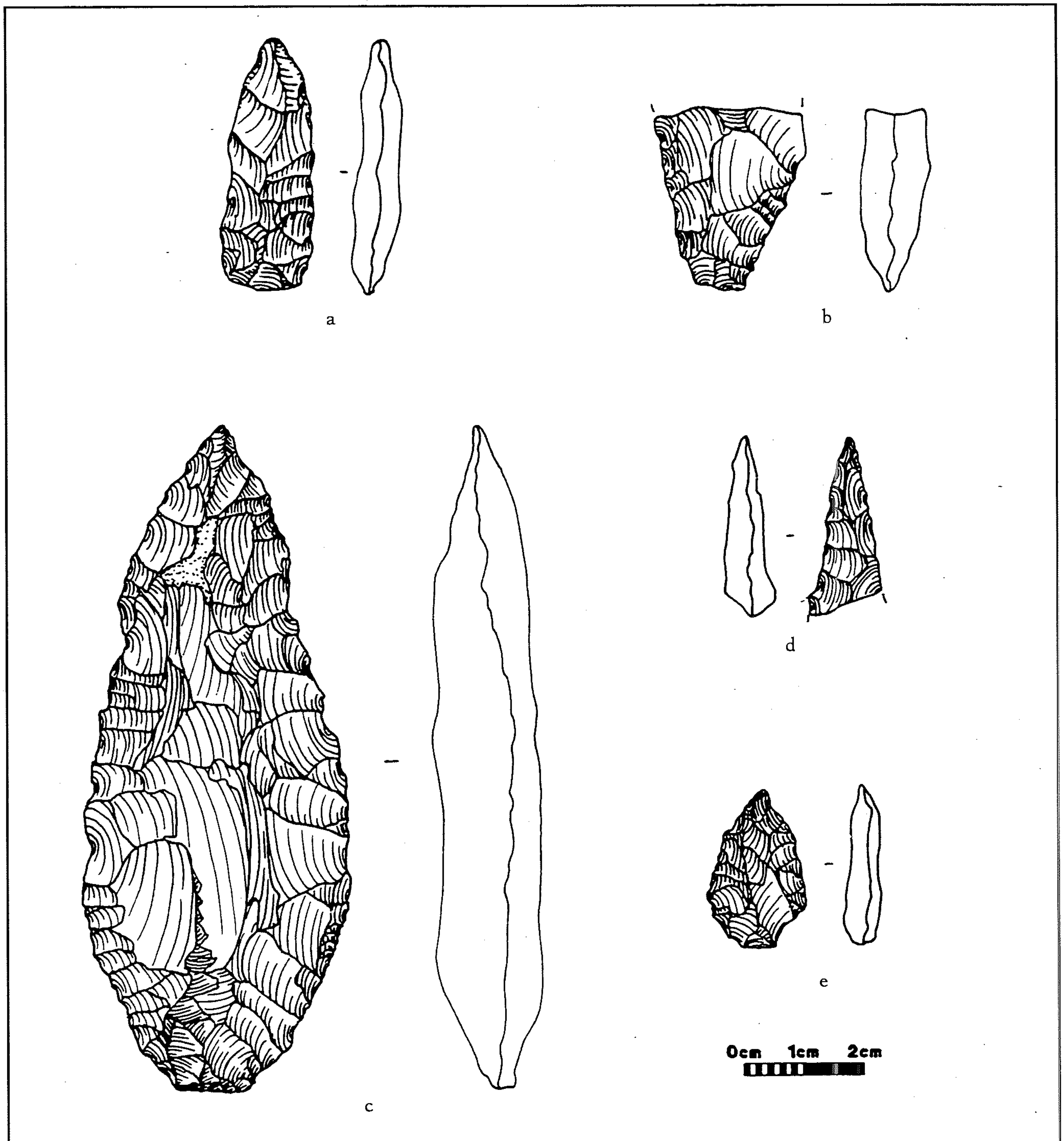



FIGURE 4.5 Bifaces from ORA-665: *a*, projectile reworked into a drill; *b-c*, knives; *d*, T-shaped drill; *e*, drill with convergent base.

unexpected. Obsidian Butte material has been regarded as a strictly Late Prehistoric trade phenomenon in Orange County (Koerper et al. 1986; Ericson et al. 1989), but our evidence suggests otherwise (see "Lithic Trade" below).

**Vertebrate Remains.** The vertebrate faunal sample from ORA-667 (table 4.7) consists of 15,481 specimens from nine burned-rock features and two other locations with large quantities of vertebrate remains. A pattern similar to that at ORA-665 is seen in the sample from ORA-667 where the large fish sample (665 specimens) allows quantification by habitat. The kelp-bed habitat contributed 71 percent of the identified specimens, and 95 percent of these specimens are sheephead. Sheephead represent 67 percent of all identified fish specimens. Rocky-bottom habitat is represented by 10 percent of the specimens, and the nearshore habitat in general is represented by another 18 percent. The kelp-bed fish, in addition to sheephead, are jack mackerel, señorita, kelp bass,

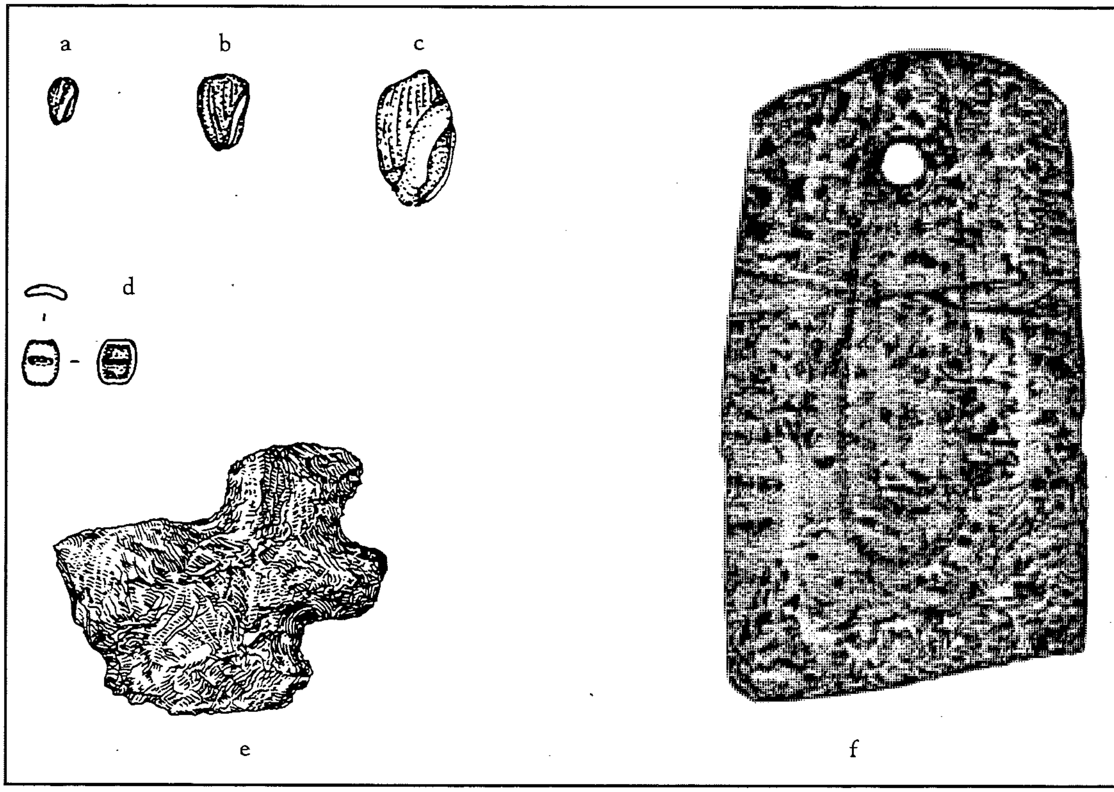



FIGURE 4.6 Nonutilitarian artifacts from ORA-665: *a-b*, *Olivella* spire-removed perpendicular beads; *c*, *Olivella* spire-removed oblique bead; *d*, *Olivella* grooved rectangle bead; *e*, eccentric crescent; *f*, siltstone pendant (all shown actual size).

blacksmith, and giant kelpfish. Fish from shallow rocky-bottom habitat include rockfish and cabezon. Lingcod is also present. Nearshore fish include Pacific mackerel, jacksmelt, bat ray, shovelnose guitarfish, and white croaker.

At ORA-667, where 752 rabbit and jackrabbit bones were identified, rabbits appear more important than at ORA-665. The forty-seven carnivore specimens include dog or coyote, fox, and bobcat. In addition, three deer specimens were identified. Rabbits were probably trapped, hit with clubs, stones, or with rabbit sticks. Atlatls and darts also may have been used with wooden points or "blunts" (see Salls 1986). Deer and carnivores were probably hunted with spear-throwers and darts.

The remains of a variety of rodents, their predators (snakes), and their commensals (amphibians) were found at the site. Most of these remains are of noncultural origin, but some probably represent marginal cultural use of squirrel, gopher, woodrat, and snakes.

**Shellfish Remains.** The shellfish sample came from twenty-five units and from levels around twenty features. A total of 28,630 hinges and apices was identified, providing an MNI estimate of 15,015 individuals from forty-five taxa (table 4.8) (Peterson 1992b). Over 93 percent of the MNI is from the rocky shore-habitat, 80 percent of it mussel. Other rocky-shore taxa making up more than 1 percent of the total MNI include gooseneck barnacle (4%), limpet (2.5%), barnacle (1.7%), and jewel box (*Pseudochama exogyra*) (1%). Twenty-five species from rocky shores were found in incidental amounts. Taxa collected from more protected bay, estuarine, or outer-coast habitats make up only about 6 percent of the MNI, including oyster (3%), Venus clam (1.4%), and scallop (1%).

**Seasonality.** Among the vertebrate sample, only otoliths provided data on the seasonality of resource procurement. The forty-eight fish otoliths analyzed suggest that most fish were caught in the summer months (table 4.9). A few otoliths indicate fall and spring fishing, but there is no evidence for fishing during December and January. This is consistent with the general pattern for Middle Holocene NCAP sites, where fishing appears to have occurred predominantly from May through October.

**Technomic Artifacts.** A wide range of extraction and maintenance activities is indicated by the technomic artifacts, suggesting that ORA-667 functioned as a residential site (fig. 4.8, table 4.10). Hunting and fishing are reflected by the many projectile points (fig. 4.7) and gorges. One net weight was recovered (fig. 4.9). Most of the food-processing tools (manos and metates) relate to the preparation of hard seeds, although two pestles may have been used for processing pulpy seeds, fruits, or even animal flesh. A cobble proto-pestle is probably a Middle Holocene artifact, but an asymmetric shouldered pestle is probably from a later occupation. Manufacturing tools are again the most diverse category and include bone awls; spherical and angular hammers; faceted abrading hammers; sandstone abraders; a tarring anvil; grooved stones used in the production of stone, bone, or wood tools; utilitarian incised stone used as cutting surfaces; anvils; and small ground slabs. Of seven drills, two

TABLE 4.5 ORA-667: radiocarbon dates

| LAB NO. | UNIT | LEVEL | $^{14}C$ AGE (RYBP) | $^{13}C/^{12}C$ ADJUSTED AGE | CALIBRATED AGE (BP) |
|---|---|---|---|---|---|
| Beta-23827 | 27 | 20-40 | 4510±100 | 4930 | 5040±100 |
| Beta-23828 | 27 | 40-60 | 4610±80 | 5030 | 5250±85 |
| Beta-23829 | 27 | 60-80 | 4580±90 | 5000 | 5220±95 |
| UCI-149 | 161 | 10-20 | 4630±60 | 5050 | 5260±70 |
| UCI-150 | 161 | 20-30 | 4520±75 | 4940 | 5050±80 |
| UCI-151 | 161 | 30-40 | 4450±60 | 4870 | 4970±70 |
| UCI-152 | 161 | 40-50 | 4800±80 | 5220 | 5440±85 |
| UCI-153 | 161 | 50-60 | 4400±75 | 4820 | 4870±80 |
| UCI-154 | 161 | 60-70 | 4930±80 | 5350 | 5580±85 |
| UCI-155 | 161 | 70-80 | 4840±85 | 5260 | 5470±90 |
| UCI-156 | 161 | 80-90 | 5025±60 | 5445 | 5660±70 |
| UCI-157 | 161 | 90-100 | 4800±65 | 5220 | 5440±70 |
| UCI-216 | 2767 | 44 | 4570±50 | 4990 | 5170±60 |
| UCI-226 | 213 | 80-90 | 3870±100 | 4290 | 4230±100 |
| UCI-227 | 293 | 40-60 | 3950±100 | 4370 | 4350±100 |
| UCI-228 | 2335 | 70-80 | 4800±70 | 5220 | 5440±80 |
| UCI-229 | 2691 | 40-50 | 4040±80 | 4460 | 4435±85 |
| UCI-230 | 389 | 20-30 | 4480±70 | 4900 | 4990±80 |
| UCI-231 | 2752 | 30-40 | 3900±60 | 4320 | 4270±70 |
| UCI-232 | 2465 | 20-30 | 4300±60 | 4720 | 4820±70 |
| UCI-233 | 2508 | 20-30 | 4290±70 | 4710 | 4810±80 |
| UCI-234 | 2492 | 40-50 | 3870±50 | 4290 | 4230±60 |
| UCI-235 | 2504 | 30-40 | 4290±50 | 4710 | 4810±60 |
| UCI-236 | 2672 | 40-50 | 3390±60 | 3810 | 3580±70 |
| UCI-237 | 2500 | 20-30 | 4800±70 | 5220 | 5440±80 |

Note: Beta-23827, -23829, and -23838 and UCI-149 through UCI-157 are from aggregate *Mytilus* shell samples. UCI-216 and UCI-226 through UCI-237 are from individual *Haliotis* shells from burned-rock features. Calibration follows Stuiver, Pearson, and Braziunas 1986 using a locally derived correction factor (Delta-R) for the reservoir effect (Mason and Peterson 1994).

TABLE 4.6 ORA-667: obsidian source and hydration data

| CATALOG NO.* | INAA # | HYDRATION MEASURE | MN(PPM) | NA (%WT) | K (%WT) | DY (PPM) | SOURCE |
|---|---|---|---|---|---|---|---|
| 24421 | 623 | | 311.39 | 3.11 | 4.80 | 2.29 | Casa Diablo |
| 24930 | 624 | | 388.26 | 3.65 | 3.98 | 23.16 | Obsidian Butte |
| 25450 | 625 | | 371.33 | 3.35 | 4.02 | 20.52 | Obsidian Butte |
| 25974 | 626 | 6.0±0.3 | 238.52 | 2.99 | 2.89 | 7.39 | Coso |
| 13233 | 622 | 6.6±0.2 | 243.55 | 3.29 | 4.03 | 7.69 | Coso |

| CATALOG NO.** | RB (PPM) | SR (PPM) | ZR (PPM) | TOTAL | RB % | SR % | ZR % | SOURCE |
|---|---|---|---|---|---|---|---|---|
| 35572 | 220.29 | 7.31 | 112.02 | 339.62 | 64.86 | 2.15 | 32.98 | Coso |

* Neutron activation analysis of debitage done at the UC Irvine reactor (Ericson 1994). ** X-ray fluorescence analysis of single large projectile point done by Bouey 1993.

were drill points (fig. 4.10a, c), three were T-shaped (fig. 4.10b), and two were quartz crystal drills. The manufacturing category also includes reamers (fig. 4.10d-f) and perforators (fig. 4.10g-h). The 396 cores and core fragments recovered, along with a large amount of debitage, indicates a heavy emphasis on stone tool-manufacture.

General utility tools (used in manufacturing and/or food processing) are represented by several kinds of scrapers, blades (fig. 4.11a-b), and knives (fig. 4.11c-d), as well as choppers and edge-ground flakes. Other artifacts not classified by function include undiagnostic retouched flakes, biface preforms, and miscellaneous pecked and ground stone.

A sample of 2,757 pieces of debitage was analyzed. Quartz makes up 48 percent of this sample and Monterey chert comprises 45 percent. Felsite, metachert, and andesite each comprise more than 1 percent, but obsidian made up less than 1 percent of the sample. Of the four obsidian flakes sourced, two are from Obsidian Butte, one from Coso, and one from Casa Diablo. Tertiary flakes make up 91 percent of the debitage, but the abundance of decortication flakes (7%) indicates that primary lithic reduction was important at ORA-667. Biface thinning flakes comprise 2 percent of the debitage sample.

**Sociotechnic and Ideotechnic Artifacts.** Ceremonial/social artifacts include two quartz crystals (fig. 4.12a); an eccentric crescent (fig. 4.12b); four incised stones (fig. 4.12c); one patterned grooved stone; three possible fish effigies, fifty-seven shell beads; and lumps of hematite, limonite, and kaolinite. The symmetrical clear quartz crystals exhibit spalling and grinding on the proximal and distal ends, indicating use as drills. Ethnographic references (for example, Du Bois 1908:94) to quartz crystals as shamans' pieces, however, suggest that these also may have had magico-religious functions. Thirty-one unmodified pieces of red ocherous siltstone

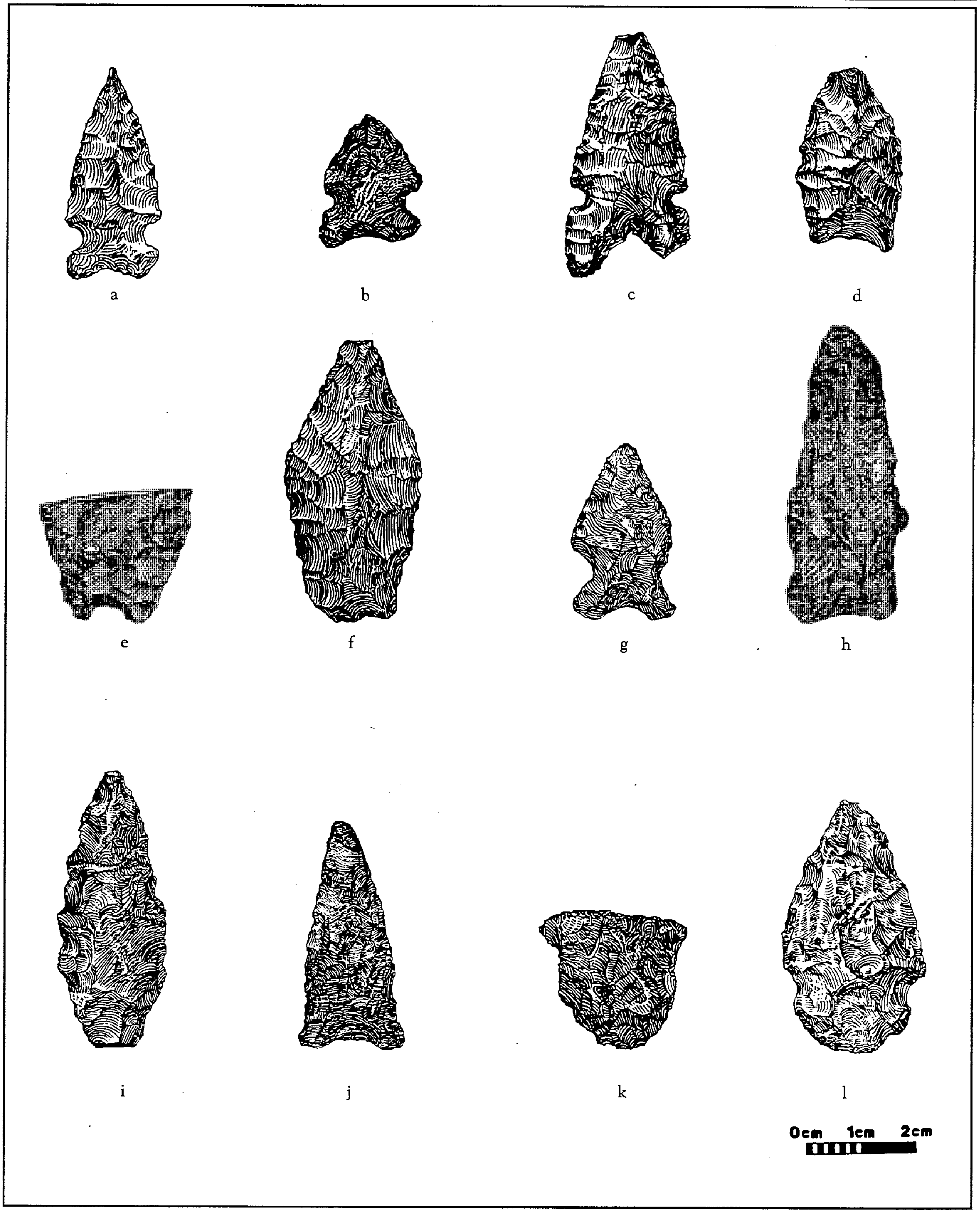



FIGURE 4.7 Projectile points from ORA-667: *a-b*, Elko side-notched; *c*, Northern side-notched; *e*, possible Humboldt; *f*, Pinto sloping-shoulders; *g*, Pinto or Elko-eared; *h*, Pinto or Gatecliff split-stem; *i*, large leaf; *j*, large triangular; *k*, Silver Lake; *l*, Silver Lake or Elko corner-notched.

Table 4.7 ORA-667: vertebrate taxa

| Common name | Scientific name | NISP | MNI | Weight |
|---|---|---|---|---|
| Horn shark | *Heterodontus francisci* | 1 | - | 0.02 |
| Soupfin shark | *Galeorhinus zyopterus* | 2 | - | 0.05 |
| Smoothhound shark | Triakidae | 7 | - | 1.39 |
| Pacific angel shark | *Squatina californica* | 1 | - | 0.01 |
| Guitarfish | *Rhinobatos productus* | 14 | - | 0.65 |
| Thornback | *Platyrhynoides triserata* | 2 | - | 0.05 |
| Bat ray | *Myliobatis californica* | 14 | - | 0.93 |
| Unidentifiable shark/ray | Elasmobranchii | 167 | - | 7.18 |
| Unidentifiable shark/ray | Chondrichthyes | 5 | - | 0.36 |
| Midshipman | *Porichthys* sp. | 1 | - | 0.04 |
| Jacksmelt | *Atherinopsis californiensis* | 20 | - | 0.53 |
| Rockfish | *Sebastes* sp. | 61 | - | 4.67 |
| Rockfish, genus unknown | Embiotocidae | 40 | - | 1.42 |
| Lingcod | *Ophiodon elongatus* | 4 | - | 0.77 |
| Cabezon | *Scorpaenichthys marmoratus* | 3 | - | 0.32 |
| Kelp bass | *Paralabrax clathratus* | 5 | - | 0.63 |
| Jack mackerel | *Trachurus symmetricus* | 9 | - | 0.28 |
| White croaker | *Genyonemus lineatus* | 3 | - | 0.12 |
| Blacksmith | *Chromis punctipinnis* | 4 | - | 0.09 |
| Señorita | *Oxyjulis californica* | 7 | - | 0.17 |
| Sheephead | *Semicossyphus pulcher* | 446 | - | 46.59 |
| Giant kelpfish | *Heterostichus rostratus* | 1 | - | 0.04 |
| Pacific bonito | *Sarda chiliensis* | 2 | - | 0.20 |
| Pacific mackerel | *Scomber japonicus* | 20 | - | 0.85 |
| Flatfishes | Pleuronectiformes | 1 | - | 0.14 |
| Unidentifiable bony fish | Teleostei | 1477 | - | 36.14 |
| Unidentifiable fish | Pisces | 3381 | - | 114.59 |
| Pond turtle | *Clemmys marmorata* | 2 | 1 | 0.20 |
| Unidentifiable bird | Aves | 124 | - | 9.90 |
| Desert cottontail | *Sylvilagus audubonii* | 6 | 1 | 0.25 |
| Rabbits | *Sylvilagus* sp. | 621 | 18 | 40.13 |
| Black-tailed jackrabbit | *Lepus californicus* | 125 | 6 | 14.09 |
| Dog or coyote | *Canis* sp. | 12 | 1 | 3.96 |
| Grey fox | *Urocyon cinereoargenteus* | 4 | 1 | 0.30 |
| Dog/coyote/fox | Canidae | 1 | - | 0.07 |
| Striped skunk | *Mephitis mephitis* | 3 | 1 | 0.11 |
| Spotted skunk | *Spilogale putorius* | 1 | 1 | 0.14 |
| Sea otter | *Enhydra lutris* | 4 | 1 | 5.22 |
| Bobcat | *Felis rufus* | 1 | 1 | 0.33 |
| Seal or sea lion | Pinnipedia | 3 | - | 1.08 |
| Unidentifiable carnivore | Carnivora | 18 | - | 3.05 |
| Black-tailed deer | *Odocoileus hemionus* | 3 | 1 | 2.70 |
| Unidentifiable artiodactyl | Artiodactyla | 31 | - | 30.24 |
| Unidentifiable mammal | Mammalia | 5008 | - | 264.22 |
| Unidentifiable vertebrate | Vertebrata | 3815 | - | 139.48 |
| Unidentified unknown | Vertebrata | 1 | - | 0.01 |
| TOTAL | | 15,481 | | 733.71 |

Note: Given in aggregate by total specimens (NISP), minimum number of individuals (MNI), and weight (Wt).

and four lumps of yellow siltstone may have been pigments for the body or other decoration (see Harrington 1934:17; Palou 1926:123; Reid 1926:22). A small unmodified lump of kaolinite also may have been a pigment (see Palou 1926:123; Strong 1929), but the Luiseño used this mineral as a medicine historically (Duflot de Mofras 1937:I-191). The shell beads fall into eight types (table 4.11).

## LITHIC TRADE

Obsidian is the most thoroughly studied long-distance exchange commodity in prehistoric Orange County. Obsidian from the Coso area in Inyo County dominated local trade in that resource from the Early and Middle Holocene to some point in the Late Holocene. After that, there may have been a trade hiatus, with little or no volcanic glass entering the area, followed by trade in Obsidian Butte material from the Salton Sea area in Imperial County (Koerper et al. 1986; Ericson et al. 1989).

Obsidian artifacts from numerous NCAP sites were analyzed via neutron activation (Ericson 1994) and X-ray fluorescence (Bouey 1993). A smaller sample was subjected to hydration analysis (tables 4.2, 4.6). From seven rock shelters

TABLE 4.8 ORA-667: MNI and weight of shellfish remains by species and habitat

| | MNI | % | WEIGHT (G) | % |
|---|---|---|---|---|
| *Unclassifiable* | | | | |
| Gastropod, undifferentiated | 67 | 100 | 17.49 | 100 |
| *Rocky shore/Outer coast* | | | | |
| *Acanthina spirata* | 16 | 0.1 | 4.90 | * |
| *Acmaea* sp. | 380 | 2.7 | 11.99 | * |
| *Anomia peruviana* | 1 | * | 1.05 | * |
| *Astraea undosa* | 6 | * | 259.52 | 1.1 |
| *Balanus* sp. | 260 | 1.8 | 767.28 | 3.3 |
| *Bursa californica* | 3 | * | 5.07 | * |
| *Cancer* sp. | 0 | * | 0.19 | * |
| *Chama pellucida* | 7 | * | 20.40 | * |
| *Chiton* sp. | 45 | 0.3 | 59.87 | 0.2 |
| *Conus californius* | 1 | * | 1.83 | * |
| *Crepidula* sp. | 45 | 0.3 | 4.51 | * |
| *Crucibulum* sp. | 8 | * | 0.27 | * |
| *Cypraea spadica* | 0 | * | 0.87 | * |
| *Fissurella volcano* | 77 | 0.5 | 4.58 | * |
| *Haliotis cracherodii* | 16 | 0.1 | 1829.26 | 7.8 |
| *Haliotis fulgens* | 18 | 0.1 | 2777.90 | 11.9 |
| *Haliotis* sp. | 43 | 0.3 | 3308.24 | 14.2 |
| *Hinnites multirugosus* | 5 | * | 430.28 | 1.8 |
| *Hipponix antiquatus* | 3 | * | 61.55 | 0.2 |
| *Littorina* sp. | 1 | * | 0.13 | * |
| *Lottia gigantea* | 8 | * | 17.04 | * |
| *Megathura crenulata* | 6 | * | 191.05 | 0.8 |
| *Mytilus* sp. | 12,051 | 86.1 | 11513.66 | 49.5 |
| *Ophilia insculpta* | 4 | * | 0.67 | * |
| *Pododesmus cepio* | 45 | 0.3 | 16.72 | * |
| *Pollicipes polymerus* | 633 | 4.5 | 135.99 | 0.5 |
| *Pseudochama exogyra* | 174 | 1.2 | 1733.52 | 7.4 |
| *Septifer bifurcatus* | 101 | 0.7 | 35.14 | 0.1 |
| *Serpulorbis squamigerous* | 0 | * | 42.77 | 0.1 |
| *Strongylocentrotus purpuratus* | 0 | * | 0.29 | * |
| *Tegula* sp. | 36 | 0.2 | 11.77 | * |
| SUBTOTALS | 13,993 | 100 | 23248.31 | 100 |
| *Bay/Lagoon /Estuary* | | | | |
| *Argopecten* sp. | 167 | 93.8 | 1856.22 | 88.3 |
| *Cerithidea californica* | 2 | 1.1 | 0.99 | * |
| *Nassarius* sp. | 1 | 0.5 | 0.12 | * |
| *Saxidomus nuttalli* | 7 | 3.9 | 263.83 | 11.2 |
| *Tagelus* sp. | 1 | 0.5 | 7.12 | 0.3 |
| SUBTOTALS | 178 | 100 | 2101.28 | 100 |
| *Offshore/Deep water* | | | | |
| *Haliotis corrugata* | 8 | 100 | 1971.99 | 100 |
| *Bays/Outer coast* | | | | |
| *Chione* spp. | 220 | 28.6 | 2215.62 | 89.5 |
| Echnoidea | 0 | * | 2.70 | 0.1 |
| *Ocenebra poulsoni* | 21 | 2.7 | 11.52 | 0.4 |
| *Olivella biplicata* | 28 | 3.6 | 17.84 | 0.7 |
| *Ostrea lurida* | 492 | 63.9 | 197.22 | 7.9 |
| *Polinices* sp. | 7 | 0.9 | 25.22 | 1.0 |
| *Protothaca* sp. | 1 | 0.1 | 0.26 | * |
| *Semele decisa* | 0 | * | 4.91 | 0.1 |
| SUBTOTALS | 769 | 100 | 2475.29 | 100 |
| *Habitat totals* | | | | |
| Unclassifiable | 67 | 0.4 | 17.49 | * |
| Rocky shore/outer coast | 13,993 | 93.1 | 23,248.31 | 77.9 |
| Bay/lagoons/estuary | 178 | 1.1 | 2101.28 | 7.0 |
| Offshore/deep water | 8 | * | 1971.99 | 6.6 |
| Bay/outer coast | 769 | 5.1 | 2475.29 | 8.3 |
| TOTAL | 15,015 | 100 | 29,814.36 | 100 |

*Less than 0.01%.

TABLE 4.9 Seasonality of fishing at ORA-667 based on annular ring reading of otoliths

| SCIENTIFIC NAME | CATALOG NO. | ES MAY / JUNE | MS JULY / AUG | LS SEPT / OCT | EW NOV / DEC | MW JAN / FEB | LW MAR / APRIL |
|---|---|---|---|---|---|---|---|
| | | CALENDAR CONVERSION | | | | | |
| *Genyonemus lineatus* | 11265 | | ********** | ********** | | | |
| *Genyonemus lineatus* | 11785 | ********** | | | | | ********** |
| *Sphyraena argentea* | 11870 | | | ********** | | | |
| *Genyonemus lineatus* | 11978 | | | ********** | ********** | | |
| *Genyonemus lineatus* | 11996 | ********** | ********** | ********** | | | |
| *Genyonemus lineatus* | 12058 | | ********** | | | | |
| *Genyonemus lineatus* | 12879 | ********** | ********** | ********** | | | |
| *Paralichthys californicus* | 13311 | | | ********** | ********** | | |
| *Genyonemus lineatus* | 13354 | ********** | | | | | |
| *Genyonemus lineatus* | 13432 | ********** | ********** | ********** | | | |
| *Sebastes miniatus* | 13506 | | | | ********** | | |
| *Sebastes miniatus* | 13507 | | | ********** | | | |
| *Genyonemus lineatus* | 13508 | | ********** | ********** | | | |
| *Umbrina roncador* | 13509 | | | ********** | ********** | | |
| *Umbrina roncador* | 13510 | ********** | ********** | | | | |
| *Sphyraena argentea* | 13511 | | | ********** | | | |
| *Roncador stearnsii* | 13512 | | | ********** | | | |
| *Genyonemus lineatus* | 13513 | ********** | ********** | | | | |
| *Genyonemus lineatus* | 13514 | | ********** | ********** | | | |
| *Roncador stearnsii* | 13515 | | | ********** | ********** | | |
| *Anisotremus davidsoni* | 13516 | | ********** | ********** | | | |
| *Genyonemus lineatus* | 13517 | | ********** | | | | |
| *Genyonemus lineatus* | 13518 | ********** | | | | | |
| *Sebastes miniatus* | 13519 | | | ********** | | | |
| *Roncador stearnsii* | 13520 | ********** | ********** | | | | |
| *Umbrina roncador* | 13521 | ********** | ********** | | | | |
| *Genyonemus lineatus* | 13522 | | | ********** | ********** | | |
| *Genyonemus lineatus* | 13523 | | | ********** | | | |
| *Genyonemus lineatus* | 13524 | | | ********** | ********** | | |
| *Genyonemus lineatus* | 13525 | ********** | | | | | ********** |
| *Umbrina roncador* | 13526 | | | ********** | ********** | | |
| *Genyonemus lineatus* | 13527 | ********** | ********** | ********** | | | |
| *Roncador stearnsii* | 13528 | | | ********** | | | |
| *Genyonemus lineatus* | 13529 | | | ********** | ********** | | |
| *Genyonemus lineatus* | 13530 | ********** | ********** | ********** | | | |
| *Genyonemus lineatus* | 13531 | ********** | ********** | ********** | | | |
| *Genyonemus lineatus* | 13532 | ********** | | | | | ********** |
| *Genyonemus lineatus* | 13533 | ********** | ********** | ********** | | | |
| *Genyonemus lineatus* | 14971 | | | | ********** | | |
| *Paralichthys californicus* | 19549 | ********** | | | | | |
| *Sebastes umbrosus* | 20220 | | | ********** | | | |
| *Sebastes macdonaldi* | 20302 | | | ********** | | | |
| *Umbrina roncador* | 22291 | | | ********** | ********** | | |
| *Scomber japonicus* | 24857 | | | ********** | ********** | | |
| *Sebastes miniatus* | 25014 | | ********** | | | | |
| *Genyonemus lineatus* | 25249 | ********** | | | | | |
| *Sebastes miniatus* | 25388 | | | ********** | | | |
| *Paralichthys californicus* | 35210 | | | ********** | | | |

Note: ES = early summer; MS = midsummer; LS = late summer; EW = early winter; MW = midwinter; LW = late winter

and associated middens (ORA-672, ORA-674, ORA-675, ORA-678, ORA-679, ORA-1205, ORA-1206) dating predominantly to the Late period, 24 obsidian flakes were recovered. Of these, twenty were from Obsidian Butte and four from Coso. Small arrow points postdate atlatl dart points (Koerper and Drover 1983). Of the fifteen obsidian bifaces sourced by X-ray fluorescence, all six Obsidian Butte specimens were arrow points, and eight Coso specimens were large bifaces. Only one Coso specimen was small enough to have served as an arrow tip, but its form was that of an atlatl projectile. These results support the idea that Coso dominated the early obsidian trade, and Obsidian Butte dominated Late Prehistoric trade (Koerper et al. 1986; Ericson et al. 1989).

Five of the eight Middle Holocene NCAP sites provided obsidian specimens for chemical characterization. Of the specimens sourced, twenty-eight were from Coso, two from Casa Diablo, and six from Obsidian Butte. Artifacts from northern obsidian sources outnumber those from the south-

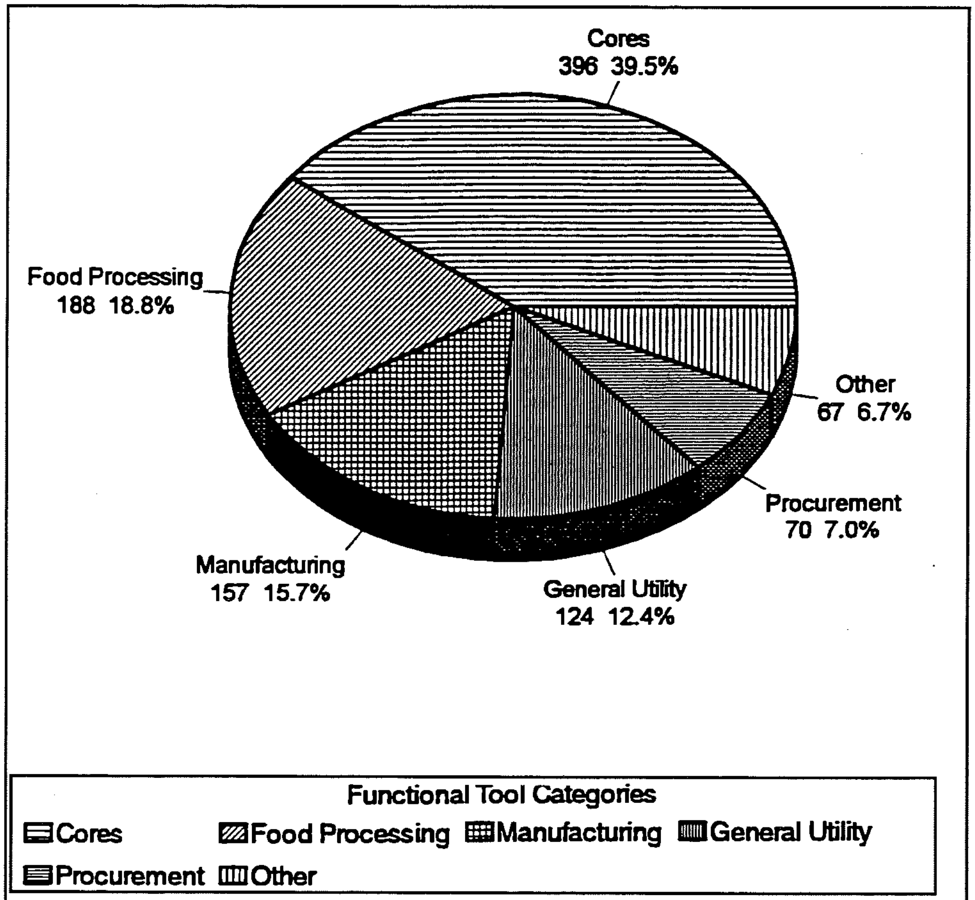



FIGURE 4.8 Frequencies of functional tool types from ORA-667. *After Singer 1992b*

| *Cores* | |
|---|---|
| Core fragments | 261 |
| Cores | 135 |

| *Manufacturing Tools* | |
|---|---|
| Angular hammers | 66 |
| Awls | 36 |
| Faceted abrading hammers | 7 |
| Drills | 7 |
| Perforators | 6 |
| Reamers | 5 |
| Sandstone abraders | 4 |
| Small ground slabs | 4 |
| Utilitarian incised stones | 3 |
| Grooved stones | 3 |
| Anvils | 2 |
| Tarring anvil | 1 |
| Possible rasp | 1 |

| *Procurement Tools* | |
|---|---|
| Projectile points | 44 |
| Gorges | 25 |
| Net weight | 1 |

| *General Utility Tools* | |
|---|---|
| Retouched flake scrapers | 40 |
| Utilized flake scrapers | 27 |
| Prismatic blades | 18 |
| Core scrapers | 16 |
| Flake knives | 8 |
| Bifacial knives | 6 |
| Prismatic microblades | 3 |
| Edge ground flakes | 3 |
| Choppers | 3 |

| *Food ProcessingTools* | |
|---|---|
| Manos | 101 |
| Shallow basin metates | 54 |
| Slab metates | 9 |
| Trough metates | 2 |
| Cobble proto-pestle | 1 |
| Asym. shouldered pestle | 1 |

| *Other* | |
|---|---|
| Retouched flakes | 38 |
| Biface preforms | 21 |
| Tool fragments | 5 |
| Misc. pecked and ground stones | 3 |

ern Obsidian Butte source by a 5:1 ratio, but we are surprised that so many of the sourced specimens are from Obsidian Butte. Two sites (ORA-660 and ORA-667) each produced a Late Prehistoric point and two Obsidian Butte specimens apiece. Late Prehistoric contamination of these and two other Middle Holocene sites might explain the presence of Obsidian Butte material, but the single hydration reading for these six specimens was a relatively large 6.0 μ. Another unexpectedly large reading of 7.8 μ was recorded for one of two Obsidian Butte specimens recovered at ORA-340, a multicomponent site. Thus, evidence from four NCAP sites suggests that major water drawdowns of the Salton Sea (Lake Cahuilla, Blake Sea) during the Middle Holocene exposed obsidian outcrops that often lay submerged.

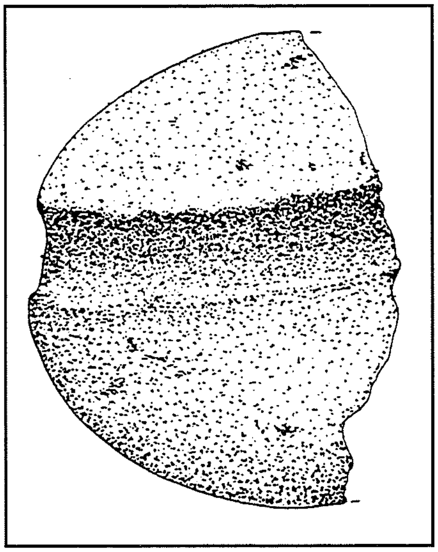


FIGURE 4.9 Net weight from ORA-667 (shown actual size).

Other exotic lithic materials that appear to have been traded into Orange County are rare in the NCAP Middle Holocene sites. These include Franciscan chert, fused shale, green felsite, Piedra de Lumbre chert, and a talc mica schist (steatite). From the eight sites with exclusively Middle Holocene dates, Franciscan chert was represented by a single tertiary flake, one biface thinning flake, and a bifacial tool, probably an atlatl dart point. Franciscan chert appears to have been traded from Santa Barbara County, probably along a coastal route into Los Angeles County and then south. Six fused shale artifacts were also recovered, including four bifaces, one tertiary flake, and one biface thinning flake. The fused shale may have come from the Grimes Canyon source in southern Ventura County, but fused shale from a Santa Ynez Valley source in Santa Barbara County is very similar (Erlandson 1994). Green felsite, also known as "Harris site green felsite," from San Diego County is a fine-grained metavolcanic rock that occurs in a range of greenish hues. At ORA-667, a projectile point, two knives, and a perforator were fashioned of this material. No green felsite debitage was identified, but specimens may be included in the general "felsite" category. Eight sites produced artifacts of Piedra de Lumbre chert from northern San Diego County (Pigniolo 1992), including two projectile points, two bifaces, three biface thinning flakes, one flake knife, a scraper, and nine tertiary flakes. Finally, ORA-929 produced two small fragments of steatite vessels, material derived from the distinctive Santa Catalina Island source. The nature of the trade between Catalina Island and the mainland is not known, but a down-the-line trade model (Renfrew 1972) probably accounts for the other exotics, including obsidian.

It appears that the extremely rare exotic lithics used for chipped-stone tools were traded in as preforms or in finished condition. We are more certain that the obsidian traded along routes across Tejon and/or Cajon passes arrived in Orange County as preforms and finished products. This is indicated by the absence of obsidian cores and the paucity of obsidian decortication flakes (two) compared to thirty-three obsidian biface thinning flakes.

It has erroneously been suggested that the jasper used in tool manufacture in Orange County is another exotic material. Two critiques (Koerper et al. 1987; Shackley 1987) challenged Cotrell's (1985) hypothesis that jasper was secured from the Mojave Desert or beyond. Recent chemical characterization studies demonstrate a local origin for the kind of jasper used to make most jasper tools found in Orange County middens (Koerper et al. 1992). The source of this jasper is on the east side of the Tustin Plain, where the material was probably found in stream gravels in drainages cutting the Santa Ana foothills. The small amount of jasper debitage, less than 0.15 percent of the over fifty thousand specimens from the eight Middle Holocene NCAP sites, indicates an exponential dropoff of jasper from the Tomato Springs area to the coast. Thirty-five of the seventy-five debitage specimens are bifacial thinning flakes, and there are seven jasper bifaces in this Middle Holocene collection. It seems that the jasper arrived at these sites as preforms or finished tools.

## DISCUSSION

From the artifacts and subsistence remains from ORA-665 and ORA-667 we can infer functional site types and reconstruct the settlement-subsistence system of which they were a part. According to Binford (1980) and Thomas (1983), there are two kinds of hunter-gatherer settlement-subsistence systems: those generated by foragers and those generated by collectors. Foragers usually move through a seasonal round with the entire group moving from one resource area to the next. The group's activities generate archaeological material at residential bases where most manufacturing, resource processing, food preparation, and social-ceremonial activities are carried out. Resource procurement activities performed away from the residential base may be archaeologically invisible or may result in sites termed locations, where a few procurement tools or subsistence remains (such as butchering waste or shell) may have been discarded. Forager residential bases may be occupied for a season or less, but the same site may be used year after year during the same season.

Collectors also establish residential bases, but instead of moving the residential base among a series of resource areas, specialized resource procurement parties are sent out to collect specific resources and bring them back to the residential base. When such parties go beyond 10 km from the residential base, they may establish field camps that may be used repeatedly for similar resource procurement tasks (Thomas 1983:88). The tools and subsistence remains at field camps

TABLE 4.10 Functional tool categories at ORA-667 from hand-excavated units, mechanical excavation, surface collection, and monitoring

| | HAND EXCAVATION | MECHANICAL EXCAVATION | SURFACE/MONITORING | TOTAL |
|---|---|---|---|---|
| *Procurement* | | | | |
| Atlatl projectile points | 25 | 16 | 2 | 43 |
| Gorge/barb | 25 | . | . | 25 |
| Net weight | . | 1 | . | 1 |
| Arrow projectile point | 1 | . | . | 1 |
| SUBTOTAL | 51 | 17 | 2 | 70 |
| *Processing* | | | | |
| Manos | 59 | 20 | 22 | 101 |
| Shallow basin metate | 35 | 8 | 11 | 54 |
| Slab metate | 22 | 3 | 4 | 29 |
| Trough metate | 2 | . | . | 2 |
| Asym. shouldered pestle | 1 | . | . | 1 |
| Cobble proto-pestle | 1 | . | . | 1 |
| SUBTOTAL | 120 | 31 | 37 | 188 |
| *General utility* | | | | |
| Retouched flake scraper | 28 | 8 | 4 | 40 |
| Utilized flake scraper | 22 | 5 | . | 27 |
| Prismatic blade | 14 | 1 | 3 | 18 |
| Core scraper | 13 | 1 | 2 | 16 |
| Flake knife | 5 | 2 | 1 | 8 |
| Knife | 3 | 3 | . | 6 |
| Chopper | 2 | 1 | . | 3 |
| Microblade | 3 | . | . | 3 |
| Edge ground flake | 3 | . | . | 3 |
| SUBTOTAL | 93 | 21 | 10 | 124 |
| *Manufacturing* | | | | |
| Angular hammer | 49 | 5 | 12 | 66 |
| Awl | 36 | . | . | 36 |
| Spherical hammer | 10 | 2 | . | 12 |
| Drill | 4 | 3 | . | 7 |
| Angular hammer/abrader | 5 | 1 | 1 | 7 |
| Perforator | 6 | . | . | 6 |
| Reamer | 4 | 1 | . | 5 |
| Faceted abrader | 4 | . | . | 4 |
| Small ground slab | 2 | 1 | 1 | 4 |
| Utilitarian incised stone | 3 | . | . | 3 |
| Grooved stone | 2 | . | 1 | 3 |
| Anvil | 2 | . | . | 2 |
| Tarring anvil | 1 | . | . | 1 |
| Possible rasp | . | . | 1 | 1 |
| SUBTOTAL | 128 | 13 | 16 | 157 |
| *Primary lithic reduction* | | | | |
| Cores | 103 | 9 | 23 | 135 |
| Core fragments | 217 | 12 | 32 | 261 |
| SUBTOTAL | 320 | 21 | 55 | 396 |
| *Other* | | | | |
| Retouched flake | 32 | 5 | 1 | 38 |
| Biface preform | 16 | 4 | 1 | 21 |
| Tool fragment | 5 | . | . | 5 |
| Misc. pecked and ground stone | 3 | . | . | 3 |
| SUBTOTAL | 56 | 9 | 2 | 67 |
| TOTAL | 768 | 112 | 122 | 1002 |

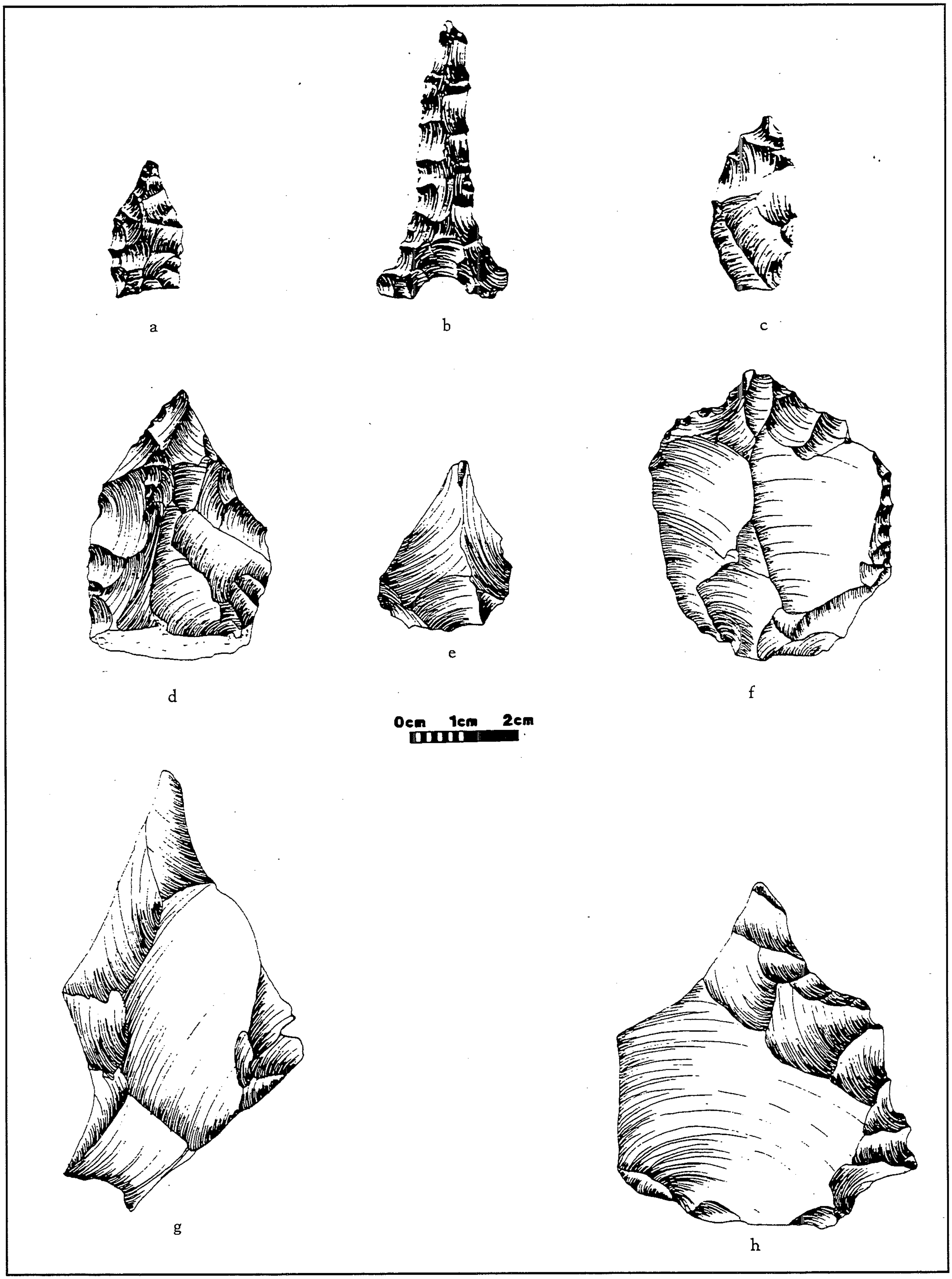



FIGURE 4.10 Manufacturing tools from ORA-667: *a*, *c*, drill points; *b*, T-shaped drill; *d-f*, reamers; *g-h*, perforators.

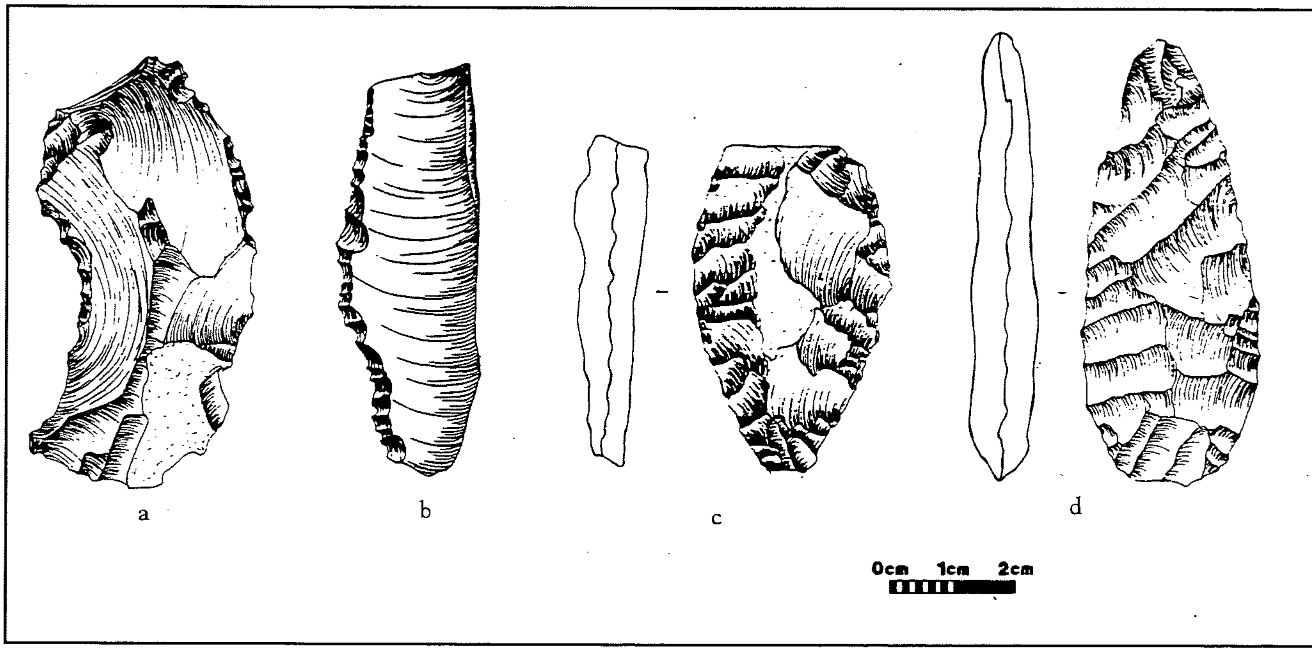



FIGURE 4.11 General utility tools from ORA-667: *a-b*, prismatic blades; *c-d*, bifacial knives.

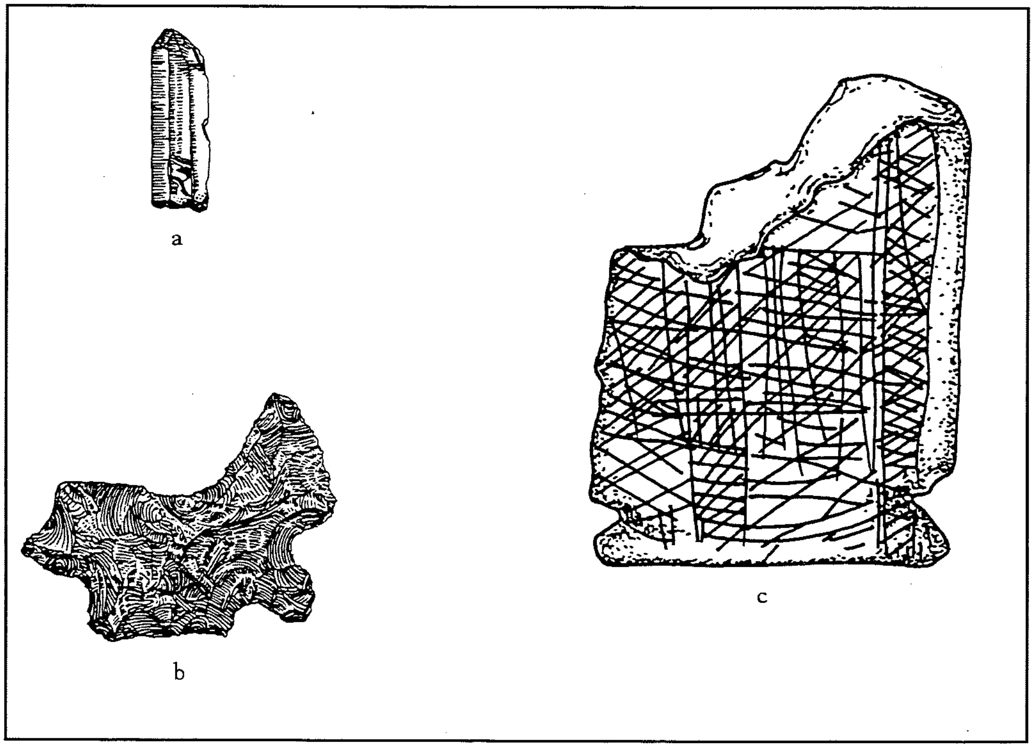



FIGURE 4.12 Ideotechnic artifacts from ORA-667: *a*, shaman's crystal or drill; *b*, eccentric crescent; *c*, patterned incised stone (all shown actual size).

should represent specialized resource procurement and food preparation activities associated with limited overnight stays. Residential bases of collectors may be occupied for a greater part of the year and contain a higher density of tools and subsistence remains than foragers' residential bases. Collectors may move only between a summer and winter residential base, or at least part of the group may occupy the same residential base all year. Thus, residential bases may be seasonal, multiseasonal or year round. The latter may be termed a village. In coastal Southern California during the Late Prehistoric period, hunter-gatherer communities maintained permanent central villages within a defined territory (Earle and O'Neil 1994). Part of the population may have occupied multiseason (late spring through early fall) residential bases or established short-term field camps within the terri-

TABLE 4.11 ORA-667: beads

| | N | % |
|---|---|---|
| *Olivella* spire-removed perpendicular | 32 | 56 |
| *Conus* spire-removed perpendicular | 5 | 9 |
| *Olivella* spire-removed oblique | 5 | 9 |
| *Olivella* grooved rectangle | 5 | 9 |
| *Olivella* end ground | 4 | 7 |
| *Olivella* barrel | 3 | 5 |
| *Olivella* wall disc | 2 | 3 |
| *Mytilus* disc | 1 | 2 |
| TOTAL | 57 | 100 |

tory (Mason and Peterson 1994). The group's cemetery was located at the village where community-wide ceremonies took place (Koerper et al. 1996).

The diverse tool assemblage indicates that ORA-665 and ORA-667 were residential bases, where tool manufacture, food procurement, food processing, and social-ceremonial activities were carried out. These sites also contain multiple burned-rock features and abundant secondary refuse. ORA-665 and ORA-667 were clearly not specialized resource procurement sites (locations) or field camps as defined by Binford (1980) and Thomas (1983).

While classification of these sites as residential bases is relatively clear-cut, it is much more difficult to determine whether they were single-season or multiseason residential bases and whether they were occupied by foragers or collectors. This task becomes somewhat easier, however, if comparative data are available. Using proportions of functional tool types and nonutilitarian artifact types, correspondence analysis and discriminant analysis were used to define and confirm site types for NCAP Late Prehistoric sites (Mason and Peterson 1994). The results of the analysis suggested that there was a functional hierarchy of Late Prehistoric site types including multiseason residential bases, minor residential bases, and single gender specialized activity locations. Late Prehistoric people were collectors, as indicated by the presence of resources from both the ocean coast and Newport Bay in the residential bases located in the San Joaquin Hills.

The Middle Holocene Milling-Stone period NCAP coastal residential bases can be compared with the Late Prehistoric NCAP hilltop residential bases. The discriminant analysis showed that Milling-Stone residential bases have a different proportion of artifact types compared to Late Prehistoric residential bases, implying a different organization of activities. In addition, densities of utilitarian tools, fish bone, other bone, and shell are all lower compared to Late Prehistoric major residential bases (Mason and Peterson 1994:314). Because residential base density measures reflect intensity of site use and processing of resources from surrounding habitats, the Milling-Stone residential bases represent less intense occupations than the Late Prehistoric residential bases, especially given the longer time of occupation of the Milling-Stone period sites (Mason and Peterson 1994:333). The less intense occupation may indicate single-season (or less) occupations compared to the multiseason Late Prehistoric occupations. It also appears that the Milling-Stone people moved to the coast during the summer (as indicated by fish otoliths) to procure marine resources, while the Late Prehistoric people remained in the hills but brought marine resources from both the ocean and Newport Bay to hilltop residential bases. The Milling-Stone residential bases pattern is characteristic of foragers. The presence of only one or two burials per site also suggests short-term seasonal occupations. Finally, specialized site types (such as single gender specialized activity loci) seen in the Late Prehistoric period are absent in the Milling-Stone period.

The difference in proportion of artifact types, lower tool and faunal specimen densities, mapping on to outer coast resources, paucity of burials, and lack of specialized site types suggest that the NCAP Milling-Stone residential bases on the outer coast were part of a settlement system that probably consisted of a seasonal round and was more similar to a forager system than a collector system. Because the rest of the seasonal round consisted of sites outside the NCAP area, reconstruction of the seasonal round must remain speculative until similar data are available from Milling-Stone period sites elsewhere in the region. However, the available information suggests that the seasonal round included occupations during other seasons at Upper Newport Bay and the San Joaquin Marsh, located about 10 km from the Newport Coast. Such locations would have provided bay and marsh resources and would also have been more sheltered locations compared to the exposed outer coast, an important consideration during winter storms. Seasonality data (migratory waterfowl specimens) suggest a winter occupation for the Milling-Stone component of ORA-119A (Koerper 1981), located adjacent to the San Joaquin Marsh and occupied about the same time as the NCAP Milling-Stone sites.

Before about 5800 CYBP, the NCAP area seems to have been only marginally utilized, as indicated by the dearth of radiocarbon dates (fig. 4.13). The few Early Holocene deposits that are present are largely shell accumulations with few associated artifacts (Mason et al. 1991b, 1992a). The relatively few radiocarbon dates suggest much less intensive use of the outer coast during the Early Holocene while the more numerous dates from the Middle Holocene may indicate a population increase. For Orange County in general, there is a dramatic increase in Middle Holocene radiocarbon–dated sites compared to Early Holocene sites (Schroth 1983; Breschini, Haversat, and Erlandson 1992).

The small population during the Early Holocene and early part of the Middle Holocene appears to have been concentrated at ORA-64, a large site on a bluff overlooking what at that time was the mouth of Newport Bay. At present, only information from test level investigations of this large (70,000 $m^2$) site is available (Koerper 1981; Drover, Koerper, and Langenwalter 1983). However, a major data recovery program recently completed by Macko Archaeological Consultants will greatly increase information about this important site. As a result of the test level investigations, there are twenty-two uncalibrated radiocarbon dates from ORA-64, ranging from about 8500 RYBP to 4900 RYBP. There appear to be two primary components, one dating to the ninth millennium BP and one dating to the seventh millennium BP. Because of the presence of winter migratory bird specimens, the earlier component is inferred to have been a winter seasonal residential base. The later component was a multiseasonal residential base occupied from mid-spring to early fall, also based on migratory bird specimens. A wide range of tools is present, including dart points, blades, scraper planes, flake scrapers, a fishing gorge, and manos and metates. Beads, ornaments, eccentrics, crystals, and burials are also present in the later component. The diversity of faunal remains from the later component is similar to those found in Late Prehistoric residential bases.

There are only two sixth millennium BP $^{14}C$ dates from ORA-64, and the most recent date for the site is 4900 $\pm$ 80 RYBP (Schroth 1983). The abandonment of ORA-64 may be related to rising sea level and changing substrates in the bay. As early as the seventh millennium BP there is evidence at ORA-64 for a shift in emphasis from rocky-shore shellfish such as mussels to bay/protected outer-coast shellfish such as Venus clams (Drover, Koerper, and Langenwalter 1983). Later, as sedimentation in the bay increased, habitats favoring scallops and oysters developed. The data from ORA-119A at the upper end of the bay show that scallops, Venus clams, and oysters (in order of abundance) made up more than 80 percent of all shellfish species in all components after 5000 RYBP (Koerper 1981). The high counts of *Argopecten* in Newport Bay middens in all time periods after 5000 RYBP may be because of relative species abundance in the bay or to dietary preferences. *Argopecten* is found almost exclusively in bay and estuary habitats and could not have been obtained in significant quantities along the outer coast (Peterson 1991:Table 13).

Vertebrate marine fauna from the bay or estuary were also important in the diet and probably increased in abundance as sandy and muddy substrates developed. Two species of shallow water elasmobranchs, the guitarfish (*Rhinobatus productus*) and the bat ray (*Myliobatis californica*), are particularly abundant in faunal assemblages from ORA-64 and ORA-119A (Koerper 1981). They probably provided more meat for the least effort compared to most other fish species. Guitarfish also have higher caloric yields than croakers and rockfish from outer coast habitats (Gilliland 1985).

It appears that the inhabitants of the Newport Bay area obtained significant amounts of protein from scallops, Venus clams, oysters, guitarfish, and bat rays. Most of these marine fauna are available in nearshore areas of the outer coast but are much more concentrated and perhaps easier to procure in the shallow, calm waters of Newport Bay. These marine fauna provided an easily obtained source of protein available on a daily basis. A reliable source of protein increases the survivability of fetuses and children and increases the population potential of the group (Waselkov 1987:123).

The abandonment of ORA-64 near the mouth of the bay may be related to the development of substrates favoring scallops and oysters, along with bat rays and guitarfish, in the upper part of Newport Bay. The completion of these developments in the upper bay may be indicated by the shift from saltwater to freshwater in San Joaquin Marsh at the head of the bay about 4500 years ago (Davis 1992:89). The focus of settlement may have shifted from lower Newport Bay (ORA-64) to upper Newport Bay (ORA-119A, ORA-287, and other sites) during the sixth millennium BP. The increased availability of these new resources may have led to a population increase and an expansion of settlement. Though Newport Bay was the focus of settlement, new ocean habitats drew people to the Newport Coast as part of their seasonal round.

Seasonal residential occupations at the outer coast after about 5800 CYBP may be related to the stabilization of sea level that resulted in the development of stable rocky-shore habitats for shellfish and the development of kelp beds about 400 to 900 m offshore that provided habitat for a number of useful fish species, including the California sheephead. The faunal data from the Middle Holocene Newport coast sites demonstrate an emphasis on sheephead fish to the point of specialization. It is not known how the sheephead compares in yield of protein and calories with Newport Bay marine fauna. Males of this species are large, providing a great amount of meat per individual fish. Sheephead had enough favorable characteristics (perhaps including taste and the addition of variety to the diet) to draw the group to the outer coast for at least a few weeks or months of the year.

The taxonomic composition of the fish bone in the ORA-665 and ORA-667 vertebrate faunal assemblages indicates fishing in and around kelp beds, shallow rocky reefs, and in nearshore open water. The absence of surf perch suggests that fishing in the surf zone and from the beach was not important. We believe the fishing indicated by the assemblage required the use of boats or rafts to reach offshore kelp beds and other habitats where long-line fishing and free diving spearfishing may have been employed. Net fishing could also have been used outside the kelp zone.

The almost exclusive focus on mussels among the Middle Holocene shellfish assemblages from the Newport coast residential bases is a result of availability rather than specialization. Mussels are the only abundant rocky-shore shellfish that provide a favorable meat to shell ratio. Abalones are generally much larger than mussels but are not available in quantity. Abalones were also exploited, as indicated by more than thirty whole abalone shells associated with features at ORA-667.

Terrestrial animals in the Newport coast Middle Holocene sites were secondary in importance to marine animals. Of the bones most likely to be cultural, rabbits (*Sylvilagus* and *Lepus*) account for most of the identified specimens. Vertebrate animal procurement was more focused on marine habitats. This probably reflects limited availability of preferred terrestrial food species in the narrow coastal plain where the sites are located and on the steep hillsides behind the sites. Procurement of land animals was probably more important at other sites occupied during the seasonal round.

The shellfish and vertebrate remains at ORA-665 and ORA-667 are evidence of the importance of animal food to the Middle Holocene residents of the region. In particular, the vertebrate remains are numerous and represent a diverse hunting strategy requiring a complex procurement tool kit. This evidence contradicts some researchers' inferences that plant foods were more important during the Middle Holocene. The arguments are based on the preponderance of stone tools for plant processing in the artifact assemblages of Middle Holocene sites. Although the dominance of plant-processing equipment is characteristic of these sites, the diversity of vertebrate species at ORA-64, an early Middle Holocene site on Newport Bay, implies that a much more diverse animal procurement tool kit was in use than is normally preserved in archaeological contexts (Drover, Koerper, and Langenwalter 1983). This view is supported by Salls' (1986) analysis of the wooden atlatl foreshafts from Rancho La Brea, which shows that some hunting gear was indeed perishable. Even some Early Holocene sites have yielded similar faunal evidence (Koerper, Langenwalter, and Schroth 1991), implying a continuity in complex animal procurement that preceded the Middle Holocene occupation along the Southern California coast. This preexisting adaptation seems to have set the stage for Middle Holocene animal procurement patterns.

We are not suggesting that animal food resources were more significant than plant resources. Presumably, plant food resources contributed more to the diet, especially in terms of calories, than animal resources. As in most Middle Holocene sites, the importance of seed collecting is indicated by the large numbers of manos and metates recovered. We do, however, take issue with the inference that the proportion of plant foods to animal foods during the Middle Holocene was more disparate compared to earlier or later periods along the California coast.

## CONCLUSIONS

The Middle Holocene sites on the Newport coast appear to be part of an expansion of settlement to take advantage of new habitats and resources that became available as sea levels stabilized between about six and five thousand years ago. These new habitats included kelp beds that provided sheephead offshore along the outer coast and sandy and muddy substrates in upper Newport Bay that supported cockles, scallops, oysters, bat rays, and guitarfish. The development of these new habitats and resources also may have allowed a population increase leading to the breakup of the single large center at ORA-64 on lower Newport Bay. The outer coast summer residential bases occupied after 5800 CYBP were probably part of a seasonal round that included occupations during other seasons at upper Newport Bay. The bay was probably a preferred area for settlement during most time periods because of the greater number of habitats that could be exploited. Whether other inland areas in the foothills of the Santa Ana Mountains also were part of the seasonal round is unknown.

The expansion of population and settlement during the Middle Holocene is similar to Late Holocene developments when collectors based around Newport Bay and the Santa Ana River expanded into the San Joaquin Hills. Before about 1350 CYBP, the San Joaquin Hills were virtually unoccupied. After that time several multiseason residential bases were established in the hills (Mason and Peterson 1994). While these sites were closer to hard seed and animal resources, they were farther from marine resources. Large quantities of bay fish and shellfish, as well as outer-coast fish and shellfish, were collected and brought to these residential bases. In both cases, population increase and access to additional resources were related factors.

The NCAP has contributed to understanding Milling-Stone and Late Prehistoric settlement systems, but the transition between the two systems during the Intermediate period (3000 CYBP–1350 CYBP) remains poorly understood. By the end of the Middle Holocene, the Newport coast was no longer occupied (fig. 4.13), and there are comparatively few components dating between about three and two thousand years ago in the Newport Bay area (Schroth 1983; Breschini, Haversat, and Erlandson 1992). During the Intermediate period (the early Late Holocene), a settlement shift occurred. Fewer $^{14}C$ dated Intermediate sites probably do not indicate depopulation but rather a concentration of population into fewer settlements in the most favorable locations near water sources. Most Intermediate period sites are located near springs or perennial streams within 3 km of Newport Bay. There are no known springs on the more distant Newport coast. This settlement shift probably marks the shift from a seasonal round system to the antecedents of the semisedentary territorial settlement system that existed at the time of Spanish contact (Earle and O'Neil 1994). The settlement shift also may be related to the arrival of Uto-Aztecan Takic speaking groups on the coast, thought to have

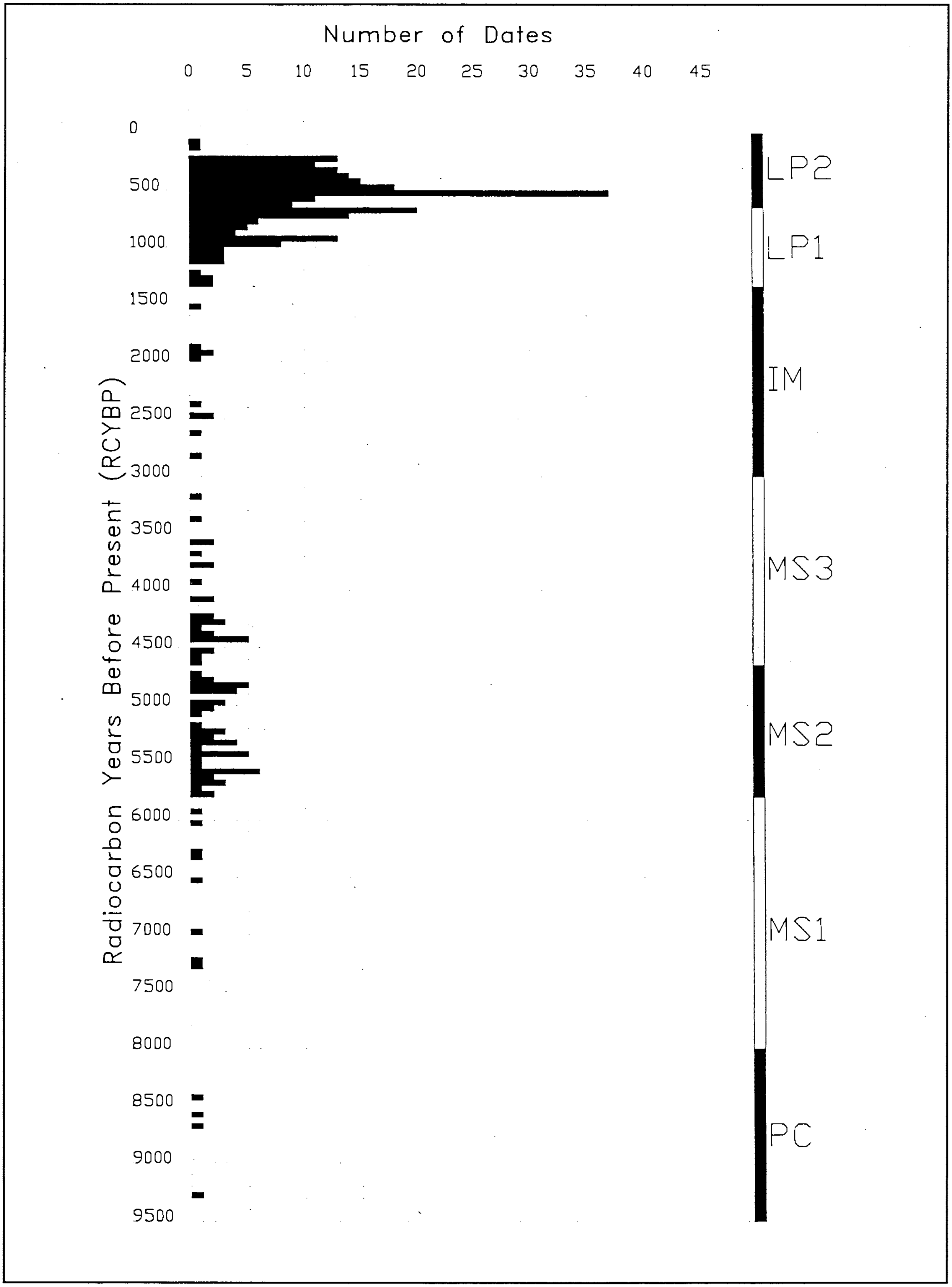



FIGURE 4.13 Frequency distribution of calibrated NCAP radiocarbon dates using 50-year intervals.

occurred about three thousand years ago (Moratto 1984:560).

**Acknowledgments.** This chapter is based on information derived from the Newport Coast Archaeological Project (NCAP), funded by contracts between Coastal Community Builders (a division of The Irvine Company) and The Keith Companies, where the senior author was formerly Director of Archaeology. The NCAP began under the direction of Michael E. Macko, who planned and directed much of the fieldwork. The lithic artifacts were analyzed by Clay A. Singer and the beads were identified by Robert O. Gibson. Mark L. Peterson and John L. Southon derived a local Delta-R, a correction factor used in calibrating the radiocarbon dates from marine shell samples. The artifacts were illustrated by Joe Cramer and Deborah Gray. The incised stone in figure 4.12 was drawn by Gary S. Hurd.

# Middle Holocene Adaptations in the Santa Monica Mountains

*Lynn H. Gamble and Chester King*

In this chapter, the nature of subsistence-settlement systems in the Santa Monica Mountains during the Middle Holocene are considered. Whitley and Simon argue that no archaeological sites in the interior of the Santa Monica Mountains were occupied during that time period (1989:100–101). We evaluate this hypothesis in the course of examining regional settlement patterns in three geographic zones: the coast, the interior coastal drainages, and interior mountains. We conclude that many of the sites occupied during this time period were relatively small and situated in defensive locations.

We have chosen to categorize the sites of the Santa Monica Mountains into three geographic zones for purposes of discussion: *coastal* sites (11) overlook the ocean and are usually less than 2 km from the beach (table 5.1); *interior coastal drainage* sites (9) are located in the upper parts of stream watersheds that drain to the south from the ridgeline of the Santa Monica Mountains (table 5.2); *interior mountain* sites (21) are located in the watersheds of Calleguas Creek, upper Malibu Canyon, and the Los Angeles River (table 5.3). These categories are used because archaeologists have speculated that there are significant differences between interior and coastal sites occupied during the Early period, as defined by C. King (1990; see fig. 1.2).

Middle Holocene sites in the Santa Monica Mountains contain a wide range of artifacts and features, including cemeteries, which imply stability of occupation, but archaeologists have long debated the permanence of Middle Holocene settlements because of inadequate information concerning types of Middle Holocene sites and lack of a consensus on definitions of permanent settlements. Artifacts such as beads, ornaments, charmstones, and hairpins changed little throughout the Middle Holocene in the Chumash area, although the numbers of artifact types increased, indicating growth in social complexity.

## SANTA MONICA MOUNTAINS

The Santa Monica Mountains (fig. 5.1) are the most southwestern of a series of east-west ranges known as the Transverse Ranges of Southern California. The Santa Monica Mountains extend east from the Oxnard alluvial plain to the Los Angeles River and include the drainages of Arroyo Conejo and Malibu Creek. On the south, they are bordered by the Pacific Ocean and the Los Angeles Basin. The area covered is approximately 73 km long and from 5 to 21 km wide. Malibu Creek, the only drainage system that flows through the range, divides it roughly in half. Elevations vary from sea level to 948 m (3111 feet) at Sandstone Peak. The coastal slope of the range has greater precipitation than the inland slope, resulting in an asymmetrical erosion pattern with the coastal side having longer, more pronounced canyons than the inland side (Dibblee 1982; Raven et al. 1986:1).

The Mediterranean-type climate is characterized by cool, wet winters and hot, dry summers. Generally the region has clear, sunny skies, except for fog along the coast, primarily from May to July. During Southern Oscillation (also called "El Niño") years, a greater number of winter storms may occur. Annual precipitation ranges from around 36 cm (14 inches) at the western end to 41 cm (16 inches) at the northern end and 61 cm (25 inches) in the Topanga area. Frost is rare along the coast and more common on the inland side and at higher elevations, although snow is very rare even at the higher elevations (Raven et al. 1986:1–7). The region apparently was drier during the Middle Holocene than during other periods of human habitation, and grassland appears to have been more common than chaparral (Heusser 1978). Whether the differences in vegetation reflect climatic changes or changes in human land management strategies has not been determined.

Because of tectonic activity and faults, the geology of the Santa Monica Mountains is complex. The mountains are

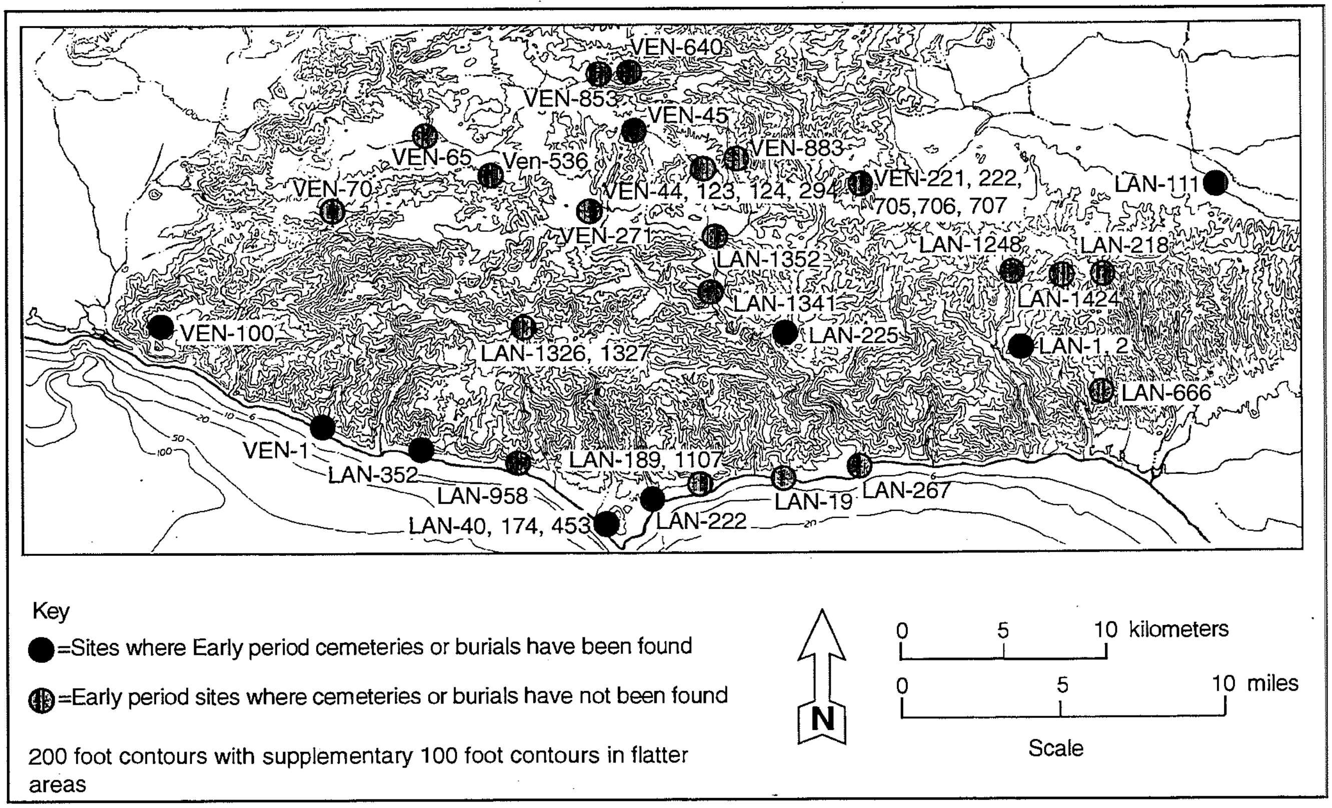



FIGURE 5.1 Middle Holocene sites in the Santa Monica Mountains

relatively young, having uplifted since the Middle Pliocene. Sedimentary and volcanic formations overlie a basement of metamorphic and plutonic rocks (Dibblee 1982; Raven et al. 1986:7).

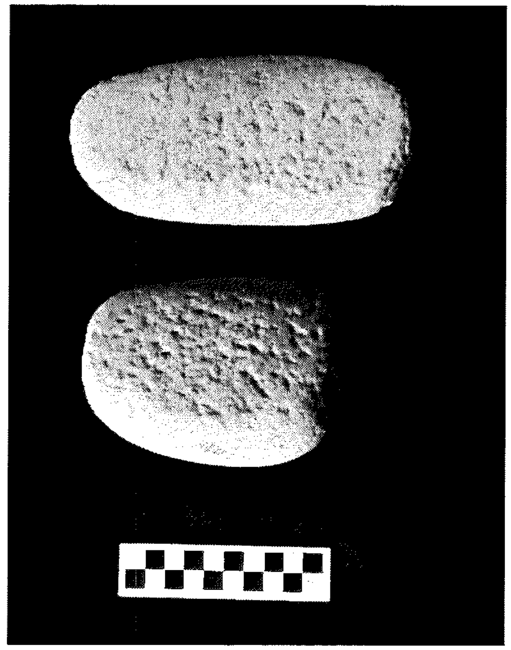
Utilized stone recovered from Santa Monica Mountains sites includes obsidian, chert, chalcedony, fused shale, silty chert, siltstone, sandstone, quartzite, granite, basalt, andesite, tuff, gneiss, ochre, quartz crystals, and asphaltum (Dillon and Boxt 1989; C. King 1994; C. King, Blackburn, and Chandonet 1968; C. King et al. 1982; L. King 1969). Rocks that do not occur within the region include obsidian (primarily from the Coso volcanics) and fused shale (from Grimes Canyon and Happy Camp Canyon). Cryptocrystalline stone sources may be found at several locations and formations in the Santa Monica Mountains. The known sources include Monterey chert along the Malibu coast and at Point Dume, Calabasas chert near LAN-225 (fig. 5.1), silty chert near Reyes Adobe in Agoura, and meta-chert (also known as colored chert or chalcedonic chert) at Malibu Creek State Park. The non-cryptocrystalline or coarse-grained raw stone materials (quartzite, andesite, rhyolite, and basalt) are much more common in sites dating to the Middle Holocene. Both andesite and rhyolite occur in the tuff breccia of the Conejo volcanics, basalt in the area of Topanga Canyon, and quartzite in conglomerate beds of the Santa Monica Mountains. Quartzite is also locally abundant in the Calabasas Formation, especially in drainages associated with steep hillsides. (For a more thorough discussion on stone materials, see Pierce, Clingen, and Gamble 1982.)

One additional raw material found in the Santa Monica Mountains and of significance to its prehistoric residents is asphaltum. The largest known asphaltum source is located at the La Brea pits, adjacent to the eastern portion of the mountain range.

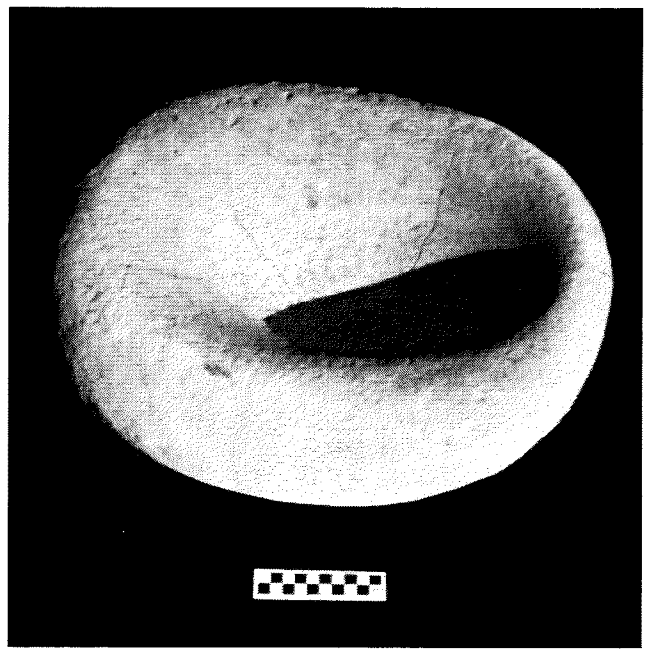
The vegetation of the Santa Monica Mountains includes chaparral, coastal sage scrub, grassland, southern oak woodland, riparian woodland, coastal strand, wetland, and coastal salt marsh (Raven et al. 1986:10). Plant foods important to the inhabitants of the Santa Monica Mountains include acorns, islay, chia, grasses, red maids, toyon, manzanita, blue dicks, and yucca (C. King 1994:18).

There are no archaeological indications of routes of travel or trade in the Santa Monica Mountains, although it is likely that some of the routes used today were important during the Middle Holocene. The Conejo Corridor, through which Highway 101 passes today, was probably an important route of travel in the past. One indication of its importance is the large number of historic villages recorded when the Portolá expedition passed through this corridor. In addition, three major routes used today between the San Fernando Valley and the coast probably were important routes in the past: Topanga Canyon, Malibu Canyon, and the Sepulveda Pass. It is likely that there were many additional routes of travel, including ridge tops. Although there is no evidence of plank canoes during the Middle Holocene, it is likely that tule balsas were used to navigate the Pacific, especially close to the shore.

Southern California native societies appear to have evolved through at least nine thousand years of prehistory. The evolution of society is reflected in changes in artifact forms and diversity, changes in plant and animal food refuse, changes in the organization of cemeteries, and shifts in settlement patterns (C. King 1990). This evolution ended with the relatively complex and unique societies encountered by Spanish explorers and colonists. At the time of the Spanish conquest, the people of the Santa Monica Mountains included speakers of both Tongva (Gabrieliño) and Chumash languages. The eastern part of the range was inhabited by Tongva speakers and the western part by Chumash speakers. Evidence indicates continuity of development of Chumash societies for over seven thousand years in the western Santa Monica Mountains (C. King 1990:200). The beginning of the Middle period (600 BC) in the area historically occupied by the Tongva was marked by the establishment of cremation mortuaries. It appears that the Tongva and related Takic-speaking groups were the descendants of both Uto-Aztecan speakers who expanded into southwestern California (probably around 2500 to 3000 years ago) and the indigenous prehistoric populations encountered by the migrating Uto-Aztecan speakers (C. King 1994:111).



LEFT: FIGURE 5.2 Two manos from the Sweetwater Mesa site



BELOW: FIGURE 5.3 Large basin metate from the Sweetwater Mesa site

## AGE OF SITES

Occupation at most of the sites included in this study has not been dated by means of radiocarbon or other absolute dating techniques. In this discussion, occupation is based on the presence of manos and metates, which were used during both the Early and Middle Holocene. Without more radiocarbon dates, we cannot readily distinguish Early and Middle Holocene sites in the Santa Monica Mountains, although it is clear that many sites occupied at the end of the Early Holocene continued to be occupied into the Middle Holocene. Most Middle Holocene sites that have been dated are immediately on the coast, and shells were used for radiocarbon determinations. Because the rates of upwelling during the Early period have not been determined, it is possible that dates obtained from shell differ significantly from the actual dates of occupation at the sites. We have focused our discussion on forty-one sites in the Santa Monica Mountains region that we suspect were occupied during the Middle Holocene (fig. 5.1, tables 5.1–5.3). Some are multicomponent sites. Ten have radiocarbon dates, seven from the Middle Holocene time period. In all likelihood, many more sites in this region were occupied during the Middle Holocene, probably somewhere in the neighborhood of 150, although this figure is speculative. One explanation for the dearth of information is that land development affected large portions of the region during times when very little archaeological work was being conducted. Unfortunately, even where archaeological work has been done, there has been little attempt to ascertain the chronological sequences of sites, particularly sites of the Middle Holocene.

Extensive excavations at Santa Monica Mountains coastal and interior Late period sites indicate that manos and metates (figs. 5.2, 5.3) were not used during the Late period (AD 1150–1804), nor after the first phase of the Middle period (200 BC). The early Middle period manos found at LAN-227 at the Century Ranch are shaped biface manos with relatively flat surfaces. They were probably not used with deep basin metates. During the late Early period and early Middle period, mortars and pestles, as well as manos and metates, were frequently used. It appears that large, deep basin metates were not frequently used before the Middle

TABLE 5.1 Coastal sites in the Santa Monica Mountains

| | $^{14}$C DATES (RYBP) | MATERIAL DATED | SITUATION/ELEVATION | ARTIFACTS | REFERENCE |
|---|---|---|---|---|---|
| Sweetwater Mesa (LAN-267) | 6310 ± 100<br>6870 ± 100<br>6960 ± 100 | *Mytilus californianus*<br>*Hinnites multirugosus*<br>*Haliotis cracherodii* | Marine terrace, 99 m | Beads, bone (including deer and fish), calcium carbonate layer, choppers, cogstone, flakes, hammerstones, manos, metates, mortars, pestles, and shell | C. King 1967; Singer and Atwood 1989a |
| Little Sycamore shell mound (VEN-1) | 6960 ± 100<br>2610 ± 80<br>510 ± 80<br>560 ± 70 | *Haliotis cracherodii*<br>*Tivela stultorum*<br>Shell<br>Shell | Marine terrace, 9 m | Awls, beads, cairn burials, calcium carbonate layer, charmstones, choppers, flakes, hammerstones, manos, metates, mortars, pestles, pipe, pitted stones, points, scrappers, and shell | Wallace et al. 1956; Foster 1989a |
| Paradise Cove (LAN-222) | 4300 ± 80 | *Haliotis cracherodii* | Marine terrace, 30 m | Cairn burials, core tools, manos, metates, and shell | C. King 1967 |
| San Nicholas Canyon (LAN-27/352) | | | Knoll, 37 m | Cairn burials, calcium carbonate layer, core tools, manos, metates, and shell | C. King 1967 |
| Steep Hill Canyon (LAN-958) | | | Knoll, 87 m | Flakes, manos, metates, and shell | Chace 1980 |
| Zuma Creek (LAN-174) | 4950 ± 200 | *Haliotis cracherodii* | Terrace, 38 m | Cairn burials, calcium carbonate layer, choppers, cogstones, large points, manos, metates, mortars, scrapers, and shell | Peck 1955; Ascher 1959; C. King 1967 |
| Zuma Mesa (LAN-40) | | | Top of marine terrace, 61 m | Core tools, flakes, manos, metates, mortars, pestles, points, rock features, scrapers, and shell | Peck 1955; Ruby 1961a |
| Point Dume (LAN-453) | | | Top of bluff overlooking Pacific Ocean, 38 m | Bifaces, cores, core tools, hammer-stones, large stemmed point, manos, metates, and shell | Foster 1989b; Raab 1989; Singer and Atwood 1989b |
| Puerco Canyon (LAN-19) | | | Edge of creek, 30–46 m | Choppers, cores, flakes, hammerstones, manos, pestles, scrapers, and shell | Ruby 1961b |
| Escondido Canyon (LAN-189) | | | Marine terrace overlooking Pacific Ocean, 30 m | Abraders, bifaces, choppers, cogstone, cores, core tools, fire-altered rock, hammerstones, manos, scrapers, no shell or bone | NARC 1980; Singer 1980; Wessel 1981; Whitley 1984; Dillon 1989 |
| Escondido Canyon (LAN-1107) | 6040 ± 95 | *Mytilus calilfornianus* | South face of low saddle, 84–91 m | Beads, cores, core tools, flakes, hammerstones, manos, metates, and shell | Dillon 1989; Singer, Atwood, and Lausten 1989; Foster 1989c |

Holocene, and the wide range of shapes of manos—wedge shaped, trifaced, and quadrafaced—associated with early Middle Holocene sites are unique to the period.

In addition to the presence of a wide range of mano shapes and deep basin metates, early Middle Holocene sites in the Santa Monica Mountains may be identified on the basis of mortuary practices. Cemeteries contain flexed burials under cairns of rocks and metates. In many cases, only traces of the burials remain because gophers have burrowed under the cairns.

During the middle portion of the Middle Holocene, large side-notched points were frequently used. Because these points were rarely used in Southern California during other time periods, they can be helpful in identifying sites occupied during the Middle Holocene.

Artifacts such as shell beads and ornaments, which are sensitive indicators of time, are seldom recovered from Early

TABLE 5.2 Sites in interior coastal drainage region in Santa Monica Mountains

| | $^{14}$C DATES (RYBP) | MATERIAL DATED | SITUATION/ELEVATION | ARTIFACTS | REFERENCE |
|---|---|---|---|---|---|
| La Jolla Valley (VEN-100) | 3830 ± 225 | Charcoal | La Jolla Valley, 198–265 m | Beads, bone, cairn burials, cores, fire-altered rock, *Haliotis* shell containers, hammerstones, hearths, house floors, manos, metates, mortars, pestles, points, shell, steatite, and tarring pebbles | West 1979 |
| Decker (LAN-1326) | | | Knoll, 472 m | Choppers, cores, core tools, flakes, hammerstones, manos, metate, points, and scrapers | Holmes 1987; Raab 1987 |
| Mulholland (LAN-1327) | | | Knoll, 472 m | Choppers, cores, core tools, flakes, hammerstones, manos, metate, points, and scrapers | Holmes 1987; Raab 1987 |
| Tank (LAN-1) | | | Knoll, 370 m | Bone, bone tools, burials, cairn burials, caches of metates, choppers, cogstones, core tools, drills, hammerstones, hearths, manos, metate, mortars, pestles, scrapers, shell, slate pendants, stemmed and other large points, stone disks, and stone features | Treganza and Malamud 1950; Treganza and Bierman 1958 |
| Topanga (LAN-2) | 2450 ± 150<br>2700 ± 150 | Charcoal<br>Charcoal (carbon dioxide gas method) | Same ridge as LAN-1, but at a slightly lower elevation, around 320 m | Abrading stone, bone, burials, choppers, crescents, hammerstones, incised stones, manos, metates, mortars, ovens, pestles, rubbing stones, scraper planes, shell, side-notched and contracting stem points, slate pendants, and stone disks | Treganza and Bierman 1958; K. Johnson 1966 |
| Montevideo (LAN-1248) | | | Low ridge, 384 m | Cogstone, cores, flakes, hammerstones, manos, and scrapers | Dillon 1986 |
| Oakmont (LAN-1424) | | | Saddle, 429–448 m | Abraders, cores, flakes, manos, metates, and scrapers | Raab and Salls 1989 |
| Corbin Tank (LAN-218) | | | Knoll, 472–502 m | Choppers, cores, hammerstones, manos, metates, and scrapers | Dillon 1982 |
| Santa Ynez Canyon (LAN-666) | | | Knoll, 385–393 m | Cores, flakes, manos, and metates | Greenwood 1976 |

period sites in the Santa Monica Mountains. Those recovered are usually from coastal sites, where larger amounts of shell in the middens have provided better conditions for preservation of shell artifacts.

The development of the soils of sites after abandonment is another measure of age, and the soils of Middle Holocene sites have a number of characteristics in common. Middle Holocene sites are most often on knoll tops or ridges that provide a view of the site's accessibility in all directions (fig. 5.4). They are usually in shallow soils that have formed from the underlying substrate. At excavated early Middle Holocene sites in residual soils, large artifacts are typically concentrated between 30 and 60 cm below the surface, and small artifacts are most frequent in the upper levels (fig. 5.5). This size sorting of artifacts can be explained as the result of gopher burrowing, which causes downward movement of artifacts too large to bring to the surface (Erlandson and Rockwell 1987; C. Pierce 1992). At later sites, the artifacts have not been as thoroughly size sorted. Other changes in human-altered soils following abandonment are also indicators of age: for example, layers of caliche resulting from the chemical dissolution of shells are often observed in sites of the Middle Holocene.

## SUBSISTENCE ACTIVITIES

Artifacts and food remains recovered from Middle Holocene sites indicate that people living along the coast were processing plant foods, fishing with bone hooks, probably using tule rafts, and occasionally taking large fish and probably sea mammals. The presence of deer and other animal bones, stone points, and knives indicates that hunting was also important (C. King 1994:113).

TABLE 5.3 Sites in interior region of Santa Monica Mountains

| | $^{14}$C DATES (RYBP) | MATERIAL DATED | SITUATION/ELEVATION | ARTIFACTS | REFERENCE |
|---|---|---|---|---|---|
| Potrero Valley (VEN-70) | | | Knoll, 280–311 m | Beads, bone tools, cores, drills, hammerstones, manos, metates, pestles, points, scrapers, and shell | Leonard 1966 |
| Running Springs Ranch (VEN-65) | | | Knoll, 201–204 m | Beads, bowls, choppers, cores, drills, hammerstones, knives, manos, metates, mortars, points, and scrapers | Pritchett and McIntyre 1979 |
| Ring Brothers site complex (VEN-536) | | | Saddle, 286–292 m | Bifaces, choppers, cores, hammerstones, manos, metates, points, rock features, and scrapers | Clewlow, Whitley, and McCann 1979 |
| Westlake (VEN-271) | | | Knoll, 298–304 m | Abrading stones, bifaces, bone, charcoal, cores, discoids, drills, flakes, hammerstones, knives, manos, metates, points, scrapers, and shell | M. Johnson 1980 |
| North Ranch (VEN-45) | | | Knoll, 381 m | Bones, cores, fire-cracked rock, flakes, hammerstones, manos, metates, ochre, points, and scrapers | Adams et al. 1980 |
| Lang Ranch (VEN-853) | 6690 ± 130<br>7610 ± 110 | Shell<br>Shell | Toe of broad ridge, 344–353 m | Beads, bone, cores, flakes, hammerstones, manos, quartz crystal, and worked bone | Greenwood, Romani, and Foster 1987 |
| Oakbrook Park (VEN-640) | | | High ground on gentle slope, 371–378 m | Bone awl, choppers, fire-altered rock, flakes, manos, mortars, pestles, and shell | C. King 1988 |
| Oak Park (VEN-123) | | | Knoll and slope, 317–323 m | Bifaces, cores, choppers, hammerstones, manos,. metates, no shell, and scrapers | Dillon 1978 |
| Oak Park (VEN-44) | | | Knoll, 304 m | Cores, core tools, flake tools, manos, and metates | Dillon 1978 |
| Oak Park (VEN-124) | | | Knoll, 311 m | Core tools, manos, metates, and pestle | Dillon 1978 |
| Oak Park (VEN-294) | 2350 ± 80<br>3740 ± 160<br>7200 ± 160<br>8250 ± 160 | Charcoal<br>Shell<br>*Haliotis* sp.<br>*Haliotis* sp. | Terrace near canyon bottom, 323 m | Beads, bone, mortars, pestles, numerous milling stones including cluster of manos and metates (concentrated in lowest levels of site), and shell | Rosen 1978 |
| Agoura (LAN-1352) | | | Ridge 265–274 m | Abraders, anvil, bifaces, bone, choppers, cores, crystals, fire-altered rock, hammerstones, manos, metates, points, quartz crystals, scrapers, and worked bone | Wlodarski 1988 |
| Palo Comado Canyon (VEN-883) | 3450 ± 170 | Charcoal | Terrace near canyon bottom, 365 m | Large round base point, hammerstones, large stemmed point, quartzite mano fragment, scraper plane, and spent cores | Whitley and Simon 1989 |
| Century Ranch (LAN-225) | | | Small knoll, 152–183 m | Bone, cairn burials, choppers, cogstones, cores, discoidals, drill, hammerstones, knives, manos, metates, mortars, ochre, pestles, pitted stones, points, quartz crystals, rock cairns, scrapers, scraper planes, and very little shell | King, Blackburn, and Chandonet 1968 |

TABLE 5.3 Sites in interior region of Santa Monica Mountains, *continued*

| | $^{14}$C DATES (RYBP) | MATERIAL DATED | SITUATION/ELEVATION | ARTIFACTS | REFERENCE |
|---|---|---|---|---|---|
| Laskey Mesa (VEN-221) | | | Knoll, 426 m | Bone, choppers, cores, core tools, flakes, hammerstones, manos, metates, pestle, scraper planes, and shell | Whitley et al. 1989 |
| Laskey Mesa (VEN-222) | | | 2 low knolls and flat mesa top, 426 m | Bifaces, bone, choppers, cores, flakes, hammerstones, manos, and scraper planes | Whitley et al. 1989 |
| Laskey Mesa (VEN-705) | | | Knoll, 411 m | 1 bone, flakes, and mano | Whitley et al. 1989 |
| Laskey Mesa (VEN-706) | | | Mesa, 411 m | Bifaces, cores, flakes, hammerstones, manos, and scraper planes | Whitley et al. 1989 |
| Laskey Mesa (VEN-707) | | | Ridge, 416 m | 1 pestle, 1 scraper plane, cores, flakes, hammerstones, manos, and metates | Whitley et al. 1989 |
| Encino (LAN-111) | | | Knoll or low ridge, 219 m | 1pestle, burial, charmstones, choppers, cores, discs, hammerstones, manos, metates, points, and scraper planes | Rozaire 1960 |
| Porter Ranch* (LAN-407) | | | On slight rise, 332–335 m | 1 mortar, bifaces, cairns, manos, metates, painted boulders, projectile points, and some human bone | Walker 1951 |

*This site is technically not in the Santa Monica Mountains, but it is very close and is a good example of an Early period site with a cemetery.

Manos (fig. 5.2) and large basin metates (fig. 5.3) were used during the Middle Holocene. C. King (1990:88–89) observed that manos and metates were most efficient in the grinding of small hard seeds produced by grasses, sages, and other small plants. Small hard seeds are produced annually and are a highly dependable food source because annuals must produce many seeds every year in order to survive. In contrast, mortars and pestles were more efficient in mashing nuts from trees and shrubs such as oak and islay. Perennials such as bushes and trees do not need to reproduce every year. In good years, when they have excess energy, they use it for the production of nuts and/or fruits, resulting in large harvests in some years and low harvests in others. The shift away from the use of manos and metates and toward the use of mortars and pestles probably indicates an increased reliance on large seeds such as acorns and islay pits. This increased reliance was made possible through increased storage of foods (C. King 1990:89).

The cemeteries found at many early Middle Holocene sites are interpreted as indicating the presence of permanent settlements—sites that were used repeatedly and where the very old and other individuals lived year round. Formal cemeteries indicate that a site was used annually. The composition of cemeteries found in the Middle Holocene, which differ from those of later periods, are a good indicator that large coastal and interior settlements were occupied throughout the Middle Holocene.

## CHANGES IN SITE LOCATIONS

Observations (C. King 1980:3–29) on changes in the location of residential areas at sites at the mouth of Rincon Creek on the boundary of Santa Barbara and Ventura Counties appear applicable to sites in the Santa Monica Mountains. Apparently there was an important change around 3500 BC. Prior to that time, settlements were positioned in defensive locations at high elevations. This positioning has been interpreted by King (1980:90–91) as an indication that ties between adjacent settlements were loose and centralized leadership was relatively weak or absent. Around 3500 BC, there appears to have been a shift to larger settlements, usually located at lower elevations. These settlements did not have as clear a view of the surrounding countryside as the earlier settlements. Site sizes indicate that social groups were larger than they were previously. Because social groups were larger, they were probably less apt to be attacked by small groups and could choose sites less defensively advantageous than before 3500 BC. This settlement pattern lasted until about 2500 BC, when there appears to have been a return to higher elevations offering good views of the surrounding landscape. This may have been a result of the development of small subsidiary settlements around larger settlements. A slight reduction in the size of these larger settlements, resulting from the development of smaller communities in the vicinity, may have increased the importance of again establishing them in defen-

FIGURE 5.4 View of the Tank site

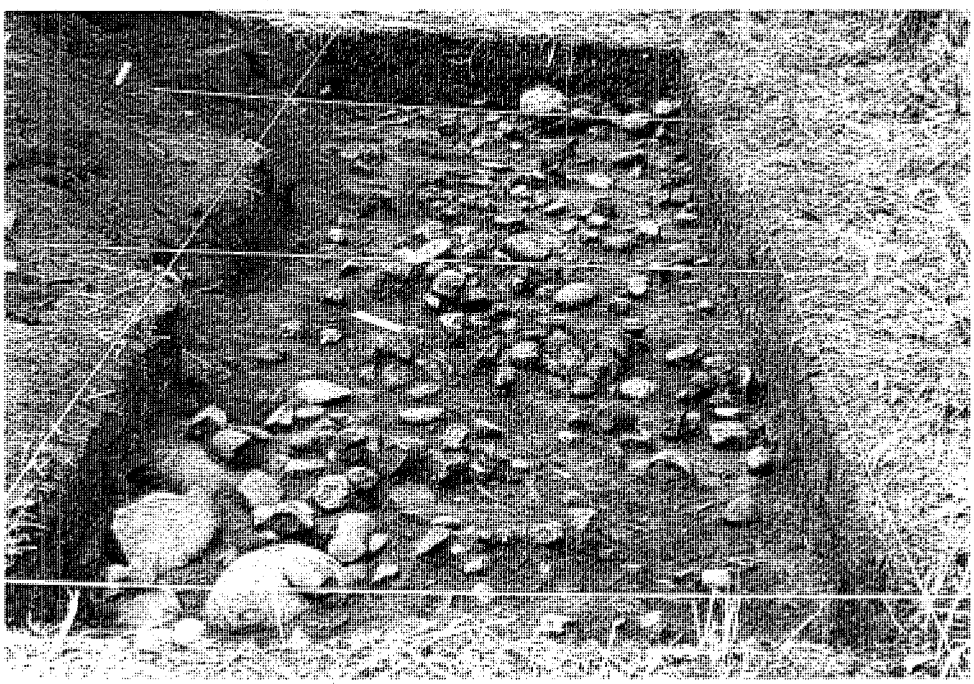


FIGURE 5.5 "Floor" of artifacts at the Sweetwater Mesa site

sive locations. The appearance of these smaller settlements near the larger ones may indicate the development of larger, more hierarchical societies (C. King 1980:90–91).

Erlandson (1994:258–259) has proposed that settlement shifts also may have resulted from the development of new landforms following the stabilization of the rising sea level. It is possible that some of the Early period sites along the coast have become submerged. In the Santa Monica Mountains region, deposition of sediments in valleys in the interior and at the mouths of streams at the coast may have buried some Middle Holocene settlements. The situations of Middle Holocene settlements, especially buried sites, needs to be further studied to determine the nature of shifts. Other apparent environmental changes during the Middle Holocene (Heusser 1978; Pisias 1978, 1979) also may have affected settlement patterns of sites.

## DISTRIBUTION OF SITES

Concentrations of Middle Holocene sites in the Santa Monica Mountains are present near the sites of historic villages observed by Spanish explorers and missionaries. They are also present at locations between the historic villages, often in the vicinity of settlements occupied during the Middle period and Phase 1 of the Late period. As in most other regions of Southern California, it appears that Middle Holocene populations of the Santa Monica Mountains were more dispersed than during the protohistoric period and that all major geographic divisions of the region were occupied; in other words, the settlement data indicate that during this period more but smaller settlements were dispersed throughout the Santa Monica Mountains.

Marine resources were probably of some significance at all of the sites discussed in this chapter. Shell is present at approximately 50 percent of the sites (tables 5.1, 5.2, 5.3). This figure is, however, misleading, given that shell at many of the sites has chemically dissolved and can no longer be visually observed. All sites in our sample have a coastal orientation in terms of resource use and other features. A few sites have enough faunal remains present that some comments may be offered regarding the relative importance of marine and terrestrial resources. At Sweetwater Mesa, Erlandson (1994:225–226) reconstructed the nutritional yield of faunal remains and suggested that shellfish provided approximately 74 percent of the animal meat and 64 percent of the animal protein at the site. Most of the animal bone was identified as deer and small mammal, with a limited amount of fish and reptile. At VEN-1, also on the coast, Wallace et al. (1956:40–41) suggested that the inhabitants subsisted primarily on shellfish supplemented by wild plant foods. The presence of shellfish remains at VEN-853 indicates the existence of ties between the coast and interior sites. Although the shellfish assemblage was relatively small, 85 percent of the shell from this site was *Mytilus californianus* (Erlandson 1994:228–229; Greenwood, Romani, and Foster 1987:22). Large mammal bone made up almost 50 percent of the recovered vertebrate remains at VEN-853 (Erlandson 1994:228–229; Greenwood, Romani, and Foster 1987:22).

## SITES WITH HOUSES, FEATURES, AND/OR BURIALS

The presence of house floors and cemeteries are measures of the degree to which settlements were central to the lives of their occupants. Middle Holocene cemeteries resembling each other have been discovered over a large area of Southern California. Existing documentation indicates that failure to locate cemeteries at many Middle Holocene sites is probably owing to the failure to excavate in all areas of a site.

In addition to cemeteries, numerous sites in the Santa Monica Mountains have other characteristics that indicate they were major settlements occupied over a period of years. These characteristics include features such as hearths or clusters of artifacts (LAN-1, LAN-267, VEN-1, and VEN-294), large site areas with high densities of cultural remains, and a wide variety of cultural and faunal remains indicating a diversity of activities. Such sites were most likely focal points in a settlement system where people spent significant amounts of time throughout the year.

### Sweetwater Mesa (LAN-267)

One of the best-documented sites from the coastal zone is LAN-267, Sweetwater Mesa (C. King 1967). First recorded in 1961 by Chester King and Michael Glassow, who noted the large size of the site and the numerous artifacts visible on the surface, the site is approximately 800 m long and is situated on a crest of land consisting of three benches ( loci A, B, and C) on two Late Pleistocene marine terraces. Three radiocarbon dates from Sweetwater Mesa (table 5.1) indicate that the site was occupied near the end of the Early Holocene and the beginning of the Middle Holocene. Shortly after its discovery, six 5 x 5 foot (1.5 x 1.5 m) units were excavated at LAN-267 to a depth of 2 feet (61 cm). Within the next few years, five more large units were excavated as well as two column samples, resulting in samples from all three loci with a focus on the central area (locus A; C. King 1967:29). As a result of these excavations, an area described as a "floor" with large quantities of artifacts and rocks was observed in the lower half of the 60 cm thick deposit (fig. 5.5). Clusters of rocks and artifacts at lower levels of Middle Holocene sites are typical of deposits from this time period (C. King 1967). The only feature recorded by King at Sweetwater Mesa is feature 1, described as a concentration of three whole metates, metate fragments, a mortar, and several large rocks in a loose pile about 1.2 m$^2$ (C. King 1967:55). No clear archaeological indications of burials were observed.

Table 5.4 gives the relative frequency of selected artifacts from King's excavations. King (1967:55) noted a lack of small projectile points, steatite artifacts, and a virtual lack of asphaltum. Fish and shellfish remains indicate that marine resources were part of the inhabitants' diet.

Subsequent to King's excavations, fifteen units were excavated in locus C by Clewlow (1981). Seven years later, the central area of the site was removed and redeposited during house reconstruction, without a formal archaeological program prior to site destruction (Singer, Atwood, and Gomes 1993). Several hundred artifacts were collected from the surface at this time, including hundreds of manos and metates and other ground- and pecked-stone items, along with equal numbers of hammers, cores, and large flake tools and debitage (Singer, Atwood, and Gomes 1993). This collection also includes a cogstone. Examination of the site by Singer after it was graded indicates that stone cairns and features were encountered during grading, evidence that a mortuary may have been destroyed in the process. The artifacts and features from this collection are similar to those described by King (Singer, Atwood, and Gomes 1993:21). The Sweetwater Mesa site has the characteristics of a classic Early period site: rock features, manos, metates, stone cairns, and large tools such as scraper planes.

TABLE 5.4 Frequencies of selected artifacts at three sites

| | LAN-267 | | LAN-1 | | LAN-225 | |
|---|---|---|---|---|---|---|
| | N | % | N | % | N | % |
| Manos | 423 | 37.2 | 2556 | 36.3 | 281 | 28.6 |
| Metates | 174 | 15.3 | 329 | 4.7 | 56 | 5.7 |
| Cog stones | 1 | 0.1 | 7 | 0.1 | 1 | 0.1 |
| Pestles | 4 | 0.4 | 9 | 0.1 | 2 | 0.2 |
| Mortars | 13 | 1.1 | 4 | 0.1 | 2 | 0.2 |
| Scraper planes | 252 | 22.1* | 2008 | 28.5 | 155 | 15.8 |
| Hammerstones | 252 | 22.1 | 1478 | 21.0 | 407 | 41.4 |
| Choppers | 18 | 1.6 | 649 | 9.2 | 78 | 7.9 |
| Slate pendants | 1 | 0.1 | 9 | 0.1 | | |
| TOTAL | 1138 | 100 | 7049 | 100 | 982 | 100 |

* These include large scrapers, cortex-based scrapers, and domed scrapers.

**Tank Site (LAN-1)**

The Tank site, located in the interior coastal drainage zone of the Santa Monica Mountains in Topanga Canyon, is one of the better known Early period sites in California (Treganza and Bierman 1958; Treganza and Malamud 1950). Heizer and Lemert (1947) discovered the site in 1946, and A. E. Treganza and C. G. Malamud excavated there a year later with joint funds from the University of California, Berkeley and Los Angeles. A second field season of excavations occurred the following year. The site was excavated again in the late 1950s and 1960s by anthropology students from Santa Monica City College.

LAN-1 is situated on a well-drained knoll at approximately 370 m elevation with an excellent view of the surrounding countryside (fig. 5.4). Two springs were in the vicinity of the site, but this was unknown during the first season of fieldwork (Treganza and Bierman 1958:46). When the site was extensively excavated in 1947 and 1948 using a series of trenches and 5 x 5 ft units, the worked stone was saved and analyzed at Berkeley. Treganza and Bierman (1958:46) estimated that approximately 232 $m^3$ (2,496 cubic feet) of soil was removed. Shell recovered from the site indicates that the inhabitants made use of marine resources. Twelve burials were recorded during these two field seasons. Two of these burials were covered with inverted metates, and a third had metates associated with it, although they were not inverted.

Twenty-nine features were recorded at LAN-1 during the two field seasons in the 1940s. These features include concentrations of artifacts such as metates, manos, scrapers, and hammerstones; concentrations of inverted metates (some possibly associated with human bone and others highly weathered); possible hearths; a cache of manos; concentrations of stones; massive piles of rejected cores, broken manos and metates, and unmodified cobbles; and clusters of metates and metate fragments (Treganza and Bierman 1958:53; Treganza and Malamud 1950:135–136). The largest single concentration of stone (feature 23), 2.4 m (8 feet) in diameter, was excavated in 1948 and consisted of quantities of granite and sandstone rocks, fifty-three metate fragments, fifteen manos, eleven scraper planes, four side scrapers, five choppers, and two abrading stones (Treganza and Bierman 1958:53). The range and types of artifacts from the Tank site are similar to those from Sweetwater Mesa (table 5.4).

The artifact types presented in table 5.4 are only a selection of those recovered during the 1940s excavations (Treganza and Bierman 1958; Treganza and Malamud 1950). In addition to the numerous features and burials, the vast quantities of artifacts recovered from LAN-1 suggest that it was a major settlement in the interior region of the Santa Monica Mountains.

The Tank site has all the attributes of a large Early period village site, including a defensive location (fig. 5.4), massive quantities of large artifacts, manos, metates, large rock features, and cairn burials. The massive scale of excavations at the Tank site and the recording of numerous features and burials (Treganza and Bierman 1958: Fig.1) provide the most extensive knowledge to date on the internal structure of an Early period village site in the Santa Monica Mountains. Even Treganza and Bierman (1958:53) noted that this type of information is largely lacking in the archaeology of Southern California, a situation that has scarcely changed since their excavations.

**LAN-225**

LAN-225, located at Century Ranch, is one of the better-documented sites with burials in the interior mountain zone of the Santa Monica Mountains (table 5.3). The site was excavated by students from UCLA in 1961 and 1962 and by a field class from Santa Monica City College directed by Thomas Blackburn and Chester King (King, Blackburn, and Chandonet 1968) in 1963. As a result of these excavations, approximately 24.5 cubic yards (18.7 $m^3$) of soil were removed (C. King, Blackburn, and Chandonet 1968:15).

Situated about five miles inland on top of a small hill near Malibu Canyon, the site is about 60 x 120 m (200 x 400 feet) in size. Five rock cairns were the only features recorded at LAN-225 (C. King, Blackburn, and Chandonet 1968:17). All had fragments of human bones beneath them. One of the burials contained traces of red ochre. The vertical distribution of artifacts was most pronounced in the lower portion of the soil profile (C. King, Blackburn, and Chandonet 1968:17), similar to the rock clusters on the floor at the Sweetwater Mesa site.

Again, the range of artifact types is similar to those at the Tank site and Sweetwater Mesa (table 5.4). This site has the same traits as most Early period sites from the Santa Monica Mountains.

### Other Sites

A few other sites warrant some discussion because of the significant information they offer. The La Jolla Valley site (VEN-100) is the closest to the coast of the interior coastal drainage sites. This site is important because house floors and burials in relatively good condition were discovered. It is unique because of the circumstances of soil formation at the site, which allowed for the preservation of house floors. In portions of VEN-100 where early occupation was identified, soil has accumulated as the result of colluvial deposition from the slope above the site. The colluvial soil buildup was apparently rapid enough to bury habitation deposits before bioturbation resulted in size sorting and destruction of features such as floors. Because most excavated Early period sites are on the crests of ridges, there are no sources of soil to build up on the sites, and the soil has developed largely as a result of bioturbation.

Several sites in the Santa Monica Mountains contain burial cairns (fig. 5.1). Coastal sites where cemeteries have been found with burials covered with metate cairns are the Little Sycamore shell mound (VEN-1), the San Nicholas Canyon site (LAN-352), the Zuma Creek site (LAN-174), and the Paradise Cove site (LAN-222). Interior sites include the Tank site (LAN-1), LAN-225 at Century Ranch, and LAN-111 at Encino. The Porter Ranch site (LAN-407) in San Fernando is similar to sites in the Santa Monica Mountains region with early Middle Holocene cemeteries.

In summary, Early period sites have been found near most historic settlements throughout Southern California. Data indicate that during the Early period there were probably more but smaller settlements throughout the region. Sites from all three regions in the Santa Monica Mountains contain remains of maritime resources. Subsistence remains from these sites do not indicate that there was an emphasis on resources from the sea, regardless of the location. Because preservation of faunal remains from sites of this time period is poor, it is difficult to assess the relative significance of maritime resources in the diet of inhabitants of the Santa Monica Mountains during the Middle Holocene.

## INTERPRETATIONS

There is a wide range of interpretation of the archaeological record of the Santa Monica Mountains, particularly concerning the distribution of population during the Middle Holocene. C. King (1967:66) believed manos and metates found at inland sites such as VEN-70 and the Gilmore Ranch site indicated the use of these artifacts during the Late period. It now appears that a better explanation of these occurrences is that these sites were occupied during both the Middle and Late Holocene and that a mixture of artifacts and soils has been caused by bioturbation. C. King's (1990) studies of Early period sites led him to conclude that manos and metates usually were made during this time period and are found at settlements on the coast, near the top of the Santa Monica Mountains, and in interior valleys. Late and Middle period sites are often adjacent to or near Early period sites both on the coast and in the interior. The middens of these later sites are less altered by weathering and bioturbation and contain different types and frequencies of artifacts.

Leonard (1971:116) interpreted the archaeological record from the Early period as indicating the presence of village sites in the interior and on the coast. His map does not include all areas where Early period sites have been found, and data now available reveal the presence of additional sites. Leonard (1971:118) did not take into account the effects of time on shell and bone in archaeological sites and interpreted the scarcity of shell in interior sites as indicating less interaction between settlements than during later periods.

Whitley et al. suggest that there were no sites in the interior of the Santa Monica Mountains (the area they refer to as the Conejo Corridor) during the Middle Holocene (or "Early Horizon" period):

> Although much has been written about 'Early Horizon' or 'Early Millingstone Period' sites in the region [Conejo Corridor], it is now recognized that the distinctions upon which these chronological assignments were made have little or no relationship to temporal placement (cf. Whitley 1979, 1980). To date we have no reliable evidence of any occupation or use of the region during the Early Horizon. Such may have occurred, but it is yet undiscovered. Instead, it is apparent that the first significant occupation of the region, marked by the establishment of site complexes [clusters of archaeological sites], occurred during the Intermediate Period, which is to say sometime around 500 BC. These same site complexes were occupied into the Historic Period and remained the basic settlement unit for the region throughout its prehistoric occupation. (1989:100–101)

Whitley and Simon (1989) do not provide an explanation of why the interior of the Santa Monica Mountains was not occupied during the "Early Horizon." Their observations may be based on a relative dearth of radiocarbon dates from early interior Santa Monica Mountains sites. Unfortunately, shell and charcoal are seldom recovered from interior sites occupied during the Middle Holocene. Traditionally, many archaeologists have not conducted studies of soils, fire-altered rock, or site organization, nor have they employed procedures to recover the full range of cultural remains, especially those small in size. Until small pieces of charcoal, shell, and other remains are collected for determining site permanency, chronology, and structure—particularly at ephemeral sites that may be of great antiquity—we cannot fully address issues surrounding settlement systems. The lack of information does not imply the lack of occupation or the lack of significance.

Excavations at Early period sites at Vandenberg Air Force Base (Gibson 1986; Gibson and Schuyler 1983) and in the Santa Clara Valley in the San Francisco Bay area indicate that spatial division of men's and women's activities was greater during the Early period than later periods. Many excavations in Early period sites probably have been in only those areas where manos and metates have been found, and these artifact frequencies are not representative of the relative frequencies of hunting and gathering activities. It is critical that archaeologists begin to study spatial organization of sites (Gamble 1983, 1991; C. King 1991; C. King et al.1982) so that these types of issues may be investigated further. To date, there has been no systematic effort to sample the range of intrasite variability present in Middle Holocene sites of the Santa Monica Mountains.

One of the greatest obstacles to examining Middle Holocene sites in this region is the scarcity of information. During surveys over the past several years archaeologists have missed observing and recording sites from this time period in the Santa Monica Mountains. Even when sites from the Middle Holocene are excavated, they are often deemed insignificant, which means that no mitigation measures are taken prior to their destruction. We believe most archaeological sites with manos and metates from this region (and elsewhere) are important because so little is known about sites from the Middle Holocene. Many of the site reports that claim these sites are insignificant do not include stratigraphic profiles, detailed artifact descriptions, spatial analyses, or absolute dates. Charcoal often is relatively rare in these sites, and flotation is seldom attempted. If flotation were a more common excavation procedure, small amounts of charcoal suitable for accelerator $^{14}C$ dating might be obtained.

In addition, there is a bias in the archaeological record. More information has been identified from sites that were occupied during the earlier part of the Middle Holocene than from the later part. Sites from the early Middle Holocene are easier to identify because of the presence of cairn burials and many large artifacts. The reduction over time in frequency of large ground-stone artifacts with burials is probably in part related to an apparent decrease in the frequency of use of metates and manos. The decrease may also reflect a decrease in technomic items and a corresponding increase in sociotechnic items placed with burials by the later Middle Holocene.

Simplistic approaches to understanding the archaeological record, failure of many archaeologists working in the region to identify Middle Holocene sites, and failure of archaeologists to conduct tests at Middle Holocene sites has led to the destruction of many sites without collection of pertinent information concerning their organization or times of occupation. Although we have some knowledge of Middle Holocene occupation in the Santa Monica Mountains, the information is sketchy and will remain so until more data is collected.

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# Middle Holocene Cultural Development in the Central Santa Barbara Channel Region

*Michael A. Glassow*

Cultural development of the central Santa Barbara Channel region (fig. 6.1) during the Middle Holocene, dating roughly between 6500 and 3000 RYBP, is still shrouded in mysteries produced by an imperfect archaeological record and limited archaeological research. Nonetheless, we know that cultural changes during the Middle Holocene were of fundamental importance to developments later in prehistory. Most obvious are the adoption of the mortar and pestle, inclusion in the diet of acorns and a large number of marine vertebrates, and increased use of sites that served as principal residential bases. My objectives in this chapter are to assess evidence for, and chronology of, cultural development in the Middle Holocene and to conceive and evaluate explanations for those aspects of cultural development that are reasonably well documented.

For purposes of this study, the central Santa Barbara Channel region includes the mainland coast between Rincon Point and El Capitan State Beach, as well as the northern Channel Islands. Much of my attention, however, will be focused on the vicinity of the Goleta Slough, along the margins of which was an unusually rich archaeological record prior to site destruction by land development since World War II. The Goleta Slough was an enclosed bay open to the sea until the 1860s, when catastrophic flooding filled most of its extent with alluvium. During the Early and Middle Holocene smaller embayments also may have existed to the east along the channel coast, in the southeastern sector of the city of Santa Barbara and just to the west of the city of Carpinteria, although at the time of European contact these were shallow water estuaries. These enclosed bodies of water are located along sections of the channel coast with the broadest stretches of relatively low-relief land extending from the coast to the flanks of the Santa Ynez Mountains. In the vicinity of the Goleta Slough the mountain flanks are about 7 km from the coast, whereas several miles to the west the mountain flanks are less than 2 km distant. As a result, the combination of the enclosed bay that is now the Goleta Slough and the adjacent lands extending to the mountain flanks provided a variety of abundant food resources, as was also the case with the two large estuary systems to the east. It is not surprising, therefore, that the largest concentrations of aboriginal Chumash Indian populations lived adjacent to the Goleta Slough. In fact, the three Chumash villages adjacent to the Goleta Slough each contained populations of several hundred individuals at the time of European contact (J. Johnson 1988), and it is likely that relatively higher population density in the vicinity of the Goleta Slough extended back in time to the earliest documented occupation, circa 7300 RYBP (Owen, Curtis, and Miller 1964).

By comparison, Middle Holocene environments of the northern Channel Islands lacked estuaries of any significant size, and populations living on the islands necessarily focused their subsistence on fauna of the intertidal and nearshore waters of the open coast and presumably on terrestrial plants. In general, much less may be said about Middle Holocene cultural development on the northern Channel Islands owing to much less intensive investigations at sites of this age, particularly of habitation deposits.

Most explanations for Middle Holocene cultural development of the central Santa Barbara Channel currently in the archaeological literature are based on arguments of migrations of new ethnic groups into the region (Harrison and Harrison 1966; D. Rogers 1929; Warren 1968). Although population expansions into this region may have occurred, these explanations leave unanswered a series of related questions concerning the course of cultural development: Why did the putative population expansions occur and why at particular times during prehistory? Why did subsistence sys-

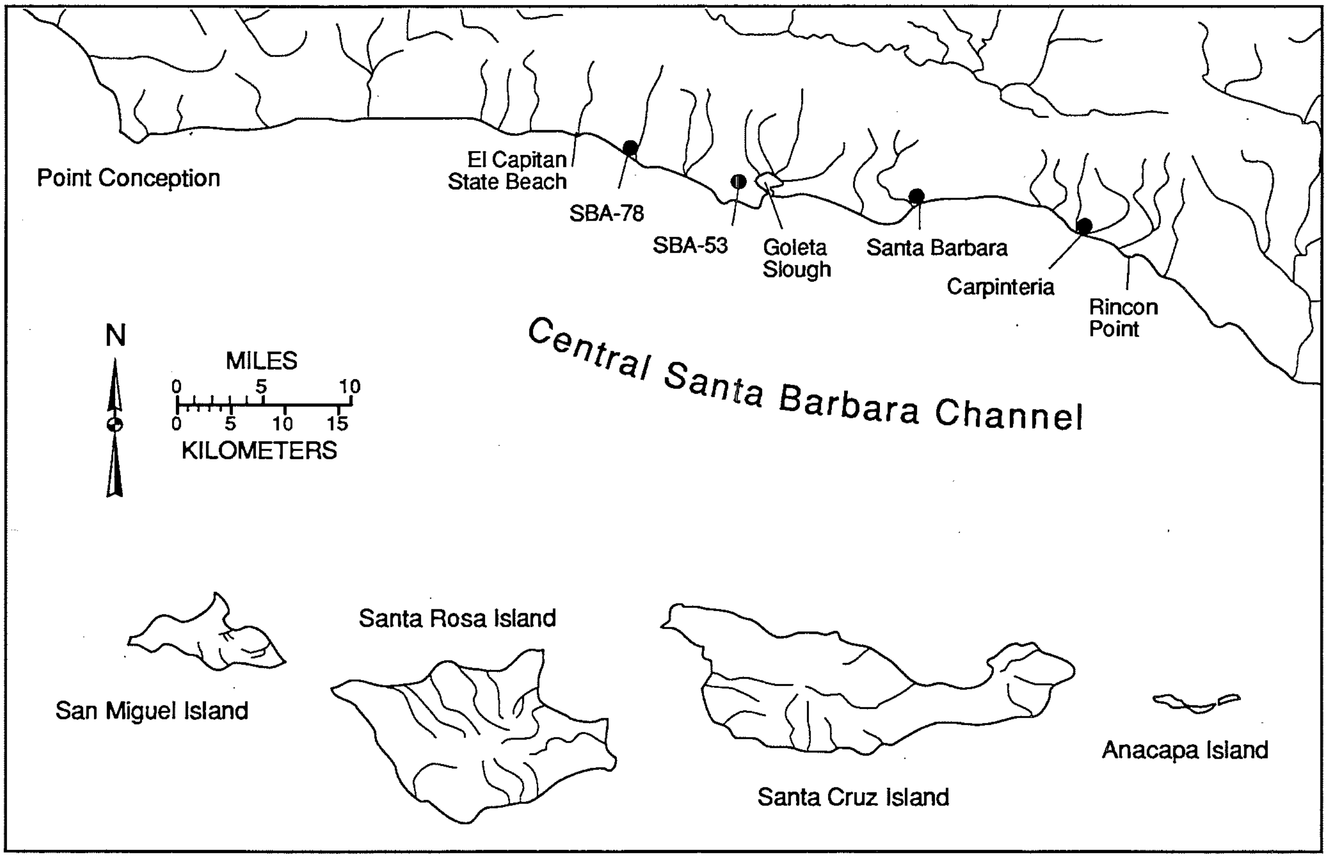


FIGURE 6.1 The Santa Barbara Channel region showing locations of principal sites and geographic features mentioned in the text

tems become more complex over time, regardless of whether the origins of this complexity were somewhere far beyond the central Santa Barbara Channel? Answers to these questions require consideration of the effects on cultural systems and regional population density of long-term environmental fluctuations of a magnitude sufficient to affect the distribution and abundance of food resources.

## NATURE OF THE DATA BASE

Fifty-two sites in the central Santa Barbara Channel region are associated with ninety-eight radiocarbon dates falling between 6500 and 3000 RYBP (table 6.1). In addition, about a dozen other sites are presumed or suspected to date to this time interval based on the presence of time-sensitive artifacts. However, I have excluded these sites from consideration because of persistent questions about the dating of such artifacts. Unfortunately, data from most sites are few, largely because of comparatively small volumes of excavated deposits (table 6.1). Most of these small-scale excavations had the purpose of assessing a site's research potential, information which is necessary for Environmental Impact Reports mandated by the California Environmental Quality Act. Another reason why available data are so sparse is the low density of artifacts and often also faunal remains in most Middle Holocene sites.

Bioturbation of site deposits dating to the Middle Holocene frustrates attempts to construct chronologies of site occupation and change in artifact forms. Earth movement by burrowing rodents over the course of several thousand years has affected most sites known to be of Middle Holocene age. Complicating matters further is the fact that most of these sites were occupied more than once during this time interval, if not also later in time. As a result, multicomponent sites frequently lack obvious soil stratification, and even if soil stratification is present, the degree of mixing between strata is such that attribution of artifacts and other cultural remains to specific occupations frequently is impossible. Furthermore, mixing of deposits of different ages has affected the integrity of organic samples from which radiocarbon dates have been obtained. Over the years many archaeologists (including myself) have failed to recognize the magnitude of the problems caused by bioturbation (see Erlandson 1984 and D. Johnson 1989 for discussions of bioturbation processes). As a result many interpretations of the chronology of site occupation and contemporaneity of artifact types are flawed. I will attempt to compensate for the effects of bioturbation, but in the end some of the interpretations offered also will be open to question because of inadequate chronological control.

## CULTURE HISTORICAL CONSIDERATIONS

Based on excavations carried out during the 1920s, David B.

Rogers (1929) proposed the first chronology of prehistoric cultural development in the Santa Barbara Channel region. His chronological scheme includes three periods, each characterized by occupation of the region by a distinct ethnic group. The first occupants of the region according to Rogers were the Oak Grove people, and as a result of radiocarbon dating we now know that sites he believed were occupied by this ethnic group date to the Early and Middle Holocene. Rogers proposed that the Oak Grove people either abandoned the region or were annihilated by a militarily superior invading group. Several hundred years after the disappearance of the Oak Grove people, a new ethnic group, which Rogers called the Hunting people, became the occupants of the region (D. Rogers 1929:356–357). Based on radiocarbon dates obtained some thirty to forty years after Rogers' work, we now know this proposed replacement occurred sometime during the Middle Holocene. Rogers' third ethnic group, the Canaliño, presumably entered the region during the Late Holocene, although some of the site assemblages he assigned to this group are known to date to the Middle Holocene.

Rogers based his interpretation of sequential occupation during the Middle Holocene by distinct ethnic groups on two major characteristics of the archaeological record. First, site components representing occupation by Oak Grove people generally were characterized by compact soils in which faunal remains were poorly preserved. If these deposits were encountered in a multicomponent site, they always formed a basal stratum quite distinct from the overlying strata consisting of more friable, sometimes darker-colored soils containing greater quantities of faunal remains. Second, site components of the Oak Grove people excavated by Rogers typically contained an abundance of metates and manos but relatively few and nondescript flaked-stone tools, whereas site components of the Hunting people contained much greater diversities of artifacts, including mortars and pestles (sometimes along with metates and manos) and distinct flaked-stone tool forms such as notched or stemmed projectile points (D. Rogers 1929).

In the late 1950s, William M. Harrison (1964) excavated at a series of central Santa Barbara Channel sites and collected enough data to evaluate Rogers' argument of ethnic replacement. Harrison divided the period of occupation by the Oak Grove people into two phases. The earlier of the two he named the Goleta phase, which he placed wholly within the Early Holocene. He named the later the El Capitán phase, which he proposed began about 5500 RYBP. Between the two phases was a time gap of several hundred years for which he had no representative site components. He referred to the initial period of occupation by the Hunting people as the Extraños phase, and he believed this phase dated to a relatively narrow interval of time within the larger interval of the El Capitán phase. The contemporaneity of these two phases is a critical element in Harrison's view of Middle Holocene cultural development.

Harrison had the benefit of radiocarbon dating, which revealed a pattern of site diversity more complicated than that imagined by Rogers. Specifically, Harrison discovered a site component that Rogers would have attributed to the Oak Grove people, but which actually dated to roughly the same time as another site that Rogers believed had been occupied by Hunting people. The site Rogers believed to have been occupied by Hunting people was SBA-53 (called the Aerophysics site by Harrison). Radiocarbon dates pertaining to this site fall between 5000 and 4600 RYBP. The site component with radiocarbon dates embracing this interval of time is the lower stratum of SBA-78. The dates pertaining to this site component extend from the Early Holocene (6830 $\pm$ 90 RYBP) to circa 3700 RYBP (table 6.1), although Harrison proposed that the radiocarbon dates from the lower stratum of SBA-78 indicated three separate occupations within this three thousand years.

Rogers (1929:146–147) initially defined the Hunting people on the basis of his excavations at SBA-53, and Harrison's extensive excavations at this site yielded a substantial collection of ground- and flaked-stone artifacts that verified this attribution. The frequencies of metates and manos in the collection were nearly equal to those of mortars and pestles. Nearly all of the classifiable projectile points (95 in all) are of a distinctive side-notched type, and a variety of other formal tool types are represented in the collection of flaked-stone tools. Like Rogers, Harrison believed that SBA-53 was occupied by Hunting people, and he placed the site's occupation into his initial phase of Hunting people occupation, the Extraños phase. The artifact assemblage from SBA-53 contrasts sharply with that from the lower stratum at SBA-78, in which metates and manos are the only milling implements present and flaked-stone tools are seemingly rare. Harrison concluded, therefore, that the ethnic group that Rogers called the Oak Grove people continued to live at SBA-78 and more generally in the Santa Barbara Channel until circa 4000 RYBP, but that the Hunting people who occupied SBA-53 were an intrusive group who entered the region sometime circa 5000 RYBP and remained ethnically distinct from, but neighbors of, Oak Grove people for several hundred years. Furthermore, Harrison proposed that the original Hunting people occupants were migrants from some distant location since he could not relate the SBA-53 artifact assemblage to any known assemblage in California. He proposed that the Hunting people originally might have been occupants of western Alaska (Harrison 1964:368, 371–372; Harrison and Harrison 1966:68–69).

Harrison considered the possibility that the contrast between such site components as SBA-53 and the lower stra-

TABLE 6.1 Dated Middle Holocene sites in the central Santa Barbara Channel region

*Channel mainland between Rincon Point and El Capitan*

| | UNCORRECTED $^{14}$C DATES (RYBP) | EXCAVATED VOLUME | PREVALENT ARTIFACTS | COMMENTS AND REFERENCES |
|---|---|---|---|---|
| SBA-1 | 4480 ± 70<br>5830 ± 80 | 6250 cm$^3$ | Metates and manos, mortars and pestles(?), side-notched projectile points | Associated with two different levels of column sample; Olson 1930; Kornfeld 1980; Peterson 1984; Erlandson 1991a |
| SBA-9 | 3850 ± 90 | Unknown | Metates and manos in soil matrix of cemetery | Cemetery excavation; D. Rogers 1929:61–62; Erlandson 1994:178 |
| SBA-14 | 4600 ± 250 | None | Metates and manos | Surface collections after plowing; D. Rogers 1929:68–71 |
| SBA-31 | 3410 ± 90<br>3800 ± 90<br>4200 ± 130 | Approx. 3.0 m$^3$ | Bone points, 1 contracting-stemmed point, 1 metate, pestles, 1 serpentine tubular bead, tarring pebbles, asphaltum | Wilcoxon, Haley, and Harmon 1989; Wilcoxon personal communication 1994 |
| SBA-46C | 3430 ± 105*<br>4530 ± 120* | Minimal | Unknown | Stratigraphically below Late period component, artifacts apparently in low density; Gamble 1990 |
| SBA-52 | 4040 ± 80 | Unknown | Unknown, substantial | Excavated in 1969; collections currently at U. of Nevada, Las Vegas |
| SBA-53 | 4620 ± 80<br>4890 ± 80<br>4980 ± 60 | 115.8 m$^3$, of which about 13 m$^3$ was screened | Metates and manos, cobble mortars and pestles, side-notched dart points, other bifaces and unifaces, asphaltum | Harrison 1964; Harrison and Harrison 1966 |
| SBA-58 | 3725 ± 80<br>3890 ± 100<br>4040 ± 160<br>4175 ± 110<br>4420 ± 160<br>4720 ± 170<br>4860 ± 110 | Approx. 1.8 m$^3$ within midden deposits | None recovered | Multicomponent site; excavations associated with 2nd, 3rd, 4th, 5th, and 7th dates; Bixler, Bolten, and Scupin 1979; Spanne personal communication 1994 |
| SBA-72 | 5270 ± 120 | <1.0 m$^3$ | Artifacts are rare; flakes noted | Midden lens 3 m below surface in stream bank; Erlandson 1988c:2, 67 |
| SBA-75A | 4990 ± 80 | 1.2 m$^3$ | Metates and manos, 1 mortar; 2 contracting-stemmed points | Contracting-stemmed points from upper 40 cm are probably from a later occupation; Erlandson 1988c |
| SBA-75B | 4780 ± 90 | 0.6 m$^3$ | 1 metate and 1 mano, 1 pestle | Same as above |
| SBA-75C | 5080 ± 80 | 1.7 m$^3$ | Metates and manos, mortars, 1 side-notched dart point | Same as above |
| SBA-78 | 3700 ± 80<br>3860 ± 80<br>4110 ± 80<br>4430 ± 70<br>4530 ± 180<br>5320 ± 70<br>5330 ± 80<br>6520 ± 80 | 175 m$^3$, of which about 45% dates to Early and Middle Holocene occupations | Metates and manos only distinctive artifacts unequivocally associated with occupations dating in excess of 5000 RYBP; later Middle Holocene deposits appear mixed | Site also contains Early and Late Holocene components; Harrison 1964; see also chapter 7 |
| SBA-84 | 4600 ± 90<br>5090 ± 80 | 19.6 m$^3$, about half of which pertains to later component | Metates and manos, 1 mortar and 1 pestle, notched cobbles (weights); other artifact types not clearly associated with Middle Holocene component | Glassow 1992a, N.D. |

Table 6.1 Dated Middle Holocene sites in central Santa Barbara Channel region, *continued*

| | Uncorrected $^{14}$C dates (RYBP) | Excavated volume | Prevalent artifacts | Comments and references |
|---|---|---|---|---|
| SBA-119A | 3270 ± 250<br>3429 ± 130<br>3530 ± 60 | Approx. 6 m$^3$ archaeological excavation; 6 m$^3$ nonarchaeological excavation | Metates and manos, shaped mortars and pestles, leaf-shaped and contracting stemmed points, asphaltum, clam disc beads, spire-ground *Olivella* beads, and rectangular *Olivella* wall beads | Mainly cemetery excavation, part of which was excavated by property owner; Harrison 1964:124–179 |
| SBA-142 | 4490 ± 80<br>6380 ± 120 | Approx. 23 m$^3$ | Unclear which artifacts are associated with Middle Holocene component(s) | Site also contains Early and Late Holocene components; Owen, Curtis, and Miller 1964; Erlandson, Colten, and Glassow 1988 |
| SBA-143 | 4820 ± 90 | Approx. 138 m$^3$ | Same as above | Site also contains Early Holocene component; Colten 1987 |
| SBA-584 | 5580 ± 130* | 0.8 m$^3$ | None recovered | Haley and Serena 1980; Brooks 1987 |
| SBA-1514 | 5980 ± 95*<br>6220 ± 100* | About 2.7 m$^3$ excavation volume, back-hoe trenches, & surface collection | Metates and manos, 1 side-notched dart point | Cultural Resource Management Services 1991 |
| SBA-1529 | 5050 ± 80<br>5720 ± 80 | 5.4 m$^3$ | 1 metate and manos, 1 pestle | Moore et al. 1983 |
| SBA-1745 | 4990 ± 90 | 0.6 m$^3$ | 1 mano, 1 spire-ground *Olivella* bead | Deposits imported from nearby site, possibly SBA-53; Colten and Erlandson 1983 |
| SBA-1776 | 3810 ± 80 | 0.5 m$^3$ | None recovered | Multicomponent site; Rudolph 1984 |
| *Santa Cruz Island* | | | | |
| SCRI-34 | 5270 ± 180 | None | Unknown | $^{14}$C sample from exposure of red abalone midden along seacliff; Glassow 1980, N.D. |
| SCRI-109 | 4600 ± 150<br>4790 ± 150 | 9,375 cm$^3$ | Large flake and core tools of local igneous stone | Second date associated with level of column sample; both dates associated with red abalone midden; Glassow 1980, N.D. |
| SCRI-146 | 5290 ± 150 | 11,875 cm$^3$ | Unknown | Associated with level of column sample taken from red abalone midden; Glassow 1980, N.D. |
| SCRI-236 | 4435 ± 100 | 9,375 cm$^3$ | Unknown | Same as above |
| SCRI-240 | 4430 ± 150 | 20,000 cm$^3$ | Unknown | Associated with level of column sample near base of archaeological deposits; UCSB Repository accession records |
| SCRI-277 | 3210 ± 150<br>5920 ± 150 | 12,500 cm$^3$<br>6,250 cm$^3$ | Unknown | Associated with two different levels of column sample; Glassow 1980 |
| SCRI-292 | 3550 ± 170<br>4360 ± 180 | 7,500 cm$^3$<br>4,375 cm$^3$ | Unknown | Same as above |
| SCRI-333 | 3310 ± 70<br>3330 ± 90<br>3700 ± 70<br>4015 ± 100<br>4590 ± 95<br>5190 ± 135 | >10 m$^3$ | Unknown | Dates associated with excavations carried out by Wilcoxon in early 1980s; earliest two dates associated with lower midden strata containing high densities of red abalone shells; remaining dates associated with upper midden stratum; Wilcoxon 1993 |

TABLE 6.1 Dated Middle Holocene sites in central Santa Barbara Channel region, *continued*

| | UNCORRECTED $^{14}$C DATES(RYBP) | EXCAVATED VOLUME | PREVALENT ARTIFACTS | COMMENTS AND REFERENCES |
|---|---|---|---|---|
| SCRI-363 | 4265 ± 185<br>4380 ± 180 | 5,625 cm$^3$<br>10,000 cm$^3$ | Unknown | Associated with two different levels of column sample; Glassow 1980 |
| SCRI-369 | 4800 ± 120 | 10,000 cm$^3$ | Unknown | Associated with column sample level; Glassow 1980 |
| SCRI-424 | 5120 ± 125 | None | Unknown | $^{14}$C sample collected from exposure of red abalone midden in gully bank; Glassow 1993b |
| SCRI-426 | 4680 ± 100 | None | Unknown | Same as above |
| SCRI-427 | 4990 ± 100 | None | Unknown | $^{14}$C sample collected from exposure along seacliff edge; Glassow 1993b |
| SCRI-428 | 3795 ± 100 | None | Unknown | Same as above |
| SCRI-430 | 5325 ± 125 | None | Unknown | Same as above |
| SANTA ROSA ISLAND | | | | |
| SRI-1 | 6420 ± 95 | None | Unknown | $^{14}$C sample collected from exposure along seacliff edge; Erlandson and Morris 1993:12–13 |
| SRI-3 | 4000 ± 120<br>4110 ± 70<br>6140 ± 60 | Unknown | Bone points, *Megathura* ornaments, square clamshell bead associated with first two dates; unknown associations with third date | First two dates associated with a midden overlying cemetery A excavated by Orr; third date obtained from nearby exposure; Orr 1968:131–135; Erlandson 1989 |
| SRI-4 | 6500 ± 200<br>6550 ± 120 | Unknown | *Olivella* spire-ground beads, clamshell disc beads, bone points | Salvage from a cemetery; Orr 1968:146–149 |
| SRI-5 | 6350 ± 130 | Unknown | Unknown | Date apparently derived from midden deposits rather than cemetery reported by Orr (1968:135–143); Berger, Ferguson, and Libby 1965:343 |
| SRI-41 Cemetery A only? | 3020 ± 100<br>3240 ± 120<br>3250 ± 140<br>3420 ± 100 | Unknown | *Olivella* spire-ground beads, *Olivella* barrel beads, bone points, contracting-stemmed dart points, mortars and pestles, digging-stick weights, asphaltum | Cemetery excavation; Orr 1968:149–171 |
| SRI-41 Cemetery X | 3970 ± 100<br>3970 ± 100<br>4260 ± 90 | Unknown | *Olivella* square wall beads, *Olivella* barrel beads, bone points, contracting-stemmed dart points, digging-stick weights, asphaltum | Cemetery excavation; Orr 1968:171–176 |
| SRI-43 | 4790 ± 90<br>5370 ± 150 | Unknown | *Olivella* spire-ground beads, bone points, mortars and pestles, digging-stick weights | Cemetery excavation; possibly some mixture between Middle and Late Holocene deposits; Orr 1968:181–187 |
| SRI-109 | 4720 ± 70 | None | Unknown | $^{14}$C sample collected from seacliff exposure of red abalone midden; Erlandson p.c. 1992 |

TABLE 6.1 Dated Middle Holocene sites in central Santa Barbara Channel region, *continued*

| *San Miguel Island* | | | | |
|---|---|---|---|---|
| | UNCORRECTED $^{14}$C DATES(RYBP) | EXCAVATED VOLUME | PREVALENT ARTIFACTS | COMMENTS AND REFERENCES |
| SMI-1 | 3240 ± 80<br>6270 ± 70 | Unknown | Unclear which artifacts pertain to these dates | These dates probably represent separate occupations; also Late Holocene occupation at this site; Rozaire 1978; Erlandson 1991d |
| SMI-172 | 5730 ± 90 | None | None | $^{14}$C sample collected from red abalone midden; Erlandson p.c. 1991 |
| SMI-261 | 3430 ± 90<br>3510 ± 80<br>6380 ± 110 | Unknown | Few artifacts from stratigraphically controlled excavations | Rozaire 1978; Erlandson p.c. 1994 |
| SMI-350 | 6030 ± 150 | None | Stone bowl | $^{14}$C sample collected from red abalone midden; D. Johnson 1972; Greenwood 1978 |
| SMI-388 | 6450 ± 130 | None | Unclear which artifacts pertain to this date | Multicomponent site; D. Johnson 1972; Greenwood 1978 |
| SMI-492 | 4920 ± 80 | about 4000 cm$^3$? | None | $^{14}$C sample collected from 18-cm thick stratum of column sample in red abalone midden; Walker and Snethkamp 1984:36, 43, 86, B10 |
| SMI-525 | 3020 ± 70 | about 4000 cm$^3$? | None | $^{14}$C sample collected from 30-cm thick stratum of column sample; Walker and Snethkamp 1984:36, 43, B34 |
| SMI-557 | 5525 ± 130 | None | None | $^{14}$C sample collected from 30-cm thick buried midden exposed along arroyo wall; Glassow 1982, vol. 2 |

* Date corrected for fractionation but not the reservoir effect; approximately 430 years should be subtracted from this date to make it comparable to other dates.

tum of SBA-78 was the result of differences in season of occupation (Harrison and Harrison 1966:66–67). However, he rejected this hypothesis for several reasons. First, the sites are only a few kilometers apart, a distance presumably closer than would be expected between sites used by the same population unit. Second, SBA-78 overlooks the ocean, yet exhibits less evidence of marine food utilization than does SBA-53, located about 2 km inland from the coast. Just the opposite pattern would be expected if the same population unit used both sites. Third, two sites occupied by Oak Grove people (SBA-56 and 57), as well as SBA-53 occupied by Hunting people, are located in an essentially identical estuarine setting, but Harrison argues that all three were occupied contemporaneously. (One of the sites, SBA-56, subsequently has been demonstrated to have been occupied about 1600 years earlier.) Finally, burial practices of presumably contemporary Hunting people and Oak Grove people sites are markedly different, which would not be expected if the same group of people occupied both SBA-53 and 78.

In 1968, Claude N. Warren argued that Harrison's proposal of migration of a foreign ethnic group to the Santa Barbara Channel circa 5000 RYBP appeared correct, but he suspected that this group could have come from the desert areas of Southern California (Warren 1968:8). Warren believed the relatively weak maritime subsistence orientation revealed by Harrison's excavations at SBA-53 did not necessarily imply that the migrants to the Santa Barbara Channel were from some other coastal area. Instead, he felt that a group of terrestrial hunters easily could have adapted their hunting technology to acquiring marine mammals, and he pointed out that fishing technology appears not to have been elaborate at the time SBA-53 was occupied.

In evaluating arguments offered by Rogers, Harrison, and Warren regarding foreign intrusion by a distinct ethnic group, it is important to recognize that they placed heavy emphasis on data from only one site: SBA-53. Indeed SBA-53 does have a number of unique aspects compared to both earlier and contemporaneous sites. The midden deposits at SBA-53 are more extensive and contain higher densities of faunal remains, particularly of shellfish. Mortars and pestles are absent in collections from earlier sites, and the proportion of mortars and pestles to metates and manos is much higher in the SBA-53 collection than in any other reasonably sized collection dating to approximately the same time (see table 6.1). The collection also contains a number of distinctive artifact forms such as unifacially flaked points (Harrison's "Worked Scraper Blades" [Harrison and Harrison 1966:15]) and bifacially flaked drills with long, parallel tips (Harrison and Harrison 1966:19–20). The extent to which SBA-53 is unique compared to earlier and contemporaneous sites in the region is critical to arguments of foreign intrusion, but just how unique is this site, and might its uniquenesses be explained by other factors?

One factor accounting for much of the uniqueness of SBA-53 is the large size of the artifact collection. It is among the largest obtained from any California site of comparable or earlier age, being many times larger than any other artifact collection listed in table 6.1. The size of the SBA-53 collection is owing to the large volume of deposits excavated by Harrison as well as intensive collecting while most of the site was being destroyed by bulldozing. The large size of the collection accounts for the diversity of artifact forms in relatively low frequencies, but it does not account for the relatively high proportion of mortars and pestles.

The unusual thickness of deposits, the great diversity of artifact forms, and the high density of shellfish remains at SBA-53 may be largely a product of its distinctive position along the former edge of the Goleta Slough, which probably was a bay at the time the site was occupied (see Stone 1982 for a history of slough infilling during the historic period). Because this location provided access to a wide variety of plant and animal foods from the bay and the marshlands around its edge, SBA-53 may have served as a principal residential base for a social unit whose environmental catchment included all the bay's waters as well as several kilometers of coastline east and west of the bay mouth. Other contemporary sites in the vicinity, such as SBA-78, may have been seasonal or day-use camps occupied by the population that resided at SBA-53. If indeed SBA-53 was a principal residential base, it would not be surprising that it contained substantial midden deposits and relatively high densities and diversities of artifacts.

In short, there is little justification for Harrison's argument that differences between SBA-53 and other sites occupied at the same time or somewhat later could not be the result of differences in season of occupation. A site such as SBA-78 could have been used seasonally by a social unit that spent a large portion of each year at SBA-53. Simply because SBA-78 overlooks the coast does not mean that it should exhibit more evidence of subsistence on marine foods, especially if many of these marine foods (for example, California mussel, nearshore fish) probably were obtained from marine habitats restricted to points of land with offshore rocks, which are closer to SBA-53 despite its inland location than to SBA-78. As well, distances between SBA-53 and 78 are great enough that residents of SBA-53 would be induced to camp at SBA-78.

Furthermore, we now know that several characteristics of the SBA-53 collections are not unique when compared to collections from contemporaneous sites. Although in apparently lower frequencies, the same cobble mortars found at SBA-53 do occur at other sites. The distinctive side-notched points in the SBA-53 collections also occur at other contemporary sites, although the number of dated sites with sizable collections is very small (see table 6.1, fourth column). The flexed position of human burials at SBA-53 also typifies a roughly contemporaneous cemetery at a site on Santa Cruz Island (SCRI-333, formerly SCRI-3, excavated by Olson [1930]; see also C. King 1990:31).

Finally, it must be emphasized that ascertaining the contemporaneity of sites is very difficult, particularly on the basis of available information. Too few radiocarbon dates exist for most sites listed in table 6.1, and many of the dates may be derived from samples lacking temporal integrity. Dating problems are highlighted by Harrison's attempts to reconstruct the depositional history of the lower stratum of SBA-78 (Harrison 1964:287–290). Although he obtained each of his radiocarbon dates from an individual shell, it is not clear how much of the deposits comprising the lower stratum of SBA-78 is earlier than, contemporary with, or later than the period of occupation at SBA-53. Indeed, there is no way of knowing the particular age of artifacts found in the lower stratum; they may date to any time between circa 6800 and 4400 RYBP, and the bulk of them could pertain to the Early rather than Middle Holocene occupations.

I have not yet considered the segment of Middle Holocene prehistory following the period of occupation of SBA-53, that is, after circa 4600 RYBP. Harrison proposed that the immigrant population of Hunting people who occupied SBA-53 (and created the cultural manifestations he placed into his Extraños phase) persisted as a distinct ethnic entity for only a few hundred years, but he did not encounter in his work any site components indicating the nature of cultural developments immediately following this phase. He did, however, propose that a later phase, the Rincon phase, immediately followed the El Capitán phase, the terminal phase of the Oak Grove people. He placed the collection from his excavations at SBA-119 into this phase. Supported by radiocarbon dates from these excavations, he believed the Rincon phase persisted between 4000 and 3000 RYBP. Furthermore, he proposed that the Rincon phase was the first of three pertaining to the Canaliño. He hypothesized that this phase represented a convergence of the two earlier ethnic groups, although he could not propose how this might have occurred (Harrison 1964:357–363).

In contrast to Harrison, Warren proposed that there was some degree of continuity between the cultural manifestations seen at SBA-53 and later manifestations. He placed the cultural manifestations at SBA-53 into the Campbell tradition, and he presumed that this tradition persisted for several thousand years. Furthermore, he suspected that the Campbell tradition eventually evolved into the Chumash culture several hundred years before European contact (Warren 1968:2–3, 8–9).

Research since Harrison and Warren published their interpretations of cultural development of the central Santa Barbara Channel has not shed much new light on Middle Holocene cultural development following the occupation of SBA-53. Sometime after 4600 RYBP, probably closer to 4000 RYBP, there are several noticeable changes in artifact forms. The cobble mortar was replaced by the basket hopper mortar (although not all later mortars show evidence of hopper attachment), and mortar exteriors began to be shaped by pecking and abrasion. In general, mortars and pestles became relatively more abundant than metates and manos, although the nature of this trend is still not well documented.

The side-notched projectile point was replaced by contracting-stemmed points of similar size and workmanship. The earliest well-dated examples are associated with a cemetery on Santa Rosa Island (cemetery A at SRI-41 [Orr 1968:171–176]). Dating circa 4300 to 3900 RYBP, the points from this context have delicate stems and basal barbs (see Orr 1968:159 for two illustrations of these points; 27 unillustrated points in the collection closely resemble these), whereas the more common form of contracting-stemmed points, undoubtedly dating after this time interval, have larger stems and usually lack prominent barbs.

The use of asphaltum began to proliferate after circa 4600 RYBP. Not only did asphaltum secure basket hoppers to the rims of mortars, it was used to attach contracting-stemmed points to projectile shafts. Very few asphalt-covered pebbles (tarring pebbles) are in the SBA-53 collection (unreported by Harrison), and they are rare in assemblages dating through the remainder of the Middle Holocene. However, after circa 4600 RYBP even small assemblages normally contain a few stones with asphaltum deposits or stains, and basketry impressions in asphaltum occur by the end of the Middle Holocene, if not earlier (see Connolly, Erlandson, and Morris 1995; Harrison 1964:149–150).

Other artifact forms remain essentially unchanged. Bone gorges and compound fishhooks retain their essential forms throughout the Middle Holocene, and no new fishing technology appears to have come into use. Shell bead types, including rectangular *Olivella* walls, spire-ground *Olivellas*, *Olivella* barrels, and clam disks, vary in only minor ways throughout the Middle Holocene (C. King 1990: Figs. 6 and 7), although there is some increase in variety of beads, ornaments, and ritual objects after circa 4000 RYBP (C. King 1990: Figs. 10–31).

## SUBSISTENCE CHANGE AMONG HUNTER-GATHERERS

Several years ago my colleagues and I proposed that population numbers fluctuated significantly during the Early and Middle Holocene (Glassow, Wilcoxon, and Erlandson 1988). We argued that regional population density remained very low between circa 7000 and 5500 RYBP and that the occupation of SBA-53 and other sites of similar age was a product of relatively rapid population growth beginning circa 5000 RYBP or perhaps a few hundred years earlier. We based our proposal on the distribution of radiocarbon-dated site components through the Early and Middle Holocene, assuming that the frequency of radiocarbon-dated site components per time interval was at least a crude reflection of population growth and decline. If indeed population was at very low levels prior to circa 5000 RYBP, then the advent of occupation of SBA-53 and contemporary sites must be viewed from a different perspective. In particular, the seemingly abrupt cultural change at the initial occupation of SBA-53 actually may be a product of relatively rapid growth of the regional population with a cultural adaptation that had been essentially that of SBA-53's occupants for some centuries. The archaeologist's inability to perceive the initial development of this adaptation simply may be owing to the minimal archaeological record dating immediately before the initial occupation of SBA-53.

In our 1988 paper we noted that population fluctuation during the Early and Middle Holocene appeared to correlate with long-term environmental changes that affected the abundance of food resources (Glassow, Wilcoxon, and Erlandson 1988:72). We proposed that relatively warm and dry climatic conditions prevailed between about 7000 and 5500 RYBP, and we argued that population density remained low during this period due to lowered resource productivity. Because we did not offer much of a theoretical justification for our position, I devote some attention here to two related questions: why did regional population density fluctuate in response to fluctuations in productivity of food resources, and why does cultural change appear to correlate with periods of population growth?

Contrary to the position I take here, one might argue that if food resource productivity declined, a regional population might be able to maintain a stable density by including new food resources or by placing greater emphasis on food resources already included in their diet breadth (for example, Hassan 1981:170). While such strategies undoubtedly were attempted, a significant increase in aridity would affect not only most or all food resources upon which a population depended but also other potential food resources not already part of the diet. Furthermore, a period of increased aridity would have included particularly dry years when food resources of any kind were extremely scarce. Under these conditions, an expansion of diet breadth or a shift in emphasis to other resources probably would not have compensated for shortfalls in traditionally exploited food resources.

Shifts to new food resources to compensate for increased aridity typically would require new procedures for acquiring and handling food resources, new schedules of food acquisition and processing activities, or new task group organization. Given the interdependence of these three aspects of a subsistence system, probably all must adjust to varying degrees in any instance of subsistence change. Technological innovations necessary for acquiring, storing, and processing new food resources, as well as associated scheduling and social organizational changes, do not necessarily come readily into existence when the need arises. Instead, a population will try to cope with its traditional subsistence system. This argument is analogous to that of Bettinger and Baumhoff (1982:489) regarding the stability of an "adaptive peak." They point out that a particular subsistence system is optimal for a given environment and population size and that other aspects of a cultural system, including sociopolitical organization and ideology, are adjusted to this subsistence system in an adaptive peak. Furthermore, they believe that subsistence change is hampered by the lag in adjustments of these other aspects, causing some level of disorganization within the cultural system. Consequently, "it is the case that even within subsistence systems themselves, certain behaviors are capable of only slow change and thus foster resistance to subsistence innovations" (1982:489).

Assuming that environmental change affected a broad array of exploited and potential food resources, one would expect that during years of depressed food resource productivity a population would experience some level of undernutrition. Undernutrition has an immediate effect on population numbers by increasing mortality among infants, young children, and the aged, as well as by decreasing fertility. The impact of undernutrition has been of interest to archaeologists and bioanthropologists working in the American Southwest, where analysis of prehistoric skeletal populations has documented persistent nutritional problems. In their attempts to understand how nutritional stress affected prehistoric Southwestern populations, Martin et al. (1991:207–222) and Wetterstrom (1986:113–123) consulted medical and human biological literature on the effects of undernutrition on rates of mortality, fertility, and fecundity. Also of relevance, Van Der Spuy (1985) presented a concise overview of the causes of lowered fertility and fecundity among human females, including malnutrition and intense exercise. Information of this sort specific to hunter-gatherers is rare, although Wilmsen (1978:71) related seasonal food shortages to intervals of decreased fertility among the hunter-gatherer San of southern Africa. Considering the biological consequences of undernutrition, there is little question that if central Santa Barbara Channel populations experienced frequent years of significant food shortages and if they were incapable of responding by adjusting their subsistence system to conditions of scarcity, their population numbers would decrease rapidly. Importantly, as population numbers decreased, the motivation for developing new food resources would diminish.

In light of the argument just presented, one might conclude that subsistence change among hunter-gatherers almost never happens, but the course of world history clearly demonstrates it happened many times. What circumstances foster subsistence change? In conceiving an answer to this question, I start by considering spatial and temporal variability in the abundance of food resources upon which populations depend. At any given time, populations practicing a particular subsistence system will be distributed among a variety of habitats (localities or regions), some of which are relatively optimal and others of which are relatively marginal in terms of the subsistence system. People living in relatively marginal habitats will experience seasons or years during which food resources are insufficient. With increasing population, these people will be under increasing selective pressure to develop new subsistence practices and a modified subsistence system. This development likely will occur in the absence of territorial competition owing to a lack of interest among neighboring peoples in territory encompassing a marginal habitat. The new subsistence system will be an aspect of a new adaptive peak, to use Bettinger and Baumhoff's term, adjusted to the marginal habitat in which the population lives and to the population size.

When resource productivity decreases in both optimal and marginal habitats, the tables might be turned. This new adaptive peak may become the most appropriate response in the optimal habitats. Indeed, since the marginal habitat may have become even more marginal, the new adaptive peak no longer may be appropriate where it developed. Nonetheless, not all subsistence systems developed in marginal habitats will be favored when environment changes, but one or more will be.

Compared to subsistence systems prevailing in a relatively optimal habitat, a subsistence system developed in a marginal habitat typically will entail greater diet breadth and higher average labor costs per unit of food value produced. Importantly, it is capable of supporting higher population densities when environmental conditions improve again. As a consequence, an adaptive peak that originally developed in a marginal habitat and then expanded into an optimal habitat during a period of unfavorable environmental conditions will foster growth of population as environmental conditions improve. Furthermore, the densities ultimately reached will be higher than those during the previous period of favorable environmental conditions.

Subsistence change, which in the long run results in significantly higher population density generally, would involve new technology or modification of old technology. Expansion of diet breadth often is made possible by adoption of new technology or modification of old technology. In fact, some resourcescould not be acquired or made nutritious without new technology. For instance, the addition of seeds to the diet requires milling implements; acorns require some form of mortar and pestle and leaching procedures; bottom-dwelling nearshore fish require fishhooks. From the viewpoint of archaeology, some technological changes appear to be quite subtle, and others may be invisible in the archaeological record. However, if attention is focused on the behavior related to the use of technological items or on the technology required to exploit particular resources, the significance of technological change often can be recognized.

The argument that subsistence systems are relatively inflexible when populations experience subsistence stress implies that subsistence change always must result from geographic expansion of one population at the expense of another. That is, a population with the higher-cost subsistence system expands at the expense of populations with lower-cost subsistence systems, much in the manner proposed by Bettinger and Baumhoff (1982) to account for the Numic spread. Considering that this process might entail interaction between groups occupying relatively small geographic areas rather than areas the size of the Great Basin, this proposal is not unreasonable. Nonetheless, some instances of geographic expansion of new subsistence practices could be the result of borrowing by neighboring populations. For instance, a population living in a relatively marginal environment might borrow subsistence technology from a neighboring group that had integrated the technology some time earlier. One might expect this to have occurred at or near the boundaries between two significantly different biotic zones.

## POPULATION FLUCTUATION AND ENVIRONMENTAL CHANGE DURING THE MIDDLE HOLOCENE

Using the same bodies of data for measuring population fluctuation and environmental change that were used in the 1988 paper with my colleagues, I attempt to look at variations in these data at a higher level of resolution than was attempted then. In using frequencies of radiocarbon-dated sites per time interval as a relative measure of regional population, I assume that settlement pattern changes have not significantly skewed the sample of dated sites and that archaeologists have not been too selective of the age of sites for which they have obtained radiocarbon dates. I believe these two sources of biases are not so extreme as to preclude using radiocarbon dates as a measure of relative population density. Nonetheless, low frequencies of dates per time interval may make patterns difficult to recognize.

Because of rodent disturbance, many of the radiocarbon dates from mainland sites are likely to be the average of material dating to significantly different periods of time. For instance, a radiocarbon date derived from a sample consisting of a dozen pieces of shell represents the average date of the shell pieces, which if dated individually may yield dates over a range of several hundred years. Although deposits at some island sites may have undergone disturbance by the site occupants (for example, excavation of semisubterranean houses), the problem of a radiocarbon date representing a composite of different ages should be much less significant. Recognizing this, I have divided mainland dates from island dates, in case patterns might be more clearly seen in the distribution of island dates. The two date distributions are presented in figure 6.2.

Error inherent in the material dated affects the resolution of the radiocarbon-based chronologies. Dates derived from marine shell must be corrected for $^{13}C/^{12}C$ fractionation and the reservoir effect. The latter is still poorly understood, and it is possible that there is substantial temporal and geographic variation in the magnitude of the reservoir effect. If this were the case, some dates from both mainland and island sites may be in error by as much as a few hundred years. Radiocarbon dates obtained from wood charcoal also are subject to significant error. For instance, the charcoal selected for a date may be from wood that grew several hundred years before it was used in a prehistoric hearth fire (Schiffer 1986). Furthermore, an archaeologist may erroneously identify wood charcoal to be of cultural origin even though it was present in a soil prior to prehistoric occupation, or the charcoal sample may consist of charcoal clearly of cultural origin mixed with naturally occurring charcoal, resulting in a radiocarbon date much earlier or later than if the charcoal was of purely cultural origin.

Dates falling between 6500 and 3000 RYBP were used in constructing the frequency distributions presented in figure 6.2. All but one date are listed in the seventh edition of California Radiocarbon Dates (Breschini, Haversat, and Erlandson 1992). Included are eighty-six radiocarbon dates from mainland sites in all of Santa Barbara County and fifty dates from northern Channel Island sites. Some of the dates derived from marine shell are reported already corrected for fractionation. To make these comparable to raw, uncorrected dates, I subtracted 430 years, the average fractionation correction for Santa Barbara Channel dates. If the 1$\sigma$ counting errors of dates from a site overlapped, the dates were averaged and treated as one for purposes of analysis. This procedure, applied to nine pairs of dates from mainland sites and five pairs and a triplet from island sites, compensates to some extent for variations in the number of dates from one site.

The two date distributions shown in figure 6.2 show similar patterns, although there are obvious differences as well.

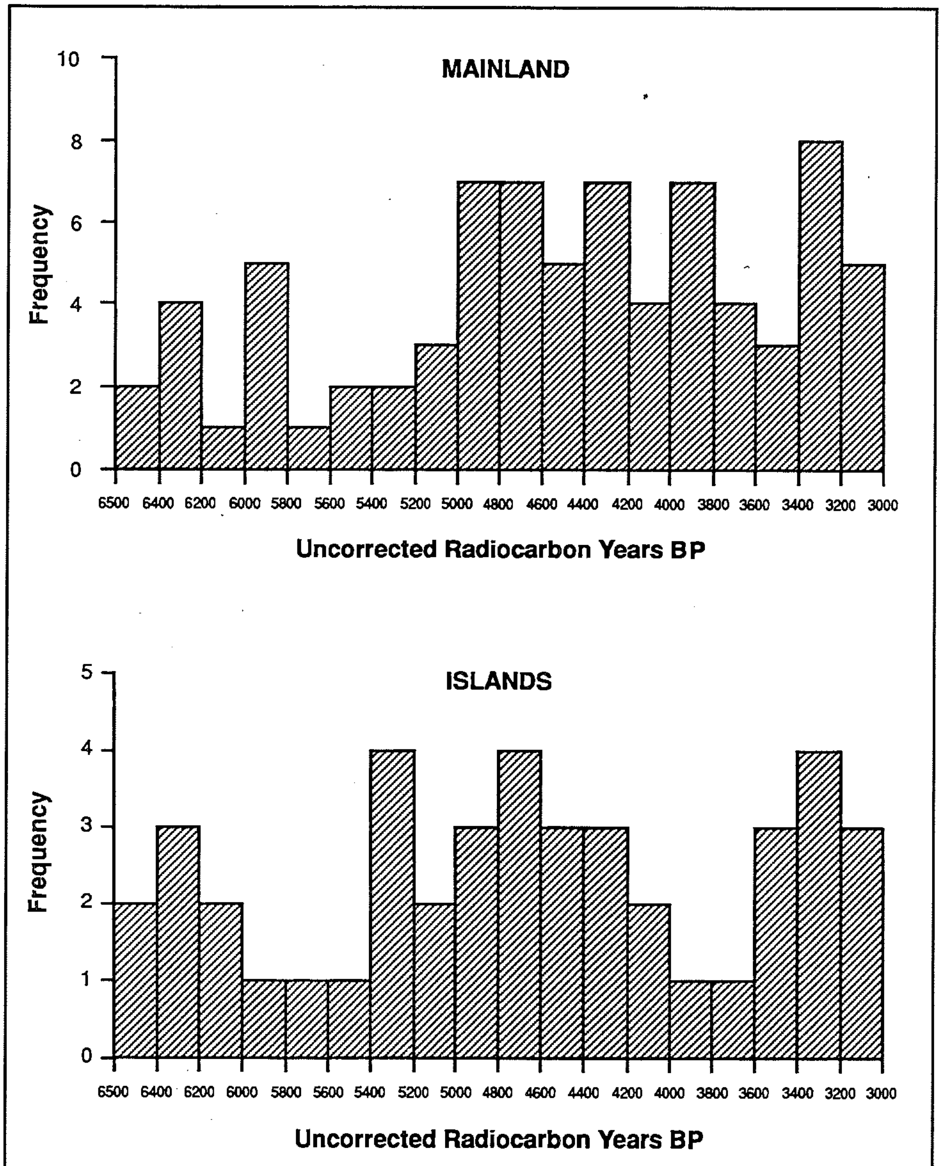


FIGURE 6.2 Frequency distributions of uncorrected radiocarbon dates from the Santa Barbara Channel mainland (Santa Barbara County) and islands between 6500 and 3000 RYBP

Both exhibit lower date frequencies during the earlier segment of the Middle Holocene, before 5400 to 5200 RYBP. Date frequencies increase after this time interval to a peak at the 4800 to 4600 RYBP interval. The relatively large number of dates between 5400 and 4200 RYBP in the island date distribution is partly owing to my interest in a distinctive type of site on the Channel Islands characterized by an unusually high incidence of red abalone shells, although my emphasis on dating these sites accounts for only five of the twenty-one dated site components within this time interval. Both date distributions show a decreasing frequency after the 4000 to 3800 RYBP interval, although it is not as clear in the mainland distribution. As well, both distributions have a peak in the 3400 to 3200 RYBP interval, but again it is not as evident in the mainland distribution.

As expected, the island date distribution exhibits a clearer pattern of variation than does the mainland distribution, and I suspect that the island date distribution presents a clearer picture of relative change in regional population density, which may have been more extreme on the islands in the first place because of the likelihood that island populations experienced periods of relatively more severe subsistence stress than did their neighbors across the channel. Nonetheless, the basic similarity seen in the mainland and island date distributions is reasonably strong evidence that the pattern of variation is meaningful, despite low date frequencies per time interval.

To evaluate whether fluctuations in regional population density, as measured by radiocarbon date frequencies, are related to changes in food resource productivity, we must have a paleoenvironmental record of sufficient sensitivity and temporal precision to determine whether correlations between population size and food productivity exist. I have depended on a reconstruction of fluctuations in sea-water temperature during the Holocene produced by Pisias (1978) as the most appropriate record for observing environmental

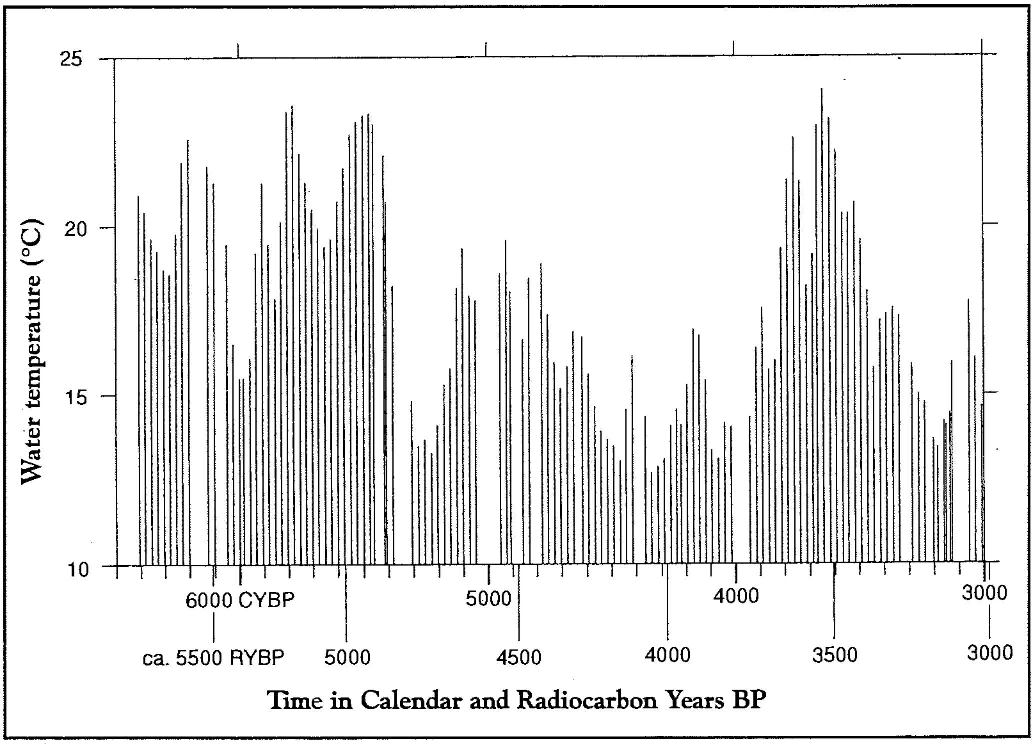


FIGURE 6.3
Paleotemperature record for sea surface water during the Middle Holocene, from Santa Barbara Channel data produced by Pisias (1978) and supplied by J. Kennett

fluctuations that would affect food resource productivity (fig. 6.3). In using this record I assume that water and air temperatures are closely related (Hubbs 1948). Low temperatures of sea water would have fostered productivity of kelp beds and the nearshore fishes that inhabit them or depend on the productivity of kelp habitats. Furthermore, California mussels would have been maximally productive since their rate of growth is inversely related to water temperature. During these intervals of cool water, therefore, marine resources would have been particularly attractive to channel populations. The problem, however, is that the abundance of plant food resources during these periods of cool water is unclear. If precipitation was very low during periods of cool water, populations may have undergone some degree of subsistence stress, but a productive marine environment may have compensated for lowered productivity of terrestrial food resources. Unfortunately, there is no precipitation record for the Middle Holocene, and the existing paleobotanical record covering this period, reconstructed from fossil pollen (Heusser 1978), does not clearly indicate either damp or dry conditions during the periods of cool water.

In the absence of a precipitation record for the Middle Holocene, a tree-ring record spanning the last sixteen hundred years may be used to provide some insight into the nature of the relationship between water temperature and precipitation. Larson and Michaelsen (N.D.) compared a precipitation record, which they reconstructed from a Southern California tree-ring record, to Pisias' temperature record for sea water. They found that sea-water temperature and precipitation seemingly vary independently of each other. During the last sixteen hundred years both quite cool and quite warm intervals several decades long correlated with periods of either low or high precipitation. If this pattern prevailed throughout much of the Holocene, periods when both marine and terrestrial resources were most abundant would occur at least some of the time when sea-water (and air) temperatures generally were cool. Conversely, periods when both marine and terrestrial resources were least abundant would occur at least some of the time when sea-water (and air) temperatures generally were very warm.

As I mentioned earlier, a period of seemingly low population density centering on about 5800 to 5600 RYBP appears to correlate with an interval of persistently arid climatic conditions. During this period sea-water temperatures were rather high, as indicated on Pisias' record prior to circa 4800 RYBP. Beginning at this date, however, there was a period about two hundred years long during which sea-water temperatures were significantly lower. I suspect that the peak in human population density centering circa 4800 to 4600 RYBP probably correlates with this period of cooler water temperatures. Likewise, the decline in population after 4600 RYBP seems to correlate with the return of relatively warm sea-water temperatures. This period of higher population levels probably was shorter than the radiocarbon date distribution implies, and the cultural type associated with this population peak, marked by the use of side-notched dart points and the mortar and pestle alongside the metate and mano, also may have been relatively short-lived.

Other correlations with Pisias' paleotemperature record are more difficult to distinguish. The apparent population peak during the 5400 to 5200 RYBP interval on the island distribution may correlate with a short interval of cool water centering on circa 5400 RYBP. Furthermore, the seemingly higher regional population density following 3600 RYBP on both distributions may correlate with another period of relatively cool sea-water temperatures between 3300 and 3000 RYBP.

## CULTURAL CHANGE

Compared to later times, most aspects of cultural change during the Middle Holocene of the central Santa Barbara Channel do not seem profound. Large, deep middens with high densities of faunal remains appear to characterize sites only near the end of the Middle Holocene, or perhaps even later, implying that populations remained relatively mobile throughout the Middle Holocene. Subsistence remained focused on terrestrial resources and only the most accessible marine resources, particularly shellfish.Changes in technology did occur, but some aspects such as types of fishing gear persisted from Early Holocene times.

As discussed earlier, the beginning of the Middle Holocene in the central Santa Barbara Channel region falls within a period during which the only milling implements were metates and manos. Based on data from north of Point Conception, this period appears to have begun circa 8500 RYBP (Glassow et al. 1991; Greenwood 1972), and it may be equally early along the central Santa Barbara Channel (Erlandson 1994). The period appears to have ended sometime during the time of depressed population density centering on circa 5600 RYBP. Not only were seeds gathered and milled using the metate and mano, but a wide variety of terrestrial and marine foods were also exploited. Shellfish collecting appears to have been a particularly important subsistence pursuit on both the islands and coastal mainland, and shellfish appear to have been the dominant source of protein, at least during times when coastal sites were occupied (Erlandson 1994; Glassow 1993a). All fishing appears to have been of species that could be caught from shore using hook-and-line, nets, traps, or bare hands (Fitch in Greenwood 1972; C. King 1990:80). Hunting of both sea and land mammals clearly was practiced as well. The cultural type of this interval of time was characteristic of populations over much of coastal Southern California (Wallace 1954, 1955; Warren 1968).

As archaeologists such as Rogers, Harrison, and Warren have recognized, a number of cultural changes clearly were in place by circa 5000 RYBP. Among the most significant from the standpoint of subsistence change appears to be the advent of the mortar and pestle. Basgall (1987:30) associates the archaeological occurrence of mortars and pestles with acorn utilization, and C. King (1967:66, 1990:88) suggests that their earliest use in the Santa Barbara Channel region probably is associated with exploitation of large, pulpy seeds, particularly acorns and islay fruits. Many other archaeologists have used the presence of mortars and pestles as an indicator of acorn utilization (for example, Glassow, Wilcoxon, and Erlandson 1988:65). Although acorns were the principal seed processed with the mortar and pestle at the time of European contact, at this early time food products other than acorns may have been pulverized with these implements.

One possibility is pulpy root products (tubers, bulbs, corms). Indeed, the unusually large number of mortars and pestles at SBA-53 may reflect the abundance of such plant products in marshlands surrounding the Goleta Slough at the time of occupation. This proposal is plausible in light of ethnographically documented uses of the mortar and pestle for processing bulbs and tubers in different parts of western North America, although the ethnographic data typically are sketchy regarding uses of these implements. Among groups in Northern and Central California and on the Columbia Plateau, a variety of root products (particularly camus bulbs on the Columbia Plateau) were processed with the mortar and pestle after drying (Garth 1978:243; Riddell 1978:374; Smith 1978:444; Spier 1930:164–165; Spier and Sapir 1930:189; Wilson and Towne 1978:389). Of particular interest is the use of the mortar and pestle by the Northern and Southern Valley Yokuts, particularly the Tachi Yokuts, to pound dried tule (bulrush) roots into flour (Gayton 1948:14–15; Mayfield 1993:66–67; Wallace 1978a:464, 1978b:450). Since bulrush currently occurs in dense stands in the Goleta Slough and undoubtedly also did throughout prehistory, this could have been an important food of the occupants of SBA-53. Indeed, the first use of the mortar and pestle in California may have been for processing root products acquired from marshland locations near lakes, rivers, and estuaries. Although this first use may reflect a significant subsistence change in its own right, acorn processing with mortars and pestles may have begun some time later in prehistory.

Another use of mortars and pestles among various ethnographically documented groups in western North America is for pulverizing dried meat. Certain Plateau groups pulverized dried salmon with a mortar and pestle (Spier and Sapir 1930:189), and the Luiseño of Southern California used these implements to pulverize venison and both the meat and bones of rabbits (Sparkman 1908:197, 198). Occupants of SBA-53 may have pulverized fish from the open waters of the Goleta Slough with their mortars and pestles. If so, the advent of the mortar and pestle may reflect the origin of fish or mammal meat as a stored food resource rather than any significant expansion of diet breadth.

Another intriguing technological change is the much greater use of chert projectile points after circa 5000 RYBP, a change that may reflect a greater proportion of hunting trips emanating from residential bases, which most or all sites known to date after this time appear to be. During the preceding period, males may have used temporary camps for hunting and the manufacture of projectile points rather than residential bases. Whatever this shift in site use was, it appears to have occurred over a large geographic area. I noted lower densities of knapping debris in site deposits prior to 6700 RYBP in the Vandenberg region of western Santa Barbara County, and I proposed that adult males and females may have been involved in different settlement systems during the Early Holocene of this region (Glassow et al. 1991:12.79, 13.17).

Shellfish collecting along the mainland open coast focused on California mussel and Pismo clam, as was also the case during the preceding period. However, estuarine species were emphasized at sites next to estuaries and bays productive in such shellfish as Venus and Washington clams. The emphasis on California mussel and Pismo clam probably indicates that population density remained relatively low, for these shellfish are not particularly abundant along the mainland coast of the central Santa Barbara Channel. As Erlandson (1988c:68) pointed out in his evaluation of subsistence remains from SBA-75, the focus of hunting activities appears to have varied significantly between sites, and indeed variability among sites in relative emphasis on all major food resource categories probably was great. Although some of this variability may be a result of differences in local abundance of particular faunal species, some of the variation probably is a product of functional differences between sites occupied by the same social unit. As I argued earlier, SBA-53 may have been the only principal residential base in much or all of the central Santa Barbara region.

On the Channel Islands, sites dating between circa 5400 and 4500 RYBP are generally thin midden deposits containing relatively high densities of mussel shell and moderate to abundant quantities of red abalone shells, the latter sometimes occurring in dense lenses. Abalone shells in sites dating later in time typically are of black rather than red abalone. The presence of red abalone shells reflects a period or periods when sea-water temperatures were low enough to favor red rather than black abalone in the intertidal zone (Glassow 1993b). In fact, oxygen isotope analysis of mussel shells from a red abalone midden on Santa Cruz Island indicates that temperatures of sea surface water were approximately 2.5 degrees C cooler circa 5000 RYBP than they are today (Glassow et al. 1994). Site components on Santa Cruz Island containing significant quantities of red abalone shells always are basal strata if they are associated with components of other time periods, and these strata always contrast sharply in soil characteristics with later overlying midden strata. These stratigraphic characteristics imply that populations on the island were very small prior to circa 5400 RYBP and that some interval of time passed between occupations represented by the red abalone middens and later occupations. Expectably, the distribution of island radiocarbon dates is consistent with this stratigraphic evidence.

The cultural type I have just described seems to have undergone significant and relatively rapid modification sometime between 4500 and 4000 RYBP, which may coincide with a period of depressed population density centering circa 3800 RYBP. What follows in time is not completely clear. Although the frequency of radiocarbon-dated site components reaches relatively high levels after 3400 RYBP, the dates are associated with relatively scanty archaeological information. However, C. King (1990:90) postulated that settlement locations became more dispersed after circa 4500 RYBP and that the need for defensive site locations apparently increased.

As mentioned earlier, sometime circa 4000 RYBP the contracting-stemmed projectile point (specifically the small-stem variety) replaced the side-notched point. The shift to a new point type probably was not simply a matter of stylistic change. The side-notched point undoubtedly was lashed onto the projectile shaft with sinew or cord, and the attachment between the point and shaft would have been very secure because of the lashing around the notches. With contracting-stemmed points, asphaltum was used to fix the point to the shaft, probably supplemented by lashing. It is difficult to imagine that the change in point form is only the result of using asphaltum in securing the haft. A possibility is that the change in point type is related to a change in hunting methods or conceivably the strategy of warfare. Because the contact with the shaft was only the area of the tapered stem at the base of the point, it may have been easily detached from the shaft during use, particularly if barbs were present. When a projectile tipped with this type of point was plunged into the flesh of an animal and then retracted, the point would remain. Another possibility is that the change reflects the introduction of foreshafts easily detached from the main shaft. Because the foreshaft and the point attached to it would remain in the flesh of an animal, the point might not need to be as securely attached as before.

Although the sparse data from sites dating after 4000 RYBP imply increasing dependence on marine resources, particularly fish and sea mammals, perhaps the most significant subsistence change was in plant foods, or at least the processing of plant foods. Large numbers of metates and manos are no longer abundant in sites, and in their place the mortar and pestle became the dominant milling implements, even though metates and manos continued to be used. The increasing use of mortars and pestles surely must reflect the increasing dietary importance of large, pulpy seeds. The shift to the use of basket-hopper mortars, frequently with shaped exteriors, likely is related to increasing efficiency in their use because hoppers would reduce loss of seeds or nuts during milling. If mortars and pestles were not used for milling acorns earlier, it seems likely that they were at this time. If so, this represents an expansion of diet breadth with profound implications for the future.

Near the end of the Middle Holocene, circa 3000 RYBP or somewhat earlier, cultural systems of the central Santa Barbara Channel were beginning to resemble those that would characterize much of the rest of prehistory. Although fishing technology remained relatively simple and watercraft were restricted to the tule raft and perhaps the dugout canoe, fishing and hunting of sea mammals were becoming increasingly important. Acorns and other large pulpy seeds probably had become an important part of subsistence, and settlement systems involved more intensive use of residential bases. Based on changes in mortuary practices and the nature of shell beads and ornaments, C. King (1990:95–96) argued that by circa 3000 RYBP social organization shifted from an essentially egalitarian form to one involving hereditary status ranking. Although his sample of data indicating this shift is very small and subject to alternative interpretations (Arnold 1991b:954–955, 1992:67–68), at least it can be concluded that social complexity was increasing, particularly in the realm of status differentiation.

In summary, I have recognized three distinct stages of cultural development during the Middle Holocene of the central Santa Barbara Channel. The first, extending back into Early Holocene times, was characterized by a subsistence emphasis on terrestrial resources and easy-to-acquire marine resources, particularly shellfish. Seeds may have been an important stored food resource, and the only instruments used for milling were the metate and mano. Settlement systems entailed the use of a principal residential base, even though the social units using them probably were relatively mobile during much of an annual cycle. Males may have been quite a bit more mobile than females, however, and may have been present at principal residential bases only intermittently. The second stage, beginning circa 5500 to 5000 RYBP, is characterized by an increased subsistence emphasis on marine resources in addition to shellfish, which remained important. The variety of plant foods collected apparently expanded, as reflected by the use of the mortar and pestle. Hunting appears to have increased, particularly of sea mammals. Manufacture and maintenance of projectiles began to be a prominent male activity undertaken at principal residential bases. In general, the importance of principal residential bases may have increased, although intersite mobility probably remained relatively high. The third stage, beginning circa 4000 RYBP, is not as obvious because of a lack of adequate data, but the introduction of the basket-hopper mortar may indicate the advent of acorn exploitation. Metates and manos decreased in importance, probably reflecting greater emphasis on large seeds such as acorns. The importance of fishing and sea-mammal hunting may have increased, but the amount of increase, if any, remains unclear.

I propose that each of the three stages spans a time interval on the sea-water paleotemperature record (fig. 6.3) when temperatures were relatively low. During these intervals of cool water subsistence systems would have remained relatively stable, and population density would have increased. In contrast, the intervals of time separating the first and second stages and the second and third stages were periods when sea-water temperatures were very warm. Food resource productivity would be significantly depressed during at least portions of these periods, and as a result population densities would have declined (fig. 6.2). Nonetheless, incentives would have existed for the geographic expansion of subsistence systems involving greater diet breadth and more complex subsistence technology. These developments would have become archaeologically visible once environmental conditions improved and population numbers again grew.

## CONCLUSIONS

I am obliged to recognize that some of the interpretations just presented lack much empirical support. Although there is a reasonable theoretical basis for my proposals concerning the course of cultural change and its relationship to fluctuations in population density and paleoenvironment in the central Santa Barbara Channel region, certainly there is yet no basis for having much confidence in them. Nonetheless, I believe it is important to stretch the available data for all they are worth in an effort to evaluate hypotheses generated from existing or new theories about how cultures change. I call particular attention to two principal aspects of my arguments. First, human population density in the central Santa Barbara Channel, and elsewhere in California, did not increase regularly through prehistory. Population density almost surely fluctuated in response to environmental fluctuations affecting the abundance of food resources. Second, subsistence systems typically are not capable of change in response to significant and relatively rapid decreases in food resource productivity. Instead, population numbers will drop to levels that can be supported with the traditional subsistence system.

Cultural change was not necessarily a process of complexity increasing at a regular and gradual rate. A superficial appraisal of the archaeological record implies that most change was gradual, but this impression surely is the result of stratigraphic mixing of temporally distinct occupational components at most sites investigated. There is justification for arguing that cultural change occurred as a series of relatively rapid spurts separated by periods of relative stasis.

Discontinuities in cultural development during the Middle Holocene are closely tied to fluctuations in population density and environmental change. Innovations in subsistence technology, and the subsistence systems of which they were part, expanded geographically during periods of subsistence stress brought about by lowered resource productivity. In the Santa Barbara Channel region these periods of subsistence stress appear to correlate with periods of high sea-water temperatures. Once environmental conditions began to improve, the new subsistence technologies provided the basis for regional population density to increase to higher levels than had been reached earlier in prehistory.

Archaeologists have given little attention to the origin of particular technological innovations and their context in subsistence systems. Implicit in many explanations of technological change is the adage that necessity is the mother of invention. Although this argument is valid, it is far too simplistic to be of much value in developing explanations of subsistence change. Ideally we would like to understand the conditions that favored a technological innovation at a particular time and place, but it is of at least as much interest to identify the conditions that favored or constrained its geographic spread from a point or points of origin. Some innovations have value only in a restricted region owing to environmental constraints and therefore would not be expected to be adopted by neighboring groups. Fishing technology dependent on using boats to gain access to offshore waters of the Santa Barbara Channel would be an example. Other innovations, however, have adaptive value in many environmental contexts or in specific environmental contexts that are scattered throughout very broad geographic areas. It is this latter type of innovation with which I have been most concerned.

On the basis of this argument I propose that invention of the mortar and pestle and its use to process previously unimportant food resources occurred somewhere in western North America before 5000 RYBP, in a relatively marginal environment in which diet breadth could be expanded by exploiting marshland food resources that were most efficiently processed using the mortar and pestle. The expansion of this technology into the central Santa Barbara Channel region occurred sometime during a prolonged period of subsistence stress. The mortar and pestle may be seen as a logical outgrowth of metate-mano milling technology, and it clearly was applicable to processing food resources found in most regions of North America. Once the mortar and pestle and the food resources processed with them came into use, populations could exist at higher densities than before. The later modification of the mortar and pestle with the addition of a basketry hopper also may have been an innovation of equal significance, particularly if it was associated with the beginning of acorn exploitation.

With regard to technology partly or wholly related to intergroup competition—that is, weapon technology—rapid expansion frequently may occur regardless of the presence of resource stress, assuming that groups are always looking for greater security in dealing with their neighbors. However, because intergroup competition may increase during periods of resource stress, there is some likelihood that weapon technology, too, tends to expand most rapidly during such periods. Although the change in hafting technique reflected by the shift from side-notched to contracting-stem point form sometime circa 4000 RYBP may be related to a change in hunting practices, it seems equally possible that it is related to a change in warfare strategy.

To conclude this discussion, I would like to return to the hypotheses offered by D. Rogers, Harrison, and Warren regarding the migration of a new ethnic group into the central Santa Barbara Channel region sometime circa 5000 RYBP. It is possible to place this hypothesis into the theoretical context I developed above. One might argue that the mortar and pestle must have been a fundamental technological attribute of the subsistence system and that other aspects of culture such as the settlement system and social organization were adjusted to subsistence practices entailing use of the mortar and pestle.

If such an argument could be developed (which is not my objective here), it would make sense to propose that the use of the mortar and pestle had to be associated with the expansion of a population from somewhere beyond the central Santa Barbara Channel region. However, as discussed above, relatively strong evidence exists for continuity between central Santa Barbara Channel cultural systems before and after 5000 RYBP, particularly with regard to shell bead styles and fishhook technology. I have also argued that regional population density was very low before circa 5000 RYBP. Consequently, if there was population expansion into the central Santa Barbara Channel region, it might have been of coast-dwelling people using the same fishhook technology and bead styles as the resident population. In essence the expanding population would have had a subsistence system based on a broader array of food resources and most likely a more complex technology.

Because a population expanding into the Santa Barbara region would have been participating in the same stylistic tradition of bead-making as the resident population, it seems reasonable to propose that such a group must have been from a nearby coastal region, most likely in the southern half of the state. Some possibilities are regions north of Point Conception, such as the Vandenberg region or the San Luis Obispo County coast, where Early to Middle Holocene sites have yielded some evidence of coastal fishing and sea-mammal hunting (Glassow et al. 1991; Greenwood 1972). Another possibility is the Channel Islands, where Early to Middle Holocene sites also have yielded similar evidence (Glassow 1993a; Walker and DeNiro 1986; Walker and

Erlandson 1986). It is worth pointing out, however, that an expanding population of people using the mortar and pestle may have been adapted to a combination of open coastal and estuarine environments, particularly if marshland and estuarine resources were integral components of their diet. If this were so, then the logical places to look for expanding populations would be where productive open coastal zones occur adjacent to well-developed estuaries bordered by marshlands. This opens the possibilities of likely homelands to regions south of the Santa Barbara Channel, particularly along the Orange and San Diego County coasts.

The Middle Holocene prehistory of the central Santa Barbara Channel offers a rich archaeological record for studying relationships between environment, population, and culture. Whether my specific arguments about Middle Holocene cultural development are correct—some of them undoubtedly are not—explanations of the fundamental aspects of cultural development require consideration of fluctuations in population and environment. However, because the relationships between cultural systems and environmental and populational variability are complex, a good deal of attention must be devoted to developing theory sufficiently robust to cope with the complexity of these relationships. I hope I have made a beginning in the development of theory appropriate to elucidating the nature of these relationships during the Middle Holocene of the central Santa Barbara Channel region.

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❁ CHAPTER 7

# The Middle Holocene on the Western Santa Barbara Coast

*Jon M. Erlandson*

LOCATED about 150 km northwest of Los Angeles, the Santa Barbara coast was once the exclusive domain of the Chumash Indians. The Chumash were one of the most populous, prosperous, and sociopolitically complex tribes in California. How they came to be that way has been of interest to archaeologists for decades (see Arnold 1992; C. King 1990; Landberg 1965; Orr 1943; D. Rogers 1929). Many early scholars thought that the Chumash were relatively recent immigrants or that their culture was a mixture of traits from intruders and the earlier occupants of the area. The Chumash, however, spoke several dialects of the Hokan linguistic family—generally thought to be the oldest and most widespread language stock in California (Moratto 1984). Today, most scholars believe Chumash culture has deep roots in the Santa Barbara Channel area, possibly developing in place for eight thousand or more years. Even so, the Chumash and their predecessors clearly had extensive contacts with neighboring tribes over the millennia, including a relatively constant exchange of goods, ideas, and technological innovations.

Recently, there has been considerable debate about when and why cultural complexity developed among the Chumash and other maritime cultures of Southern California (C. King 1990; Arnold 1992; Martz 1992; Raab et al. 1995a). For the Chumash, much of this debate has focused on the appearance of such cultural features as diversified or intensified subsistence, stratified social hierarchies featuring inherited status, intensive trade and craft specialization, warfare and political confederations, and the evolution of elaborate artistic and technological traditions. Not surprisingly, attention has focused on the relatively recent end of the evolutionary trajectory that led to the sophisticated Chumash culture. The debate also has emphasized relatively local explanations for the cultural changes observed, stressing the importance of environmental changes, population growth, resource stress, and the need for people to expend increasing amounts of energy to survive.

During much of this debate, my attention has focused on the early end of the Santa Barbara Channel cultural sequence, where I have searched for the roots of cultural complexity in archaeological sites occupied more than seven thousand years ago. Numerous sites in the area were occupied during the Early Holocene (see Erlandson 1991a, b, 1994), but there is little evidence for any of the hallmarks of Chumash cultural complexity. Compared to the ethnographic Chumash, Early Holocene societies of the Santa Barbara Channel seem to have been relatively egalitarian, with less pronounced divisions of labor, less interaction with neighbors, less need for elaborate ritual and ceremonial activities, and a more generalized technology. The limited evidence for cultural complexity during the Early Holocene may be due primarily to low population densities, given that smaller populations generally live in smaller and more widely scattered villages, have less social interaction, and require fewer social controls to avoid conflicts, resource overexploitation, and environmental degradation (Erlandson 1994:266–267).

Relatively little attention has been paid in recent years to broader patterns of Middle Holocene cultural developments in the Santa Barbara Channel area (see Glassow, Wilcoxon, and Erlandson 1988; C. King 1990). D. B. Rogers (1929), Harrison (1964), and Orr devoted considerable attention to this period, but Rogers could only guess at the age of his sites, Harrison excavated only a handful of sites, and Orr's work was limited largely to Santa Rosa Island. Other research at Middle Holocene sites has been conducted primarily during CRM projects with more limited goals or site-specific emphases (Cultural Resource Management Services 1991; Erlandson 1988c; Moore et al. 1983; Rudolph 1984; Wilcoxon, Haley, and Harmon 1989). Finally, in an area where multicomponent sites are common, stratigraphic mixing caused by burrowing animals and other disturbance processes often cloud our interpretations of what features, artifacts, and ecofacts are truly Middle Holocene in origin.

Since some of the hallmarks of an elaborated culture ancestral to the Chumash first seem to appear between three and four thousand years ago (Erlandson 1996; Harrison 1964; C. King 1990; Orr 1968:149–176), and little evidence exists for these traits during the Early Holocene, it seems appropriate to reexamine the archaeological record of the Middle Holocene in the Santa Barbara area. If local population growth and environmental changes were important sources of cultural change in Santa Barbara Channel prehistory (Glassow, Wilcoxon, and Erlandson 1988), much of the evidence should be found in archaeological sites of this time period.

This chapter examines the archaeological record of the western Santa Barbara coast between about 6650 and 3350 RYBP. Until recently, at least compared to other areas of the Santa Barbara Channel, the archaeology of the coastline west of the Goleta Slough was relatively poorly known. In the last decade, however, oil and other developments in the area have led to a host of archaeological studies that have provided a wealth of new data. The following sections describe the number and types of archaeological sites documented, reconstruct the coastal geography of the area using shellfish assemblages from key sites, and discuss subsistence and technological changes that appear to have taken place during this period. These data are used to explore the nature and causes of cultural changes occurring in the Santa Barbara area through time.

Examining the evidence for local variation in human adaptations along the Santa Barbara coast during the Middle Holocene is another goal of the analysis. The broad patterns of cultural evolution on the Southern California coast have been known for decades, and scholars have long recognized that significant adaptive variations for such subareas as the San Diego and Santa Barbara coasts go back millennia (see Moratto 1984; Wallace 1955; Warren 1968). Most regional syntheses portray the Santa Barbara Channel or the maritime Chumash as relatively homogeneous entities, however, even though considerable adaptive diversity has been demonstrated for groups living on the islands, the Santa Barbara mainland, and north of Point Conception (see Glassow and Wilcoxon 1988). This chapter explores the evidence for adaptive variation among Middle Holocene peoples who occupied an even smaller and much more environmentally homogeneous area: the Santa Barbara mainland coast.

## ENVIRONMENTAL SETTING

Today, much of the California coast faces west and is exposed to the predominant weather and storm tracks that move across the Pacific Ocean from the northwest. The Santa Barbara coast faces south, however, toward the productive and relatively protected waters of the Santa Barbara Channel (fig. 7.1). To the north, the Santa Ynez Mountains rise rapidly from the sea, creating a variety of terrestrial habitats because of differences in elevation, aspect, and bedrock. To the south, the four northern Channel Islands parallel the mainland coast and further shelter Santa Barbara Channel waters. These geographic characteristics circumscribe the Santa Barbara coast, framing a narrow stretch of land between the ocean on the south and the mountains to the north. Neither of these was an impassable barrier, but the mountains and the sea limited the settlement, travel, and social interaction of the Chumash and their ancestors. Nonetheless, the diverse habitats of the land and sea provided a variety of productive resources that nurtured the people of this coast.

The study area encompasses 50 km of coastline from Point Conception on the west to Tecolote Canyon on the east (fig. 7.2). Here, a relatively narrow coastal plain is dissected by more than forty canyons in which small streams flow from the coastal foothills into the sea. These canyons are quite small, and rain falls primarily from late fall to late spring so that many coastal streams flow intermittently, drying up or retreating underground during the dry season. This encouraged settlement around larger canyons with perennial streams, especially for sites occupied during summer or fall.

Although generally similar, this study area differs from the central Santa Barbara coast in a number of ways. Until historic times, for instance, the area from Tecolote Canyon to Rincon Point was broken by a series of large estuaries like the Carpinteria Slough, El Estero, and the Goleta Slough. These estuaries supported a diverse and rich set of food resources from the land and the sea including a variety of medium and large land mammals, sea mammals, fish, shellfish, birds, and plant foods. Such large estuaries have never existed along the western Santa Barbara coast, an area that contains no productive estuaries today. To the east, much of the coastal plain is also relatively wide—up to 10 km in the Goleta area. Thus, canyons of the central Santa Barbara coast often have much larger catchments, and permanent water sources are more widely available. The generally wider coastal plain and larger canyons also provided more extensive habitat for hunting deer and other land mammals or for collecting acorns, seeds, and other plant foods. Overall, the diversity and productivity of food resources were probably considerably greater along the central Santa Barbara coast, and human population densities were probably correspondingly higher.

In the past, the geography of the western Santa Barbara coast was quite different. About nine thousand years ago,

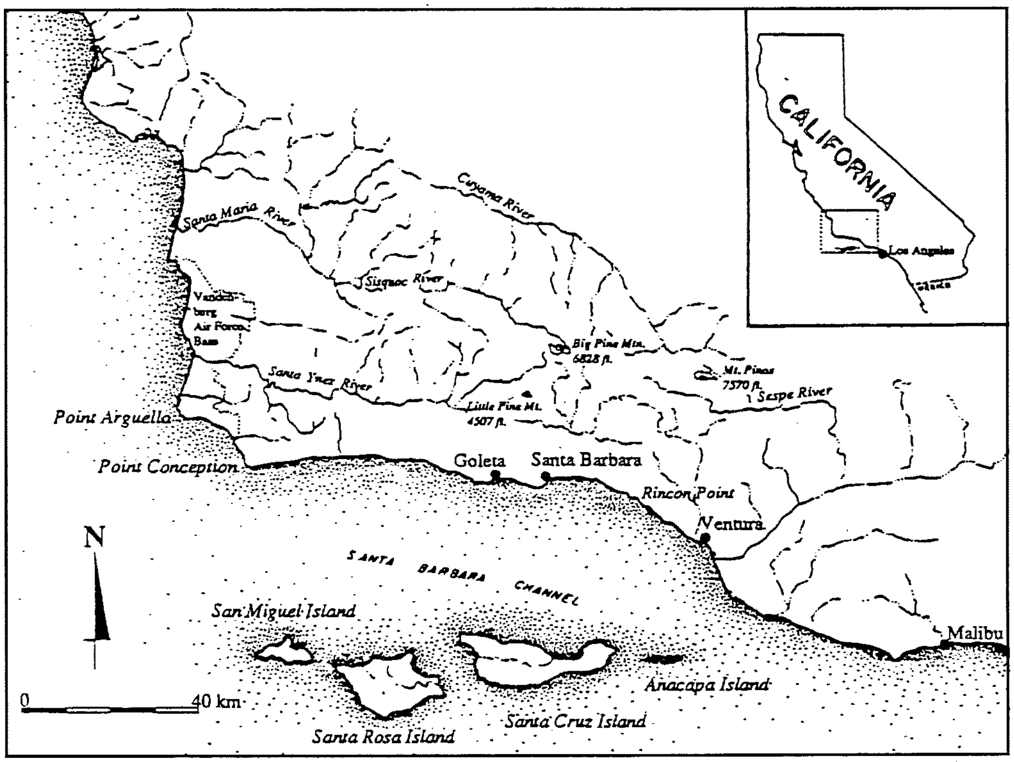


FIGURE 7.1 The Santa Barbara Channel region

sea levels were probably 15 to 30 m lower than today, but rapidly rising. This extended the coastal plain by a kilometer or more, formed small but productive estuaries at the mouths of many coastal canyons, and flooded extensive riparian habitats with salt water (Erlandson 1994). Many of the stream terraces that support oak woodlands and other productive terrestrial habitats today probably did not exist—or were much less stable landforms—during the Early Holocene.

During the Middle Holocene, the rise in sea level slowed dramatically and essentially stabilized (Inman 1983:9). Coastal erosion and a very slow rise in sea level continued to gradually reduce the width of the coastal plain, however, forming increasingly formidable sea cliffs along much of the coast and cutting broader wave-cut platforms that may have encouraged the growth of kelp beds and increased nearshore productivity. These trends probably continued into the Late Holocene as the geography of the Santa Barbara coast gradually evolved into the landscape occupied by the historic Chumash.

These environmental changes affected the distribution and productivity of terrestrial and marine resources, but most of the major food resources available to the Chumash probably were present throughout the Holocene. Pollen studies from the Santa Barbara Channel area suggest that similar plant communities have been present in the area for ten thousand or more years (Heusser 1978; Morgan, Cummings, and Rudolph 1991; West 1987), but their distribution and abundance undoubtedly changed through time. Pollen data generally support the idea that a warmer and dryer Altithermal period spanned much of the Middle Holocene (about 7000 to 4000 RYBP), but these general patterns were almost certainly interrupted by numerous climatic fluctuations of shorter duration (Glassow, Wilcoxon, and Erlandson 1988). Pisias (1978) showed that temperatures on the sea surface fluctuated substantially over the past eight thousand years, for instance, and these shifts probably were linked to changes in local marine productivity and regional climatic patterns.

## ARCHAEOLOGICAL BACKGROUND

The archaeology of the western Santa Barbara coast was relatively poorly known until development stimulated a number of archaeological studies during the past fifteen years. D. B. Rogers (1929) recorded numerous sites in the area during the 1920s, but he excavated little west of Refugio Canyon, and the age of many of these sites remains uncertain. Harrison's (1964) excavations at Dos Pueblos (SBA-78) revealed extensive evidence for Middle Holocene occupation, but this evidence was mixed with both earlier and later occupation refuse. A comprehensive description of the materials has not been completed. Until recently, few Middle Holocene sites in the area had been excavated with modern recovery techniques (see Erlandson 1988d; Erlandson et al. 1993; Glassow 1992; Santoro et al. 1993). As might be expected, however, data from archaeological sites of the western Santa Barbara coast fit relatively comfortably within the culture histories developed for the broader Chumash or

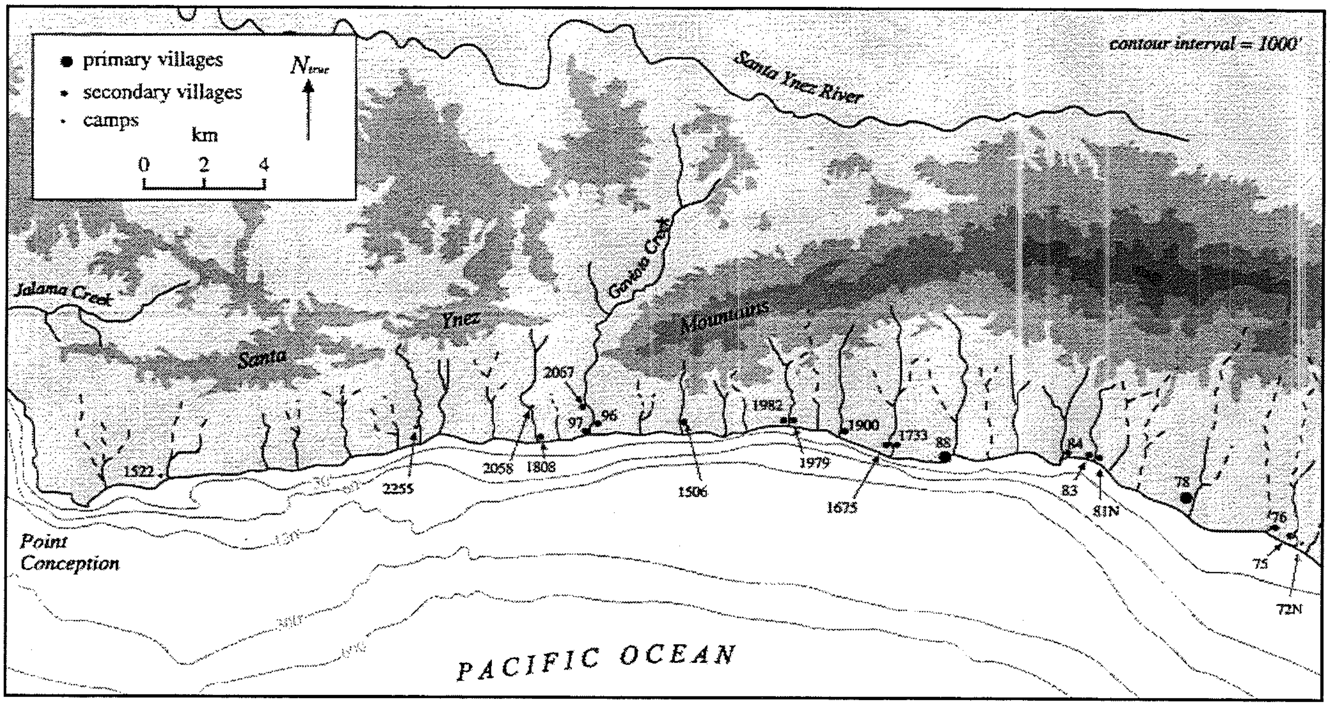


FIGURE 7.2 The western Santa Barbara coast, showing Middle Holocene site locations

Southern California region (fig. 1.2).

The western Santa Barbara coast may have been occupied as early as eleven thousand years ago, the probable age of a Clovis-like fluted point fragment found in the area (Erlandson, Cooley, and Carrico 1987). By the Early Holocene, there is much more substantial evidence for the settlement of the area, with at least eleven sites $^{14}$C dated between about 8600 and 6700 RYBP (Erlandson 1994). Of these sites, however, only four or five appear to have seen sustained occupation. Most Early Holocene sites were located around small estuaries, since shellfish assemblages dated between about 8600 and 7000 years ago routinely produce large percentages of estuarine shell. Milling stones are the most conspicuous tools in these sites, and tools associated with hunting and fishing are relatively rare, as are the bones of fish, birds, and mammals—even in soils that should preserve faunal remains (Erlandson 1991a, 1994). Artifacts and faunal assemblages consistently indicate that shellfish and seeds were the most important resources for Early Holocene people of the area.

By about three to four thousand years ago, a significant diversification and elaboration of material culture reminiscent of the historic Chumash is evident in Channel Island cemeteries at SRI-41 (Orr 1968) and SCRI-333 (Hoover 1971; C. King 1990). On the western Santa Barbara coast, similar developments are clearly evident at least two thousand years ago. Dated sites at Tecolote Canyon (SBA-72 and 73) and Las Llagas (SBA-81) clearly show an elaboration of subsistence technology, as well as beads and ornaments used in socioeconomic contexts. The elaboration of Chumash material culture seems to be accompanied by a general trend toward large and more numerous sites through time (C. King 1990). When Cabrillo's ships sailed into the Santa Barbara Channel in AD 1542, the earliest known contact between Europeans and the Chumash, as many as sixteen Chumash towns may have been located on the western Santa Barbara coast (Paez 1968). In AD 1769, when Spanish settlement of Alta California began, three thousand or more Chumash may have lived in the area (Brown 1967).

## MIDDLE HOLOCENE SITES

In the past ten years, a wealth of data on the archaeology of the western Santa Barbara coast has been collected. What we have found suggests that its environments and archaeological sites differ subtly from those in the area immediately to the east. This slight variation is intriguing because it suggests that the trajectory of cultural developments in the two areas may have varied somewhat, and it provides an opportunity to examine the subtleties of human adaptive responses to environmental variability along the Santa Barbara coast.

As noted earlier, the environment of the western Santa Barbara coast generally seems to have been less productive than the area to the east. In historic times, the largest Chumash villages were clustered around the Goleta Slough and other productive estuaries of the central Santa Barbara coast. In fact, the estuaries and broader coastal plains of the central Santa Barbara coast are dotted with scores of archaeological sites, the result of long and intensive settlement by the Chumash and their ancestors. Many of these are large village sites obviously occupied for extended periods and on multiple occasions. These include such well-known Middle Holocene sites as SBA-52, SBA-53, SBA-54, and SBA-58, all located along the northwest margin of the ancestral Goleta Slough (chapter 6; Harrison 1964; Harrison and Harrison 1966; D. Rogers 1929). These and other village sites of the central Santa Barbara coast (SBA-1, SBA-119, and SBA-1514) and the Channel Islands (SCRI-333, SRI-41) may have been primary villages, containing substantial cemeteries and other signs of relatively permanent and sustained occupation.

At least twenty-three sites of the western Santa Barbara coast have produced uncorrected $^{14}C$ dates between about 6700 and 3300 RYBP (fig. 7.2, table 7.1). Several undated sites have also produced large side-notched points or other artifacts that are almost certainly Middle Holocene in age. Little information is available on the structure and contents of some of these sites, but archaeological investigations have provided some quantitative data on the artifactual and faunal constituents of several of them. Unfortunately, at least five of these (SBA-75, SBA-78, SBA-84, SBA-96, and SBA-97) are multicomponent sites that contain stratigraphically mixed assemblages from earlier or later time periods, or both. Following are descriptions of the best-documented or best-preserved examples of a series of site types: primary villages, secondary villages, small campsites (or activity areas), and lithic sites.

These four settlement types were chosen because the archaeological sites of the western Santa Barbara coast do not fit neatly into simple classifications like residential base versus satellite camp. There is considerable variability in the size, structure, and contents of Middle Holocene sites in the area, in fact, variation that results from differences in site function, the intensity and duration of site occupation, and the formation processes that altered a site after its abandonment. To adequately characterize this diversity—and to recognize the uncertainty about how certain sites fit into a settlement system—a greater range of site types was required. Two types of village sites were defined, in part to emphasize that many residential bases along the western Santa Barbara coast seem to have been occupied for relatively short periods of time. Distinguishing primary and secondary village sites was also important in examining changes in population densities through time and their role in stimulating broader cultural changes among the Chumash and their predecessors.

Differentiation of these site types is based primarily on variations in the size, density, and contents of individual sites. There are clear functional implications for some of these distinctions: the different roles that large village sites with cemeteries versus small ephemeral campsites played in Middle Holocene settlement systems, for instance. In the case of primary and secondary villages, variations in the structure and contents of sites often have less to do with differences in site function than with the intensity or duration of site occupation. Thus, primary and secondary village sites both may have functioned as residential bases, but primary villages appear to have been occupied either by larger numbers of people or for longer periods of time. Finally, in some cases too few data are available on the structure and contents of a site to be certain about its function in a settlement system or the intensity of site occupation.

**Primary Village Sites**

Sites often called "residential bases" are divided into two types: primary and secondary village sites. Located in highly favorable locales that seem to have been occupied for sustained periods of time, primary village sites are large, with deep or well-developed midden deposits and substantial cemetery plots. They probably contained relatively permanent houses and other structures, but evidence for these has been largely obscured by rodent burrowing and other disturbance processes. It seems likely that primary village sites were occupied by relatively large numbers of people for extended periods of time. In some cases, however, such sites might have been occupied on several separate occasions by smaller groups, for shorter periods of time, or both. Only two of the twenty-three sites in the study area $^{14}C$ dated to the Middle Holocene are both large and dense enough to be classified as primary villages. Not surprisingly, each is located adjacent to a large canyon with a perennial stream. Both sites have been excavated (Harrison 1964; D. Rogers 1929), but data from the excavations are sketchy.

*SBA-88 (Refugio 3)*. This site is located on the point north of Refugio Bay. It was excavated by D. B. Rogers in 1926, who dug more than eighty trenches and exposed portions of a cemetery that contained at least eighteen poorly preserved burials. Rogers (1929:242), who generally underestimated the size of sites, stated that SBA-88 covered an area about 75 x 90 m and suggested that another 30 m of the southern site area may have eroded into the sea. The average depth of the midden was about 86 cm (34 inches), including a semi-cemented caliche horizon generally encountered about 60 cm (24 inches) below the surface. Outside the cemetery area, Rogers found relatively few artifacts: metate fragments, a few crude chert knives, hammerstones, a pestle, and a pestle blank. Within a roughly 33 $m^2$ area centered on the cemetery plot, however, Rogers found numerous artifact-bearing rock cairns that covered human burials:

> Within this limited plot was found a series of eighteen graves that were in many ways remarkable. They were all placed at a uniform depth and all covered with a pavement of massive stone, many of these being artifacts. . . . Practically no small artifacts in the nature of ornaments, weapons or utensils were found, the only exceptions being a few crudely fashioned flint knives, and one greatly disintegrated stone ring

TABLE 7.1 $^{14}C$ dates from Middle Holocene sites of western Santa Barbara coast

| | UNCORRECTED $^{14}C$ DATE | LAB NO. | DATED MATERIAL | REFERENCE |
|---|---|---|---|---|
| SBA-72N | 4920 ± 70 | Beta-28032 | California mussel | This chapter |
| | 5270 ± 120 | UCR-116 | Pismo clam | This chapter |
| SBA-75A | 4990 ± 80 | Beta-8297 | Pismo clam | Erlandson 1988c |
| SBA-75B | 4780 ± 90 | Beta-8299 | Pismo clam | Erlandson 1988c |
| SBA-75C | 5080 ± 80 | Beta-8298 | Pismo clam | Erlandson 1988c |
| SBA-76 | 5290 ± 70 | Beta-52444 | Pismo clam | This chapter |
| SBA-78 | 3700 ± 70 | A-377 | Pismo clam | Harrison 1964 |
| | 3860 ± 80 | A-345 | Pismo clam | Harrison 1964 |
| | 4110 ± 80 | A-349 | Red abalone | Harrison 1964 |
| | 4430 ± 70 | A-347 | Pismo clam | Harrison 1964 |
| | 4530 ± 180 | A-346 | Pismo clam | Harrison 1964 |
| | 5320 ± 70 | A-348 | Pismo clam | Harrison 1964 |
| | 5330 ± 80 | A-356 | Pismo clam | Harrison 1964 |
| | 6520 ± 80 | A-362 | California mussel | Harrison 1964 |
| | 6830 ± 90 | A-376 | Pismo clam | Harrison 1964 |
| SBA-81N | 5210 ± 70 | Beta-52445 | Pismo clam | This chapter |
| SBA-83 | 4740 ± 70 | Beta-52446 | Pismo clam | This chapter |
| SBA-84 | 4600 ± 90 | Beta-40554 | Pismo clam | Glassow 1992a:122 |
| | 5090 ± 80 | Beta-40553 | Pismo clam | Glassow 1992a:122 |
| SBA-88 | 5780 ± 80 | Beta-73591 | Washington clam | This chapter |
| | 5800 ± 80 | Beta-14552 | Pismo clam | This chapter |
| SBA-96 | 5940 ± 80 | Beta-15931 | Moon snail | Erlandson 1994 |
| SBA-97 | 5930 ± 100 | Beta-18534 | Moon snail | Erlandson et al. 1992 |
| | 6260 ± 80 | Beta-34199 | Pismo clam | Erlandson et al. 1992 |
| | 6640 ± 100 | Beta-39042 | Horse clam | Erlandson et al. 1992 |
| SBA-1506 | 3640 ± 70 | Beta-57972 | Marine shell | Santoro et al. 1993 |
| SBA-1522 | 5820 ± 65 | Beta-62251 | California mussel | Erlandson et al. 1993 |
| SBA-1675 | 4270 ± 60 | CAMS- | Marine shell | Gerber, personal communication, 1993 |
| | 4520 ± 60 | Beta-57975 | Pismo clam | Santoro et al. 1993 |
| SBA-1733 | 3320 ± 60 | Beta-5338 | Pismo clam | Neff 1983 |
| SBA-1808 | 3100 ± 70 | Beta-13595 | California mussel | Erlandson et al. 1993 |
| | 3300 ± 70 | Beta-13596 | California mussel | Erlandson et al. 1993 |
| | 3310 ± 90 | Beta-13594 | California mussel | Erlandson et al. 1993 |
| | 3870 ± 90 | Beta-10735 | Mixed shell | Erlandson et al. 1993 |
| SBA-1900 | 3460 ± 60 | Beta-39605 | Abalone shell | Santoro et al. 1993 |
| | 3480 ± 80 | Beta-43454 | Abalone shell | Santoro et al. 1993 |
| | 3550 ± 80 | Beta-43453 | Abalone shell | Santoro et al. 1993 |
| SBA-1979 | 3390 ± 80 | Beta-16624 | Pismo clam | Breschini, Haversat, and Erlandson 1992 |
| | 3950 ± 80 | Beta-57971 | Mixed shell | Santoro et al. 1993 |
| SBA-1982 | 3510 ± 60 | Beta-52399 | Red abalone | Santoro et al. 1993 |
| | 4210 ± 100 | Beta-16625 | Mixed shell | Breschini, Haversat, and Erlandson 1992 |
| | 4260 ± 60 | Beta-57974 | Mixed shell | Santoro et al. 1993 |
| | 4310 ± 70 | Beta-16626 | California mussel | Breschini, Haversat, and Erlandson 1992 |
| SBA-2058 | 5940 ± 120 | Beta-26293 | Butter clam | This chapter |
| | 6065 ± 305 | USGS? | Marine shell | This chapter |
| SBA-2067 | 3820 ± 100 | Beta-20410 | Mussel | Erlandson et al. 1993 |
| | 4300 ± 80 | Beta-18608 | Charcoal | Erlandson et al. 1993 |
| SBA-2255 | 4740 ± 70 | QL-4464 | Marine shell | This chapter |

Note: All shell dates in uncorrected $^{14}C$ years; AMS dates have had 430 years subtracted—an average value for $^{13}C/^{12}C$ adjustments for shell samples from the Santa Barbara coast.

of small size. Perhaps the most striking and constant phenomenon in the exposed cemetery was the almost complete disintegration of the skeletons, of which only fragments of the more massive bones remained. The graves and the superimposed cairns were enveloped by an unbroken stratum of hard, calcareous cement. (1929:243)

The rock cairns and surrounding soil produced numerous large metate fragments, manos, two pecked stone slabs or "stelae," two ritually "killed" mortars, two crude pestles, a hopper mortar, a grooved stone ring of "green steatite" (serpentine?), hammerstones, a pitted stone, a notched stone, and a thin limestone slab described as an "aboriginal gong" that produced a musical note when struck with a hammer (D. Rogers 1926). One burial also had a large cockle shell near the skull. A catalog for the collection, housed at the Santa Barbara Museum of Natural History, also lists two bola stones, an end-notched stone, a crude flake tool, a biconical obsidian drill, a large chert knife, and three leaf-shaped flake tools.

Rogers (1929:243–244) attributed the occupation of SBA-88 to his earliest Oak Grove (Milling-Stone) culture and found "not one bit of evidence" for occupation by later peoples. He raised the possibility that two early occupations may have occurred at the site, noting the presence of a few "slightly advanced" and less-encrusted artifacts found in the cemetery plot. However, the clustering of eighteen burials in a spatially discrete cemetery, the apparently identical treatment and preservation of the interments, and the concentration of artifacts around these burials all suggest that the artifacts from this burial plot may be contemporary. Variation in the encrustation and preservation of artifacts within the cemetery could well result from their differential placement relative to the contact between the leached A horizon and the calichified B horizon in the site soil.

In 1986 I collected shell samples for $^{14}C$ dating and took notes on the site constituents. A Pismo clam (*Tivela stultorum*) shell from near the base of the indurated midden deposit was dated to 5800 RYBP (table 7.1). Testing the age of the cemetery, analysis of a single large butter clam (*Saxidomus nuttalli*) shell cemented to a mano Rogers found with burial 1 produced an uncorrected $^{14}C$ date of 5780 ± 80 RYBP. It is not certain this shell was associated directly with one of the SBA-88 burials, but clam and other shell offerings often accompany Milling-Stone burials. So far, these dates are the earliest for the appearance of crude mortars on the Santa Barbara coast.

The shellfish remains in the dense shell midden exposed in the sea cliff were almost entirely California mussel (*Mytilus californianus*) and Pismo clam fragments, suggesting that a mixture of rocky shore and wave-swept sandy beaches were the primary intertidal habitats exploited by the site occupants. A small (about 75 g) shell sample from the cemented soil near burial 1 was dominated by bay or estuarine shell, however, including butter clam, venus clam (*Chione* sp.), littleneck clam (*Protothaca staminea*), and purple clam (*Sanguinolaria nuttallia*). Little or no mammal, bird, or fish bone was noted by Rogers (1929), in sea-cliff profiles or in the burial 1 soil matrix.

**SBA-78 (Mikiw).** Another Middle Holocene primary village is SBA-78 at Dos Pueblos, where Harrison (1964) identified two occupational loci separated by over 200 m, each containing human burials. In the northern area C, some 250 m from the sea cliff, Harrison exposed extensive midden deposits badly mixed by the interment of thirty-one burials. Eight uncorrected $^{14}C$ dates from this area clustered between 6800 and 6500 RYBP, circa 5300 RYBP, from 4500 to 4400 RYBP, and between about 4100 to 3700 RYBP. The southern area A, where Harrison identified the remains of two more burials in a small test area, also produced an uncorrected date of about 5300 RYBP. Thus SBA-78, more famous for its identification as the historic Chumash town of Mikiw, seems to have been occupied repeatedly during the Middle Holocene.

The many manos and metates found in the lower strata show the clearest association of artifact types with the Middle Holocene levels at SBA-78. Unfortunately, stratigraphic mixing was so extensive that confidently associating other artifact types with the Middle Holocene layers is difficult:

Empirically, the stratigraphic evidence is in conflict with much of the evidence obtained from the radiocarbon dates. In several instances, materials located deeper in the deposit are dated later in time than those above them; in one instance this phenomenon occurs between physically observable strata, rather than between arbitrary 6-inch levels. If one attempts to interpret the sequence solely on the basis of every radiocarbon date associated with its specific stratigraphic level, the result is complete confusion. (Harrison 1964:288–289)

Despite these problems, it seems likely that most of the square or rectangular *Olivella*, abalone (*Haliotis* sp.), and clam shell beads recovered, as well as a few large side-notched point fragments, hammerstones, and drills, were associated with the Middle Holocene occupations of the site.

Almost no qualitative or quantitative data are available on the Middle Holocene faunal constituents from SBA-78. Harrison (1964:284) screened all excavated sediments over 1/8-inch mesh, but the faunal collections have yet to be described. Harrison did note that "bone material of any kind was sparse" in the Middle Holocene levels and that clam and mussel shells dominated the shellfish assemblage, with mussels predominant in the lower portions of the deposit, clams in the upper.

Of thirty-three burials identified at SBA-78, Harrison (1964:314) attributed twenty-four to the Middle Holocene. The two fragmentary adult skeletons found in area A were buried side by side in a fully extended prone position, heads pointed to the west. Because of the close proximity of these burials and the lack of additional burials in the surrounding 10 x 15-foot area, Harrison concluded that the two people were interred in the same grave. One of two whole Pismo clam shells located next to the femur of one individual dated to 5300 RYBP. In area C, Harrison attributed twenty-two of thirty-one burials to the Middle Holocene and identified three separate burial positions: semiflexed, semiextended, and fully extended. Reconstructing the stratigraphic relationships between the burials, Harrison (1964:314–315) identified three periods of cemetery use during the Middle Holocene. He believed the earliest was marked by two semiflexed skeletons, an intermediate episode was indicated by four semiextended burials, and the latest episode by thirteen fully extended burials. If Harrison's interpretation is correct, the semiflexed and semiextended burials should predate the 5,300-year-old burials in area A. This proposed sequence of changes in burial position is intriguing because most people of the Santa Barbara Channel during the Early and Late Holocene seem to have been buried in flexed or loosely flexed positions (see Erlandson 1994:187, 266; Klug and Miller 1964; Orr 1968:118). Middle Holocene people were often buried in extended or semiextended positions, however, and Harrison's SBA-78 data suggest that there may have been a gradual evolution in burial position from the Early to Middle Holocene.

### Secondary Village Sites

Seventeen Middle Holocene sites of the western Santa Barbara coast are classified as secondary villages, sites where substantial—but less intensive or sustained—occupation took place. Like primary villages, these sites probably served as residential bases, but they are generally smaller or contain less dense midden deposits. Many are known to contain either isolated burials or small cemeteries but, at most, too little investigation has been done to determine whether burials are present. Among the secondary villages, there is considerable variation in site size, structure, and constituent density, but insufficient information is available to subdivide these sites further.

**SBA-96 and SBA-97.** These sites are located on the coastal bluffs overlooking Cañada de la Gaviota. Both sites seem to have been occupied more intensively during the Early Holocene (Erlandson 1994; Erlandson et al. 1992); both also appear to contain Late Holocene components. The mixing of components by burrowing animals confounds the interpretation of assemblages from these sites, but both contain estuarine shellfish fauna and artifact assemblages largely typical of Early Holocene sites in the area. During the Middle Holocene, each of the sites seems to have been abandoned shortly after 6000 RYBP, possibly because the estuary at the canyon mouth had closed off or dramatically declined in productivity. No other site occupation in Gaviota Canyon is known until about 4300 RYBP, but nearby lithic sites may date to the intervening period (see "Lithic Sites").

**SBA-75.** This large site located on the rim of Tecolote Canyon covers an area at least 200 x 300 m. Test-excavated in the mid-1980s by UCSB archaeologists, SBA-75 contains three horizontally discrete clusters of artifacts, features, and midden refuse (Erlandson 1988c:19). Two of these clusters have been partly destroyed by road construction, but one intact cluster was approximately 80 x 100 m. Human burials were identified in the heart of each cluster, including one interment covered with a cairn of Pismo clam shells. The three residential clusters at SBA-75 appear to have been occupied successively between about 5200 and 4700 RYBP. The density of archaeological materials at each cluster is much lower than at SBA-88. The faunal assemblage from SBA-75 is biased to an unknown degree by the use of 1/4-inch screens, but the recovered remains are dominated by marine shell, especially Pismo clam and California mussel. Small amounts of estuarine shell also are present. The number of formal tools recovered is small: twelve metates, eleven manos, three mortars, one pestle, two contracting-stem points, and one side-notched point. The contracting-stem points and one well-made mortar fragment may indicate a limited use of SBA-75 during the Late Holocene. This would confirm D. Rogers' (1929) belief, based solely on surface inspections, that the site was occupied during both his Oak Grove and Canaliño periods.

**SBA-76 and SBA-81N.** These sites are located west of SBA-75 on the bluffs near the mouths of Eagle and Las Llagas Canyons. Only limited exploration of the sites has been done, but each is similar in a number of ways to the three loci at SBA-75. They are relatively low-density shell middens, generally intermediate in size, that contain small cemetery areas, ground-stone tools dominated by manos and metates, and shellfish assemblages dominated by Pismo clams and California mussels. These sites are roughly the same age as SBA-75, with $^{14}C$ dates of 5290 ± 70 RYBP for SBA-76 and 5210 ± 70 RYBP for SBA-81N.

**SBA-2067.** Buried in the flood plain of Cañada de la Gaviota about 1.2 km from the sea, SBA-2067 is located beneath a nineteenth-century adobe, the foundations of which were buried almost a meter below the surface (Erlandson et al. 1993). Between 1 and 2 m below the adobe was a well-preserved site dated between about 4300 and 3800 RYBP. The stratigraphy of the site is complex, and interpretation was complicated by extensive historic disturbance from highway construction, cutting of an artificial creek channel through the site, and grading associated with pipeline construction. Data collected during test excavations and monitoring suggest, however, that the site once covered an area at least 40 x 100 m. About 52 $m^3$ of the site was excavated systematically, roughly half in Middle Holocene deposits.

The western site area contains numerous burned-rock features, but the eastern area also included a well-preserved shell midden encountered at or below the water table, as much as 3 m below the surface. This 60 cm thick midden seems to have been deposited about 3820 ± 100 RYBP. A charcoal sample from a large burned-rock feature (feature 1) west of the shell midden dated to 4280 ± 80 RYBP (table 7.1). These dates, along with the complex stratigraphy and structure of the site, suggest that SBA-2067 may have been occupied repeatedly during the later Middle Holocene. Some of the seventeen burned-rock features found were in a paleosol stratigraphically above the shell midden, however, and may date to the Late Holocene.

Many of the burned-rock features may have been used for cooking *Yucca whipplei*, still abundant on sandstone ridges north of the site. Also recovered were twenty-four bifacial tools, including seventeen undiagnostic fragments, two contracting-stem point bases, two concave-based points, two drills, and one large leaf-shaped knife. Other recovered artifacts included four cores, three tarring pebbles, an abalone disk bead, the tip of a polished bone tool, several flake tools, and thousands of pieces of debitage. Despite the relative paucity of formal artifacts in the site, the number and density of biface fragments are substantially higher than those found in several Early Holocene sites located nearby.

Shellfish remains in the buried midden reached a maximum density of only 3.4 g per 1000 $cm^3$, but at least eighteen shellfish taxa were identified. Mussels (*Mytilus californianus* and *Septifer bifurcatus*) and other rocky-shore species dominate the shell assemblage (table 7.3). A variety of vertebrate remains also was recovered, including the bones of a variety of large, medium, and small land mammals, sea mammals, reptiles, an extinct flightless duck (*Chendytes lawi*), sharks, and teleost fish (Erlandson et al. 1993: Table 11–12). A dietary reconstruction based on the faunal remains recovered (from 1/8-inch screens) in two test units dug in the buried midden suggests that shellfish provided up to 70 percent of the meat eaten by the site occupants, land mammals about 23 percent, sea mammals about 3.5 percent, birds about 3 percent, and fish less than 1 percent. These figures may overestimate the importance of shellfish, however, since fish and other vertebrate remains generally are underrepresented in 1/8-inch screen samples.

**SBA-1900.** Located on the east rim of Arroyo Quemado about 300 m from the sea, SBA-1900 was excavated during investigations related to a pipeline project (Santoro et al. 1993). Surface and subsurface data suggest that the site covers an area about 50 x 125 m, but it was probably larger before Highway 101 was built. About 34 $m^3$ of the site was hand excavated, a sample supplemented by careful monitoring of pipeline trenching. Three tightly clustered $^{14}C$ dates from abalone shells found amid a large rock feature suggest that the site was occupied about 3500 RYBP, which is consistent with the artifacts recovered at the site (Santoro et al. 1993).

Investigations at SBA-1900 focused on two large rock features partly excavated prior to pipeline realignment. The two adjacent features, encompassing an area at least 10 x 12 m, contained concentrations of rounded and angular cobbles, burned rock, ground-stone tools, chipped-stone tools, and other artifacts. The ground-stone tools included 46 metates, 46 manos, 6 mortars, 1 pestle, 4 charmstones, a notched cobble net sinker, and a grooved shaft straightener. Chipped-stone artifacts included 43 biface fragments, 43 flake tools, 30 cores, 27 large drills, 24 hammerstones, a scraper-plane, and over 14,000 pieces of debitage. Most of the bifaces seem to be projectile point fragments—at least two with contracting-stem bases—but most were undiagnostic. Other artifacts recovered include 14 tarring pebbles, 8 cobbles with asphaltum on them, 1 perforated shale disk (fig. 7.3), 26 pieces of worked bone, 125 pieces of *Olivella* bead-making refuse, 8 whole *Olivella* shells, 4 *Olivella* shell beads (1 spire removed and 3 rectangular), and 2 clam disk beads.

At least twenty-six species of shellfish were identified in a 2 kg sample of analyzed shell. The maximum density of shell encountered among the analyzed units was just 0.51 g per 1000 $cm^3$. Consistent with the shoreline in the area today, the shellfish assemblage was dominated by taxa from rocky-shore habitats, the source for about 95 percent of the identifiable shell (table 7.3). Analysis of 279 fish bones by Salls (1993) identified the remains of at least 24 kinds of bony fish and 8 types of sharks and rays. By far the most abundant fish was the white croaker (*Genyonemus lineatus*), which contributed 32 of the 76 MNI in the assemblage. Salls (1993) concluded that the general structure of coastal habitats in the site vicinity had changed little over the past thirty-five hundred years and that fishing by the site occupants focused on seine and dip netting in beach and nearshore sandy bottom habitats. Exploited to lesser extents were shallow rocky reef and kelp-bed habitats, where hook and line fishing probably took place, and pelagic habitats beyond the kelp beds where blue sharks (*Prionace glauca*) and bonito sharks (*Isurus oxyrhynchus*) may have been harpooned. Other vertebrate remains were heavily fragmented, and only 4 percent of the 7,161 bone fragments could be identified to a species or other distinct taxon. Hudson (1993) concluded that deer were the most important mammal at the site, followed by sea mammals—Guadalupe fur seal (*Arctocephalus townsendi*), California sea lion (*Zalophus californianus*), northern fur seal (*Callorhinus ursinus*), and sea otter (*Enhydra lutris*).

Finally, differing opinions are given for the function of the rock features at SBA-1900. Rock cairns are often found

TABLE 7.2 Middle Holocene sites of the western Santa Barbara coast

| | AGE RANGE (RYBP) | VOLUME EXCAVATED | SITE TYPE AND CHARACTERISTICS | REFERENCES |
|---|---|---|---|---|
| SBA-72N | 5270 ± 120 | 0.05 $m^3$ | Small camp or activity area; buried 2 to 3 m below Tecolote Canyon floor | This chapter |
| SBA-75A | 4990 ± 80 | 1.2 $m^3$ | Secondary village with Late Holocene component; burials, contracting-stem points | Erlandson 1988c |
| SBA-75B | 4780 ± 90 | 0.6 $m^3$ | Secondary village; burials, metate, mano, pestle; *Tivela*, *Mytilus* | Erlandson 1988c |
| SBA-75C | 5080 ± 80 | 1.7 $m^3$ | Secondary village; burials, side-notched point, metates, manos, mortars | Erlandson 1988c |
| SBA-76 | 5290 ± 70 | None | Secondary village; burials, metates, manos; *Tivela*, *Mytilus* | This chapter |
| SBA-78 | 3700–6830 | Approx. 80 $m^3$ | Large multicomponent village with mixed Late, Middle, and Early Holocene strata; 2 discrete Middle Holocene loci | Harrison 1964 |
| SBA-81N | 5210 ± 70 | None | Secondary village; manos, metates, human burials | This chapter |
| SBA-83 | 4740 ± 70 | Unknown | Secondary village; multicomponent site with Late and Middle Holocene components? | D. Rogers 1929 |
| SBA-84 | 4600–5090 | Approx. 10 $m^3$ | Secondary village (?) with Late and Middle Holocene components | Glassow 1992a |
| SBA-88 | 5800 ± 80 | Unknown | Primary village; dense accumulations of shell; manos, 3 mortars | D. Rogers 1929<br>This chapter |
| SBA-96 | 5940–7590 | Approx. 20 $m^3$ | Secondary village; multicomponent shell midden with Early, Middle, and Late Holocene components | Erlandson 1994 |
| SBA-97 | 5930–7080 | Approx. 11 $m^3$ | Secondary village; multicomponent site spans Early-Middle Holocene transition, with Late Holocene component | Erlandson et al. 1992 |
| SBA-1506 | 3640 ± 70 | Approx. 4 $m^3$ | Large, low-density, secondary village (?); 4 contracting-stem points, 17 manos, 3 metates, 2 mortars, *Tivela* shell | Santoro et al. 1993 |
| SBA-1522 | 5820 ± 65 | <1 $m^3$ | Small ephemeral campsite(?) with mussel shell and lithic scatter | Erlandson et al. 1993 |
| SBA-1675 | 4270–4520 | Approx. 4 $m^3$ | Secondary village(?); large low-density shell and lithic scatter; manos, 1 pestle, 1 charmstone; *Tivela* dominates shell assemblage | Santoro et al. 1993 |
| SBA-1733 | 3320 ± 60 | Unknown | Secondary village(?) on stream terrace in Corral Canyon | Neff 1983 |
| SBA-1808 | 3100–3870 | 28 $m^3$ | Secondary village with discrete activity areas; possibly multicomponent | Erlandson et al. 1993 |
| SBA-1900 | 3460–3550 | 30–35 $m^3$ | Secondary village; large rock feature | Santoro et al. 1993 |
| SBA-1979 | 3390–3950 | Approx. 3 $m^3$ | Campsite or secondary village(?); shellfish dominated by *Mytilus* and *Tivela* | Santoro et al. 1993 |
| SBA-1982 | 3510–4310 | Approx. 4 $m^3$ | Secondary village (?); 2 manos, 2 pestles, 2 bifaces, 3 rectangular *Olivella* beads | Santoro et al. 1993 |
| SBA-2058 | 5940–6065 | None | Ephemeral campsite with estuarine shell | This chapter |
| SBA-2067 | 3820–4300 | Approx. 26 $m^3$ | Secondary village buried in canyon floor; shell midden and numerous rock features | Erlandson et al. 1993 |
| SBA-2255 | 4740 ± 70 | None | Ephemeral campsite buried in canyon fill | This chapter |

Note: All age estimates in uncorrected radiocarbon years; volume excavated includes systematic hand excavations only (test pits and shovel test pits).

Table 7.3 Shellfish types by primary habitat from Middle Holocene sites

| Species/taxa | Common name | SBA-97 | SBA-2058 | SBA-88 | SBA-81N | SBA-2067 | SBA-1900 | SBA-1808 | SBA-1982 |
|---|---|---|---|---|---|---|---|---|---|
| *Bays/estuaries* | | | | | | | | | |
| *Argopecten* sp. | Scallop | | 2.3 | - | - | - | - | * | * |
| *Chione* sp. | Venus clams | 33.8 | 30.9 | P | - | - | - | 1.5 | 0.1 |
| *Clinocardium nuttalli* | Basket cockle | - | - | - | - | - | 0.1 | 0.1 | 1.0 |
| *Haminaea vesicula* | Bubble shell | - | - | - | - | - | * | - | - |
| *Ostrea lurida* | Pacific oyster | 5.8 | 0.9 | - | - | 0.3 | - | - | - |
| *Polinices* sp. | Moon snail | 1.9 | 10.5 | - | - | - | * | - | - |
| *Sanguinolaria nuttalli* | Purple clam | 3.5 | 9.4 | P | - | - | * | - | - |
| *Saxidomus nuttalli* | Butter clam | 11.5 | 39.1 | P | - | - | - | 1.5 | 0.1 |
| *Tagelus califorianus* | Jacknife clam | - | - | - | - | - | 0.1 | - | - |
| *Tresus nuttalli* | Horse clam | 3.1 | 2.0 | - | - | - | - | 0.1 | - |
| *Exposed rocky coast* | | | | | | | | | |
| *Acanthina spirata* | Thorn snail | - | - | - | - | - | - | * | - |
| Acmaeadae | Limpets, undiff. | - | - | - | - | * | 0.1 | * | - |
| *Astraea undosa* | Wavy top | - | - | - | - | - | 0.2 | - | - |
| *Balanus* sp. | Acorn barnacles | - | - | P | 0.4 | 1.5 | 0.9 | 0.5 | 0.8 |
| *Cryptochiton stelleri* | Giant chiton | - | - | - | - | 1.7 | 0.4 | 0.9 | 0.3 |
| *Diodora* sp. | Keyhole limpet | - | - | - | - | * | - | - | - |
| *Haliotis rufescens* | Red abalone | - | - | - | - | 0.1 | - | - | - |
| *Haliotis* sp. | Abalones | - | - | - | * | 0.1 | 7.6 | - | 0.7 |
| *Hinnites multirugosus* | Rock scallop | - | - | - | - | - | 2.9 | - | - |
| *Mytilus californianus* | California mussel | - | - | A | 16.0 | 36.9 | - | 76.0 | 87.7 |
| *Mytilus* sp. | Mussel, undiff. | 2.7 | - | - | - | - | 63.2 | - | - |
| *Norrisia norrisii* | Smooth turban | - | - | - | - | - | 0.8 | - | - |
| Pholadidae | Boring clams | * | - | - | - | 0.2 | 0.1 | 0.4 | 0.1 |
| *Pododesmus* sp. | Jingle shell | - | - | - | - | 0.2 | - | - | - |
| *Pollicipes polymerus* | Gooseneck barnacle | * | - | P | 0.1 | * | 1.6 | 0.9 | 0.7 |
| Polyplacophora | Chitons, undiff. | * | - | - | * | 1.2 | 0.6 | 2.6 | 0.6 |
| *Septifer bifurcatus* | Platform mussel | - | - | P | 1.2 | 54.4 | 1.1 | 6.8 | 1.9 |
| *Strongylocentrotus* | Sea urchins | - | - | - | - | - | * | 0.1 | - |
| *Tegula* sp. | Turban snail | - | - | - | - | - | - | 0.3 | - |
| *Exposed sand beach* | | | | | | | | | |
| *Donax gouldii* | Bean clam | - | - | - | - | * | - | - | - |
| *Mactra californica* | Surf clam | - | - | - | - | - | * | - | - |
| *Tivela stultorum* | Pismo clam | 8.9 | - | A | 80.7 | 0.1 | 3.7 | 0.1 | 0.3 |
| *Miscellanous* | | | | | | | | | |
| *Crepidula* sp. | Slipper shells | - | - | - | - | - | * | * | 0.2 |
| Decapoda | Crabs, undiff. | - | - | - | - | 0.1 | 1.1 | 0.1 | 0.4 |
| *Protothaca* sp. | Littleneck clams | 3.2 | 2.8 | P | 0.1 | 0.7 | * | 1.7 | 0.3 |
| Mollusca | Unidentified shell | 23.0 | 0.8 | - | 1.5 | 2.4 | 15.6 | 6.2 | 4.8 |
| TOTAL sample weight (kg) | | 0.874 | 0.148 | - | 0.580 | 1.986 | 2.042 | 0.668 | 0.227 |

Note: All values in percentages with * indicating trace amounts, except SBA-88 (A = abundant, P = present). Data from Erlandson et al. 1993, Santoro et al. 1993, personal notes, and Ricketts, Calvin, and Hedgepeth 1968. All quantitative shellfish data are based on 1/8-inch screen recovery, except SBA-1982, where 1/4-inch screens were used.

over burials in Santa Barbara Channel cemeteries, and the occurrence of four plummet-shaped or cylindrical charmstones among the rocks led Chumash elders to conclude that the features were related to mortuary or other ceremonial contexts. Santoro et al. (1993:6–88) argued, however, that the features were not associated with burials or ceremonial activities. Because excavations were limited to horizontal exposures of the sediments overlying the rock features, this issue was not resolved. Given the association of numerous manos and metates, charmstones, a human tooth (Hudson 1993), red abalone shells, and shell beads with the rock features, however, it seems likely that they were related to an underlying cemetery or other ceremonial activities. If so, SBA-1900 may have been a village, although the low-density of site constituents and the tight clustering of $^{14}C$ dates suggest that it was occupied for a relatively short period of time.

**SBA-1808.** Located on the coastal bluffs on the rim of Cañada Agua Caliente, this large but low density site has been dated to about 3300 RYBP. About 28 $m^3$ of sediment

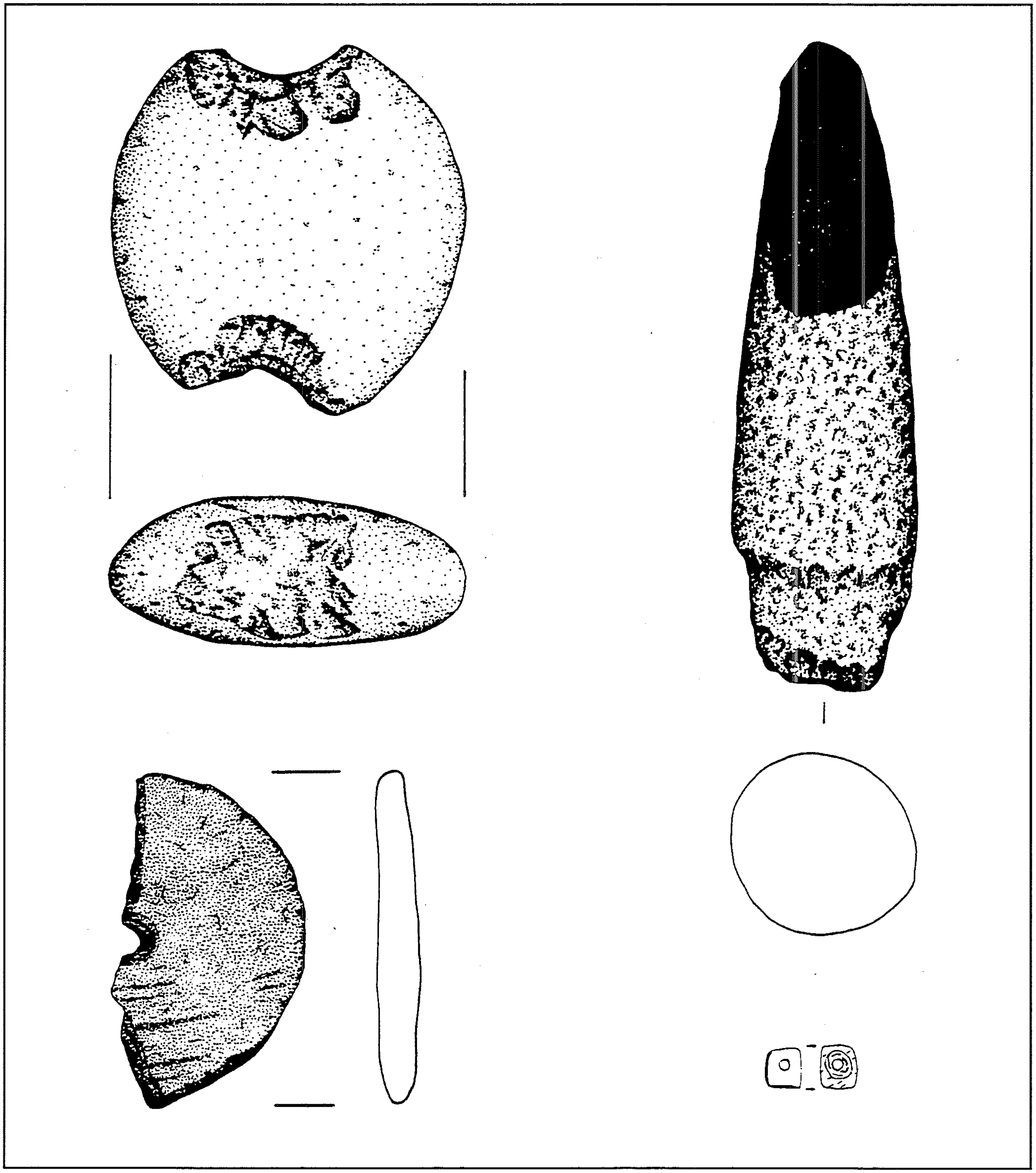

Figure 7.3 Artifacts from SBA-1900: *Upper left*, #504-252, notched stone fishing weight; *upper right*, #504-275, charmstone with asphaltum; *lower right*, #504-462, rectangular *Olivella* bead; *lower left*, #504-273, ground shale disk fragment. Actual size. *Drawings by Pam Easter. Reproduced courtesy of Ogden Environmental and Energy Services Co., Inc.*

was excavated from various parts of the site, followed by controlled monitoring of pipeline excavations through about 200 $m^3$ of low density site deposits (Erlandson et al. 1993). Surface and subsurface data suggest that the site may contain multiple components, but a spatially discrete locus in the northern site area appears to date solely to the end of the Middle Holocene. This northern locus shows intriguing signs of spatial organization that suggest it may have been a residential base. The shell midden area is relatively small (about 30 x 75 m), however, and the very low density of artifacts and faunal remains across the larger site area suggests that it was occupied for a relatively short period. Very few chipped-stone tools were recovered at the site, although over 19,000 pieces of debitage were identified. Several manos and a fragment of a contracting-stem projectile point were found in the southern site area, but virtually no other diagnostic artifacts were found. Other tools recovered include three chert cores, a quartzite hammerstone, a biface midsection, and several flake tools.

The identifiable shellfish remains are dominated by California mussels (81%) and platform mussels (7%), with almost 95 percent of the assemblage coming from rocky-shore habitats (table 7.3). About 5 percent of the identifiable shell comes from protected bay or estuarine habitats. Pismo clam contributes only a fraction (0.3%) of the assemblage. Interpretation of the vertebrate remains is complicated by severe fragmentation and the abundance of bone that may be natural in origin. Patterns of burning and other data suggest, however, that the remains of sea mammal, fish (anchovy, rockfish, sardine, surf perch, and white croaker), rabbit, medium and large mammals, and undifferentiated small fauna are largely of cultural origin. A dietary reconstruction based on the faunal remains (from 1/16-inch screen) of primarily cultural origin suggests that shellfish provided roughly 53 percent of the meat consumed by the site occupants, with fish providing about 12 percent, sea mammals about 14 percent, and other vertebrates about 22 percent (Erlandson et al. 1993).

### Small Campsites

Four Middle Holocene sites of the western Santa Barbara coast are campsites (or activity areas), sites where only brief occupations took place or nonresidential sites where shellfish or other resource processing took place. Three are described below.

**SBA-2058.** An estuarine shellfish fauna dating to about six thousand years ago was recovered at SBA-2058, located about a kilometer from the coast in the bottom of Agua Caliente Canyon. This small low-density site is exposed in a high bank cut by a stream meander, buried under as much as 6 m of stratified alluvium. It consists of a cluster of burned rock, almost certainly a hearth or rock oven, surrounded by a diffuse scatter of estuarine shell. The small shellfish sample from the site is almost entirely of estuarine origin, dominated by butter clam, venus clam, moon snail (*Polinices lewisii*), and purple clam (table 7.3). Charcoal flecks are also scattered through the 15 to 20 cm thick paleosol, but no tools or diagnostic artifacts were recovered. The site almost certainly was a briefly occupied campsite.

**SBA-72N.** Another buried site is located in the bottom of Tecolote Canyon 2 to 3 m below the surface of a large Chumash village site. It consists of two thin shell-midden lenses associated with weakly developed paleosols. The oldest of these, exposed about 2.9 m below the surface of the flood plain, is dominated by Pismo clam shell and was dated to about 5270 ± 120 RYBP. A second shell midden lens located about 2.5 m below the surface is dominated by California mussel shell, fragments of which were dated to 4920 ± 70 RYBP. A 50 x 100 cm test pit excavated through this upper shell lens produced large quantities of mussel shell but only very small amounts of fish bone, other bone, and chipped-stone debitage. These two shell-midden strata appear to have served as either short-term campsites associated primarily with shellfish collecting or shellfish-processing areas associated with a nearby residential site. The rough contemporaneity of the two buried shell middens at SBA-72 with the residential loci at nearby SBA-75, and the similarity of the shellfish assemblages, suggests that these sites may have been functionally related.

**SBA-2255.** Another small buried site, SBA-2255 is located about 800 m from the beach in the bottom of Cañada Santa Anita. The site, exposed in a stream meander 4 to 5 m below the surface of a wooded stream terrace, is a low-density scatter of rocky-shore shellfish (mussels, chitons, turbans) remains, burned bone, charcoal, and a few chipped-stone artifacts found in a thick paleosol. A shell sample from the site produced an uncorrected $^{14}C$ date of 4310 ± 70 RYBP. The structure and constituents of the site suggest that it was a campsite briefly occupied by a small group of people.

### Lithic Sites

Along the western Santa Barbara coast, a number of lithic sites have been identified on elevated canyon rims of the coastal plain. Several were excavated during archaeological investigations related to recent oil pipeline projects (see Erlandson et al. 1993; Santoro et al. 1993). The tested sites vary in size, structure, and contents, but all are dominated by chipped- and ground-stone tools or tool-making debris. Shell, bone, and other organic remains are either absent or rare in these sites, making $^{14}C$ dating extremely difficult. Study of these lithic sites was designed to determine whether they were limited activity sites for the manufacture of chipped- and ground-stone tools, residential sites focused on the exploitation of plant resources, or residential middens in which shell and bone have been lost to acidic soils or other destructive processes.

Lithic sites that have produced sizable tool inventories include SBA-1878, SBA-1883, SBA-1951, SBA-1952, SBA-2060, and SBA-2382. Ground-stone tools from all six sites were dominated by manos and metates, suggesting that they were occupied prior to about 3500 RYBP. The presence of a few mortar fragments or distinctive side-notched or contracting-stem points also suggests that the sites most likely were occupied after 6000 to 5000 RYBP. SBA-1883 and SBA-2060 are shallow, medium to large (about 40 x 80 m and 100 x 180 m, respectively) sites with relatively low artifact densities. SBA-1951 and SBA-2382 produced fragments of large side-notched points, suggesting that they were occupied sometime between about 6500 and 4500 RYBP.

SBA-1952 once covered an area about 150 x 200 m, with site deposits reaching a depth of up to 90 cm and maximum densities of tools and debitage approaching or exceeding many substantial residential middens located nearby. SBA-1952 rests on a small knoll-like landform overlooking Cañada Cementerio east of Gaviota. Much of the southern half of the site has been destroyed by road construction, but portions of the central and southern site area have been excavated (Erlandson et al. 1993). In all, about 25 $m^3$ of the site deposits were hand excavated, with another 1,600 $m^3$ carefully monitored during mechanical excavations. The recovered artifacts include 109 metate fragments, 93 whole or broken manos, 73 hammerstones (68 flaked and battered core hammers and 5 cobble hammers), 33 cores, 74 flake tools, 12 borers and drills, 4 scraper planes, 12 bifaces, and over 10,500 pieces of chipped-stone debitage. Most bifaces were broken and undiagnostic, but fragments of a contracting-stem point, a corner-notched point, and two intrusive arrow points were identified. Only fifty-six bone fragments weighing 1.14 g were recovered from the test units excavated at SBA-1952. Most of these fragments are the unburned remains of small rodents thought to be natural site constituents. The others include thirty-eight fish scales or small bones, and ten tiny shell fragments, almost certainly introduced into the assemblage accidentally during wet-screening. Thus, virtually none of the faunal remains recovered can be associated confidently with the human occupation of the site. The dearth of faunal remains, despite evidence for extensive small mammal burrowing at the site, seems to be attributable to the acidic soils at the site: fifteen soil samples analyzed had pH readings between 4.95 and 6.15.

Except for the lack of faunal remains (including human bone), these lithic sites are similar in size and structure to a number of primary or secondary villages of the western Santa Barbara coast. The remains of both marine and terrestrial fauna seem to have been lost to acidic site soils, but marine shell could never have been abundant or it would have raised soil pH significantly and left substantial caliche residues in the clay-rich B horizons. The lack of shell or caliche deposits suggests that the site occupants collected little or no shellfish while living at the sites. This could be a seasonal phenomenon, but it supports other evidence that shellfish productivity declined in many areas of the western Santa Barbara coast during the Middle Holocene. Together with the strong emphasis on grinding implements, the lack of shellfish and a dearth of tools associated with fishing suggests that SBA-1878, SBA-1883, SBA-1952, and SBA-2060 are more terrestrially-oriented aspects of Middle Holocene settlement along the western Santa Barbara coast.

## ENVIRONMENTS AND ADAPTATIONS

### Coastal Environments

Shellfish remains from archaeological sites provide an opportunity to identify changes in coastal geography and intertidal habitats through time. During the Early Holocene, evidence from a number of sites indicates that rapidly rising sea levels flooded the mouths of coastal canyons, forming productive bays and estuaries along the western Santa Barbara coast. These protected habitats attracted a variety of aquatic and terrestrial resources that were a magnet for early human settlers (Erlandson 1988b, 1991a, 1994). During the Middle Holocene, there is evidence for greater spatial and temporal variation in the distribution of coastal habitat types. Despite this diversity, some recurring patterns are evident in the archaeological record.

**Bay and Estuary Habitats.** The earliest Middle Holocene assemblages from the western Santa Barbara coast all contain estuarine shellfish remains. This is true of SBA-96 and SBA-97 at Gaviota (dated between about 6640 and 5900 RYBP), SBA-2058 in Cañada Agua Caliente (dated to about 6000 RYBP), and the lower levels of SBA-88 at Refugio (dated to about 5800 RYBP). The estuarine shellfish assemblages in these sites are relatively sparse, however, when compared to several Early Holocene middens in the same area (see Erlandson 1994). After about 5800 RYBP, estuarine shellfish are absent or rare in Middle Holocene sites of the western Santa Barbara coast, although bay and estuarine shellfish assemblages do not completely disappear from local sites after this time. Small amounts of bay or estuarine shell were found at the 3300-year-old SBA-1808, for instance, and estuarine shell is common in surface assemblages at the historic village of Mikiw (SBA-78). Late Holocene shell middens at the mouth of Tecolote Canyon also contain substantial amounts of estuarine shell, although these may have been obtained from the nearby Goleta Slough. In general, however, the declining number and density of estuarine shell middens over time suggests that protected bay and estuarine habitats were disappearing or declining in productivity after about six thousand years ago. This process, predicted by Inman (1983:19) and others (chapter 2), coincides with the dramatic slowing of postglacial rise in sea level and the accumulation of sediments in the mouths of coastal canyons.

**Exposed Sand Beaches.** Between Refugio and Tecolote Canyons, Middle Holocene sites consistently contain large proportions of Pismo clam shells, a species abundant in surf-swept and relatively stable sandy beaches of the outer coast. A number of these sites (SBA-72N, SBA-75, SBA-76, SBA-

81N) have been dated between about 5200 and 4800 RYBP. No quantitative data are available for the Middle Holocene shellfish assemblage at SBA-78, but a suite of $^{14}C$ dates on Pismo clam shells range between about 6830 and 3700 RYBP. Some later sites, like the 3300-year-old SBA-1733 in Corral Canyon, also have shellfish assemblages rich in Pismo clam (Neff 1983). Clearly, sand beaches were widespread in the area during the Middle Holocene, and people regularly dug shellfish from them.

This shift towards the more intensive exploitation of high-energy sand beaches is most likely related to geomorphological changes along the western Santa Barbara coast. Extensive sand beaches may have existed during the Early Holocene, but people perhaps did not collect shellfish from them because digging for Pismo clams was less productive than collecting estuarine clams. Geological models suggest, however, that the appearance of extensive sandy beaches is linked to stabilizing sea levels, estuarine infilling, and intensified coastal erosion (Inman 1983). As long as estuaries and submarine canyons were present at the mouths of coastal canyons, they trapped or diverted coarse sediments carried by coastal streams and littoral currents, limiting sand buildup on beaches of the outer coast. As the rise in sea level slowed, estuaries and submarine canyons filled with sediment, and sand was carried onto the beach and dispersed by long-shore drift. Thus, the declining productivity of estuaries on the western Santa Barbara coast probably coincided with the increasing productivity of sandy beaches, leading people to shift their shellfish harvest from one habitat to another.

**Exposed Rocky Coast.** Several Middle Holocene sites contain large proportions of shell from exposed rocky coasts. These assemblages are dominated by mussels but also include chitons, crabs, barnacles, and other rocky shore shellfish types. Many of the sites with abundant rocky-coast fauna are also rich in Pismo clam shell, especially those sites in the eastern part of the study area. This suggests that many sites were located close to a mosaic of coastal habitats in which sandy beaches were interspersed with rocky headlands or other eroding rock outcrops. To the west, exposed rocky shorelines seem to have been the primary intertidal habitat, as a number of sites (SBA-1808, SBA-2067, SBA-2255, SBA-1900, and SBA-1982) dating between about 4740 and 3300 RYBP are dominated by mussels and other rocky-shore taxa. This area seems to be transitional, as Santa Barbara County shell middens north of Point Conception are almost all dominated by California mussels throughout the Holocene. Just north of Point Conception, a large dense midden (SBA-1666) dated between 6800 and 5800 RYBP is comprised almost entirely of California mussel shell (Erlandson et al. 1993).

### Middle Holocene Population Levels

Most scholars of Santa Barbara Channel prehistory think population growth was a major contributor to the cultural changes that occurred in the area over the past ten thousand years. Unfortunately, measuring changes in human population in the past is difficult. One crude measure is changes in the number of archaeological sites for various time periods. Such figures assume all archaeological sites have been equally well preserved, that each site was occupied by a similar number of people, and that the sampled sites are representative of the past. None of these assumptions is likely to be strictly true, but changes in the number of sites may provide a general idea of population levels through time.

Along the western Santa Barbara coast, eleven sites seem to be reliably dated to the Early Holocene. In contrast, twenty-four sites have produced Middle Holocene dates (counting individual site loci at SBA-75 and SBA-78 separately). By themselves, these numbers suggest that significantly more people lived in the area during the Middle Holocene. These figures may be misleading, however, since the Early Holocene sites all fall within a 1500-year time period, representing 7.3 sites per millennium. For the roughly 3330 years of the Middle Holocene, the twenty-four dated sites also represent 7.3 sites per millennium. Perhaps all sites should not be given equal weight in estimating past population levels, since some were small campsites, others small villages, and still others large villages.

To correct for this problem, I devised a crude (and somewhat subjective) measure that takes into account general differences in the size, density, and contents of individual sites. I gave nominal rank scores to each $^{14}C$ dated site based on its classification as a campsite or activity area (score = 1), secondary village (score = 4), or primary village (score = 8). The exponential growth in the scores reflects the fact that a single person or small group could produce some of the campsites in the area within a few days or weeks, whereas the villages represent considerably more sustained occupation by larger groups of people. Using this method, I arrived at similar population scores of 26 per millennium for the eleven Early Holocene sites (total score = 39) and 28 per millennium for the twenty-four Middle Holocene sites (N = 92). These scores still imply very little population increase from the Early Holocene to the Middle Holocene. If the six sizable lithic sites that appear to date to the Middle Holocene are added to the calculations as secondary villages, however, they increase the population score for the Middle Holocene to about 35 per 1000 years (N = 116). This represents a 35 percent increase over the course of the Middle Holocene, a figure that does not seem especially dramatic. It should be noted, however, that population densities along the environmentally circumscribed Santa Barbara coast may have increased gradually even if the number of people living in the area remained roughly the same. This is true because sea level rise and coastal erosion continued to gradu-

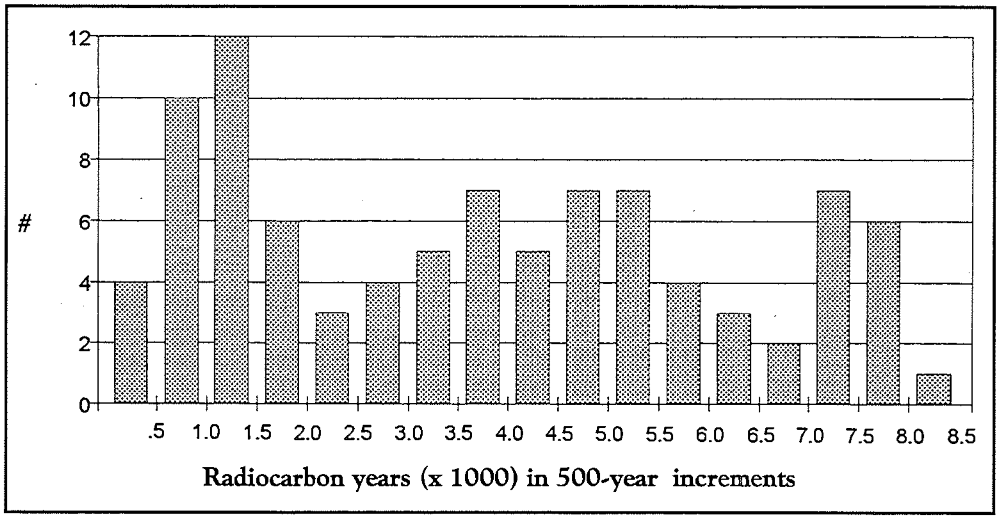


Figure 7.4 Temporal distribution of $^{14}C$ components for the western Santa Barbara coast

ally reduce the width of an already narrow coastal plain, independently increasing the density of coastal populations.

As a final measure of long-term population trends, I calculated the total number of $^{14}C$ components (see Glassow, Wilcoxon, and Erlandson 1988) represented by the radiocarbon dates available from sites of the western Santa Barbara coast. To avoid biases caused by intensive dating programs at individual sites, I counted all dates from a site that fall within a given time interval as a single component. Dividing the Holocene into three equal 3330-year intervals, I broke 134 $^{14}C$ dates from my study area into 500-year intervals (fig. 7.4). This resulted in a total of 94 $^{14}C$ components, 16 from the Early Holocene, 36 from the Middle Holocene, and 42 from the Late Holocene. The distribution of dated sites through time shows some fluctuations that may be the result of sampling errors, but some of the patterning may be significant. Although the highest value for the Early Holocene equaled the highest for the Middle Holocene, for instance, the number of $^{14}C$ components per 500-year interval was consistently higher for the Middle Holocene. Population densities may have gradually expanded along the western Santa Barbara coast through time. It is likely that population growth was neither continuous nor even, and population declines such as those hypothesized by Glassow, Wilcoxon, and Erlandson (1988) may have occurred. Particularly interesting in this regard is the low frequency of dated sites between 7000 and 5500 RYBP, a period when Glassow, Wilcoxon, and Erlandson (1988:72; chapter 6) suggested that population densities may have declined because of increased aridity and lower terrestrial productivity.

### Technological Developments

Increases in population density and a decline in the productivity of estuarine resources—particularly shellfish—may help explain some of the technological changes that occur along the western Santa Barbara coast during the Middle Holocene. Perhaps the most significant of these is the appearance of stone mortars and pestles, which may occur as early as 5800 RYBP at SBA-88. Historically, mortars and pestles were used by California Indians to process a variety of foods, but their appearance in the archaeological record is often thought to signal the first intensive use of acorns and other pulpy plant foods. The earliest use of stone mortars along the western Santa Barbara coast needs to be more firmly dated, but there is little question that mortars become increasingly important at some Middle Holocene sites. Even so, mortars and pestles make up a small percentage (7%) of the milling equipment even at 3500-year-old SBA-1900, where metate fragments outnumber mortar fragments 7.7 to 1. This ratio is very different than at some sites of the central Santa Barbara coast; the 4600- to 5000-year-old SBA-53, for example, produced roughly equal numbers of mortars, pestles, manos, and metates (Harrison 1964:60–65). Along the western Santa Barbara coast, the appearance of mortars may represent a significant broadening of the resource base, but old patterns seem to have considerable longevity.

Another addition to Middle Holocene technologies is the appearance of large side-notched points. At present, it is not certain when such points first appear on the Santa Barbara coast, but they are the dominant type found at SBA-53. It is also unclear whether this was a stylistic or functional change, a broadening of the subsistence base, or an intensification of mammal hunting. The data available from the western Santa Barbara coast do not shed much light on these problems. It should be noted, however, that similar changes in projectile points take place over a vast area of North America between approximately four thousand and six thousand years ago (see chapter 1). This suggests that the appearance of such points along the Santa Barbara coast is related to very broad patterns of technological change and cultural interaction.

Other technological changes that may first appear during the Middle Holocene include the first well-documented appearance of square or rectangular *Olivella* beads, notched-stone net sinkers, and tarring pebbles. C. King (1990:285) noted a few rectangular *Olivella* beads from two Santa Barbara Channel sites (SBA-142 and SRI-3) attributed to phase X of his Early period (ca. 7500 to 6000 RYBP). Both these sites are now known to contain multiple components, however, and each has produced Middle Holocene radiocarbon dates (Erlandson 1994:189; Erlandson, Colten, and Glassow 1988). Like side-notched points, rectangular *Olivella* beads are found over much of California and the western Great Basin during the Middle Holocene. Since many shell beads found in sites of the southwestern Great Basin are thought to have been traded from the Santa Barbara Channel and surrounding areas of the California coast (Bennyhoff and Hughes 1987:155), it seems likely that the appearance of such beads on the Santa Barbara coast is more of a home-grown invention. In fact, this trade—evident in the presence of Great Basin obsidian in most Middle Holocene sites of the Santa Barbara coast—may account for the diffusion of side-notched points and other cultural innovations.

Notched cobbles that appear to have been used as net sinkers or fishing weights (see chapter 11) are also likely to be a local invention and appear to be another innovation in the development of fishing technologies by Santa Barbara Channel peoples. Previously thought to have initially appeared about twenty-five hundred years ago, SBA-1900 and SBA-88 produced notched stone weights from contexts that appear to date to about 5800 and 3500 RYBP, respectively. At SBA-1900, the use of net weights appears to correlate with a fish assemblage dominated by nearshore species typically caught in beach seines (Salls 1993). Some of these same species (white croakers, and so on) are also found in Early Holocene middens in the Gaviota area, but notched stones have yet to be found in those sites.

Tarring pebbles are small rounded stones used to coat the inside of baskets with a watertight asphaltum seal. These were heated, placed inside a basket with a lump of tar, and swirled around to coat the basket interior with a layer of melted tar. At SCRI-333 on Santa Cruz Island, asphaltum basketry impressions have been found in contexts dated between 4000 and 3300 RYBP. On San Nicolas Island, two Middle Holocene sites have produced basketry impressions: SNI-11 dated to 3980 ± 100 RYBP and SNI-40 to 4160 ± 140 RYBP (Bleitz 1991). On the western Santa Barbara coast, tarring pebbles from the 3800- to 4300-year-old buried midden at SBA-2067 are in line with these island dates. Twined basketry is now known to extend back to the Early Holocene in the Santa Barbara Channel area (Connolly, Erlandson, and Norris 1995), but these dates suggest that baskets waterproofed with melted tar were a Middle Holocene innovation in the Santa Barbara Channel area.

### Settlement Patterns

Along the western Santa Barbara coast, Middle Holocene sites vary considerably in size, structure, setting, and in the density and diversity of their contents. They range from large villages to small campsites or activity areas, from dense shell middens to sites containing almost nothing but chipped- and ground-stone artifacts, and from sites located on the high bluffs along the current shoreline to those located on low stream terraces a kilometer or more from the sea. Of the twenty-four Middle Holocene site loci that have been radiocarbon dated, I classified only two as primary villages, eighteen as secondary villages, and four as short-term camps or activity areas. In reality, however, the secondary villages are a varied group of sites that probably encompass a range of site types falling somewhere between large permanent villages and short-term campsites.

It is often assumed that California's coastal peoples became more sedentary through time. I recently examined the evidence for Early Holocene settlement along the western Santa Barbara coast, however, and concluded that settlement as much as eighty-five hundred years ago may have been similar to that of the Barbareño Chumash pattern when Europeans first entered the Santa Barbara Channel (Erlandson 1994:259). The Chumash were semisedentary, living in a central residential village most of the year, with people dispersing to satellite camps or smaller seasonal villages to fish, gather acorns, and so on. The main residential village of a Chumash social group was often occupied for many years and contained permanent or semipermanent houses and other structures, as well as discrete cemetery, food processing, workshop, and ceremonial areas. Village sites of the coastal Chumash, therefore, were generally large and dense aggregations of residential refuse, architectural features, and refuse from a variety of activities. Favored village locales—what I have called primary villages—where resources were especially abundant or where political and trade activities were centered may have been occupied by large populations for generations.

During the Middle Holocene, there is little evidence for this kind of sustained occupation along the western Santa Barbara coast. Based on the available data, only SBA-78 and SBA-88 are both large and relatively dense accumulations of midden refuse, with substantial cemetery plots. Many of the sites classified as secondary villages are also relatively large and seem likely to have been residential bases occupied for substantial parts of an annual cycle. Many of these probably were occupied for several years sequentially or at least on multiple occasions. For most, however, the site deposits are not particularly deep, the density of artifacts and faunal refuse is relatively low, and—for those that contain cemetery plots—the number of burials seems to be small. After examining a number of these sites, my impression is that many were villages occupied for a relatively small number of years.

Nonetheless, only four small or ephemeral campsites or other limited activity areas dated to the Middle Holocene have been identified in my study area. Three of these small sites are buried in canyon-bottom alluvium, however, and so they may be more numerous than the known archaeological record implies. Nonetheless, it seems clear that Middle Holocene peoples of the area were neither highly mobile nor highly sedentary. Settlement was probably semisedentary, with villages being moved frequently but not necessarily on a seasonal basis. Along the western Santa Barbara coast, it seems more likely that Middle Holocene peoples often moved all but their most favored (primary) village sites every few years. People may have moved their villages in response to the overexploitation of local food resources. The declining productivity of Middle Holocene shellfish beds could have played a major role in such a process. Shellfish are a highly reliable and predictable resource in many environments, but even a few people can quickly overexploit shellfish beds of limited extent. As people had to travel farther to reach productive shellfish beds, the impetus to move the village itself would have grown stronger. Thus, village locations may have been moved every few years to take advantage of relatively pristine shellfish beds, along with other important resources.

### Subsistence Patterns

Sixty-five years ago, D. B. Rogers (1929) proposed that his Hunting period (now known to have begun about five thousand years ago) was marked by an increase in the amount of mammal and fish bones found in archaeological sites of the Santa Barbara coast. There is considerable evidence for Middle Holocene subsistence from sites of the western Santa Barbara coast. The abundance of metates and manos at many Middle Holocene sites, for instance, suggests that small seeds and other plant foods continued to be important resources. Qualitative and quantitative data on the artifactual and faunal constituents of various sites suggest that people were expanding the breadth of their economies somewhat, possibly in response to local or regional environmental and demographic changes.

To gain a detailed understanding of the causes and consequences of changes in human subsistence, more than anecdotal or qualitative data are needed. Unfortunately, only two sites of the western Santa Barbara coast have produced quantitative faunal data suitable for dietary reconstructions. Earlier, I estimated the contribution of various classes of animals to the meat or protein intake of the occupants of SBA-1808 and SBA-2067. These estimates are rough approximations subject to a variety of sources of error (see Erlandson 1994:57–58, 111–113), but when used consistently they provide an opportunity to study synchronic and diachronic changes in human subsistence and adaptation. SBA-2067 and SBA-1808 date to about 4000 and 3300 RYBP. These dietary reconstructions suggest that shellfish were relatively important sources of animal protein even during the later Middle Holocene, contributing between 50 and 62 percent of the totals. These percentages compare with an average value of 77 percent for three Early Holocene shell middens from the same area (Erlandson 1994).

Such data are needed from many more sites before we can understand how human subsistence changed through time—and varied at any given time—along the western Santa Barbara coast. Generally, however, the available data suggest that human subsistence varied considerably during the Middle Holocene, with variability in the importance of shellfish, plant versus animal foods, and in resources from the land versus the sea. Variations in the quantities of milling tools at various sites also implies significant diversity in the subsistence of Middle Holocene peoples of the area. Particularly interesting is the persistence of milling stones at SBA-78 and SBA-1900, in contexts dated to about 3500 RYBP, while roughly contemporary sites like SBA-1808 and SBA-2067 produced few milling tools. At present, it is not clear whether this adaptive variation is attributable to differences in the season of site occupations, site function, local resource distributions, or other factors.

## SUMMARY AND CONCLUSIONS

On the western Santa Barbara coast, Early Holocene economies emphasized shellfish and plant foods, with settlement focused around small estuaries formed by rapidly rising sea levels. The technology, economy, and social structure of these early groups is relatively simple compared to those of the Chumash people who occupied the same area during the past two thousand to three thousand years. By six thousand years ago, most of the estuaries of the western Santa Barbara coast were gone, victims of slowing sea-level rise and sedimentation. During the Middle Holocene, shellfish exploitation focused on sandy beaches and rocky shores, and the dietary significance of shellfish declined as other animal foods became more important. New technologies were introduced during the Middle Holocene, with the first appearance of mortars and pestles, large side-notched and (later) contracting-stem points, notched stone weights, tarring pebbles, and new bead types. These developments, along with an apparent increase in the number of charmstones found in Middle Holocene sites, may be related to a gradual process of subsistence diversification and cultural elaboration evident in other areas of the Santa Barbara Channel and the Southern California coast. The primary processes that stimulated these developments were probably increases in population density, environmental changes, periodic imbalances between human populations and food resources (resource stress), and—importantly—interaction with neighboring groups and the spread of new ideas and technologies that accompanied long-distance trade.

The available data suggest that Middle Holocene peoples of the western Santa Barbara coast followed a somewhat different developmental trajectory than contemporary peoples in surrounding areas. The lack of Milling-Stone sites on the Channel Islands is well documented, for instance, and is most likely the result of local environmental differences— in this case a dearth of island plants that produced abundant edible seeds. For the central Santa Barbara mainland coast, groundstone assemblages dominated by manos and metates are largely replaced by those dominated by mortars and pestles between about 5000 and 4000 RYBP (chapter 6; Glassow, Wilcoxon, and Erlandson 1988). On the western Santa Barbara coast, however, assemblages dominated by manos and metates persist in some sites until at least 3500 RYBP and perhaps considerably later. Other Middle Holocene sites in the area have produced very few milling tools at all.

Such variation led Harrison (1964; Harrison and Harrison 1966) to propose that late Milling-Stone peoples at SBA-78 and SBA-119 (at Rincón) coexisted with intrusive Hunting peoples (who lived at SBA-53 and other sites) on the Santa Barbara coast for one thousand years or more. The archaeological record from the western Santa Barbara coast suggests to me, however, a combination of functional variability between sites and diverse adaptive responses to local environmental conditions. Glassow's (chapter 6) suggestion that the importance of mortars and pestles at SBA-53 between 5000 and 4600 RYBP may reflect their use in pulverizing pulpy roots abundant in the marshlands of the Goleta Slough is particularly intriguing. If so, the persistence of manos and metates in assemblages of the western Santa Barbara coast (and at SBA-119) might result from the loss of estuarine and marsh habitats during the Middle Holocene. A more pronounced shift to mortars and pestles along the central Santa Barbara coast might also reflect the greater abundance of oak trees in the locally much more extensive coastal plain and canyon habitats.

I attribute variation in the Middle Holocene archaeological record of the Santa Barbara Channel not to cultural replacement or the coexistence of separate ethnic groups living parallel lives but to the diversification of habitats through time and the increasingly diversified responses of people adapting to local environmental conditions. On the western Santa Barbara coast, this adaptive diversity seems to have included the more frequent movement of village sites in response to local resource depletion, a smaller number of large and more permanent villages located in favorable geographic locales, considerable diversity in site economies, and generally lower population densities relative to neighboring groups living in the richer environments of the central Santa Barbara coast.

Archaeologists tend to underemphasize such local variations in their attempts to construct coherent regional syntheses or to fit data from particular sites into such broad reconstructions. The maritime Chumash and their ancestors often have been portrayed as relatively homogeneous cultural entities adapted to fundamentally similar environmental conditions. On one scale this may be true, but evidence from the larger Santa Barbara Channel area now suggests that a rich mosaic of adaptive variation existed at least as early as the Middle Holocene. This cultural diversity— and the nature of its relationship to local environmental variation—is a fascinating topic in its own right (Moss and Erlandson 1995:3).

**Acknowledgments.** I thank Michael Glassow and anonymous reviewers for comments that improved this chapter substantially. Funds for some of the $^{14}C$ dates reported in this chapter were given to the Santa Barbara Channel Radiocarbon Dating Fund by Pacific Pipeline Systems Incorporated (PPSI) and the University of Oregon. Funding for the PPSI dates was facilitated by John Ruiz and John Sespe of the Coastal Band of the Chumash Nation. Thomas Rockwell of San Diego State University graciously arranged for the dating of a $^{14}C$ sample from SBA-2255, and John Johnson, Curator of Anthropology at the Santa Barbara Museum of Natural History, kindly sent me a shell from SBA-88 for dating. Finally, Joyce Gerber of Dames and Moore shared unpublished data on the age of SBA-1675, and Richard Carrico of Ogden Environmental provided reports on recent research on a section of the All American Celeron pipeline that crossed the western Santa Barbara coast.

# Climatic Consequences or Population Pragmatism?
## *A Middle Holocene Prehistory of the Central California Coast*

*Terry L. Jones and Georgie Waugh*

WITH THE INCREASING APPLICATION of optimal foraging and intensification concepts to interpretations of prehistoric hunter-gatherer behavior in California (for example, Basgall 1987; Broughton 1994a; Erlandson 1991a), archaeologists face an emerging challenge to evaluate economic behavior relative to environmental context and to distinguish environmental causality from population-induced subsistence change. Alternative perspectives on this issue have been demonstrated recently in coastal and interior environmental settings. Basgall (1987), Basgall and Hall (1992), and Hildebrandt and Mikkelsen (1993) develop models in which economic intensification is seen as largely unrelated to environmental change. Others (for example, Cleland and Spaulding 1992; Glassow, Wilcoxon, and Erlandson 1988) argue for causal relationships between diachronic environmental variability and transitions in subsistence and mobility. Intimately related to these efforts are ongoing attempts to evaluate the relative subsistence utility of coastal versus terrestrial resources and habitats. Marine environments provide a unique setting with which to evaluate alternative perspectives on environment because of the dramatic effects of sea-level rise during the Early and Middle Holocene. Consideration of the Middle Holocene prehistory of the central coast raises issues that speak directly to alternative perspectives on environmental causality and the relative value of marine versus terrestrial resources.

The Middle Holocene in western North America is generally perceived as a period of warm, dry climate (Antevs 1948; Byrne, Busby, and Heizer 1979). As a consequence, many regional prehistories portray the era as one of cultural adjustment to severe conditions (see Antevs 1952; Baumhoff and Heizer 1965). Owing to an absence of regional data, events transpiring on the Central California coast have often been considered largely in conjectural terms: the coast was envisioned as a potential refuge from the severe interior conditions (Moratto, King, and Wolfenden 1978:158) or as an area directly affected by drought and decreased environmental productivity (Heusser 1978). Data accumulated in the last fifteen years finally allow the central coast to speak for itself. The portrait that emerges is one of distinctive local complexity as environmental flux through the Middle Holocene appears to have varied markedly throughout the region. Against this complex and varied backdrop, the Middle Holocene, particularly the period from 4000 to 3500 BC, marks a major cornerstone of cultural change. The trajectory and character of this change is considered here for the purposes of evaluating possible causal relationships between the paleoenvironmental record and human economic behavior and examining the direction of subsistence change vis-à-vis marine versus terrestrial emphases. Toward these goals, we examine the particular environmental settings along the central coast and the context and consequences of those settings as they relate to Middle Holocene human activity as reflected in artifact assemblages, dietary practices, settlement pattern, exchange, and human osteology. We conclude that environmental influence is readily apparent in unstable settings (for example, estuaries) at certain points in time but that broad-scale/low-intensity environmental change did not have uniform influence over the entire region and was less significant than localized variability. Broad-scale uniformity of Middle Holocene cultural changes, however, implicates population dynamics as a major causal variable. Marine resources were used throughout the Middle Holocene, but significant differences are apparent between open coasts and estuaries and in the relative intensity of use of different marine foods, particularly fish and shellfish.

Classificatory terms that identify variation in this regional and local cultural history pose a major problem in coastal

California. Middle Holocene transitions are variously referred to as the Lower/Middle Archaic transition in northern California (Fredrickson 1974, 1984), the Ex/Ey transition in the Santa Barbara Channel (C. King 1990), and Initial Early/Terminal Early in the Vandenberg area (Glassow 1992b). Throughout most of California, tool assemblages marking the early Middle Holocene are dominated by milling slabs, handstones, cobble and other core tools, and flake tools, with a low incidence of projectile points. First identified in Southern California, this milling-stone–dominated technology served as the hallmark for the Milling-Stone horizon (Wallace 1955). The assemblage has since been recognized in Central and Northern California (Cartier 1993a; Fitzgerald 1993; Hildebrandt 1983; McGuire 1994; Meyer, Rosenthal, and White 1994; True, Baumhoff, and Hellen 1979) in early Middle Holocene contexts. In most regions, the base tool inventory of the Milling-Stone horizon was augmented by an increased diversity of projectile point types and the mortar and pestle around 3500 BC[1]. In some areas, the assemblage transition was accretionary; in others, a wholesale replacement is evident; and in still others (for example, San Diego County) little or no change occurred. Because this technology was not restricted to the Early Holocene and persisted until historic contact in some locations, the Milling-Stone horizon has always been considered a problematic cultural historical unit. To recognize what we believe is meaningful regional patterning in Middle Holocene assemblages, and as a compromise among competing cultural historical schemes, nomenclature developed for the central coast portrays a large-scale transition circa 3500 BC between the Milling-Stone and Early periods (T. Jones 1993; Jones and Waugh 1995). The Milling-Stone period is roughly equivalent to Fredrickson's Lower Archaic and C. King's Phase Ex; the Early period equates with Fredrickson's Middle Archaic and King's Phases Ey and Ez.

## ENVIRONMENTAL CONTEXT

Shoreline along Santa Cruz, Monterey, and San Luis Obispo counties can be classified as one of two types: open-coast beaches (that is, unprotected surf-swept shore)or rocky headlands and lagoon or estuaries. The latter, products of the drowning of river valleys during late Pleistocene/Early Holocene rise in sea level, provide significant shelter from the open ocean. The central coast is dominated by exposed shoreline with a mixture of rocky and sandy substrates that have shifted in expanse throughout the course of the Holocene. Major estuaries/lagoons are presently found at Elkhorn Slough (fig. 8.1) and Morro Bay (fig. 8.2). Preliminary excavation findings from the Pismo Beach area (Gibson 1981) suggest that a similar system was present in that locality prehistorically (Dills 1981). Perlman (1980) and T. Jones (1991) suggest that estuaries rank above exposed coasts in human resource potential because of dense packing of potential food commodities.

The terrestrial environment of the central coast is diverse, owing to its hydrographic and climatic variability. Vast tracts of land support grassland and oak woodland, while within reach of the summer fog belt, redwood forest occurs at moderate elevations in the coastal mountains. In precontact times, marshland, associated with the edges of estuaries and small inland lakes, made up a significant proportion of the central coast landscape. Lacustrine habitats of potential importance to prehistoric humans have been identified in the southern Santa Clara Valley (Lake San Felipe [Jenkins 1973] and Laguna Seca) and possibly at Scotts Valley in Santa Cruz County (Cartier 1993a). Freshwater shellfish remains (*Anodonta* sp., *Margaritifera margaritifera*, and *Gonidea angulata*) have been recovered from the former shoreline of Lake San Felipe (Hildebrandt and Mikkelsen 1993). T. Jones (1991) and T. Jones and D. Jones (1992) suggest that these lakes were as attractive to early human colonists as were the estuaries. Based on findings from test excavations in the Gilroy area, however, Hildebrandt and Mikkelsen (1993) portray San Felipe Lake as a relatively low-ranked habitat, which became a focus of Late Holocene lacustrine intensification.

The central coast vegetation mosaic harbors a variety of large-and medium-sized terrestrial mammals, including black-tailed deer (*Odocoileus hemionus*), bobcat (*Lynx rufus*), coyote (*Canis latrans*), gray fox (*Urocyon cinereoargenteus*), cottontail rabbit (*Sylvilagus audubonii*), and jackrabbit (*Lepus californicus*). Archaeofaunal data and historic accounts (Gordon 1974:85) indicate that tule elk (*Cervus elaphus*) and pronghorn (*Antilocapra americana*) were once common here as well.

Open rocky shorelines offer a distinctive suite of potential resources. Common shellfish taxa include California mussel (*Mytilus californianus*), barnacle (*Balanus* sp.), limpet (*Collisella* sp.), chiton (*Nuttalina californica*), black abalone (*Haliotis cracherodii*), and black turban snail (*Tegula funebralis*). The red abalone (*Haliotis rufescens*) occurs as well, but only in the low intertidal zone (Ferguson 1984:58). Dense kelp forests, also common along open rocky shores, provide habitat for a diverse array of rock fish including cabezon (*Scorpaenichthys marmoratus*), surf perch (Embiotocidae), rockfish (*Sebastes* sp.), and lingcod (*Ophiodon elongatus*). The exposed shoreline provides an abundance of offshore rocks and secluded nearshore settings used as haulouts and rookeries for large marine mammals. Seasonal migrants include

1 All calendar ages in this chapter are based on radiocarbon dates calibrated and corrected with Stuiver and Reimer's (1986) CALIB program. All marine shell dates were corrected for isotope fractionation (+410 years) and marine upwelling with a Delta R value of -325 + 35 years.

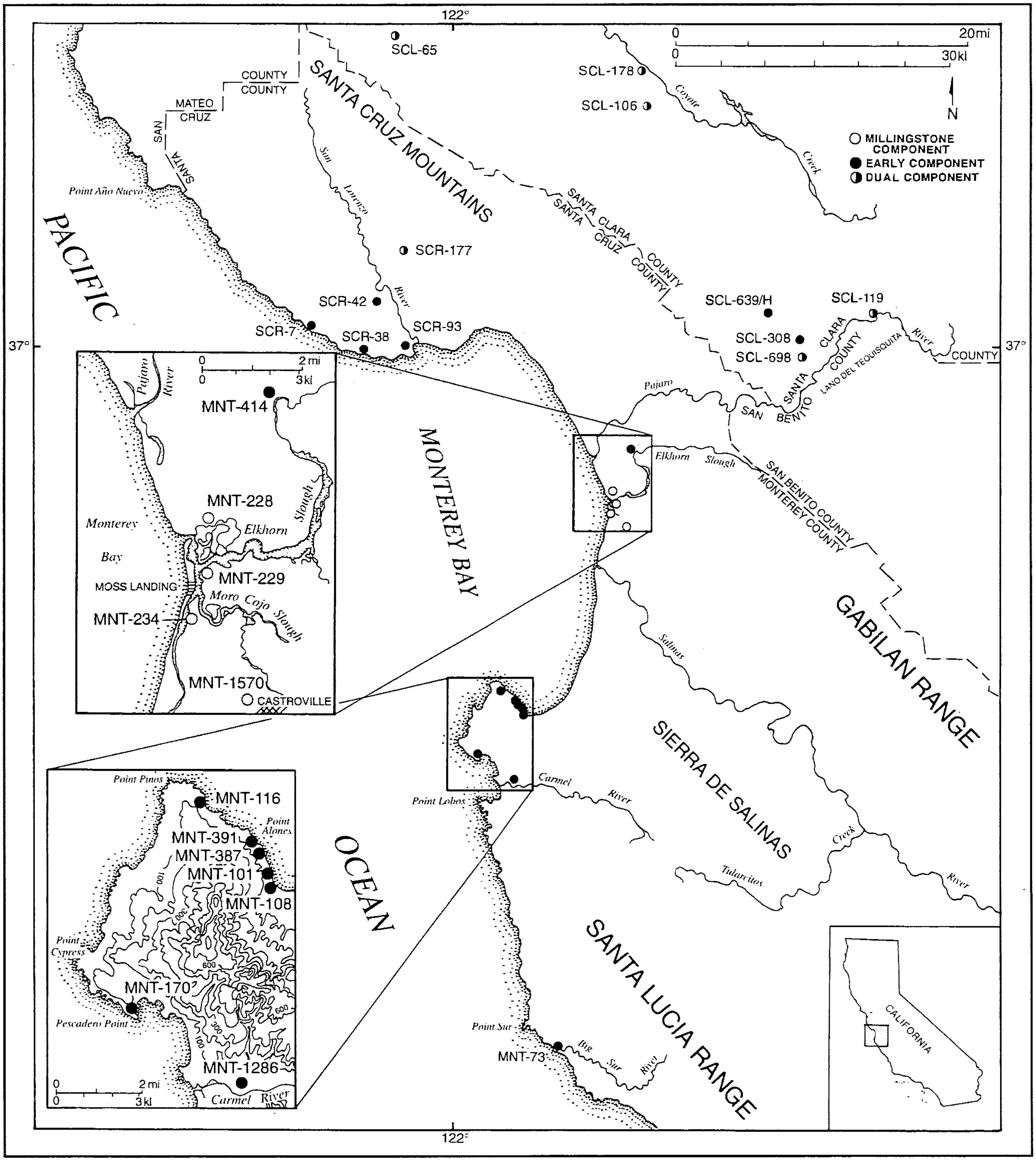


FIGURE 8.1 Middle Holocene archaeological sites in the Monterey Bay and northern Big Sur districts.

the California sea lion (*Zalophus californianus*), Stellar sea lion (*Eumetopias jubata*), northern fur seal (*Callorhinus ursinus*), and southern fur seal (*Arctocephalus townsendi*). Northern elephant seals (*Mirounga angustirostris*) presently breed at Point Año Nuevo in southern San Mateo County. Permanent residents include the sea otter (*Enhydra lutris*) and harbor seal (*Phoca vitulina*).

Central coast estuaries alternately support salt marsh and mud-flat communities, which provide habitat for a distinctive set of calm water-adapted intertidal clams and cockles, including bent-nose clam (*Macoma nasuta*), Pacific gaper (*Tresus nuttalli*), littleneck clam (*Protothaca staminea*), Washington clam (*Saxidomus nuttalli*), and Nuttall's cockle (*Clinocardium nuttalli*). Bay mussels (*Mytilus trossulus*) are also common as are oysters (*Ostrea lurida*) in locations with firm substrates and nearby freshwater outflows. The open

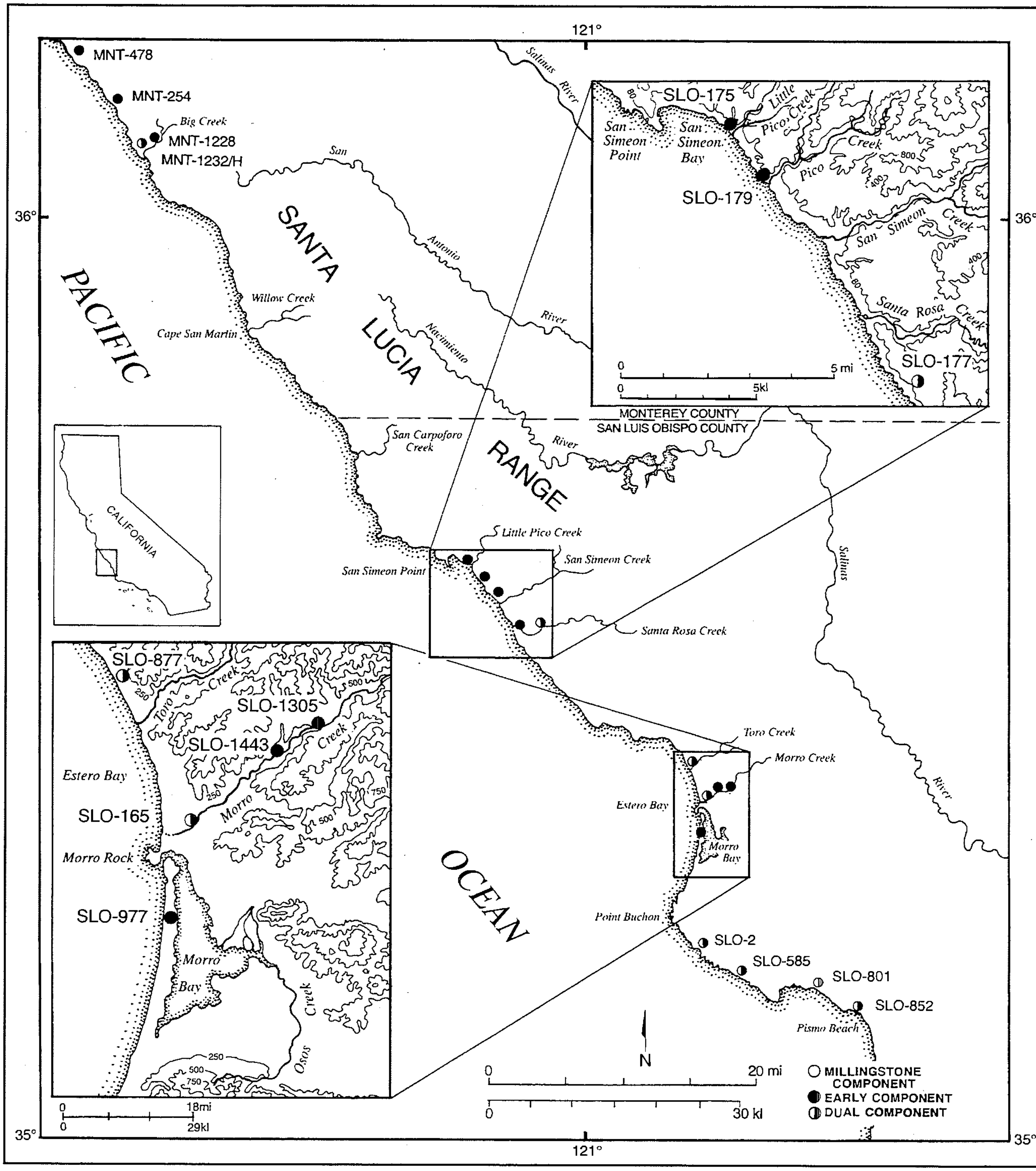


FIGURE 8.2 Middle Holocene archaeological sites in the southern Big Sur and San Luis Obispo districts.

beach Pismo clam (*Tivela stultorum*) occurs in significant frequencies along open beaches only as far north as Estero Bay, with an occasional specimen encountered in Monterey Bay.

Central coast estuarine marshes provide extensive habitat for marine and terrestrial waterfowl. Marine mammals are also found within these embayments, although permanent residents—harbor seals and sea otters—are more common than migratory breeders. Perhaps the most significant resource of the lagoonal habitats is their fisheries. Most thoroughly researched is Elkhorn Slough, where Yoklavich et al. (1991) inventoried a seasonal nursery for a vast number of fish taxa, many of which are not found nearshore on the outer coast. These include bat ray (*Myliobatus californica*), plainfin midshipman (*Porichthys notatus*), skates, sharks, and sculpins (Gobalet and Jones 1995). Some taxa, notably surfperches and the Pacific staghorn sculpin (*Leptocottus* *armatus*), are found within the slough year round. Preliminary studies of the contemporary Morro Bay fishery (Horn and Allen 1976) and archaeological findings (Salls, Huddleston, and Bleitz-Sandburg 1989; T. Jones et al. 1994) indicate that this habitat was equally rich in ichthyofauna.

## SITE VISIBILITY

No discussion of Early and Middle Holocene environmental variability is complete without considering the effects of natural processes on archaeological site visibility and the potential for drawing false or misleading cultural inferences from patterns that are natural in origin. Archaeological research has been pursued on the Central California coast for nearly a century, and the latter half of this work was completed during the radiocarbon era. Thousands of acres have been surveyed, and hundreds of subsurface investigations have been completed, but despite this extensive field effort, few early Middle Holocene components are known. None whatsoever were identified before 1972 and, as recently as 1985, only four had been reported. Three natural processes contribute substantially to the low visibility of early sites in Central California: rise in sea level, coastal erosion, and rapid alluvial deposition. Problems with coastal site visibility are dealt with at length by Bickel (1978). For the most part, these problems increase along a north-south axis, with the greatest amount of land lost to rise in sea level in the north and the least in the south. The amount of coastal terrace lost along the central coast is moderate, but it must still be assumed that many early Middle Holocene deposits have been destroyed.

Problems with alluvial deposition in the interior are equally serious, albeit less frequently acknowledged, and limit our ability to firmly evaluate the relative importance of marine versus terrestrial habitats during the early Middle Holocene. Several key projects demonstrated that Middle Holocene components dating approximately 3000 to 2000 BC commonly occur at prohibitive depths in the interior valleys adjacent to the central coast. These include CCO-308, where a component dating to 2500 BC was found at a depth of 5 m (Fredrickson 1966); the BART skeleton from San Francisco dating to 3710 BC at a depth of 22.9 m (Henn, Jackson, and Schloeker 1972); and CA-SCR-239 in Scotts Valley dating to 3700 BC, beneath 3 m of natural, sterile alluvium (Cartier 1992). With components dating only to late Middle Holocene at such prohibitive depths, it is reasonable to conclude that many early Middle Holocene sites lie buried at depths unreachable by normal archaeological investigation. With higher annual rainfall in the north, these problems become exacerbated on a north-south axis. Any arguments for the relative use of inland versus coastal settings incorporating negative data or those positing relative utility on a north-south axis are likely to underestimate problems of site visibility.

## PALEOENVIRONMENT

### Terrestrial Component

Vegetation histories for the central coast continue to be largely dependent on research completed to the north at San Francisco Bay and to the south in the Santa Barbara Channel. The Middle Holocene has long been portrayed as a time of warmer and drier climatic conditions (Antevs 1948), classified alternatively as the Altithermal, Xerothermic, or Hypsithermal (Porter and Denton 1967). As more fine-grained regional studies have been completed, it has become clear that such conditions were neither constant through the entire Middle Holocene nor as severe as those evident during Pleistocene times.

Compared to the Pleistocene, Holocene climatic changes were relatively minor, and many researchers emphasize the apparent complacency of Holocene pollen profiles (Byrne 1979), particularly on the central coast (Rypins et al. 1989:84; West 1987). There is a considerable difference of opinion on the dating of peak warm conditions and the severity of ambient conditions. In the San Francisco Bay area, Axelrod (1981:850) speculated that drier, warmer postglacial conditions, fostering an expansion of xeric vegetation, culminated sometime around the Middle Holocene. In the Santa Cruz Mountains, this transition is reflected by a decrease in pine and an increase in redwood (Adam, Byrne, and Luther 1981:269). Axelrod (1981:851) further argued that along the coast the effect of ocean waters probably ameliorated climate change. Adam, Byrne, and Luther (1981) have pointed out that the continued high frequency of redwood pollen in the Middle Holocene argues against persistent drought during this period on the coast. In any event, as cooler, moister climates returned following the Middle Holocene optimum, xeric taxa were apparently restricted to local sites in the interior and to the south coast ranges (Axelrod 1981:854).

To the south in the Santa Barbara Channel region, vegetation reconstructions developed from pollen data (Heusser 1978) suggest that the peak of the Middle Holocene warming occurred between 3500 and 2200 BC, reflected by high frequencies of oak and Compositae pollen grains. This dating conforms with Moratto's (1984:548) generalized dating of the Altithermal in California (circa 2600–900 BC). Marine water-surface temperatures were warmer than present between 6000 BC and 3400 BC and cooled noticeably between 3400 and 1800 BC. Pisias (1978:381) suggested that low water temperatures may have been responsible for peak atmospheric warming and drying, because a positive relationship is today evident between surface sea temperatures and rainfall along the California coast. As demonstrated by the El Niño Southern Oscillation of 1983, warm ocean temperatures are often associated with increased winter rainfall and decreased summer fog. The latter increases mean annual temperatures along the coast. Conversely, cool ocean waters are most commonly associated with periods of reduced

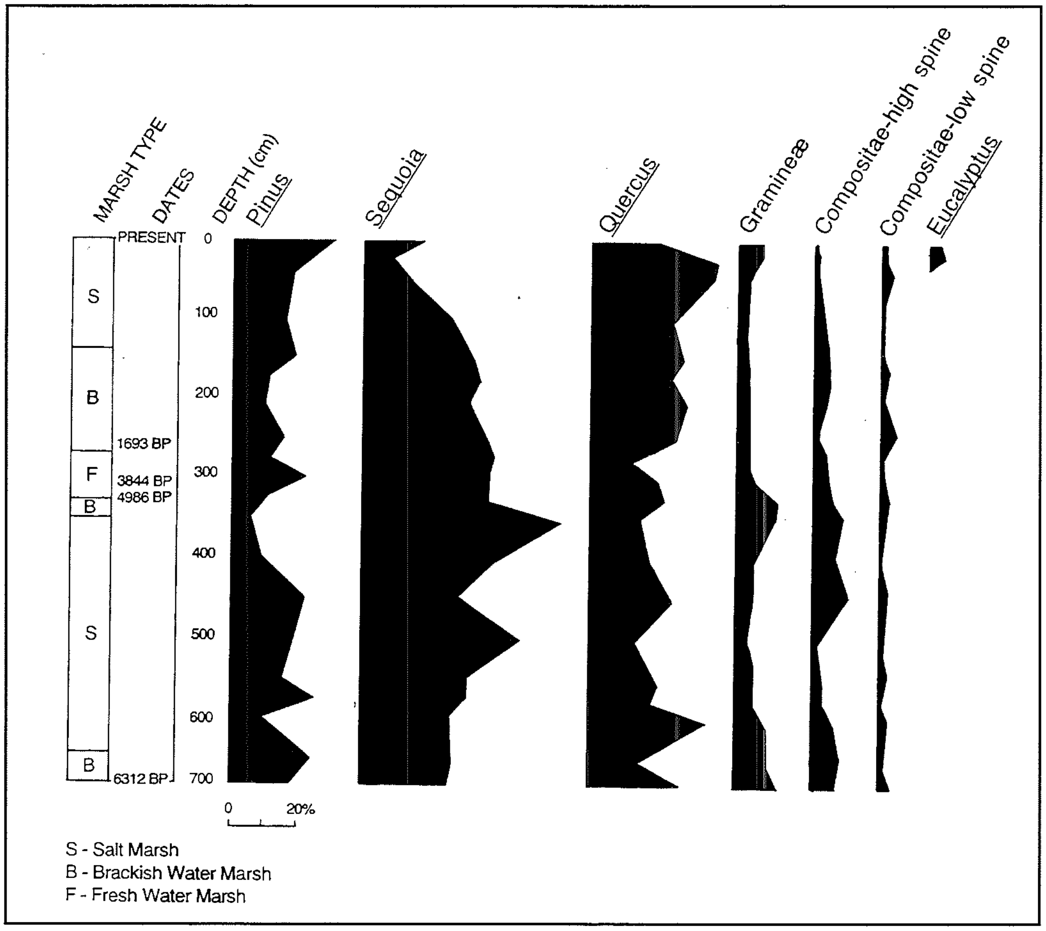


FIGURE 8.3 Terrestrial taxa from the Elkhorn Slough pollen core. *West 1988*

rainfall. Pisias' explanation for contemporaneity between a cold ocean and peak Middle Holocene warming fails to explain the correspondence between warm ocean temperatures and warm climate during the early Middle Holocene. Based on the dating of red abalone middens on the northern Channel Islands, Glassow et al. (1994) confirmed a decline in water temperature circa 3400 BC. Recent oxygen isotope studies from archaeological mussel shells from the channel further corroborate a decline in sea temperature circa 3400 BC. Van Geen et al. (1992) reported evidence from the San Francisco Bay area for a greater upwelling off the California coast circa 2000 BC than at present, which is consistent with lower water temperatures and greater summer insolation. Recent findings from the Sierra Nevada Range suggest that the interior experienced a warm and dry early Middle Holocene climate. Maximal warm dry conditions occurred during the Early Holocene (Davis and Moratto 1988; Smith and Anderson 1992), with a cooling regime beginning as early as 2500 BC (Smith and Anderson 1992:99). As rainfall correlates strongly with latitude in California, these findings suggest that the central coast was likewise drier than present during the early Middle Holocene.

A pollen profile reported by West (1988) from Elkhorn Slough provides the only direct index for central coast vegetation history through the Middle Holocene. Discussed elsewhere in varying detail (Dietz, Hildebrandt, and Jones 1988; T. Jones 1992:14; T. Jones and D. Jones 1992), dating of this sequence, originally tentative, has been refined based on two recently obtained radiocarbon dates. The combined pollen and radiocarbon data reveal an extremely complex sequence reflecting evolution of both the terrestrial and hydrographic landscapes as a result of large-scale Holocene climatic changes and localized stochastic events. Now dated by a total of four radiocarbon assays (table 8.1) the 6.9 m-deep column dates to a maximum of 4363 BC. Pine, redwood, oak, and grass pollen are all present in moderate frequencies in the lowermost levels, but a shift of some significance is evident between 400 and 356 cm, where pine reaches its lowest frequency and oak declines (fig. 8.3). Concomitantly, grasses, high-spine composites, and redwood all appear in increased proportions. Dating circa 3200 BC, this pattern conforms with the decrease in pine and increase in redwood associated with the Middle Holocene in the San Francisco Bay area (Adam, Byrne, and Luther 1981), and likewise seems to correlate with Heusser's (1978) dating of peak warming in the Santa Barbara Channel. As in San Francisco Bay, high frequencies of redwood pollen suggest this was not a period of extended drought.

In summary, Middle Holocene paleoenvironmental reconstructions from adjacent regions including both terres-

TABLE 8.1 Radiocarbon dates from Elkhorn Slough sediment cores

| LAB NO. | UNCORRECTED DATE (YEARS BP) | DEPTH (CM) | CALIBRATED DATE[1] | 1σ PROBABILITY | REFERENCE |
|---|---|---|---|---|---|
| N/A | 1730±130 | 275 | AD 260<br>AD 300<br>AD 320 | AD 120–420 | Schwartz 1983 |
| WSU-3358* | 3550±70 | 313[2] | 1895 BC | 2020–1780 BC | Dietz, Hildebrandt, and Jones 1988:37 |
| Beta-63515** | 4410±60 | 344[3] | 3040 BC | 3290–2920 BC | This chapter |
| Beta-63514** | 5540±60 | 683[4] | 4360 BC | 4460–4350 BC | This chapter |

*Charcoal; **Peat; processed using the AMS technique; corrected for $^{13}C$; 1. Tree-ring calibration via the Stuiver and Reimer (1986) computer program; 2. Mean between 300 and 325 cm; 3. Mean between 337.5 and 350 cm; 4. Mean between 675 and 690 cm.

trial and marine perspectives are not wholly concordant for the central coast. Most suggest the presence of warmer seawater temperatures and warmer and drier climate during the early Middle Holocene (Milling-Stone period). The dating of peak Middle Holocene warming is subject to question, but multiple lines of evidence suggest a cooling of ocean waters circa 3500 to 3000 BC, at the onset of what we here refer to as the Early period. The persistence, indeed an increase, in redwood pollen across this transition suggests that climatic changes occurring across the Milling-Stone/Early period transition represented neither significant deterioration nor improvement in local climate, particularly with respect to the aboriginal resource base. Climatic change was more extreme inland, but could by no means have been severe enough in and of itself to promote major cultural change on the coast.

**Rise in Sea Level and Habitat Change**

The Middle Holocene on the Central California coast is characterized by a marked shift in the rate of rise in sea level, as the Flandrian transgression came to a near halt. According to Atwater, Helley, and Hedel (1977), sea level along the California coast was between 40 and 60 m below the present level circa 8000 BC; by circa 3000 to 4000 BC it had risen to within 10 to 12 m of its present level. Bickel (1978:11) suggests that after 4000 BC, sea-level rise proceeded at a pace of only 1 to 2 m per millennium. Prior to 6000 BC, the rate approximated 20 m per millennium.

The effect of this marked slowing of sea-level rise varies between open coasts and estuaries. On the outer coast, some localities show evidence for wide expansion of sandy beaches as sands accumulated over formerly rocky shores. This process is represented in the shellfish remains from SLO-877 on the open coast of San Luis Obispo County (fig. 8.2), where strata dating between 6000 and 3500 BC show high frequencies of rocky coast taxa: California mussel, turban snail, and barnacle. Beginning at 3500 BC, Pismo clam (an open sandy beach taxon) accounts for nearly 75 percent of the identified species (Breschini and Haversat 1991a; Gibson 1992:8). A different version of this process was identified at SLO-177 and SLO-178 in Cambria on the northern San Luis Obispo coast, where a change from mussel to turban snail is evident circa1000 BC. Rudolph (1985:131) attributed this change to shift in landscape from a stable sea cliff to a boulder-strewn sandy beach as a consequence of slow rise in sea level and accelerated cliff erosion. Not all portions of the outer coast yield evidence for increased sedimentation during the Middle Holocene, however. Littoral sites in Big Sur show no significant taxonomic change in the rocky-coast shellfish assemblage between 4400 BC and AD 1830 (T. Jones and Haney 1992; T. Jones 1995). Indeed, the California mussel was the dominant mollusc exploited throughout the Middle Holocene (table 8.2), reflecting a general diachronic homogeneity in available resources.

The apparent relative constancy of the outer central coast resource base through the Middle Holocene is contrasted markedly by the dynamic environmental histories of Morro Bay and Elkhorn Slough. Archaeological investigations of these two systems have followed the seminal study of environmental change and human response in the San Francisco Bay estuary by Bickel (1978), who outlined a general sequence of Holocene sedimentation applicable to most California estuaries. During the Early Holocene, rise in sea level kept pace with sedimentary deposition within San Francisco Bay, constraining the expansion of mudflats. The Middle Holocene slowing of rise in sea level, however, encouraged the growth of mudflats and marshes, as sediment accumulation outpaced the slowly rising ocean waters.

The smaller central coast estuaries conform only partially with San Francisco Bay. A general trend toward infilling is evident through the Holocene, but the chronology of this progression varies between the smaller systems and San Francisco Bay. Indeed, because of its size, San Francisco Bay might best be considered an anomaly within the broader configu-

TABLE 8.2 Percentage summary of shellfish from exposed central coast sites

| | *Milling-Stone Period* (6500–3500 BC) | | | *Early Period* (3500–600 BC) | | *Middle Period* (600 BC–AD 1000) | | |
|---|---|---|---|---|---|---|---|---|
| | MNT-1232/H | SCR-7 | MNT-391 | MNT-1228 | SLO-175 | MNT-63 | MNT-185/H | SLO-175 |
| Mussel | 97.0 | 94.5 | 61.1 | 98.0 | 80.5 | 78.3 | 70.5 | 78.9 |
| Abalone | 0.3 | 0.0 | 9.4 | 0.1 | 0.1 | 1.7 | 0.8 | 0.0 |
| Barnacle | 1.8 | 4.9 | 6.8 | 0.5 | 9.3 | 0.4 | 9.4 | 6.7 |
| Limpet | 0.1 | 0.1 | 0.4 | 0.1 | 0.0 | 0.3 | 9.8 | 0.0 |
| Urchin | 0.5 | 0.1 | 1.2 | 0.1 | 0.3 | 1.7 | 0.3 | 0.6 |
| Chiton | 0.1 | 0.1 | 0.7 | 0.4 | 0.4 | 9.4 | 0.1 | 0.5 |
| Littleneck | 0.0 | 0.1 | 0.3 | 0.0 | 0.2 | 0.1 | 0.0 | 0.0 |
| Cockle | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 |
| Turban | 0.2 | 0.0 | 4.6 | 0.5 | 7.8 | 5.8 | 1.3 | 9.1 |
| Other | 0.1 | 0.2 | 15.3 | 0.3 | 1.4 | 2.3 | 7.8 | 4.1 |
| TOTAL | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Sources: Cartier 1993b; T. Jones and Haney 1992; T. Jones 1995; T. Jones and Waugh 1995; Motz et al. 1989

TABLE 8.3 Percentage summary of shellfish from Elkhorn Slough and Morro Bay

| | *Milling-Stone Period* (6500–3500 BC) | | | *Early Period* (3500–600 BC) | *Middle Period* (600 BC–AD 1000) | | |
|---|---|---|---|---|---|---|---|
| | SLO-165 | MNT-228 | MNT-229 | SLO-165 | SLO-165 | MNT-228 | MNT-229 |
| Protected habitat clams | 81.4 | 65.6 | 74.9 | 23.8 | 27.2 | 16.8 | 53.4 |
| Pismo clams | 2.2 | 0.0 | 0.1 | 21.0 | 11.1 | 0.0 | 0.1 |
| Oyster | 1.7 | 3.0 | 1.7 | 2.7 | 3.1 | 0.0 | 1.1 |
| Mussel | 9.8 | 28.6 | 20.5 | 31.2 | 31.3 | 81.7 | 42.2 |
| Barnacle | 1.7 | 0.3 | 0.6 | 3.7 | 5.8 | 1.1 | 0.6 |
| Moon snail | 0.1 | 1.7 | 0.1 | 2.7 | 5.9 | 0.1 | 0.0 |
| Turban snail | 0.1 | 0.0 | 0.0 | 0.5 | 0.7 | 0.0 | 0.0 |
| Other/non I.D. | 2.9 | 0.8 | 2.1 | 14.3 | 14.9 | 0.3 | 2.6 |
| TOTAL | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |

Sources: Dietz, Hildebrandt, and Jones 1988, T. Jones et al. 1994, 1996

ration of California estuarine prehistory. Radiocarbon-dated molluscan assemblages from Morro Bay, Elkhorn Slough, and, to a limited extent, Pismo Beach indicate that extensive protected clam habitat was well established in these locations by 6200 BC and that clams were the dominant taxon by a considerable margin (table 8.3). Through time, protected-habitat clams decreased, mussels increased, and oysters showed no significant change at either Elkhorn Slough or Morro Bay (table 8.3). Pismo clams appear in significant proportions at Morro Bay during the Early period, but latitude is responsible for the absence of this southern taxon at Elkhorn Slough. This sequence is nearly the reverse of what is reported from San Francisco Bay, where oysters occur in high frequencies early, give way to mussels in the Middle period, and later to clams (Bennyhoff 1978:39). The high incidence of oysters in early San Francisco Bay sites has long been attributed to a greater availability of rocky substrates prior to Late Holocene sedimentation, but oyster-dominated middens may be more indicative of the salinity tolerances of the taxon rather than substrate requirements. In the smaller lagoons of Elkhorn Slough and Morro Bay, taxonomic changes through time do not suggest a decrease in oysters or concomitant increase in clam habitat.

Findings from SLO-165 illuminate the Middle Holocene sedimentological history of a portion of Morro Bay. Situated near the mouth of what today is Morro Creek, this site yielded dated faunal assemblages that indicate the presence of a substantial estuary formerly connected to Morro Bay. Of interest in regard to the Middle Holocene are conclusions on the presence of fish and shellfish. Fish and protected-habitat molluscs were collected in respectable quantities circa 6200 BC, but the fishery was by far richer and of greater abundance between 3500 and 600 BC (T. Jones et al.1994; Salls, Huddleston, and Bleitz-Sandburg 1989). A protected shellfish habitat continued to provide substantial yields throughout the Middle period, but fish returns declined. By the Late period, both shellfish and fish yields had declined considerably. The richness of the Early period fishery probably is an outgrowth of sea-level dynamics, as the Morro Bay lagoon encompassed its greatest expanse of open

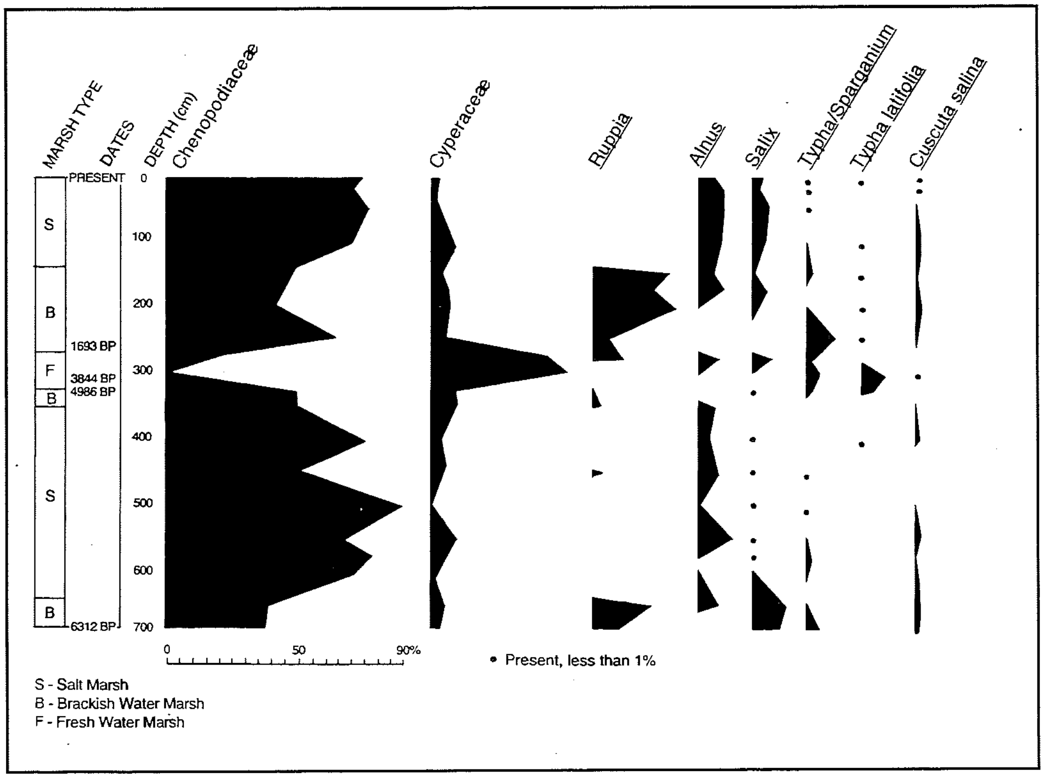


FIGURE 8.4 Hydrophytic taxa from the Elkhorn Slough pollen core. *West 1988*

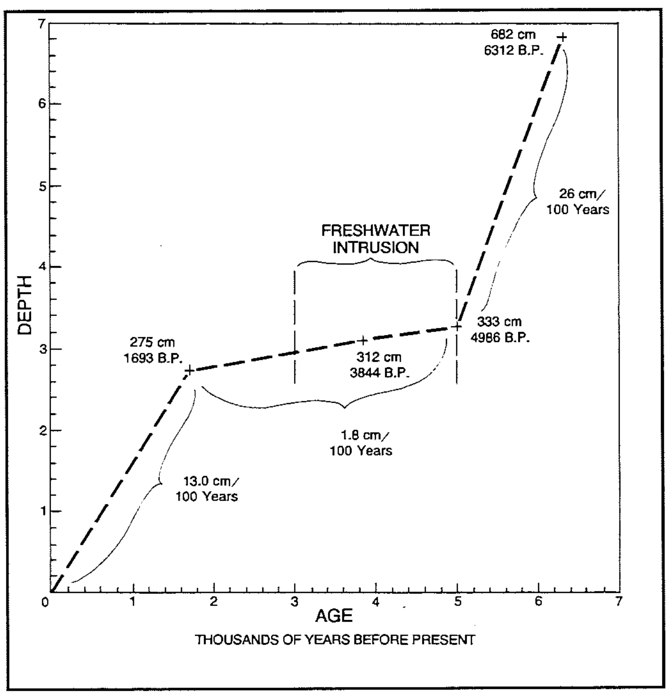


FIGURE 8.5 Elkhorn Slough sedimentation rates inferred from radiocarbon dating results.

water immediately following the diminishing rise of sea levels at Middle Holocene. Accumulating sediments continued to provide rich shellfish habitat at the expense of fish habitat, which decreased as the lagoon filled.

The Elkhorn Slough pollen sequence reveals a decidedly different Middle Holocene environmental sequence, highlighted by a dramatic reversal in salinity represented by fluctuations in aquatic taxa: Chenopodiaceae, Cyperaceae, *Typha* sp., and *Ruppia* sp. (fig. 8.4). Most significant is an apparent infusion of fresh water, marked by the disappearance of saline taxa (that is, *Salicornia* of the Chenopodiaceae family) and a sharp rise in less salt-tolerant members of the Cyperaceae family and *Typha* sp. West (1988:29–31) brackets this event between 280 and 333 cm below the present surface, and a newly obtained radiocarbon assay from a depth of 344 cm dates its inception at circa 3040 BC. The peak of freshwater conditions is dated 1900 BC by an assay from 313 cm. While the pollen core could reflect a localized event within Elkhorn Slough, archaeological site data, discussed in more detail below, suggest otherwise. The combined chronometric data further indicate that the freshwater reversal was associated with a drastic reduction in sedimentation rates within the slough (fig. 8.5). Radiocarbon dates from Elkhorn Slough shell middens indicate that saline or brackish conditions returned by 1000 BC.

Alternative explanations, developed to explain similar oscillations in other California estuaries, can potentially be applied to Elkhorn Slough. Decreased productivity at Batiquitos and other lagoons in San Diego County has been attributed to the silting-in of the mouths of the embayments (Gallegos 1987, 1992; Masters 1988; Warren and Pavesic 1963). At Newport Bay on the south coast, Davis (1992) correlates similar changes with broad scale (that is, global) climatic change. The Elkhorn Slough salinity reversal could have resulted from climate change, tectonic activity, a shift in river courses, or outflow from inland lakes in southern

Santa Clara County. In conflict with any correlate to broad-scale climatic change, however, is the simple fact that the other central coast estuary, Morro Bay, shows no evidence of contemporaneous events. The hydrographic landscape in the vicinity of Elkhorn Slough clearly reflects shifting river courses, and it is most likely that the temporary deterioration of Elkhorn Slough reflects an interval during which neither the Pajaro nor Salinas River emptied into the Slough, and it had no marine outlet.

For the central coast of California, paleoenvironmental reconstructions thus suggest that while climate was warmer during portions of the Middle Holocene, elevated temperatures did not prevail continuously. More importantly, in concert with the effect of the slowing rise in sea level and the concomitant habitat change, many coastal settings exhibit unique histories of environmental change that appear to have been influenced less by broad-scale climatic shifts than by local stochastic events.

Evidence for human response to the variety and intensity of the environmental flux and events along the central coast falls into these categories: sites and assemblages, settlement and subsistence, trade and exchange, and human osteology. The pattern that this evidence provides demonstrates a provocative, albeit sometimes scant, picture of human activity.

## SITES AND ASSEMBLAGES

Between 6500 and 3500 BC archaeological evidence for assemblage variability is simply not supported by a robust set of data on the central coast. In the southern part of the region near San Luis Obispo, assemblage definition in large part still depends on recovery from sites at Diablo Canyon (Greenwood 1972). Of the two radiocarbon-dated sites there, SLO-2 and SLO-585, the latter with an apparent differentiation of dated components that directly pertain to the Middle Holocene is the most informative in terms of temporal assemblage patterning. Here, in the deposit dated from circa 6500 to 3000 BC, the handstone/milling-stone dyad is more common, exceeding that from the post-3000 BC deposit by a ratio of 8.8:1. Conversely, pestles were restricted to the more recent component. And while bowl mortars were recovered from both components, they were fully represented after 3000 BC by a ratio of 3.5:1. Another key artifact type was the large side-notched projectile point with both wide and narrow stem, the most common point type in the upper component, which was followed in frequency by leaf-shaped points and by large triangular specimens with straight bases. Variants of the latter, with convex bases and narrow stems were recovered at SLO-2 in all levels. Contracting stem points were not retrieved from the lower component at SLO-585; indeed, only one specimen that could be so classed was recovered from the upper component. Variations of the contracting stem specimens, however, were recovered from SLO-2 in fairly substantial numbers. Consistent with contemporaneous sites in Southern California, projectile points are a very minor constituent of Milling-Stone period components on the central coast, and it difficult to isolate temporally diagnostic types for the early Middle Holocene.

Elsewhere in mid-coastal contexts, the dearth of sites with clearly definable components that date between 6500 and 3500 BC, together with the vagaries of differential preservation and bioturbation, have hindered investigations that might serve to tie the Middle Holocene together in an integrative manner in this region. Dated sites are reported from this time span, and key artifacts are recovered, but too often the mixing of components and the limited sample have provided frustrating results. A case in point is SLO-177, one among a complex of sites at Lodge Hill near Cambria (Gibson 1979; Pierce 1979), where $^{14}C$ dates from Early Holocene times (circa 6500 BC) and a substantial complement of milling tools were recorded. The clear mixing of key artifact types from early to late periods, however, obviates the ability to sort out discrete assemblages, much less to derive specific patterns of subsistence. This, of course, is not a new story for coastal sites in the region and has been elegantly summarized elsewhere (Bouey and Basgall 1991; Erlandson and Yesner 1992).

Several additional sites that have supplied dates ranging from approximately 6000 to 3500 BC include SLO-877 near Cayucos (Breschini and Haversat 1991a) and SLO-801 and SLO-832. The latter two sites are located adjacent to what apparently was a large marsh and estuarine environment near present-day Pismo Beach (Dills 1981). Unfortunately only $^{14}C$ dates are available, but no substantive artifact collection was recovered; so, once again little knowledge has been forthcoming in terms of assemblage definition or subsistence data. At SLO-165 at Morro Bay, however, some evidence of assemblage constituents is present in the form of flake and cobble tools, a milling slab, and a net weight (T. Jones et al. 1994).

Along the shore and in the cismontane valleys of the northern central coast, several sites bring data to bear on the period between circa 6500 BC and 3500 BC. Located adjacent to the wide flood plain of the Santa Clara Valley and the large shallow seasonal lake, Laguna Seca, is SCL-178. During the early Middle Holocene occupation at this site, the assemblage was dominated by ground stone, cobble tools, and several notched stones, the last identified as net weights (Hildebrandt 1983)—strongly resembling that artifact class for a similar time frame at SLO-165. Flaked stone, as represented by debitage, was construed as evidence of hunting practices.

Ten kilometers from the Santa Cruz coastline in Scotts Valley, SCR-177 is situated on a small alluvial fan, adjacent

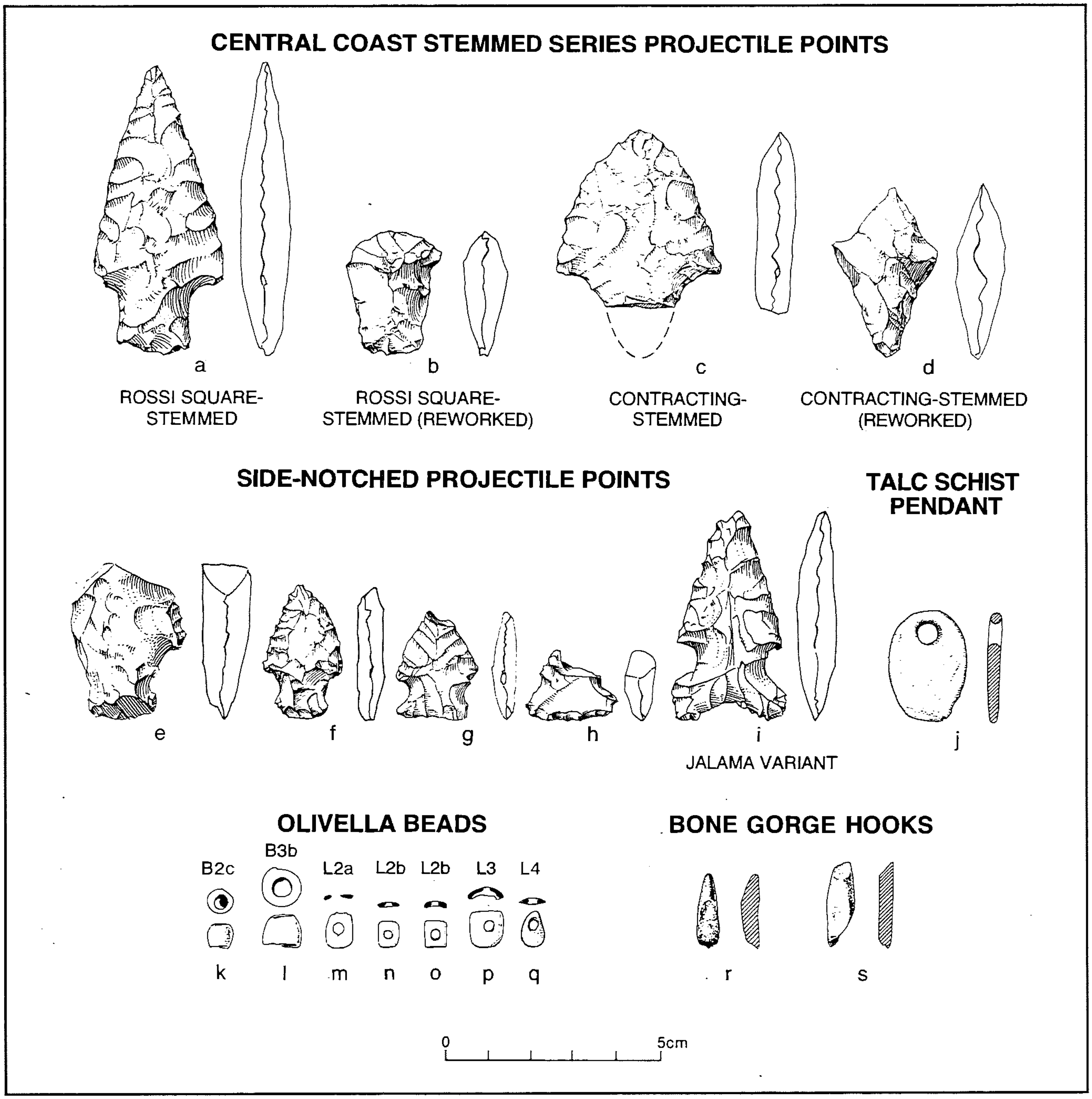


FIGURE 8.6 Early period projectile points, beads, bone tools, and stone pendant: *a*, 42-3-19, (MNT-1228); *b*, 42-10-17 (MNT-1228); *c*, 42-10-26 (MNT-1228); *d*, 42-6-33 (MNT-1228); *e*, P942-1-100 (MNT-73); *f*, 170-238 (MNT-170); *g*, 170-627 (MNT-170); *h*, 170-709 (MNT-170); *i*, 484-280 (SLO- 175); *j*, 42-4-17 (MNT-1228); *k*, 170-707 (MNT-170); *l*, 42-1-23 (MNT-1228); *m*, 42-9-07 (MNT-1228); *n*, 170-110 (MNT-170); *o*, 170-455 (MNT-170); *p*, 170-619 (MNT-170); *q*, 47-4-70 (MNT-1228); *r*, 42-1-20 (MNT-1228); *s*, 42-1-42 (MNT-1228).

to a small freshwater marsh (Cartier 1993a). For the period bracketed by dates of 5500 to 3200 BC, a substantial sample of ground stone, particularly milling equipment, was the dominant artifact class and was supplemented by a wide variety of cobble tools whose material did not conform to local lithic resources. Some leaf-shaped projectile points and bifaces were also recovered.

The Saratoga site, SCL-65, located at the eastern base of the Santa Cruz Mountains, suffered from salvage operation that did not supply clear provenience for a large portion of the assemblage. Part of that assemblage, however, was associated with a component that featured burials whose bone collagen was dated to 4500 to 4000 BC (Fitzgerald 1993). Ground-stone tools consisted of milling slabs and handstones, while mortars and pestles were absent from the earlier component. The latter pairing was noted at an incipient date of circa 2000 BC.

On the rocky exposed shore of Big Sur, stratum II at CA-

TABLE 8.4 Summary of Middle Holocene archaeological component site locations on Central California coast

| | 0–2 KM FROM SHORE | | | | | | INLAND | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Open coast* | | *Protected coast* | | *2–10 km* | | *10–35 km* | | *Lacustrine* | | *Totals* | |
| | N | % | N | % | N | % | N | % | N | % | N | % |
| 3500-1350 BC | 27 | 60.0 | 4 | 8.9 | 4 | 8.9 | 4 | 8.9 | 6 | 13.3 | 45 | 100.0 |
| 6500-3500 BC | 4 | 19.0 | 8 | 38.0 | 4 | 19.0 | 1 | 4.7 | 4 | 19.0 | 21 | 100.0 |
| Totals | 31 | 12 | 8 | 5 | 10 | 66 | | | | | | |

TABLE 8.5 Shell: bone and mammal bone: fish bone ratios from Middle Holocene central coast site components

| | SHELL (KG): MAMMAL BONE (NISP) | SHELL (KG): FISH BONE (NISP) | FISH BONE (NISP): MAMMAL BONE (NISP) |
|---|---|---|---|
| MILLING-STONE PERIOD (6500–3500 BC) | | | |
| *Estuarine sites* | | | |
| SLO-165 | 27:1 | 0.2:1 | 132:1 |
| MNT-228 | 192.9:1 | 5.4:1 | 41.6:1 |
| *Open-coast sites* | | | |
| MNT-1232/H stratum II | 60.7:1 | 15.8:1 | 3.8:1 |
| EARLY PERIOD (3500–600 BC) | | | |
| *Estuarine sites* | | | |
| SLO-165 | 75:1 | 0.04:1 | 1589:1 |
| *Open-coast sites* | | | |
| MNT-1228 | 16:1 | 134:1 | 0.2:1 |
| MNT-73 | 2:1 | 0.4:1 | 3.1:1 |
| SLO-175 | 32:1 | 0.1:1 | 355:1 |
| MNT-108 | - | - | 11.6:1 |
| SLO-179 | 4.7:1 | 0.04:1 | 102:1 |

Sources: Breschini and Haversat 1989; T. Jones and Haney 1992; T. Jones et al. 1994; T. Jones 1995; T. Jones and Waugh 1995; Waugh 1992

MNT-1232/H (the Interpretive Trail site), yielded artifacts and fauna dating 4400-3000 BC (T. Jones and Haney 1992; T. Jones 1995). The assemblage is not large, as the deposit consists primarily of a dense accumulation of shell remains. It is dominated by handstones, milling slabs, and a single lanceolate projectile point. Mortars and pestles are absent.

The period after 3500 BC is more fully represented on the central coast and is marked by an extensive series of shoreline midden deposits. From north to south these include SCR-7, MNT-108, MNT-387, MNT-391, MNT-116, MNT-170, MNT-73, MNT-1228, SLO-175, SLO-179, SLO-383, SLO-165, and SLO-977 (figs. 8.1, 8.2). Assemblages available from these locations exhibit marked uniformity. Two phases, Saunders in the Monterey Bay area and Little Pico Creek I in San Luis Obispo County, represent local variants of a generalized artifact pattern, which is best represented at MNT-391 (Cartier 1993b). Significant artifactual and chronometric data are also available from MNT-108 (Breschini and Haversat 1989, 1992), MNT-1228 (T. Jones and Haney 1992), MNT-73 (T. Jones 1994), SCR-7 (D. Jones and Hildebrandt 1990), SLO-175 (T. Jones and Waugh 1995), and SLO-165 (T. Jones et al. 1994).

All of these assemblages include Central Coast Stemmed Series and side-notched projectile points, co-occurring with the mortar/pestle and milling slabs/handstones, Class B and L *Olivella* beads, bipointed bone gorge hooks, and simple talc-schist pendants (fig. 8.6). Crude cobble/core tools (fig. 8.7) also occur in variable frequencies at some locations (for instance, MNT-170, MNT-391, SCR-7). A robust side-notched variant with bifurcated base, referred to by Lathrap and Troike (1984:107) as a Jalama Side-notched, is known only from the southern districts. Abalone square beads, found in abundance at MNT-391, have not yet been found in Big Sur or in the San Luis Obispo region.

## SETTLEMENT AND SUBSISTENCE

Varied environmental histories of the central coast shorelines have affected different progressions of settlement and subsistence through the Middle Holocene. Milling-Stone components have been identified in a variety of settings, including open and protected coasts, inland valleys, and lacustrine or other freshwater marsh settings. Although potentially a correlate of visibility and/or site survivorship, a slight emphasis on estuarine locations is apparent among central coast archaeological components (table 8.4). An equal settlement focus on lakes has been suggested (T. Jones 1991, 1992) but has been challenged elsewhere (Fenenga 1993:251; Hildebrandt and Mikkelsen 1993).

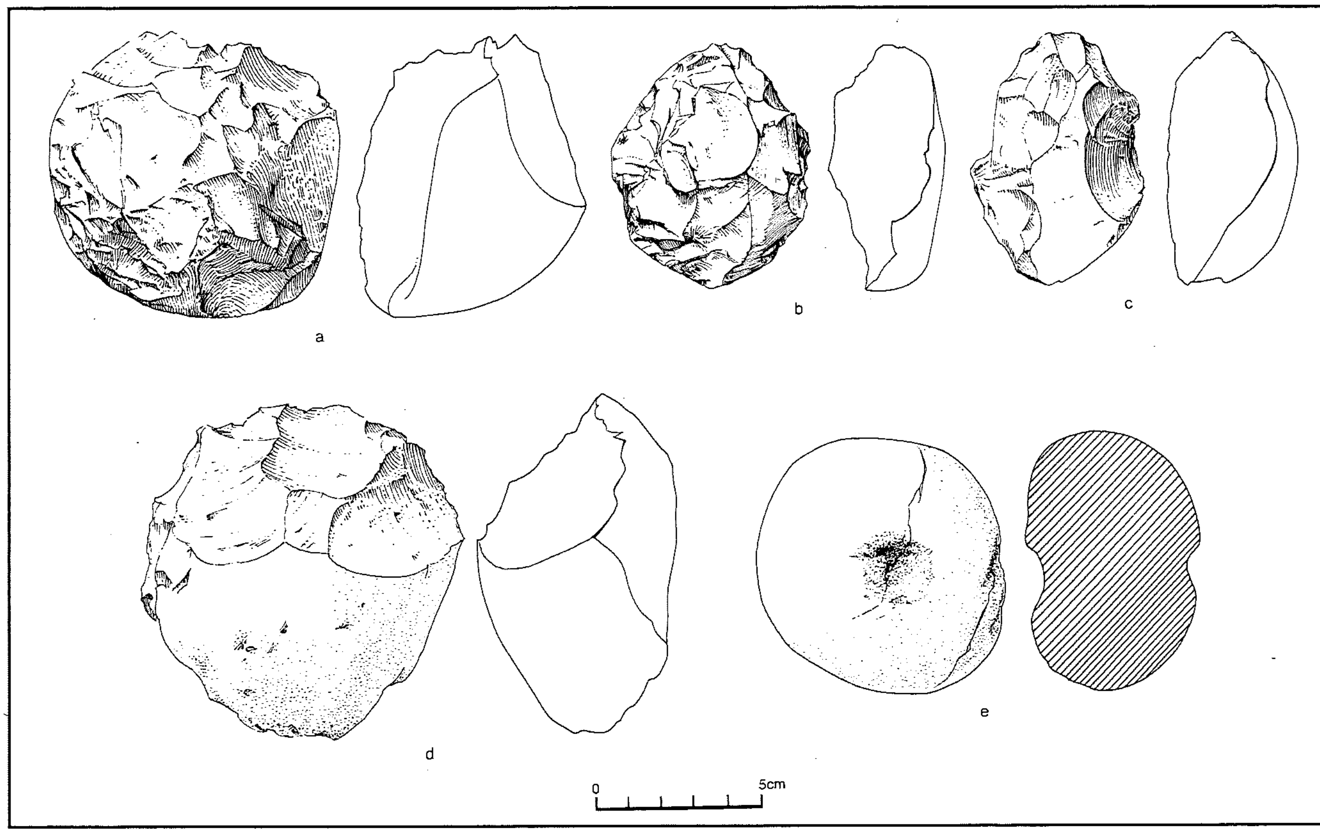


FIGURE 8.7 Early period cobble/core tools and pitted stone from MNT-170: *a*, 170-51; *b*, 170-408; *c*, 170-808; *d*, 170-604; *e*, 170-490.

Owing to vagaries of faunal preservation, subsistence remains are available from an incomplete range of Milling-Stone period locations. Nonetheless, a hard seed/shellfish/fish diet, comparable to that ascribed to Early Holocene coastal groups in Southern California (Erlandson 1991a, 1994), can generally be inferred. Mollusc remains occur in high densities in both estuarine and outer-coast settings (table 8.5), but fish remains are abundant only at Elkhorn Slough and Morro Bay. Fish are represented among the Milling-Stone components at MNT-1232/H on the Big Sur coast and SLO-2 at Diablo Canyon, but frequencies are considerably lower. Based on species counts at Diablo Canyon (Greenwood 1972:91), Fitch (1972:115) suggests that fish were most commonly taken either by hand or by intertidal traps. An asphaltum-smeared sinker recovered from SLO-165 testifies to the use of nets at this time as well, as does the recovery of notched sinkers from the inland lacustrine setting of SCL-178.

The period beginning about 3500 BC is marked by a substantial increase in occupation of the open coast (table 8.4), concomitant with shifts in assemblage composition and an intensification in the deposition of vertebrate remains. While there is considerable variability between sites, reflecting localized specialization, fish and mammal remains generally show striking increases relative to shellfish (table 8.5). This trend, first recognized by Greenwood (1972:91) at Diablo Canyon, has since been documented at open-coast sites MNT-1228 and MNT-1232/H, which show high frequencies of mammalian remains. SLO-165 at Morro Bay and MNT-108 on the Monterey Peninsula have yielded dense accumulations of fishbone. Fishing and particularly hunting, apparently emerged as distinct specializations about 3500 BC. Variation is evident among mammal assemblages, which on the Monterey Peninsula show high frequencies of marine mammals but at Big Sur are dominated by terrestrial taxa (table 8.6). Marine mammals apparently had a greater onshore presence on the Monterey Peninsula prehistorically than at Big Sur, a presence that probably included mainland rookeries (Hildebrandt and Jones 1992). The appearance of the mortar and pestle during the Early period is further equated with a shift to a more intensified economy. While this technological dyad did not become the dominant vegetal-processing implements until the Middle period, their use suggests at least some experimentation with nut crops and storage. In concert with the emergence of a hunting specialization, it can further be inferred that the ethnographic pattern of gender-specific task appropriation emerged at this time.

A useful index of change and intensification is provided by mussel and limpet size profiles from MNT-1232/H on the Big Sur coast. Extending across the Milling-Stone/Early period transition, these mollusc shells show a distinct trend toward diminution over time (fig. 8.8), suggesting longer occupation of coastal residential bases and more frequent col-

TABLE 8.6 Early period mammal remains from Central California coast

| | | BIG SUR DISTRICT | | | MONTEREY BAY DISTRICT | | | | |
|---|---|---|---|---|---|---|---|---|---|
| COMMON NAME | TAXON | MNT-1232/H | MNT-1228 | MNT-73 | MNT-391 | MNT-108* | MNT-170* | SCR-7* | TOTALS |
| *Terrestrial taxa* | | | | | | | | | |
| Black-tailed deer | *Odocoileus hemionus* | 14 | 75 | 31 | 25 | 33 | 4 | 12 | 194 |
| Prong-horn | *Antilocapra americana* | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Gray fox | *Urocyon cinereoargenteus* | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 2 |
| Dog/coyote | *Canis latrans* | 1 | 1 | 1 | 4 | 8 | 0 | 0 | 15 |
| Rabbit | *Sylvilagus bachmani* | 3 | 0 | 8 | 5 | 18** | 2 | 7 | 43 |
| Jackrabbit | *Lepus californicus* | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Bobcat | *Lynx rufus* | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| Skunk | *Mephitus mephitus* | 0 | 0 | 1 | 0 | 2 | 0 | 0 | 3 |
| Weasel | *Mustela frenata* | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Badger | *Taxidea taxus* | 0 | 0 | 0 | 0 | 6 | 0 | 0 | 6 |
| SUBTOTAL | | 19 | 78 | 42 | 34 | 68 | 6 | 20 | 267 |
| *Marine taxa* | | | | | | | | | |
| Northern fur seal | *Callorhinus ursinus* | 5 | 0 | 0 | 13 | 16 | 0 | 0 | 34 |
| Southern fur seal | *Arctocephalus townsendi* | 0 | 0 | 0 | 12 | 0 | 0 | 0 | 12 |
| Fur seal | | 0 | 0 | 0 | 35 | 0 | 6 | 0 | 41 |
| California sea lion | *Zalophus californianus* | 0 | 0 | 0 | 6 | 0 | 0 | 2 | 8 |
| Steller sea lion | *Eumetopias jubatus* | 0 | 1 | 1 | 1 | 0 | 0 | 1 | 4 |
| Sea lion | | 0 | 0 | 0 | 17 | 0 | 9 | 0 | 26 |
| Sea otter | *Enhydra lutris* | 1 | 0 | 2 | 54 | 4 | 8 | 6 | 75 |
| Harbor seal | *Phoca vitulina* | 3 | 3 | 2 | 2 | 2 | 3 | 1 | 16 |
| SUBTOTAL | | 9 | 4 | 5 | 140 | 22 | 26 | 10 | 216 |
| TOTAL | | 28 | 82 | 47 | 177 | 92 | 35 | 30 | 491 |

*Partially mixed component. **168 elements of *Sylvilagus* sp. not included.

Sources: Breschini and Haversat 1989:100-101; Cartier 1993b:219; Dietz 1991:144; T. Jones 1994; T. Jones and Haney 1992; D. Jones and Hildebrandt 1990; T. Jones 1995

lection. Extended site use is corroborated by seasonality analyses of fish otoliths from SLO-165, which suggest nearly year-round habitation (fig. 8.9).

Settlement history at Elkhorn Slough is more complex. Radiocarbon dates indicate that the Slough witnessed a major population hiatus during the Early period coincident with the intrusion of freshwater (fig. 8.10). This contrasts markedly with Morro Bay, where human occupation seems to have been most intensive during the Early period, with a depopulation occurring much later during the latter half of the Middle period (fig. 8.10). The temporary deterioration of Elkhorn Slough may have contributed to increased human presence on the exposed shoreline of the Monterey Bay area.

In general, changes in settlement and subsistence along the central coast suggest a transition from selective exploitation strategy to a more intensive strategy involving extended, but not permanent, occupation of residential bases. This transition was noted by Greenwood (1972:91), who found among the shellfish remains at SLO-2 evidence for wide-ranging subsistence forays, including trips by inhabitants of Diablo Canyon to Morro Bay. Evidence for these collecting trips disappeared at the onset of the Hunting period (around 3500 BC) when increased attention to the pursuit of game apparently rendered such trips unnecessary. These changes, equating with what Beaton (1991) describes as a shift from extensification to intensification (see also Waugh 1986:17–19), can be attributed to population circumscription during the Middle Holocene. Dietary diversity decreased as the presence of groups in adjoining areas constrained mobility, decreasing the size of resource acquisition radii and forcing an inward focus in subsistence.

## TRADE AND EXCHANGE

Hallmarks of trade and exchange networks for the archaeology of the central coast are obsidian and shell beads. Obsidian evidently arrived in finished bifacial forms, which subsequently were refurbished and reworked. Hydration study results from SCL-65 and SCR-177 indicate clearly that obsidian was reaching the central coast prior to 3500 BC, but the salvage nature of those two investigations makes it impossible to evaluate obsidian frequency quantitatively. For those Milling-Stone period components for which hydration values can be quantified relative to excavation volume and field-recovery strategies, it is apparent that obsidian was indeed a rare commodity. Of a combined excavation volume of over 30 $m^3$ (processed with 3-mm mesh) from MNT-229, MNT-228, and MNT-1232/H, only a single hydration reading marks the occupation (table 8.7). In contrast, several sites postdating 3500 BC have yielded obsidian in abundance. MNT-108 on the Monterey Peninsula produced 184 pieces from a mere 4.8 $m^3$ of deposit, although the exclusive use of water screening at that location undoubtedly contributed to this inordinately high figure. Recovery techniques employed at MNT-73, occupied from 2300 to 1700 BC on the

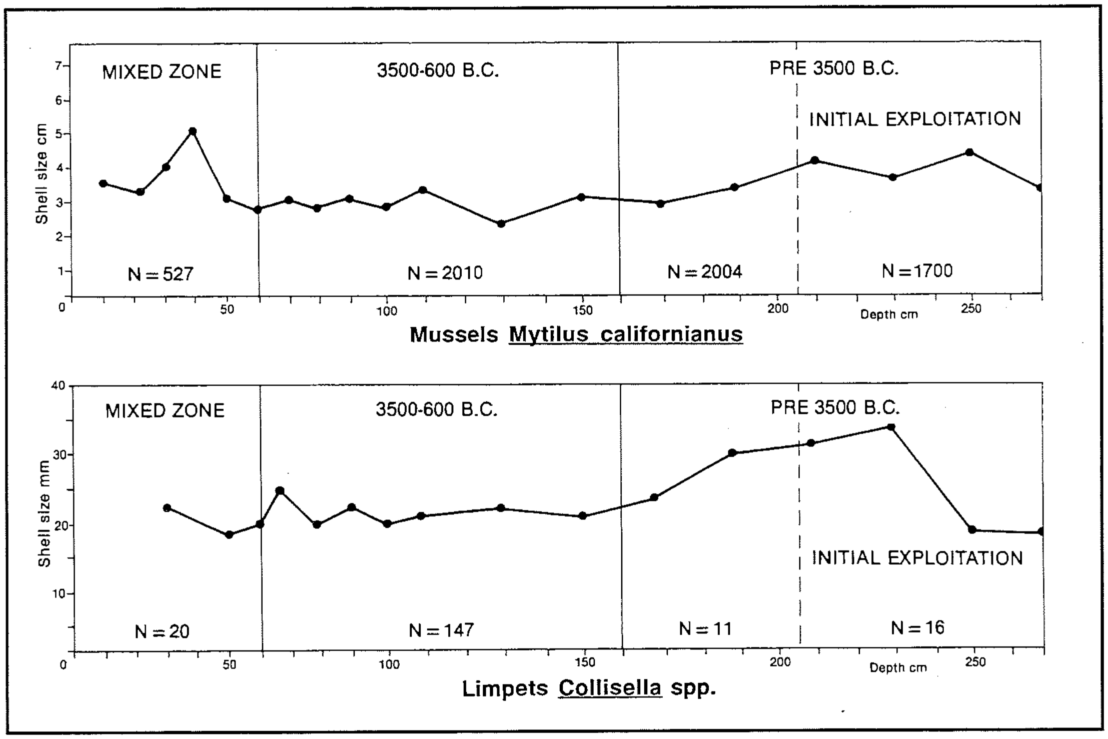


FIGURE 8.8 Middle Holocene mussel and limpet size profile from MNT-1232/H

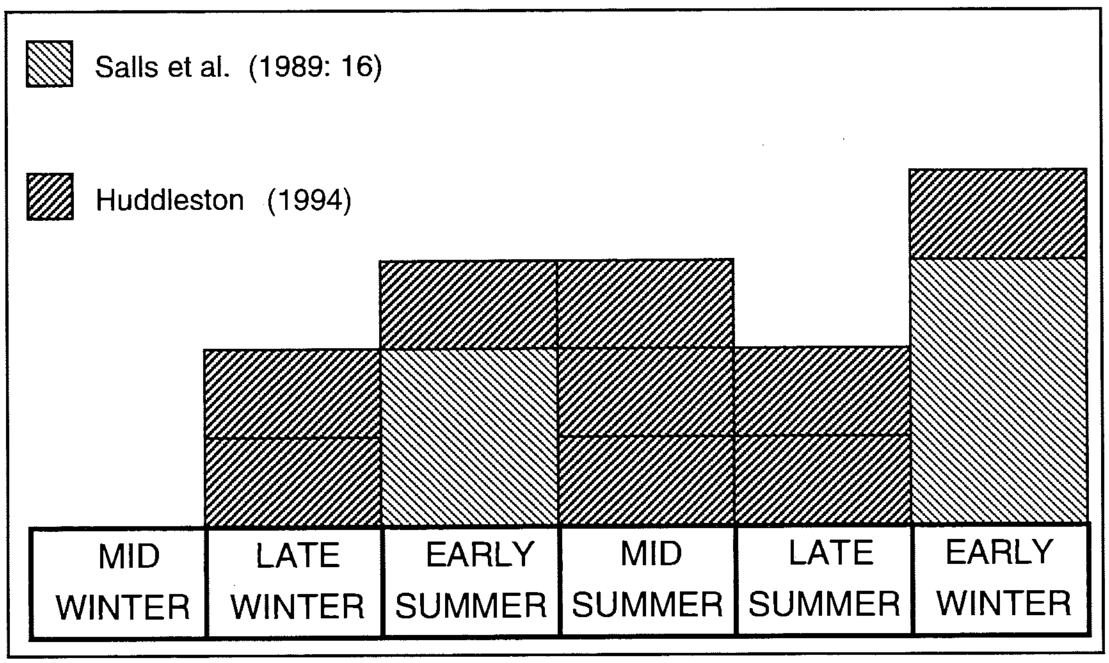


FIGURE 8.9 Seasonality of otoliths from SLO-165

Big Sur coast, however, were identical to those employed at the earlier sites, and obsidian was more than eighty times more abundant than at MNT-229 (table 8.7), with most pieces originating from sources 200 to 300 km distant at Napa, Coso, and Casa Diablo. The chronology of increased obsidian arrival is synchronous with the initial settlement of many sites along the central coast at the beginning of the Early period. Apparently the earliest use of settlements at MNT-73, MNT-108, MNT-254/266, MNT-391, MNT-1228, and SLO-179 was accomplished in concert with the development of exchange networks of at least an informal if not formal nature. This increase in obsidian exchange appears to be only one more facet of a major shift toward a more intensified lifeway resulting from population circumscription beginning at the Milling-Stone/Early period interface. With direct resource access restricted in some areas by the increased human population, exchange was apparently engaged in as a substitute for direct resource acquisition. The currently available regional obsidian-hydration profile further indicates that obsidian exchange continued along these lines with increased frequency through the Middle period.

Beads and ornaments present a more complex, poorly understood argument for exchange. On the Big Sur coast, increased import of obsidian occurs concurrently with the

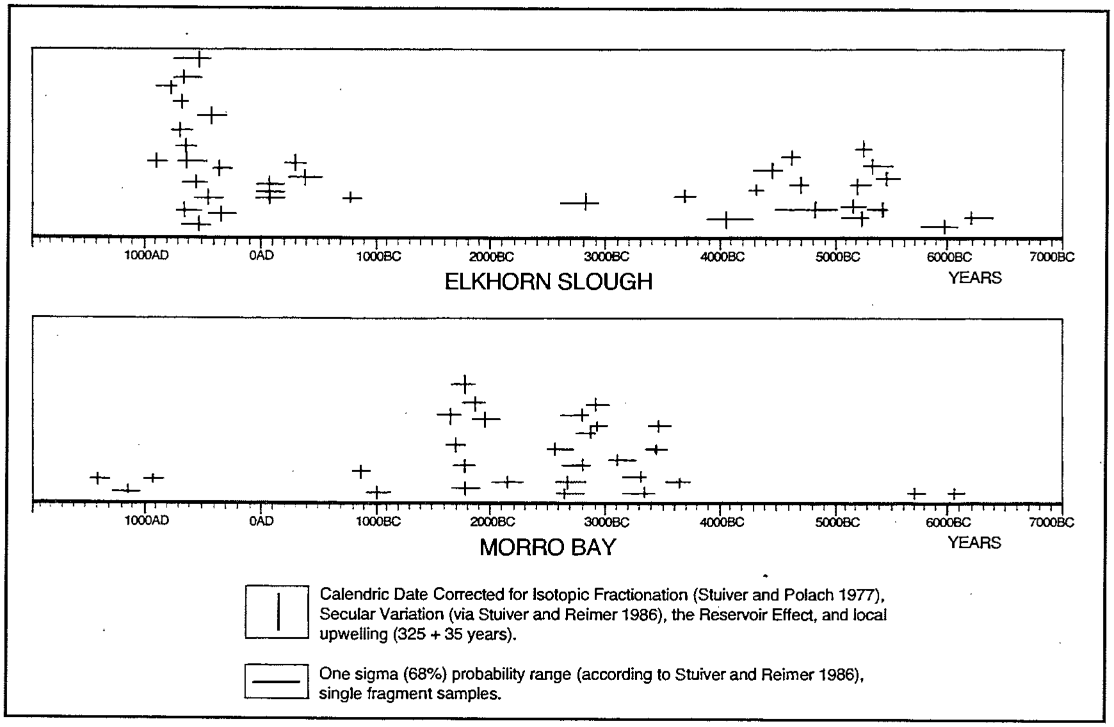


FIGURE 8.10 Summary of radiocarbon dating from Elkhorn Slough and Morro Bay. *Breschini, Haversat, and Erlandson 1992; Breschini and Haversat 1991b; Dallas 1992; Dietz, Hildebrandt, and Jones 1988; Gibson 1992d; T. Jones et al. 1994, 1996; Patch and Jones 1984.*

initial manufacture of talc-schist ornaments (fig. 8.6), produced at MNT-1228 and MNT-1232/H (T. Jones and Haney 1992). Dated between 3700 and 2900 BC at MNT-1228 (T. Jones and Haney 1992:267), similar pendants have been identified in comparable temporal contexts at MNT-391 (Cartier 1993b) and SBA-53 (Harrison and Harrison 1966). Early period manufacturing sites for *Olivella* rectangular beads have been documented at MNT-108 and MNT-391, and it is likely that additional manufacturing localities will be identified as more excavation is undertaken along the central coast. Beads and ornaments were probably produced in many locations as part of regularized but casual, unspecialized, nonmonetized exchange.

## HUMAN OSTEOLOGY

Conclusions derived from osteological analyses can supply important information on population structure and health and, thus, address issues on the demography of prehistoric groups. Unfortunately, data that provide adequate mortality or morbidity profiles for Middle Holocene populations from the central coast are scanty at best. At SCL-65 only fragmented burials were recovered and no substantive analysis was possible (Fitzgerald 1993). At SLO-2 at Diablo Canyon (Greenwood 1972), only three of the sixty-six burials apparently dated to the Milling-Stone period, and analyses were not directed toward temporally specific burial groups. Data were supplied on anthropometrics and a brief summary of age-related degenerative disease. Mortality peaked at the 25 to 40 year age range, and 26 percent of the total population was over 40 years of age at death. Because the dating of the total burial population is not secure and detailed pathologies were not supplied, summary information is only partially useful.

At MNT-391, an Early period site (Pierce, Filippo, and Van Zandt 1993), however, the mortality profile and pathological analyses are more complete. The mortality profile shows peaks at 15 to 19 and 40 to 44 years of age. The median age for both sexes was 40 years, and survival into the fifth decade was not uncommon. Data indicate that there was no demonstrable evidence for dietary deficiency or parasitism and the general health of the group was good—conditions that very probably reflect the lifeways of a nonsedentary hunting-gathering group with access to a wide array of resources. Of some interest to paleodemographers is the conclusion that the morphology of the male skulls at MNT-391 reflects a craniofacial pattern similar to that observed in individuals in the lower Sacramento Valley (although see Gerow 1974), while females display a more generalized pattern such as found over a broad geographic area (Pierce, Filippo, and Van Zandt 1993:48).

## SUMMARY AND DISCUSSION

Fifteen years ago consideration of the Middle Holocene on the Central California coast would have been brief and highly speculative. Our discussion here represents an attempt to summarize a significant and rapidly expanding data base that will no doubt continue to grow. The central coast shows greatly varied environmental histories through the Middle Holocene, which have had variable influence on resident human populations. Significant changes are evident at the two major estuaries, Elkhorn Slough and Morro Bay. Over

TABLE 8.7 Obsidian recovery from Middle Holocene central coast components

| | OBSIDIAN (N) | OBSIDIAN/M³ | OBSIDIAN/M³ 3-MM MESH | OBSIDIAN WITH EARLY HYDRATION MEASUREMENT/M³ 3-MM MESH |
|---|---|---|---|---|
| *Milling-Stone components* | | | | |
| MNT-228B | 1 | 0.125 | 0.156 | 0.000 |
| MNT-1232/H stratum II | 2 | 0.435 | 0.869 | 0.000 |
| MNT-229 | 32 | 1.440 | 1.440 | 0.021 |
| *Early components* | | | | |
| MNT-108* | 34 | 7.083 | 7.083 | 2.500 |
| MNT-170 | 55 | 0.937 | 1.667 | 0.000 |
| MNT-73 | 138 | 6.602 | 6.602 | 3.971 |

*Total obsidian recovery = 184 specimens, but only 34 specimens were large enough for sourcing. A sample of 20 specimens was subjected to hydration analysis.
Sources: Breschini and Haversat 1989; Dietz, Hildebrandt, and Jones 1988; Dietz 1991; T. Jones and Haney 1992; T. Jones et al. 1992; T. Jones 1995; T. Jones and Waugh 1995

the course of the Holocene, these systems shared a common pattern of infilling reflected in archaeological shellfish assemblages, but they also demonstrate individual idiosyncrasies. Elkhorn Slough was apparently abandoned by human populations between 3000 and 1000 BC in response to a rapid reversal in the slough's salinity, which temporarily degraded its resource potential. Morro Bay, on the other hand, exhibits an intensive occupation during this same span. An occupational hiatus is evident later, at about AD 1 (fig. 8.10). In contrast to the estuaries, the open coast of San Luis Obispo County, Big Sur, and the Monterey Bay shows a constancy of occupation through the Middle Holocene, which impacted the quality of the resource base and demanded further cultural adjustments.

Clearly, environmental change affected significant cultural responses at both Elkhorn Slough and Morro Bay. Rapid habitat degradation simply forced people to pursue other settlement and subsistence options. Elsewhere, on the open coast, humans transcended low-intensity, broad-scale ambient change associated with the warm conditions of the early Middle Holocene. From these varied trajectories, it is relatively apparent that broad-scale Holocene climatic changes did not have a uniform influence over the region, and indeed should not be considered the primary agents underlying Middle Holocene cultural changes. In the absence of uniform environmental flux, Middle Holocene cultural changes can be more confidently attributed to population trajectories, as a successful, mobile, Early Holocene subsistence pattern fostered population growth and eventually, circumscription. As a consequence, a more settled, intensified lifeway began circa 4000 to 3500 BC; hunting, fishing, and processing specializations—marked by the mortar and pestle—came into use, and individual residential bases were occupied for more extended periods of time. Storage was probably employed on a limited basis, and inter-regional exchange was engaged in routinely as a substitute for direct resource access. Health was good and longevity high as the crowding-induced maladies of the Middle period had yet to take their toll (see Lambert 1993).

With respect to polarized alternative perspectives on environmental causality, the Central California coast suggests this issue cannot be resolved in absolute terms. High-intensity and rapidly transpiring environmental change indisputably provoked human responses, indicating that environmental variability cannot be entirely overlooked as a causal variable. Less-intense and long-duration climatic change did not affect major human response on the central coast, however, particularly in the coastal zone where environmental flux was muted by the tempering influence of coastal waters (D. L. Johnson 1977). It is possible, however, that coastal population increase during the Middle Holocene reflects the deterioration of more arid environments far in the interior and westward migration to the coast. In general, population pressure seems to explain significant aspects of Middle Holocene settlement and subsistence change, particularly when attributed to a threshold of population circumscription.

With respect to trajectories of marine versus terrestrial resource exploitation over time, a full spectrum of marine resources and habitats was exploited during the early Middle Holocene, but problems with site visibility and component integrity obfuscate possible patterns. Nonetheless, estuaries seem to have attracted more settlement than the open coast, and many interior early Middle Holocene sites occur near lakes (for example, SCL-178, SCR-177, SCL-119/SBN-24). On both estuaries and open coasts, shellfish were important during the Milling-Stone period but decreased in dietary significance through time. Rich estuarine fisheries, on the other hand, were important during the early Middle Holocene and became increasingly so with time. Open-coast fisheries, however, became significant only after the Middle Holocene. Fish are clearly a resource that can withstand intensification; with increasing labor inputs and more sophisticated technology, fisheries can provide increased caloric yields for growing human populations. Shellfish, particularly mussel beds along the rocky coast, are strictly limited in their caloric potential and do not respond well to overly intensive harvest (Jones and Richman 1995). The simultaneous decrease in shellfish harvesting and increase in fishing during the Middle Holocene are consistent with growing human populations. Furthermore, optimal subsistence solutions were unlikely to conform with a strict marine/terrestrial dichotomy over time but would have incorporated resources and habitats based on utility ranking and potential for intensification.

**Acknowledgments.** We thank G. James West, Michael Moratto, Roger Byrne, and anonymous reviewers for insightful comments made on earlier drafts of this chapter. For allowing us to contribute to this undertaking, we express our most sincere thanks to Jon Erlandson and Michael Glassow. We much appreciated their gracious approach to editing. We also thank Rusty van Rossman for his fine graphics.

# Cultural Construction of Coastal Landscapes
## *A Middle Holocene Perspective from San Francisco Bay*

*Kent G. Lightfoot*

THE ARCHAEOLOGICAL INVESTIGATION of the greater San Francisco Bay is an opportunity to study the diachronic developments of coastal hunter-gatherers who inhabited the largest estuarine system in California. At the terminus of the Sacramento-San Joaquin basin, draining 40 percent of the land mass of California, this coastal embayment supports the greatest expanse of contiguous tidal marshlands on the Pacific Coast of North America (Josselyn 1983:1). Home of Ohlone (Costanoan), Coast Miwok, Bay Miwok, and Patwin speaking peoples for many generations (Field et al. 1992; Milliken 1991), the Bay area comprises a diverse and extensive archaeological record. Since the early 1900s, archaeological fieldwork has focused on large shell middens—artificial mounds constructed of sediments, marine shell, ash, and rock—that were once widely distributed along the bayshores and streams of the greater estuarine system, including San Francisco Bay, San Pablo Bay, Carquinez Strait, and Suisun Bay (fig. 9.1).

Despite considerable research, questions still remain about why hunter-gatherer populations constructed the shell mounds, what role the shell mounds played in their regional subsistence-settlement practices, and whether prehistoric peoples employed the shell mounds primarily as residential bases, as garbage dumps, or as specialized ceremonial sites. Questions also remain about the timing of early coastal developments in the Bay area, where shell mounds first appear in the archaeological record about five to six thousand years later than the earliest documented coastal sites in Southern California (see Erlandson 1944; Erlandson and Colten 1991b; T. Jones 1991).

An understanding of both cultural and ecological developments in the Middle Holocene (ca. 6650–3350 RYBP) is critical for addressing these questions. This was a formative time for the Bay area, when the estuarine system expanded tremendously, extensive mudflats first became established, and tidal marshes began to flourish. It was also the time when native peoples began to construct the basal levels of the earliest known shell mounds. I believe a critical look at the late Middle Holocene is necessary to understand why hunter-gatherers created mounded space in the first place and how these sites became important ceremonial and residential places in their subsistence-settlement systems.

### HISTORY OF RESEARCH

Archaeological investigations of the greater San Francisco Bay have taken place at three times. The first involved the initial scientific studies of shell mounds between 1902 and 1925. These included Nelson's (1909) recording of 425 shell mounds along San Francisco Bay, San Pablo Bay, and the Carquinez Strait as well as extensive salvage excavations in the East Bay at Emeryville (ALA-309; Schenck 1926; Uhle 1907), Ellis Landing (CCO-295; Nelson 1910), West Berkeley (ALA-307; Wallace and Lathrap 1975:3), and the Stege Mound complex (CCO-298 and CCO-300; Loud 1924). Nelson (1909:327) observed in 1908 that "not a single mound of any size is left in its absolutely pristine condition" and that most sites were being rapidly destroyed by agricultural activities, urban expansion, and commercial mining operations for garden soil and fertilizer.

The early excavators interpreted the shell mounds as the remains of large villages created by the accumulation of domestic refuse over hundreds or thousands of years (Schenck 1926:205, 275; Uhle 1907:21), a conclusion supported by Gifford's (1916) constituent analysis of archaeological materials from eleven sites. Given the extensive size of the mounds, as well as their great density across the bayshore landscape (see Kroeber 1925:466), it was generally believed that shellfish and other estuarine resources provided a subsistence base capable of supporting large, permanent populations without agriculture. Uhle (1907:21) and Nelson

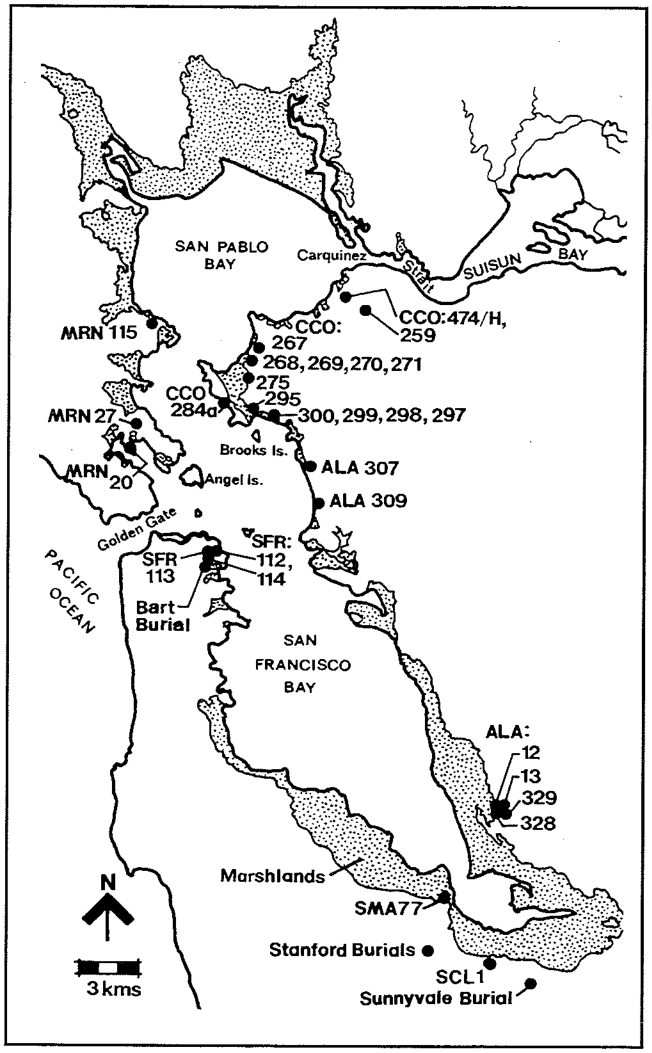


FIGURE 9.1 Archaeological sites of the greater San Francisco Bay. Sites named in the text include Castro (SCL-1), Ellis Landing (CCO-295), Emeryville (ALA-309), Fernandez (CCO-259), Patterson (ALA-328), Ryan (ALA-329), the lower San Pablo Creek mounds (CCO-268, CCO-269, CCO-270, CCO-271), the Stége Mound complex (CCO-297, CCO-298, CCO-299, CCO-300), Thomas (MRN-115), University Village (SMA-77), and West Berkeley (ALA-307). *Adapted from Simons 1992:74*

(1909:334) reasoned that Bay area sites were not specialized burial mounds, such as those found in the Ohio Valley, but rather that they were primarily occupation places in which residents were buried.

After World War II, the second phase of fieldwork was undertaken by the newly created University of California Archaeological Survey at West Berkeley (Wallace and Lathrap 1975), the Fernandez site (CCO-259; J. Davis 1960), Ryan Mound (ALA-329; Wilson 1993:1), the Thomas site (MRN-115; Meighan 1953), and ALA-12 and ALA-13 (Bickel 1981:35). Other excavations in the 1950s and 1960s included a multiyear study of Patterson Mound (ALA-328) (J. Davis and Treganza 1959), the investigation of University Village (SMA-77) and Ryan Mound (Gerow 1968; Coberly 1973), and fieldwork at MRN-20 (McGeein and Mueller 1955) and MRN-27 (T. King 1970). Quantitative methods for analyzing midden constituents, pioneered by Gifford (1916), were refined at this time (for example, Cook 1950; Greengo 1951).

Although shell mounds were still interpreted as village sites, questions were raised about the continuous, long-term occupation of these coastal locations (Glassow 1967; Gould 1964:129) and the degree to which shellfish and other estuarine resources could support large, permanent populations (Heizer and Baumhoff 1956:38; Gould 1964:152). Heizer (1949) argued that Bay area peoples were marginal and culturally backward, a perspective apparently stemming from his view that coastal or littoral economies were inferior to those based on acorns (Heizer and Baumhoff 1956:38). Heizer's provocative view fueled considerable controversy on the cultural relationship of the Bay area to the nearby Delta and lower Sacramento Valley. Debate focused on the usefulness of applying archaeological cultural sequences developed for the interior (for instance, the Central California Taxonomic System) to the Bay area (for example, Gerow 1968), a discussion that continues today (Bennyhoff 1986; Moratto 1984).

A third surge of field and laboratory studies has taken place in the last twenty years, stimulated primarily by federal and state agencies complying with environmental regulations (Banks and Orlins 1985; Bocek 1991; Pastron and Walsh 1988a, b; Waechter 1993), by field schools (Luby 1994; Moratto, Riley, and Wilson 1974), or by the repatriation of extant museum collections for reburial (Leventhal 1993; Wilson 1993). Much of the recent fieldwork involves investigations of newly discovered, deeply buried shell middens, such as SFR-112, SFR-113, and SFR-114 (Hattori and Pastron 1993; Pastron and Walsh 1988a, b); the excavation and careful reburial of graves that are in the right-of-way of construction projects, such as John Holson's recent work at CCO-269, CCO-600, and CCO-601; and the reexamination of the basal levels of shell mounds originally recorded by Nelson that have not yet been obliterated by urban expansion, such as Ellis Landing and the Stege Mound complex (Banks and Orlins 1979, 1981, 1985). These studies are employing sophisticated analyses of sediments (see Blackard 1979), midden constituents (for example, Allen-Wheeler 1985), and faunal remains (see Broughton 1994c; Gobalet 1981, 1985; Simons 1981, 1985; Veldhuizen 1981). In addition, more refined chronological estimates for site occupations are being generated through the comparison of radiocarbon dates, obsidian hydration readings, and shell bead seriations (Banks and Orlins 1981; Leventhal 1993; Pastron and Walsh 1988a; Wilson 1993). Bay area hunter-gatherers are now placed into a broader regional context, one that emphasizes the exploitation of a diverse combination of estuarine, freshwater, and terrestrial resources (Banks and Orlins 1985:42–48; Bocek 1991; Parkman 1994; Simons 1992), a perspective that strikes a balance between the earlier, contrasting views of bayshore productivity espoused by Uhle and Nelson, on one hand,

and Heizer and Gould, on the other.

## SHELL MOUNDS OF THE BAY AREA

Archaeological investigations over the last ninety-two years provide a corpus of information for examining the site structure, artifact assemblages, faunal remains, human burials, and architectural features of shell mounds. Almost any Native American site containing significant shell deposits in the Bay area has been classified as a shell mound. In reality, the term "shell mound" almost certainly subsumes considerable variation in settlement types and masks the diverse roles these sites probably played in the economic, sociopolitical, and ceremonial organization of coastal peoples. The following section examines the range of variation for five dimensions of Bay area sites classified as "shell mounds": mounded space, burial placement, domestic refuse, occupation history, and regional settlement pattern.

### Mounded Space

There is great variation in both the volume and the internal composition of mounded space in Bay area sites (figs. 9.2, 9.3). Nelson's survey of San Francisco Bay, which he completed in 1908, provides the best description of shell mounds before many were completely leveled by plowing, mining, and housing developments. The mounds were typically oval or oblong, their longest axis running parallel to the shoreline or freshwater stream. Some mounds described by Nelson had flat surfaces on which multiple "house" depressions were found. Their basal diameters ranged from 9 to 183 m across, and they rose from 1 to 9 m above the 1908 land surface (Nelson 1909:325). The mound deposits often extended several meters below modern ground level (see Nelson 1910: Plate 49; Uhle 1907: Plate 4).

The mounds exhibit complex structures: a maze of pockets and lenses of ash, soil, shell, and fire-cracked rocks comprise the matrix of the site (see Banks and Orlins 1979:7.83; Schenck 1926:169–171; Wallace and Lathrap 1975:8) (fig. 9.4). Within this matrix are human burials, architectural features, a diverse range of mammal, fish, and bird remains, and artifacts of stone, bone, and clay. The internal composition of the mounds varies greatly both within sites and between sites. Mounds contain some strata or lenses comprised primarily of shell, others comprised of sediments (sand and clay), others are mixtures of ash, rock, shell, and sand (Gifford 1916; Nelson 1909:310; Schenck 1926:171). Some mounds are constructed largely of sand, clay, and rocks with some shell; others are built primarily of shell and ash (Gifford 1916; Nelson 1909:322, 335).

### Burial Placement

In almost every shell mound that has undergone extensive excavation, multiple human interments have been unearthed (for instance, Nelson 1909:343). Both inhumations and cremations are found in the mounds, often in shallow, oval pits (Gerow 1968:38; Uhle 1907:24; Wallace and Lathrap 1975:45). The inhumations are usually in a flexed position, sometimes laid out on layers of ash and charcoal suggesting pre-interment fires in graves (Drake 1948:319; Gerow 1968:38; Schenck 1926:196–197; Uhle 1907:24). Archaeologists recorded 706 burials from the Emeryville Mound alone (Bennyhoff 1986:68), and it is estimated that some mounds once contained several thousand graves (Nelson 1910:381; Wilson 1993:2).

The placement of human remains in mound deposits follows three different patterns. Some people were buried in clearly demarcated cemetery complexes. These are defined as discrete clusters of burials containing more individuals than a nuclear family (T. King 1970:17). Cemeteries, often in the basal deposits of the mounds, have been recorded for the Patterson Mound (Bickel 1981:303; J. Davis and Treganza 1959:9–10), the San Bruno Mound (Drake 1948:318–319), University Village (Gerow 1968:34), SFR-114 (Hattori and Pastron 1993:18), MRN-27 (T. King 1970), and West Berkeley (Wallace and Lathrap 1975:45).

Other people were interred in smaller burial groups, usually numbering between six and nine individuals. These smaller groups are found throughout some mound deposits and are often associated with house floors of compacted clay, some containing burned posts and other architectural features (Bickel 1981:312–314; Nelson 1910:383; Schenck 1926:183, 195, 202). Schenck (1926:195) argued that this pattern may reflect the burial of household members, including both adults and children, near their dwelling places.

Still other individuals were buried alone or in pairs, the latter sometimes in the same grave (see Bickel 1981:294). These individual interments are found throughout mound deposits, from the lowest to the uppermost levels (Nelson 1910:381; Wallace and Lathrop 1975:45). They appear to span much, if not all, of the entire occupation of some mound locations (Uhle 1907:22–24; Wallace and Lathrap 1975; Wilson 1993: Table 2).

There appears to be considerable variation in the practice of these three burial patterns by Bay area peoples. For example, the Patterson Mound contained a basal cemetery, at least one small-group burial, and isolated interments. MRN-27 was characterized by a cemetery only but no isolated or small-group burials (T. King 1970:7). Individual interments, small-group burials, but no well-defined basal cemetery were found at Emeryville and Ellis Landing. It is possible, however, that the detection and recognition of basal cemeteries may be in part a function of field strategy, since extensive, areal excavations are necessary to define these kinds of features.

Interpretations of the mortuary remains suggest that few young children and infants are represented in some mound populations (Nelson 1910:382; Schenck 1926:203–204), that

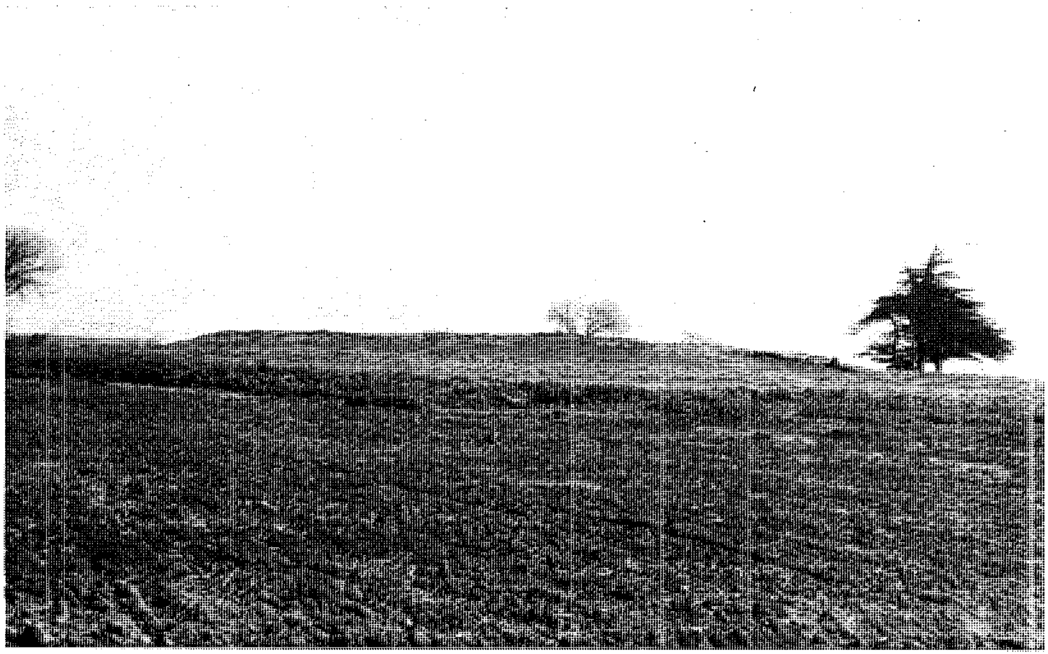

FIGURE 9.2 Ryan Mound (ALA-329). *Photo by Waldo Wedel in February, 1935. Reprinted courtesy of the Phoebe Hearst Museum of Anthropology, University of California, Berkeley (negative no. 15-10733)*

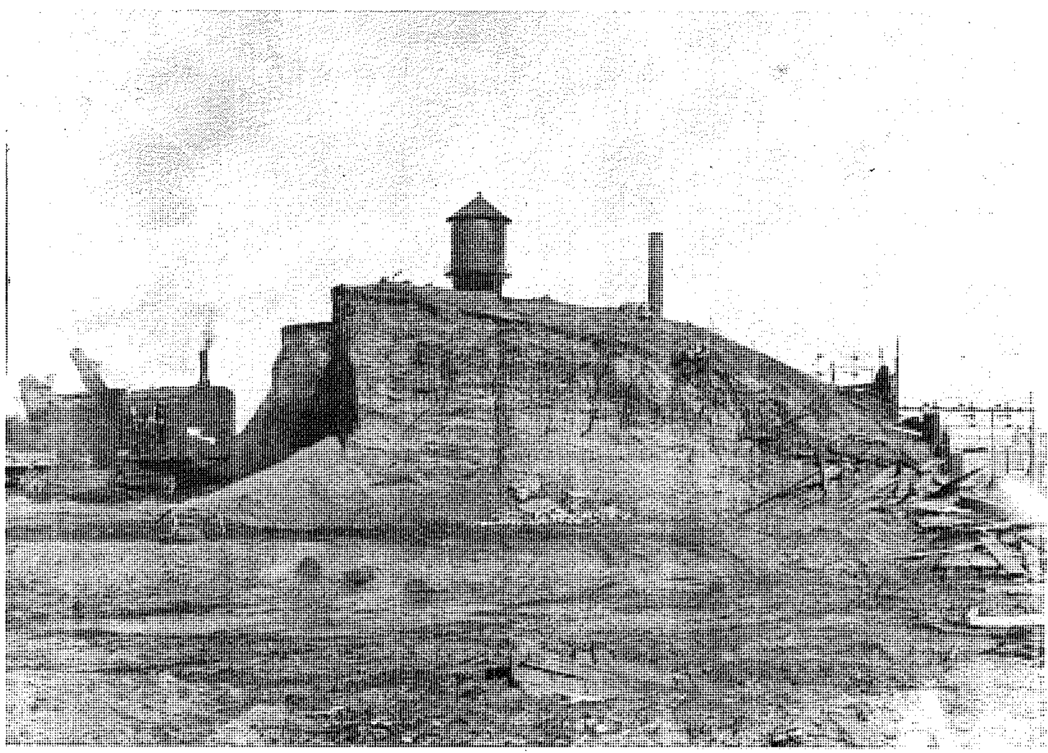

FIGURE 9.3 Emeryville Mound (ALA-309). The mound was being leveled to convert the area into a factory. The photo record designates the provenience as the "southerly wall of areas 34 and 40; looking north." *Photo by W. Egbert Schenck, October 1924; courtesy of the Phoebe Hearst Museum of Anthropology, University of California, Berkeley (negative no. 15-7812a)*

many individuals are interred with few or no mortuary offerings (Nelson 1909:344; Wallace and Lathrap 1975:46; Wilson 1993:10–11), and that a few graves are richly embellished with red ochre, shell ornaments, and other mortuary goods (J. Davis and Treganza 1959:64; T. King 1970; Leventhal 1993; Schenck 1926:198–202). This last observation has stimulated various interpretations about status and/or wealth differences in the social organization of Bay area people (see T. King 1970, 1974; Leventhal 1993; Luby 1991; Schenck 1926:198; Wilson 1993:10–11).

**Domestic Refuse**

To what degree did Bay area peoples employ shell mounds as residential locations? Most excavators have interpreted these sites as vast accumulations of domestic refuse resulting from their use as villages. However, this interpretation needs to be carefully reconsidered for two related reasons (see Leventhal 1993).

First, it has long been noted that Bay area mound deposits, especially from nonburial contexts, yield very low artifact densities. Uhle's (1907:20) excavation of Emeryville pro-

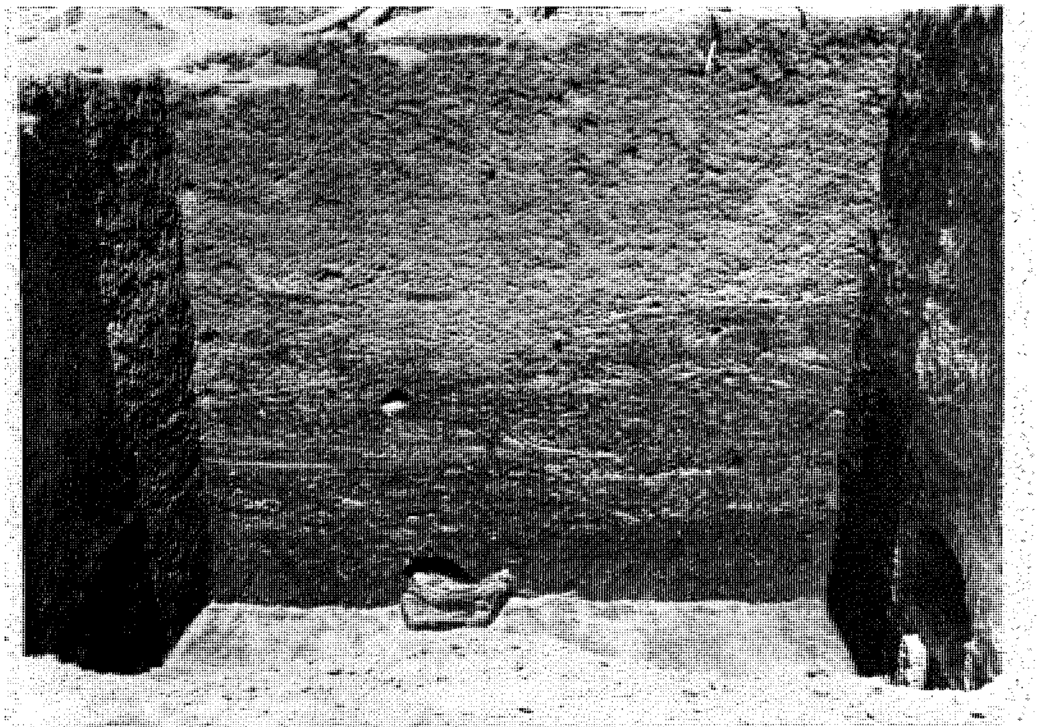

Figure 9.4 Section profile of West Berkeley (ALA-307). The section is about 5.5 m thick. *Photographed in 1950 and published in Wallace and Lathrop 1975, plate 2. Reprinted courtesy of the Phoebe Hearst Museum of Anthropology, University of California, Berkeley (ARF Photo Archive)*

duced only three artifacts/m$^3$, results that stimulated Kroeber (1936:112) to question why mounds of such enormous size could produce such "meagerness of content." Wallace and Lathrap (1975:8–9) noted that the density of artifacts, either whole or broken, recovered from typical mound excavations, including the West Berkeley site, was only 0.8/m$^3$. Shell mounds at MRN-20 and MRN-115, excavated in the 1940s and 1950s, had artifact densities as low as 0.3 and 0.4/m$^3$ (McGeein and Mueller 1955:53; Meighan 1953:4). Recent fieldwork, involving more sophisticated recovery techniques, still only produced artifact densities of 4 to 11/m$^3$ at the Stege Mound complex (Banks and Orlins 1985:88–90), 11/m$^3$ at the lower San Pablo Creek mounds (Banks and Orlins 1979:7.88), and 18/m$^3$ for some units at MRN-14 (Riley 1979:162).

Second, researchers are now reconsidering alternative interpretations for mounded sites with low artifact densities and human graves. Meighan (1987) interprets the early Windmiller "dirt" mounds in the California Delta, commonly assumed to be the remains of villages, as specialized burial places. He is impressed with the paucity of artifacts and faunal remains in nongrave contexts and believes that redeposited midden soil was used in the construction of the mounds. Claassen (1991) also reinterprets the early shell mounds of the American Southeast (5500–3000 BP) as specialized burial or ceremonial sites. Employing ethnographic data to show that shell has ritual meaning to many cultures, she argues that molluscs were harvested in ceremonial contexts primarily for the construction of mound complexes and only secondarily (or not at all) for food. Claassen (1991:287, 295) supports this interpretation by citing the paucity of house structures in shell deposits and the common occurrence of paired mollusc valves, indicating little post-depositional disturbance. Leventhal (1993) raises similar concerns in his reanalysis of the Ryan Mound in San Francisco Bay, employing several independent lines of evidence to argue persuasively that it functioned primarily as a specialized cemetery. He notes that graves constitute the majority of archaeological features, that few residential features (house structures, hearths, and so on) are found in the mound, that there is little evidence of flaked stone or other tool manufacture, and that most artifacts are finished products associated with burials (1993:44–114, 244).

It would appear that some Bay area sites probably served as specialized cemeteries—sacred places, segregated some distance from residential places, where ritual activities venerating the dead were performed. University Village is one possibility. Although fifty or sixty graves were unearthed at this site, the matrix surrounding these burials, an area of more than 40 hectares, "was relatively devoid of occupational refuse," the major exception being several basin-shaped, shell-filled features less than 1 m wide and 10 cm deep (Gerow 1968:27). However, it is unclear whether the Ryan Mound served solely as a specialized cemetery. While Leventhal (1993) makes a very convincing case for the significant ceremonial context of this site, Wilson's (1993:2–16, Table 4) recent analysis of sediments and hundreds of artifacts from nonburial contexts suggests that coastal hunter-gatherers may have also been using the Ryan Mound as residential space.

A detailed consideration of other large shell mounds extensively excavated in the Bay area suggests that most were used as both ceremonial locations and residential places. Many mound deposits contain domestic refuse from the manufacture and use of various bone and lithic tools, the processing and cooking of foods, and the construction, use, and abandonment of residential space, including house structures and related work areas.

**Artifact Assemblages.** While the specific artifact assemblages vary in detail from site to site, a very impressive range of bone artifact types, chipped stone and ground stone tools, clay objects, and shell artifacts are found in shell mounds (see Bickel 1981:53–275; J. Davis and Treganza 1959:38–58; Wallace and Lathrap 1975:9–10). Artifacts are found in both burial and nonburial contexts. Recent investigations identify a diverse range of artifact types in nonburial contexts at the lower San Pablo Creek mounds (CCO-268, CCO-269, CCO-270, CCO-271; Banks and Orlins 1979:7.91–7.144), the Stege Mound complex (CCO-297, CCO-298; Banks and Orlins 1981), SFR-112 (Pastron and Walsh 1988a: 42), and the Ryan Mound (Wilson 1993:10–13). The artifact assemblages include considerable workshop debitage, an indication that stone and bone tools were manufactured, retooled, or modified at shell mound locations (Banks and Orlins 1981; Uhle 1907:63; Wilson 1993:15).

**Vertebrate Faunal Remains.** Vertebrate faunal assemblages also exhibit tremendous diversity. There is little question that the large shell mound locations were used to process, cook, and consume a wide variety of foods. While the frequency of particular animal species varies within and between sites (see Broughton 1994c; Simons 1992), faunal studies have distinguished foods harvested from open bay waters, tidal flats and beaches, salt and freshwater marshes, bay grasslands, and nearby oak woodlands. These include terrestrial mammals (artiodactyls and carnivores, such as *Canis* sp.); marine mammals (sea otters [*Enhydra lutris*], pinnipeds in some sites); many species of fish (bat rays [*Myliobatis californica*], green and white sturgeons [Acipenseridae], king and silver salmons [*Oncorhynchus tshawytscha*, *O. kisutch*], thresher sharks [*Alopias vulpinus*], leopard sharks [*Triakis semifasciata*], assorted surf perches [Embiotocidae], and jack smelt [*Atherinopsis californiensis*]); and a very striking number of birds, mostly ducks and geese (Anatidae), as well as cormorants (Phalacrocoracidae), loons (Gaviidae), and grebes (Podicipedidae) (Bickel 1981:27–30; Brooks 1975; Follett 1975; Gobalet 1981, 1985; Gobalet and Strand 1979; Howard 1929; McGeein and Mueller 1955:59–60; Riley 1979; Simons 1979, 1981, 1985, 1992; Wilson 1993:16–22).

**Shell Refuse.** The initial excavators, working almost exclusively in the East Bay, described shell matrixes composed primarily of three intertidal molluscs: bay mussel (*Mytilus edulis*), Pacific oyster (*Ostrea lurida*), and bent-nose clam (*Macoma nasuta*). A common observation was that bay mussel and Pacific oyster comprised the bulk of the shell in the lower levels and that clams became increasingly prevalent in upper strata (Nelson 1909:338, 1910:376; Loud 1924:358; Uhle 1907:17). Diachronic changes in the frequency of shellfish species were explained by a rising sea level and silting of the bay (Greengo 1951), overexploitation of particular species (Gifford 1916:10), seasonal exploitation of particular species (Schenck 1926:173–174), or greater energy investment involved in harvesting burrowing clams in contrast to rock-clinging oysters and mussels (Gerow 1968:32; Wallace and Lathrap 1975:51). Some recent excavations record a similar temporal pattern (Hattori and Pastron 1993:18; Pastron and Walsh 1988a:82). However, the results of other recent analyses indicate that greater variation exists across both space and time in the frequency of mussels, oysters, clams, and other mollusc species in shell mounds than initially recognized (Banks and Orlins 1979:7.45–7.46; Bickel 1978:14, 1981:25–27; Greengo 1951; Pastron and Walsh 1988b:41–42; Phebus 1973:71; see also Gifford 1916:10).

In contrast to Claassen's (1991) findings in Southeastern shell mounds, mollusc remains from Bay area sites are often burned, presumably from food processing, and tend to be highly fragmented (Allen-Wheeler 1985:190; Gifford 1916:11; Schenck 1926:182; Uhle 1907:14). While some lenses and pits of whole mollusc shells are reported, extensive deposits of crushed shell are common, suggesting trampling and other post-depositional actions associated with residential places (see Gifford 1916:11). Wilson's (1993:4) comparison of midden sediments from the Ryan Mound with offsite soils indicates significantly higher levels of nitrogen, calcium, potassium, and phosphorous for the former, findings that bolster his argument that "extensive human occupational activities" took place at the site.

**Architectural Features.** House floors, hearths, and other kinds of features are recorded at every large shell mound where extensive excavations have been undertaken. Some architectural features were found on top of the mounds, while others were buried deep in midden deposits. In Nelson's initial survey (1909:326, 346–348), he recorded multiple house pits on tops of mounds that had not yet been obliterated, including fifteen pit features at Ellis Landing. Leventhal (1993:31) quotes an 1875 newspaper article by Lorenzo Yates, who described the top of the Ryan Mound as containing multiple circular depressions that he interpreted as "sweat-houses." Meighan's (1953:2–4) excavation of one of twelve surface depressions recorded by Nelson on the Thomas site revealed a circular, dome-shaped, burned structure constructed of redwood poles (two still in a vertical position), clay, and grass thatch. The structure contained a central hearth containing twenty-four fire-cracked rocks and the charred remains of four coiled and twined baskets.

Excavations at Emeryville (Schenck 1926:183, 195), MRN-20 (McGeein and Mueller 1955:54), West Berkeley (Wallace and Lathrap 1975:44, 120), Patterson Mound (Bickel 1981:316–317; J. Davis and Treganza 1959:58, Diagram 2), the Fernandez site (J. Davis 1960:40), ALA-13 (Bickel 1981:317), MRN-27 (T. King 1970:21), and possibly the Ryan Mound (Wilson 1993:4) also revealed house floors, hearths, ovens, and other features buried in mound deposits. Most structures were similar to the burned house described above: circular house floor plans, most measuring about 3 to 5.5 m in diameter (although a few were much larger), with hard-packed clay floors 7 to 10 cm thick usually associated with fire pits, and roof fall. Postmold patterns or charred timbers were evident in some cases.

Other architectural features commonly found in shell mounds suggest that a variety of extramural work areas were probably associated with house structures. These features include storage pits (McGeein and Mueller 1955:54; Wallace and Lathrap 1975:44); extramural hearths (Banks and Orlins 1979:7.85; Pastron and Walsh 1988a:77–78, 1988b: 45; Wallace and Lathrap 1975:44); ovens or pits for baking foods and steaming shellfish (Banks and Orlins 1979:7.86–7.87; Bickel 1981:317); "cooking areas" containing ash, charcoal, burned shellfish, bones, and fish remains (Banks and Orlins 1979:7.86); and fish-baking features consisting of fire-cracked rocks, ash, and layers of "compacted" fish scales and bones, the latter measuring 10 to 20 cm thick (Drake 1948:320; Schenck 1926:178).

### Occupation History

It has been widely assumed that Bay area shell mounds were continuously occupied for extended periods. Gifford (1916:12–13) and Nelson (1910:401) calculated that the massive volumes of refuse in Emeryville and Ellis Landing would have taken a hunter-gatherer population about three to four thousand years to accumulate. Later studies employed radiocarbon dates and diagnostic artifacts to argue for long-term occupations (see J. Davis and Treganza 1959; Wallace and Lathrap 1975). However, some archaeologists (Glassow 1967; Gould 1964:129) remain skeptical about assuming continuous, long-term occupations of large shell middens in California without better chronological control.

The occupation histories of shell mounds in figure 9.5 were examined by plotting radiocarbon assessments from nine sites where five or more dates have been published. All dates are uncorrected radiocarbon determinations (as are other dates cited in this chapter unless otherwise noted). The dates indicate diverse patterns of use. One site (SFR-113) displays a tight cluster of dates, suggesting a fairly short occupation span (see also Hattori and Pastron 1993:18 for their interpretation of SFR-114). Four sites (SFR-112, CCO-270, CCO-271, CCO-297) exhibit two or three pulses of occupation whose dates and standard deviations suggest episodic use of mound locations spanning five hundred to eleven hundred years or more. Two sites (ALA-329, CCO-269) are characterized by four or five pulses of occupation whose dates and standard deviations indicate repeated cycles of use and abandonment over nineteen hundred years. The final two sites (ALA-307, CCO-298) are distinguished by a consecutive series of dates whose standard deviations overlap, suggesting extensive (possibly continuous) use over one thousand to twelve thousand years or more.

The majority of the sample (seven sites) suggests that shell mound locations were reused frequently over extended periods ranging from five to nineteen hundred years. A similar observation is made by Banks and Orlins (1981, 1985:31–34), whose detailed synthesis of chronometric data and temporally sensitive artifacts from more than fifty sites in the Richmond/San Pablo area of the East Bay indicates repeated use of sites spanning many centuries. While there appears to be little question that some shell mound locations were used over long periods, the nature of the occupation cycle is ambiguous. That is, it is not clear whether some bayshore locations were used sporadically, with occupations divided by lengthy intervals of abandonment, or whether their use was more continuous, with repeated occupations divided by only short periods of nonuse. It is possible that at least a few mounds, such as West Berkeley (ALA-307) or CCO-298 of the Stege Mound complex, could have been used relatively continuously for many years with little or no break in use.

The number of radiocarbon dates per site, however, may be too few to document the full occupation histories of any location. As more radiocarbon dates or other chronological information become available, the discrete pulses of occupation may become less pronounced or disappear altogether. The comparison of hundreds of obsidian hydration readings from a site with relatively few radiocarbon dates is a case in point. Wilson's (1993:5–9) analysis of 305 obsidian hydration measurements from the Ryan Mound (ALA-329) shows continuous rim readings from about 4 to 0.9 microns (converted to Napa obsidian hydration values). Rather than five discrete intervals of occupation (as suggested in fig. 9.5), the obsidian hydration data suggest continuous use of more than two thousand years.

The full occupation histories of many of the largest mounds are probably not represented in the radiocarbon dates or other chronological information obtained in recent fieldwork. Since the tops of most of these mounds were removed prior to or during the early 1900s, evidence for later intervals of occupation may have already been largely obliterated when radiocarbon samples were first collected after World War II. The radiocarbon dates in figure 9.5 were all collected in the field after 1950. Consequently, we must keep in mind that our current interpretations for large mounds, such as West Berkeley, Ellis Landing, Emeryville, and those in the Stege Mound complex, may be skewed towards earlier periods of prehistoric use and possibly neglect developments in late prehistoric or early contact times.

When Bay peoples did occupy shell mound locations, there is good evidence that most sites were used in the late fall/winter months and that some were occupied beyond the winter, possibly year-round. The abundant remains of migratory ducks and geese in mound deposits evidence late fall/winter hunting and processing of waterfowl meat (Brooks 1975:107; Howard 1929; McGeein and Mueller 1955:59; Nelson 1909:345; Simons 1979:15.15). A limiting factor in the year-round occupation of some Bay area locations is the scarcity of potable water during the summer months, when smaller streams tend to dry up. It is commonly argued that some locations were not used in the summer months for this reason (Bocek 1991; Hattori and Pastron 1993:18; McGeein and Mueller 1955:60; Schenck 1926:277).

However, other locations were apparently used throughout much of the year, including the summer months. This interpretation is based on evidence for collecting young cormorants in the summer months (Howard 1929), hunting Scolopacid shore birds in the spring and late summer/early fall (Simons 1979:15.15), and harvesting Chinook salmon in fall and late spring/summer (Gobalet and Strand 1979:14.23–14.24). The analysis of shellfish growth bands from Pacific littleneck clam (*Protothaca staminea*) and basket cockle (*Clinocardicum nuttallii*) shells from CCO-297 and CCO-298 suggests year-round harvesting patterns for the latter site and harvesting in all but the fall and early winter for the former (Veldhuizen 1981:15.22).

**Regional Settlement Pattern**

Most shell mounds are distributed along the bayshore where freshwater streams empty into the bay. The sites are often found in discrete groups or clusters, with the largest sites situated closest to the bay (Heizer and Baumhoff 1956:37; Nelson 1909:328–329). Banks and Orlins (1979:8.10–8.12, 1981:3.64–3.65, 1985:113–114) define at least eight mound clusters in the East Bay: Stege Mound complex, Emeryville complex, lower San Pablo Creek, Willow Marsh near Coyote Hills Regional Park, upper Wildcat Creek, Rheem Creek, Potrero San Pablo marsh, and Potrero San Pablo Peninsula. Each mound cluster is composed of four to six mounds that vary greatly in size. In three mound complexes that have been dated, the oldest and largest sites in each mound cluster are located closest to the bay, ringed by other medium-sized and small mounds (Banks and Orlins 1985:113–114). Banks and Orlins (1985:116–118) argue that the location of individual sites in mound clusters is an indication of when they were first used (those farthest from the bayshore are younger, for example). It is difficult to assess the contemporaneity of the largest sites with the younger medium-sized and small sites in the mound clusters, since the upper portions of most of the former were removed or altered prior to archaeological investigation. However, it is possible that the larger and older mounds may have served as sociopolitical and ceremonial centers for nearby mounded villages and that future studies of mound clusters may provide important insights into the prehistoric organizational structure of Bay area peoples.

Bocek (1991) observes a similar settlement pattern for sites in the San Francisco Peninsula. Clusters of sites, often in pairs or groups of three or four, are distributed along creeks which drain into the bay. While she interprets this pattern as evidence of "short-distance sedentism" whereby people moved between residential sites within a cluster on a seasonal basis, few data are available on the seasonal occupation of sites to evaluate this model.

Other kinds of sites are found in the hinterland of bayshore shell mounds, including bedrock milling stations, seasonal encampments, and specialized task sites (Parkman 1994). Bayshore people probably used these sites to hunt artiodactyls and to harvest seeds, acorns, greens, and bulbs from nearby bayshore grasslands and hills. In some cases, seasonal residences (especially in nonwinter months) were established in the hinterland of the shell mounds (T. King 1974; Parkman 1994). In other cases, terrestrial products were probably exploited by task groups who employed logistical operations to move back and forth between the mounded villages and outlying resource areas.

**Summary**

Great variation characterizes the size, internal composition, function, and occupation history of bayshore sites. Some may have served as specialized cemeteries, others as short-term residential bases, while still others may have been processing locations for estuarine resources. However, most of the large, deeply stratified bayshore sites—such as Emeryville, Ellis Landing, Patterson Mound, Fernandez site, the Stege Mound complex, West Berkeley, and probably the Ryan Mound—were repeatedly used over hundreds or thousands of years as both residential places and long-term repositories for the dead. There is good evidence that coastal peoples used these mounds as residential space, where they ate, slept, worked, and socialized, and as ceremonial places, where they buried their dead and performed ritual activities.

Some of the large mounded villages may have served as important ceremonial and sociopolitical centers in the local region. This interpretation is supported by the burial of raptorial birds, such as California condors, in the basal levels of West Berkeley and Emeryville (Wallace and Lathrap 1959), the burial of discrete charmstone clusters at the Ryan Mound (Wilson 1993:13), and the presence of elaborate architectural structures at MRN-27 and West Berkeley. The

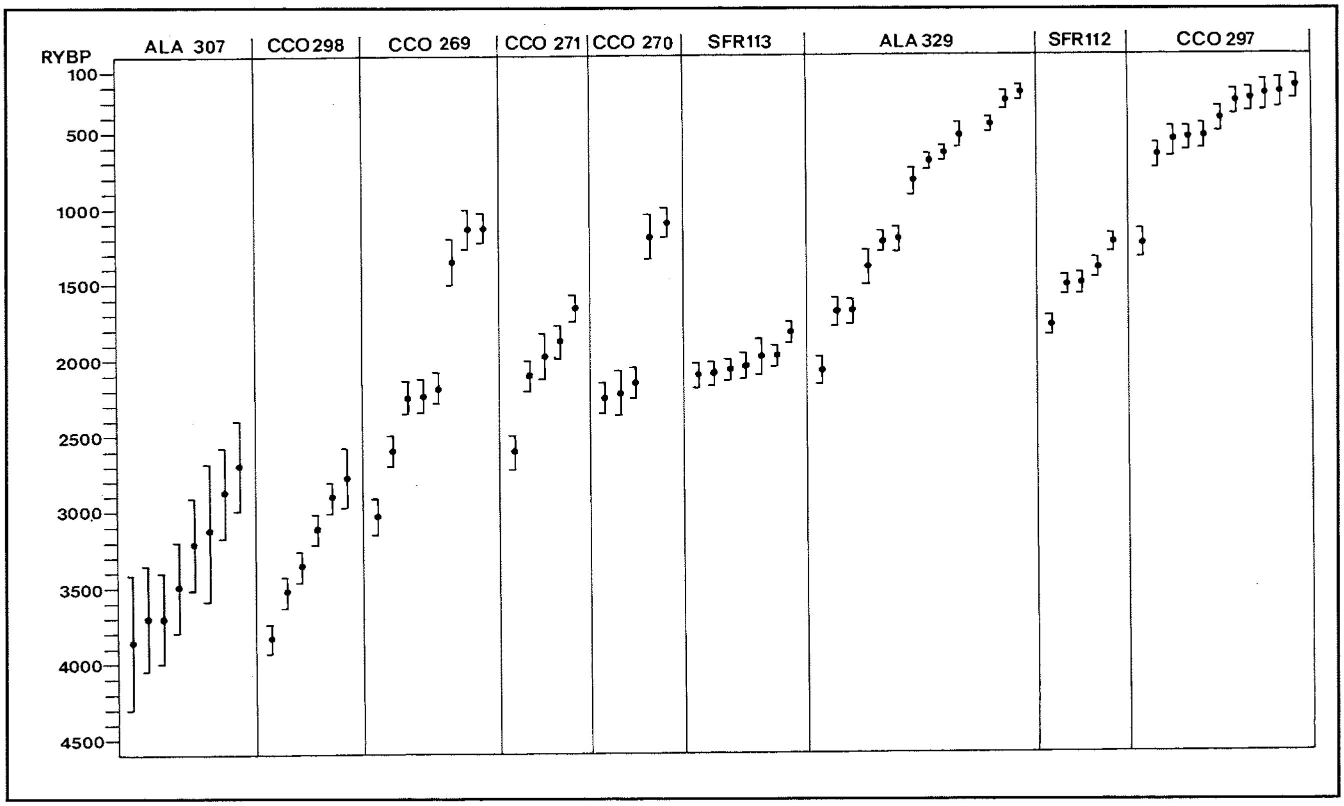


FIGURE 9.5 Radiocarbon dates from nine Bay area sites. Radiocarbon data from ALA-307 (Wallace and Lathrap 1975:58), CCO-297, CCO-298 (Banks and Orlins 1981: Table 9.1), CCO-269, CCO-270, CC0-271 (Banks and Orlins 1979:8.3), ALA-329 (Wilson 1993:8), and SFR-112, SFR-113 (Pastron and Walsh 1988a: 25, 1988b: 61)

structures are of hardpacked yellow-brown clay floors, about 8 to 12 m long, that exhibit multiple postmolds and no formal hearths (T. King 1970:31–32; Wallace and Lathrap 1975:44). While they have been interpreted as ceremonial structures (similar to ethnographically described round houses), they may also represent assembly houses, where social, political, and ritual meetings were conducted (see Leventhal 1993:244), or the abodes of influential families.

## MIDDLE HOLOCENE DEVELOPMENTS

A critical look at cultural and ecological developments in the Middle Holocene is necessary to understand why hunter-gatherers began to construct shell mounds and why some mounds continued to be used over many generations as important ceremonial and residential places.

### Growth of the Estuarine System

The greater San Francisco Bay is a drowned river valley that has been submerged three times in the last million years. The most recent submergence began about ten thousand years ago when post-Pleistocene sea level rise inundated the Golden Gate and deeper river channels (Josselyn 1983:4–6). The paleoenvironmental interpretations of Atwater, Helley, and Hedel (1977) and Atwater et al. (1979) are based on detailed analyses of sediments from deep boreholes in southern San Francisco Bay, some penetrating more than 100 m below sea level, collected for bridge foundation studies. Atwater and his colleagues suggest that rapid marine transgression took place from 9500 to 8000 RYBP, when sea level rose an average of 2 cm per year. The moderate slope of the bay region (beyond the drowned river channels) contributed to the rapid spread of the estuary. It is estimated that the estuarine system advanced 30 m a year in some places (Atwater, Helley, and Hedel 1977:11). The rapid rate of estuarine expansion precluded any extensive salt or brackish marsh development at this time (Josselyn 1983:6).

Sea-level rise decreased tenfold between eight and six thousand years ago. The rate was only 0.1 to 0.2 cm/year beginning about 6000 RYBP, and the bay system expanded at a much slower rate (Atwater, Helley, and Hedel 1977:11). The broad, nearly flat surfaces of southern San Francisco Bay, northern San Pablo Bay, and Suisun Bay were gradually inundated, and sediment accumulations along the margins of the estuarine system finally exceeded sea level rise. The latter process created thousands of hectares of intertidal mudflats and flourishing salt and brackish tidal marshes. However, great temporal variation characterized the development and growth of tidal marshes across the estuarine system. A comparison of sediment cores suggests marshland development in the Delta began about 6000 RYBP, about 3000 RYBP at the north end of Coyote Hills, and about 2000 RYBP in the southern reaches of San Francisco Bay (Atwater et al.

1979:349; Bickel 1981:19). A population explosion in the number of oyster beds began in the southern reaches of San Francisco Bay about 2500 RYBP (Bickel 1978:12).

**Archaeological Record**

Little is known about Bay area sites prior to 4,000 years ago. As Bickel (1978:9) and Moratto (1984:221) have noted, the rapid expansion of the estuarine system would have inundated early sites under bay waters and mud. Fitzgerald's (1993) study of Middle Holocene components from three sites (SCL-65, SCL-177, and SCL-178) south of San Francisco Bay may provide some insights into the early populations who exploited the riparian and grassland habitats of the region. These Middle Holocene peoples may be characterized by milling-stone assemblages similar to those unearthed in contemporaneous Southern California sites, consisting of milling slabs, handstones, stemmed points, pitted stones, and hammerstones. Fitzgerald (1993:100) suggests that the milling-stone assemblages changed about 4,500 years ago, when mortars and pestles began to increase in numbers.

Among the earliest archaeological materials yet recovered from the margins of the greater San Francisco Bay are human skeletal remains, including "Stanford Man I and II," the "Sunnyvale female," and the "BART male" (Bickel 1978:10, 14–15). The Stanford and Sunnyvale burials were found several kilometers from the bayshore (fig. 9.1), buried 2 to 5 m below the ground surface. The BART skeleton was recovered in a tidal marsh setting on the bayshore in San Francisco, 22 m below present ground surface or about 14 m below the 1850 ground surface. Radiocarbon dates suggest the four burials date between 5000 to 4000 RYBP (see Bickel 1978:9–10).

However, the earliest known archaeological site may be CCO-474/H located along the east shore of San Pablo Bay (Waechter 1993). Obsidian hydration dates suggest an occupation spanning from about 5500 to 2500 BP. Excavations revealed a "dirt" midden which contained faunal remains almost exclusively from terrestrial habitats and a paucity of milling equipment. No sea mammal remains were identified, and only a few bones of goose (Anatidae) and grebe (Podicipedidae) and seven fragments of fish bone, identified only as Osteichthyes or bony fish, were unearthed (Waechter 1993:5). A total of 440 g of mollusc remains were recovered, consisting primarily of bay mussel and Pacific oyster. The paucity of estuarine resources at the site may be significant. Waechter (1993:13) interprets CCO-474/H as a temporary camp reused over an extensive period of time, possibly as a shellfish-gathering station from which mollusc and other estuarine species were transported to interior Contra Costa villages such as Stone Valley (CCO-308). However, it is also possible that the paucity of estuarine resources at CCO-474/H may reflect the late development of intertidal mudflats and tidal marshlands in this area of San Pablo Bay.

The timing of the initial exploitation of estuarine resources by local hunter-gatherers probably varied greatly across the Bay area, depending largely upon when mudflats and tidal marshes were established in local areas. Given the relatively late development of these habitats in the formation of the estuarine system, shell middens were probably not present prior to about six thousand years ago, and they would not have become common for another several thousand years in most areas of the bay. Thus, while some early shell middens may be deeply buried under bay mud, they are probably located along the outer margins of the bay system.

The earliest known shell middens date between 4000 and 3000 RYBP (fig. 9.5). Early chronometric dates have been reported from University Village (2700 ± 400 RYBP, 3150 ± 200 RYBP; Gerow 1968:99), the Castro Mound (SCL-1) (3400 ± 100 RYBP; Bickel 1978:20), West Berkeley (3860 ± 450 RYBP), Ellis Landing (2990 ± 120 RYBP, 3680 ± 100 RYBP; Banks and Orlins 1981:Table 9.1), and one of the Stege Mounds (CCO-298) (3820 ± 100 RYBP). Banks and Orlins (1981:3.334, 1985:31) identify an additional four shell mounds (CCO-267, CCO-275, CCO-284a, and CCO-300) in their San Pablo/Richmond study area that contain diagnostic artifacts of this time period. Artifact assemblages for the late Middle Holocene shell mounds include stemmed and short, broad leaf projectile points; squared-based knife blades; mortars (both unshaped and cylindrical), pestles (short and stubby, cylindrical); crescentric stones; perforated charmstones; bone awls; polished ribs; notched and grooved net sinkers; rectangular and spire-lopped *Olivella* beads; rectangular abalone (*Haliotis* sp.) beads and various pendant types; antler wedges; and stone bars or "pencils" (see Banks and Orlins 1981:3.57; Gerow 1968:58–93; Wallace and Lathrap 1975:53). The shell matrix at these sites was composed primarily of bay mussel, Pacific oyster, or a combination of the two species.

**Formation of Early Shell Mounds**

The earliest human modification of the bayshore landscape involved the construction of shell mounds. The initial accumulation of midden deposits would have raised these coastal places above the nearly flat, extensive, featureless plains of the bayshore marshlands (Atwater et al. 1979:357–359). As sea level rose in the late Middle and Late Holocene, coastal peoples continued to use the same locations over time by depositing materials in vertical relief at a rate that exceeded marine transgression. It is therefore not surprising that Nelson (1909:323, 329–330) observed in 1908 that at least ten mounds extended 1 to 6 m below "sea level" and that thirty large mounds were subject to severe wave action during storms.

There is some evidence to suggest that shell mounds were not produced simply by the long-term accumulation of refuse from village locations (see also Leventhal 1993:142). The complex strata of sediments may be explained, in part, by people intentionally dumping rocks, sands, and clay onto sites (see Nelson 1909:335). This dumping may reflect attempts to raise the heights of the mounds. The high diversity of artifacts and faunal specimens but low density of material remains is also suggestive. Shell middens tend to have low artifact densities, in general, given the greater volume of shell refuse that is included in the calculation of density figures. Shell middens that are intentionally elevated by dumping additional sediments onto the deposits will produce even lower artifact densities.

Why did Bay area peoples begin constructing shell mounds in the late Middle Holocene? They could simply have moved their residential places upslope in advance of rising sea level. This process would have produced relatively thin midden deposits that were laterally dispersed, with the earliest remains deposited downslope from the later materials. This site pattern was encountered in my excavations of prehistoric middens on the east end of Long Island, New York (Lightfoot et al. 1987).

There are four reasons why shell mounds, as opposed to broadly dispersed, lateral middens, were produced by Bay area peoples beginning in the late Middle Holocene:

- Mounds were constructed to keep villages well above high tide. Winter, the principal time when shell mounds were occupied, was also the wettest season of the year. Bayshore locations tend to be periodically inundated by high tides—especially during storms—and discharge from nearby flooding streams. Even coastal locations some distance from bay waters are prone to seasonal flooding. The analysis of sediments from CCO-269 and CCO-271 in the East Bay show evidence of seasonal flooding from nearby San Pablo Creek during the formation of the midden deposits (Blackard 1979:12.5–12.6). The construction of mounds along the low lying bayshore would have insured that residential places remained dry during all seasons of the year.

- Mounds were constructed as ideal locations for exploiting nearby estuarine resources. Several investigators have observed bayshore mounds in marshlands completely surrounded by water. These mounds are essentially islands cut off from land during the wet, winter months (Banks and Orlins 1985:36–37; Nelson 1910:369). While these conditions were problematical for foot travel, they were perfectly suited for water transportation. Boats probably served as the principal means of transportation for Bay area peoples, especially during the winter months. Studies of faunal remains strongly indicate that boats, probably similar to the tule balsas observed by early Spanish visitors, were employed by Bay area peoples to harvest fish and birds from open bay waters (Follett 1975:80–81; Simons 1979:15.22–15.23). Mounded villages along or in bayshore waters were ideal points from which people could paddle across the greater San Francisco Bay to visit other villages, to hunt ducks and geese, to harvest sharks, sturgeons, and surf perches using nets and fishooks, and to collect molluscs from productive beds.

- Mounds were constructed as long-term repositories for the dead. Human remains were placed in the basal deposits of the earliest shell mounds, and later residents continued to use the mounds as burial grounds and as ceremonial places. At the core of these mounds were the human burials, ceremonial offerings such as California condors, and physical remains (houses, artifacts, and other materials) of past peoples who were probably revered as ancestors by the living. The repeated construction and use of the mounds forged a direct link between the living and the dead. Bay area peoples dwelled on top of mounds whose cores encapsulated the sacred remains of their ancestors going back many generations, possibly spanning ninteen hundred years or more.

- Mounds were constructed as territorial symbols for local village communities. Over generations of use and deposition, shell mounds became highly visible cultural features on a relatively flat bayshore landscape. Residences on top of these mounds would be evident to people across the bay, especially at night when fires burned in hearths and cooking pits. I believe these mounded villages served as landmarks to hunters and fisherpeople in boats, providing a cultural map of the communities along the bayshore. Bay area village communities probably justified their territorial rights to nearby land and estuarine resources by claiming genealogical relations to their ancestors buried in the mounded villages. These ancestors would be viewed as the original users of bayshore locations and their many resources.

Mounded villages would have played an increasingly important role as territorial symbols during times of population growth, when the number of villages multiplied. There is some settlement data from the East Bay, the most intensively studied area in the region, that indicate a relatively sizable population may have resided here during the terminal Middle Holocene (ca. 4000–3000 RYBP). Seven shell mounds dating to this period have been identified in western Alameda and Contra Costa Counties, including Ellis

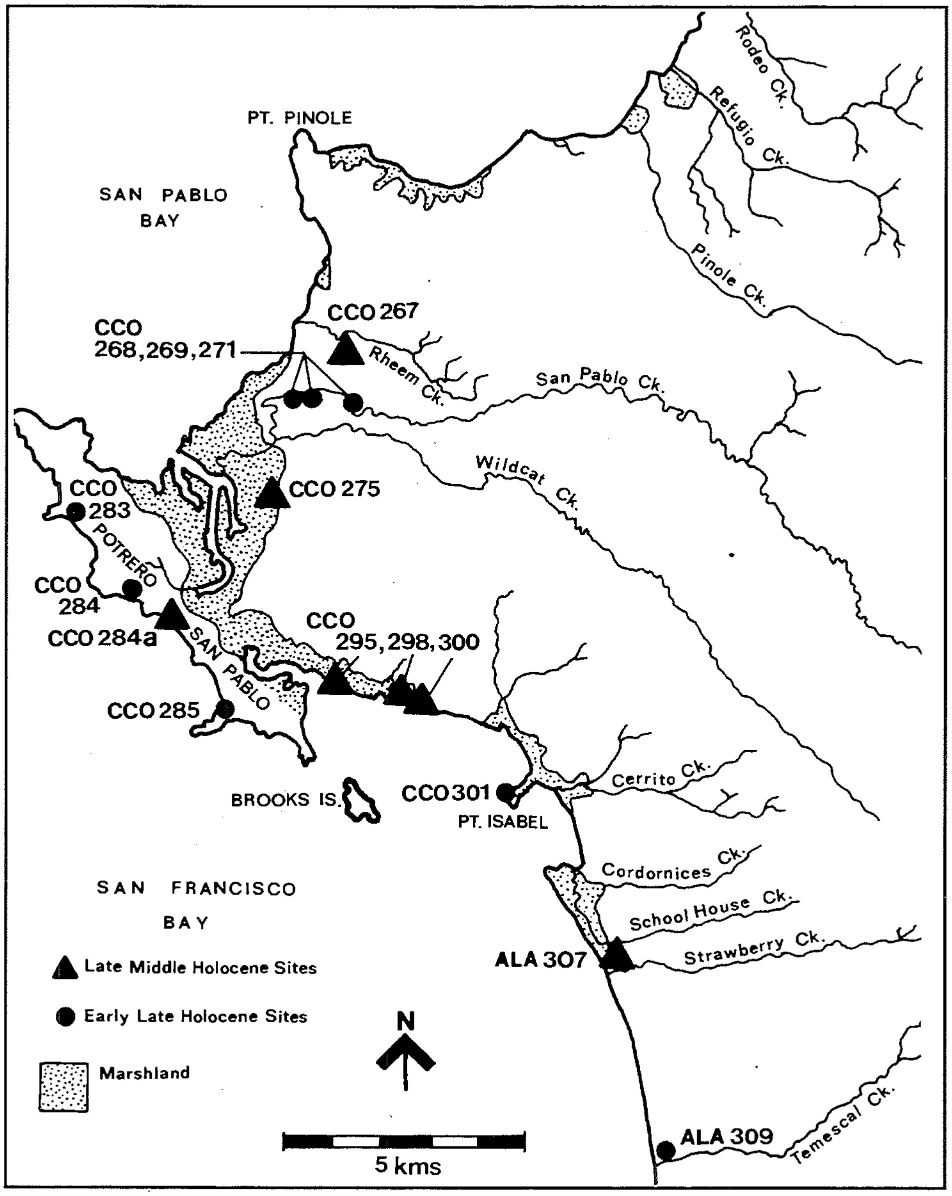


FIGURE 9.6 Late Middle Holocene (ca. 4000–3000 RYBP) and early Late Holocene (ca. 3000–2500 RYBP) sites of the East Bay. Settlement data and base map from Banks and Orlins (1979: Map 9, 1985:32)

Landing (CCO-295), West Berkeley (ALA-307), and two Stege Complex Mounds (CCO-298 and CCO-300) (fig. 9.6). These mounds are spaced, on average, 3.2 km from their nearest neighbors, with a standard deviation of 1.6 km. (The two Stege Mounds were counted as one location.)

In the early Late Holocene (ca. 3000–2500 RYBP), eight new shell mounds were established, including Emeryville (ALA-309), increasing the total number of mounds in the East Bay to fifteen. The spatial distribution of these mounds (2.1 km from their nearest neighbor, with a standard deviation of 1.2 km) suggests that the bayshore landscape was becoming more crowded. (Again, the Stege Mounds were counted as one location, as were as the two mounds of the lower San Pablo Creek complex—CCO-268 and CCO-269). While local population fluctuations most probably occurred in later times (see Banks and Orlins 1985:34), it appears that areas between sites continued to fill in and that mound complexes arose around some of the early villages.

Although the spatial organization and implications of this later prehistoric settlement system are beyond the scope of this discussion, it appears that territorial boundaries and user rights to estuarine resource zones would have become an increasingly important issue among bayshore communities. This appears to be the case at the time of initial European contact, when the population density of the East Bay is estimated to have been 1.2 to 1.9 persons/km$^2$ (Milliken 1981:4.58).

## CONCLUSION

Archaeological investigations of Bay area sites beginning in the early 1900s demonstrate considerable variation in the size, internal composition, age, and use of prehistoric coastal settlements. However, the large, deeply stratified shell mounds distributed along the bayshore of the greater San

Francisco Bay have several characteristics in common. They represent coastal locations that were used (repeatedly or periodically) over hundreds or thousands of years by hunter-gatherer groups as long-term repositories for their dead, ceremonial places, and residential locations.

The earliest known mounded villages date to the late Middle Holocene, when the rate of sea level rise declined and extensive mudflats and tidal marshes were first becoming established in some bay locations. The relatively late occurrence of shell middens in the Bay area, compared to Early Holocene coastal sites in Southern California, may reflect a combination of factors, including the inundation of earlier sites by bay waters and mud and the recent stabilization of the Bay area estuarine environment. However, while the expanding estuarine system may have inundated some early sites, especially those of early Middle Holocene peoples with distinctive milling-stone assemblages, these locations probably reflect places where interior riparian/grassland exploitation took place rather than coastal sites per se (for example, CCO-474/H). Given the late development of estuarine habitats, it is doubt that shell middens were present in the Bay area prior to six thousand years ago.

Once local hunter-gatherers began to exploit available estuarine resources, people began to construct mounded deposits to keep low-lying bayshore locations above water during wet winter months. The intentional construction of mounded space would have continued to keep coastal residences high and dry as sea level continued to rise slowly. These mounded villages would have been ideally suited for water transportation between coastal settlements and estuarine resource patches. Over generations of use and intentional dumping episodes, the mounds became highly visible cultural features along the bayshore landscape. The large mounded villages probably served as territorial symbols for local village communities, especially during times of population growth. Territorial rights to nearby resources could be justified by claiming descent from ancestors buried in the mound deposits. Some of these large mounded villages probably also served as important ceremonial and sociopolitical centers for the region, a point that will need to be considered in future research.

**Acknowledgments.** I thank Roberta Jewett and Les Rowntree for insightful comments on this chapter. Robert Orlins, Breck Parkman, Sharon Waechter, and Glen Wilson were most helpful in sharing with me manuscripts on their archaeological research in the greater San Francisco region. I appreciate the encouragement from David Fredrickson, Michael Glassow, and Jon Erlandson to write this chapter. Gene Prince of the Phoebe Hearst Museum of Anthropology developed the historic photographs in figures 9.2, 9.3, and 9.4.

# Middle Holocene Adaptations on the Northern California Coast

## *Terrestrial Resource Productivity and its Influence on the Use of Marine Foods*

*William R. Hildebrandt and Valerie A. Levulett*

THE NORTH COAST of California is a rugged and mountainous region containing numerous salmon-bearing streams surrounded by a mosaic of coniferous forest, open prairie, and mixed hardwood forest. At the time of European contact, it was occupied by high densities of native peoples speaking several languages and dialects of the Athapascan, Algic, Hokan, and Yukian linguistic stocks. Many of these groups (for instance, Tolowa, Yurok, and Wiyot) were concentrated in coastal and riverine settings, where the development of capital-intensive technological systems (for instance, oceangoing canoes, fish weirs, smoke houses) not only facilitated the procurement and storage of marine mammals and fish but also contributed to the establishment of several large, socially complex communities (Fredrickson 1984; Gould 1975; Kroeber 1925).

Although coastal environments were intensively occupied during late prehistoric and historic times, little evidence exists for their use during the Middle Holocene (T. Jones 1991; Lightfoot 1993; Moss and Erlandson 1995). Instead, most of the Middle Holocene record is restricted to Borax Lake Pattern sites (ca. 6000–3000 RYBP) located in upland settings (1400–1700 m above mean sea level) 20 to 60 km from the coast (Fredrickson 1984). Excavations on Pilot Ridge and South Fork Mountain (Hildebrandt and Hayes 1983, 1993), as well as along the banks of the Trinity River (Sundahl 1988; Sundahl and Henn 1993), uncovered a series of small multiactivity base camps containing a mix of artifact forms that remain constant across contrasting environmental circumstances. These include Borax Lake wide-stemmed points, serrated bifaces, ovoid formed flake tools, edged flaked spalls, handstones, milling slabs, cobble tools, anvils, and drills. Because no tools associated with intensive use of acorns were found (see Basgall 1987), Hildebrandt and Hayes (1983, 1993) argue that the Borax Lake Pattern represents a relatively mobile, "forager" approach to subsistence-settlement organization (Binford 1980), focusing on a wide range of both plant and animal resources.

During the Middle Holocene, most of these upland areas probably consisted of relatively open associations of pines, oaks, and a variety of shrubs—environmental settings conducive to the adaptive strategy outlined above. After about 3000 RYBP, climate cooled and effective moisture increased, causing a downward migration of montane forest and a corresponding decrease in the abundance and diversity of economically important plants and animals (West 1989, 1990, 1993). Simultaneously with these changes, upland residential bases were replaced by task-specific sites, while lowland settlements appear to have been occupied for longer periods of time. Hildebrandt and Hayes (1993) hypothesize that the lowland settlements were supported by the intensive use of salmon and acorns, an adaptive shift made possible by the development of sophisticated extractive technologies (for example, fish weirs) and the establishment of permanent storage facilities (plank houses, for instance). Although no direct evidence for fish weirs has been found in Northern California, the earliest known wood stake weirs in southeast Alaska date between 3,000 and 4,000 years ago (Moss, Erlandson, and Stuckenrath 1990), providing at least partial support for the Hildebrandt and Hayes (1993) proposal.

In contrast to interior northwest California, archaeological data from coastal settings reveal only a few marginal components predating 2000 RYBP. Borax Lake Pattern materials are restricted to a single site (HUM-513/H) located about 1.5 km from the ocean. Preliminary investigations at the site by Roscoe (1995) revealed an artifact assemblage consisting of both flaked and ground stone tools, but no vertebrate or invertebrate faunal remains were recovered. Due to the widespread prairie and marshland habitats in the area, and the large number of projectile points and butchering tools found, Roscoe (1995) argued that the procurement/

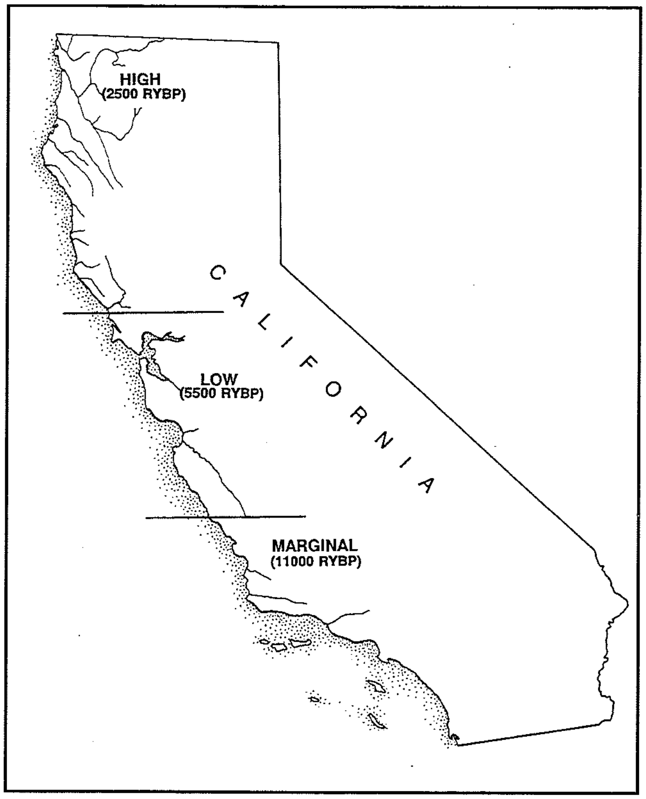


FIGURE 10.1 Salmon productivity and antiquity of outer-coast habitation along the coasts of Northern, Central, and Southern California

processing of large game (predominately Roosevelt elk) was probably a major activity at the site.

On the outer coast (that is, within 500 m of the tidal zone), the earliest recorded assemblages date to the interval from 3000 to 2000 RYBP, but they appear to represent short-term, ephemeral uses of the marine environment (represented by small shell middens). By 1500 RYBP, residential use becomes relatively common (Gould 1972; Levulett 1985), and by about 1000 RYBP, intensive exploitation of coastal resources is clearly indicated by the abundant presence of sedentary villages as well as the widespread use of oceangoing canoes (Fredrickson 1984; Jobson and Hildebrandt 1980; Levulett 1985).

The absence of earlier sites along the north coast is considered problematical by many scholars of California prehistory, particularly when considering the antiquity of settlement along the Southern California coast (see Arnold 1991a; Erlandson and Colten 1991b; T. Jones 1991; Moss and Erlandson 1995) and recent reevaluations of the importance of marine foods to hunter-gatherer populations (Erlandson 1988a, 1994; Glassow and Wilcoxon 1988; T. Jones 1991). Given the Early Holocene age of south coast settlement, these authors have questioned the long-held perspectives of Cohen (1977, 1981) and Osborn (1977), arguing that marine resources (particularly shellfish) were not second-rate resources but highly valued due to their accessibility to mobility-restricted hunter-gatherers. Although generally less productive than large game, shellfish could be readily exploited close to home by nearly all members of the social group, thereby increasing the net-energy return for the entire population.

> The mobility of different members of the hunting and gathering groups must also be considered in assessing potential resource value.... Young mothers, children, the elderly, and the injured would have been limited in their range away from the home base. Some resources could have been exploited as efficiently by these group members, while other resources could only have been obtained by those with unlimited freedom of movement. The optimal diet for the group as a whole would consist of foods gathered by all its members, each performing to maximum efficiency within his or her areal range (T. Jones 1991:435).

In light of these considerations, several researchers have suggested that the near absence of early sites along the north coast may not reflect past reality. Instead, they argue that the dearth of early sites may be due to lack of archaeological evidence caused by Holocene sea-level rise inundating or eroding older cultural deposits and/or inadequate amounts of excavation—that earlier components will be discovered when additional work takes place (Arnold 1991a; Erlandson and Colten 1991b; T. Jones 1991; Lyman 1991). A third alternative, mentioned briefly by T. Jones (1991), Hildebrandt and Jones (1992), and Lightfoot (1993), is that north-to-south differences in the antiquity of coastal use do not stem from problems of archaeological visibility but are largely a function of latitudinal gradients in the productivity of adjacent terrestrial habitats. In Southern California, where terrestrial resource productivity was relatively low, people focused on the use of marine foods much earlier than in the north, where the opposite was the case.

The purpose of this chapter is to provide support for this final alternative through demonstrating a correlation between latitudinal gradients in terrestrial resource productivity and north-south trends in the antiquity of coastal occupation and documenting the initiation of marine resource use in northwest California with data from a series of coastal and interior sites located in areas where problems associated with rising sea level and sample size have had little influence on the archaeological record.

## TERRESTRIAL/RIVERINE RESOURCES AND THE ANTIQUITY OF COASTAL SETTLEMENT

To evaluate latitudinal differences in the antiquity and character of coastal settlement, we divide California into three sections based on hydrology and local vegetation (fig. 10.1). The northern section includes all lands from the Russian

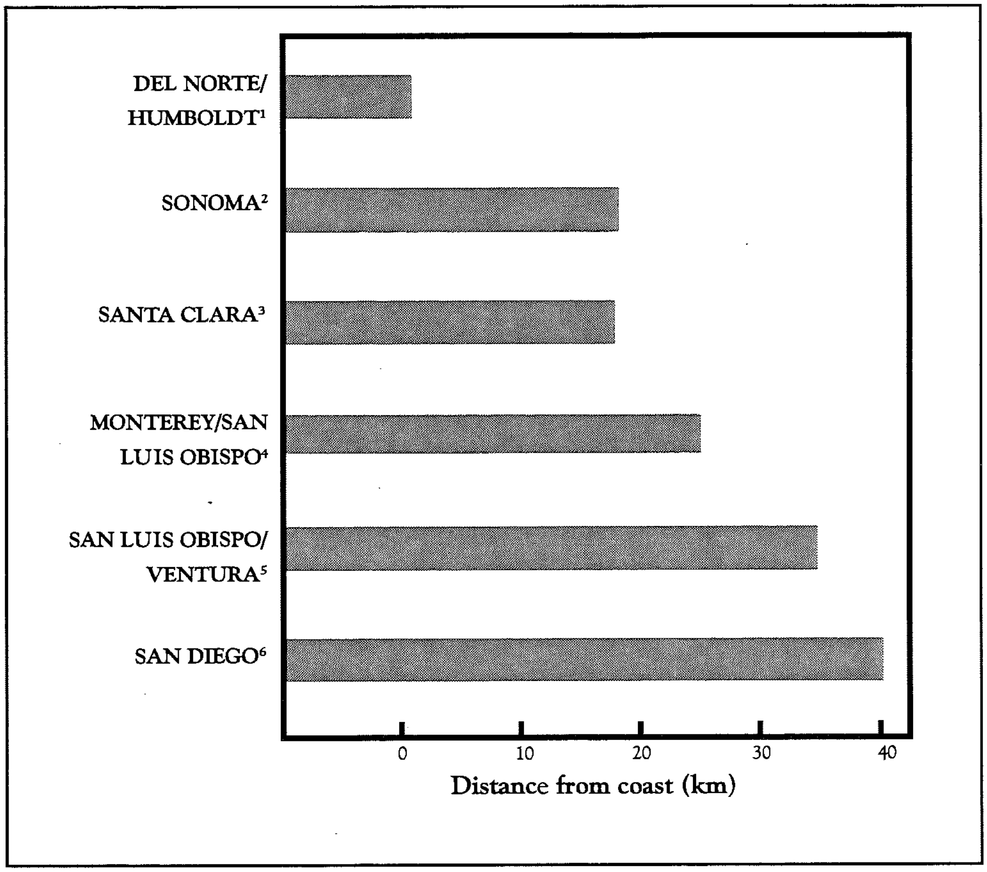


FIGURE 10.2 Maximum distance from coast of prehistoric sites with subsistence-related marine shellfish. Data from (1) Fitzgerald, personal communication, 1993, Levulett 1985; (2) Gmoser 1994; (3) Hildebrandt and Mikkelsen 1993; (4) Breschini and Haversat 1988; (5) Smith and La Fave 1961, Wire 1961; (6) True, Pankey, and Warren 1991

River north, encompassing the most productive salmon/steelhead streams in the state. The central section extends south to San Luis Obispo County, where annual rainfall decreases and the number and size of coastal streams is reduced. In the southern section, continued decreases in precipitation result in drought resistant plant associations (for example, coastal sagebrush, chaparral, southern oak forest) and the near absence of an anadromous fishery (Fry 1979; Kuchler 1977).

Chronological data presented by Erlandson (1988d, 1994) and T. Jones (1991) provide compelling evidence for coastal settlement in Southern California between 11,000 and 8000 RYBP. Except for a few sites associated with estuaries (see Dietz, Hildebrandt, and Jones 1988; T. Jones 1992; Schwaderer 1992), earliest occupation of the central coast decreases to circa 5500 to 5000 RYBP, while initial occupation of the north coast, as already noted, is further reduced to between about 2500 and 2000 RYBP. This general trend from early settlement in the south to progressively later occupation in the north is correlated with latitudinal gradients in the abundance and diversity of anadromous fish, large land mammals, and a variety of other subsistence resources.

Due to abundant rainfall (about 100 to 200 cm per year), the large coastal streams of the north supported multiple runs of steelhead (*Salmo gairdnerii*), silver salmon (*Oncorhynchus kisutch*), and king salmon (*O. tshawytscha*), many crowding into small spawning tributaries within a few miles from the coast (Fry 1979; Moyle 1976). All ethnographic accounts emphasize the importance of this resource. Rostlund (1952), for example, estimates that the Yurok may have harvested about 740,000 pounds (about 33,635 kg) of fish per year (or about 110 kg per person; see also Baumhoff 1963). A large portion of this harvest usually occurred during the fall when large communal weirs were constructed and a winter's supply of fish could be obtained within a relatively short period of time.

> The weir was an elaborate structure built in ten named sections by ten groups of men.... The fish were then easily removed with dip nets. Vast numbers of fish were taken during the ten days that the dam was allowed to stand. After that it was deliberately torn down, at least in part.... Its destruction again cleared the channel and permitted the fish to ascend the stream to spawn, at the same time providing the upriver residents with their essential supply of fish. (Kroeber and Barrett 1960:12)

Other fish were also available within north coast rivers, but the effort exerted to exploit them was apparently quite variable. According to Kroeber, for instance,

> Lampreys, customarily known as eels, much prized by the

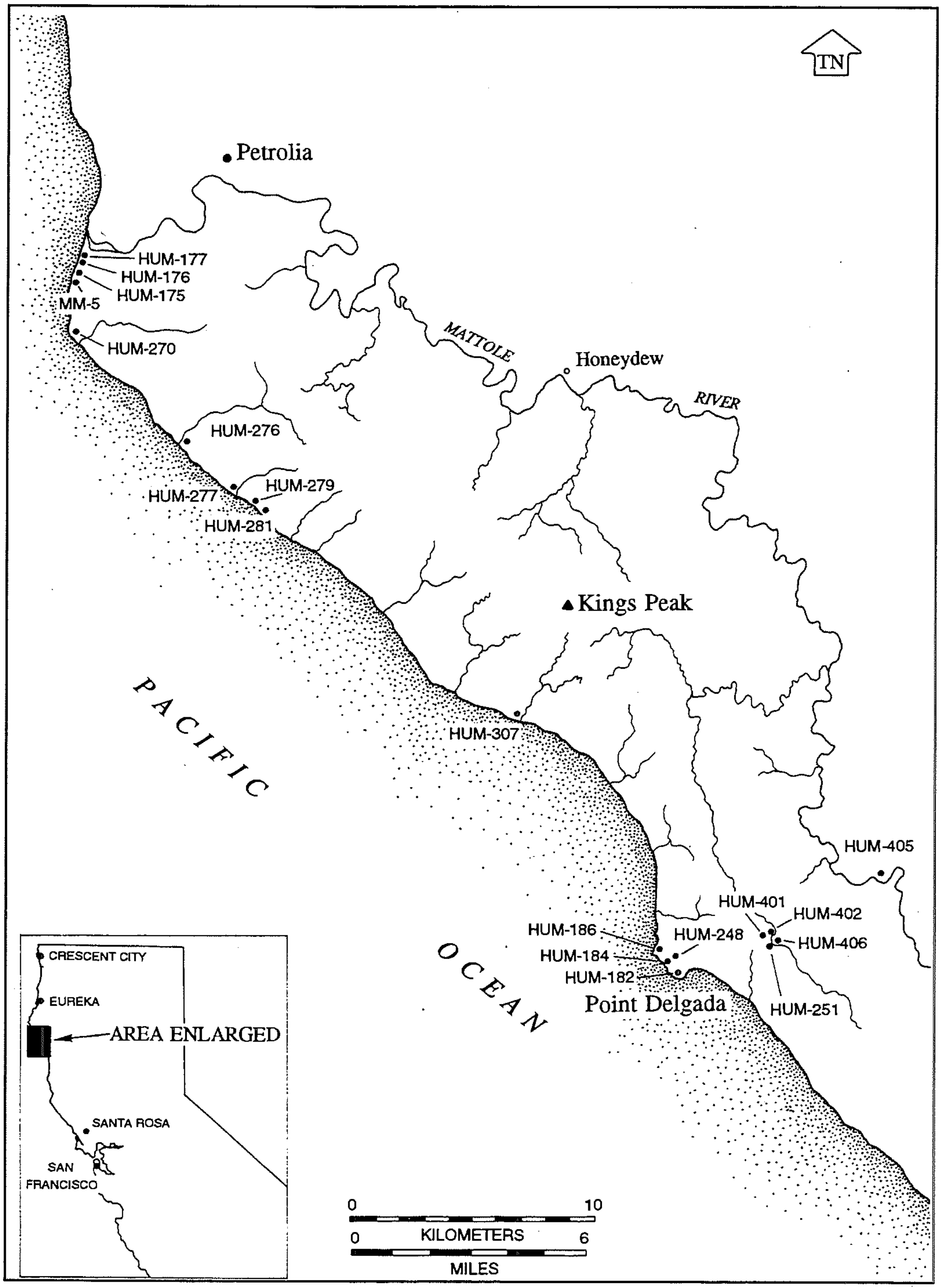


FIGURE 10.3 King Range coast area showing important archaeological sites

Yurok for their rich greasiness, also ascend the river in great numbers, and sturgeon are not rare. Both species are taken much like salmon.... Trout in the affluent creeks are too small to be much considered by a people frequently netting 20-pound salmon. (1925:85)

Annual rainfall drops to 50–100 cm along the Central California coast, resulting in a less productive anadromous fishery. Discounting the Sacramento-San Joaquin drainage system, which empties into San Francisco Bay well into the interior, fish runs are limited to reduced numbers of silver salmon and steelhead. Along the semiarid Southern California coast (30–40 cm of rain per year), anadromous fisheries are limited to a few small runs of steelhead.

Large land mammals follow a similar, but less magnified trend. All areas along the coast supported resident populations of black tail deer (*Odocoileus hemionus columbianus*). In more northerly areas this resource was augmented by the presence of elk, Roosevelt elk (*Cervus canadensis roosevelti*) in the north and tule elk (*C. nanodes*) in the central portions of the state (McCullough 1969). Recent archaeological findings in Santa Barbara County (Glassow et al. 1991)

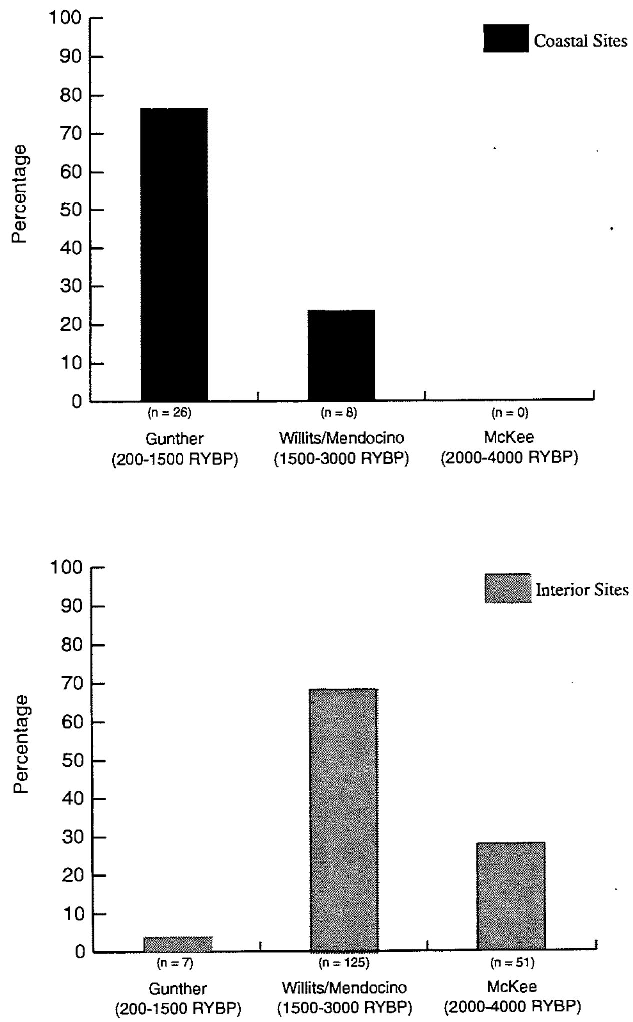


FIGURE 10.4 Distribution of chronologically sensitive projectile point types in King Range coastal and interior sites

indicate that elk extended to the south coast prehistorically. However, given the preference elk have for open prairie and marshland habitats, situations that are rare in Southern California, their numbers were probably quite low. Some areas of the south coast also supported pronghorn (*Antilocapra americana*) in addition to deer and elk, but the combined density of these three taxa probably didn't match the large mammal biomass available in areas to the north. In the absence of good interregional population data, these relationships can be illustrated by comparing archaeofaunal remains from the three areas (table 10.1). Along the north coast, deer (59%) and elk (38%) are both abundant, while rabbits make up only 3 percent of the assemblage. In Central California, elk (15%) decrease relative to deer (70%), and rabbits increase slightly (15%). Along the south coast, however, rabbits comprise an average of 95 percent of the assemblages.

The distance marine or estuarine shellfish were carried into the interior also provides an interesting measure of the relative importance of coastal resources. In areas where marine foods constituted a minor component of the overall diet, one would not expect shellfish to be transported great distances from the coast, while the opposite might be the case in contexts where terrestrial meat sources were more limited. Although shellfish were often dried outside the shell prior to transport (leaving little evidence in the interior archaeological record [see Dietz 1991]), tracking the movement of whole animals remains a reasonable measure of the relative importance of this resource, particularly when considering the additional costs associated with transporting fresh meat within the shell.

A review of archaeological data from several coastal counties within California produces results consistent with the latitudinal gradients outlined above (fig. 10.2). In northwest California (Humboldt and Del Norte Counties), shell midden sites do not extend beyond 1 km of the coast (Levulett 1985). Moving south to Sonoma County, Gmoser (1994) reports a few shell midden sites roughly 18 km from the coast along the Laguna de Santa Rosa. Bypassing the San Francisco Bay area, maximum distances remain the same in Santa Clara County (Hildebrandt and Mikkelsen 1993) but increase thereafter, reaching 25 km in Monterey/San Luis Obispo Counties (Breschini and Haversat 1988), 35 km in San Luis Obispo/Santa Barbara Counties (Wire 1961; Smith and LaFave 1961), and 40 km in San Diego County (True, Pankey, and Warren 1991).

Given these latitudinal trends in the availability of anadromous fish, elk, and deer as well as north-south differences in the distance marine foods were transported into the interior, it seems likely that people in Southern California would have turned to the systematic exploitation of shellfish to supplement terrestrial and riverine sources of meat long before those living in areas to the north, where the interior resource base was much more productive.

## ANTIQUITY OF COASTAL SETTLEMENT: A VIEW FROM NORTHERN CALIFORNIA

To further evaluate the relationship between terrestrial-riverine productivity and the antiquity of coastal settlement, we now turn to the results of a long-term study within the King Range National Conservation Area (fig. 10.3). This area is particularly relevant to the issue at hand because many of its coastal terraces have risen at rates greater than has the sea over the last 7,000 years. Moreover, the entire 42 km section of undeveloped coastline has been intensively surveyed, and over 240 $m^3$ have been excavated from fifteen sites.

Geomorphological studies of exposed terraces and beachlines indicate that portions of this seismically active area have uplifted at a rate of up to 4 to 5 m per 1,000 years, providing an opportunity to observe land surfaces minimally impacted by Holocene sea-level rise (Lajoie, Sarna-Wojcicki,

TABLE 10.1 Terrestrial faunal remains from important near-coastal sites in California (number of identified specimens)

| | North* | | Central** | | South*** | | Total | |
|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % |
| Elk | 557 | 38 | 977 | 15 | - | - | 1534 | 13 |
| Deer | 870 | 59 | 4560 | 70 | 175 | 5 | 5605 | 49 |
| Lagomorphs | 44 | 3 | 1009 | 15 | 3177 | 95 | 4230 | 37 |
| TOTAL | 1471 | - | 6546 | - | 3352 | - | 11,369 | - |

*Hildebrandt 1981, Layton 1990, Levulett and Hildebrandt 1987
**Breschini and Haversat 1989, Dietz 1987, Dietz, Hildebrandt, and Jones 1988, Dietz and Jackson 1981, Schwaderer1992; Simons 1992
***Erlandson 1988d, Gallegos 1991, Glassow 1991b, C. King 1982, Koerper 1986, Koerper, Langenwalter, and Schroth 1991
Note: Glassow (1991b) includes only SBA-539, SBA-670, and SBA-931; elk bone from Glassow (1991b) not included due to sampling difficulties; Simons (1992) includes only ALA-309.

TABLE 10.2 Spatial distribution of selected obsidian sources found in King Range sites

| | Coastal | Interior | Total |
|---|---|---|---|
| Medicine Lake | 122 | 15 | 137 |
| Borax Lake | 5 | 17 | 22 |
| Napa | 39 | 5 | 44 |
| Annadel | 8 | 5 | 13 |
| TOTAL | 174 | 42 | 216 |

and Ota 1982; McLaughlin et al. 1983). The magnitude of this phenomenon was recently illustrated by the Cape Mendocino earthquake of 1992 where several terraces were lifted as much as 1.0–1.5 m above their previous elevation (Fitzgerald and Ozaki 1993). Bickel also recognized the unique opportunities afforded by this area. Searching for places in Northern California where early sites were likely to be present, she suggested that:

> . . . reconnaissance be focused on areas of the coastline which might have been coastal five thousand years ago or earlier; that is, local areas of relatively narrow, continental shelf. For example, much of the coast from Cape Mendocino south to Point Delgada should be studied. (Bickel 1978:10)

Archaeological investigations within the King Range (see Levulett 1985; Levulett and Hildebrandt 1987; Waechter 1990) produced an occupational sequence beginning with relatively sporadic and short term use of the coast between about 2500 RYBP and 1500 RYBP. After 1500 RYBP, coastal settlement became more regularized (represented by six short term residential bases), but not until after 700 RYBP did intensive exploitation of the coastal environment occur. Although sedentary villages like those of the Tolowa and Yurok never developed in the King Range, excavation of sixteen single component areas revealed several large seasonal residential bases associated with numerous specialized shellfish processing areas.

Moving only 12 km into the interior, we later excavated approximately 54 $m^3$ of deposits from the McKee Flat site (HUM-405; fig. 10.3). The site lies on a terrace along the upper Mattole River in an area that produced elk, deer, anadromous fish, and a wide range of other resources, including acorns from the tan oak. These excavations encountered a residential deposit yielding 170 diagnostic projectile points, 430 bifaces, 350 flake tools, 80 pieces of milling equipment (including mortars and pestles), and many other objects. Probably representing a semipermanent residential base, four radiocarbon dates place most of the occupation between 4000 and 2000 RYBP (Levulett and Hildebrandt N.D.), predating any evidence for intensive use of the coast.

Adjacent to a small tributary of the Mattole River about 5.5 km from the McKee Flat site, 46 $m^3$ of deposits were excavated from four small hunting sites (HUM-251, HUM-401, HUM-402, and HUM-406; fig. 10.3). Obsidian hydration data and projectile point types show a high degree of temporal overlap with the McKee Flat occupation. The combined assemblage includes 170 projectile points, 210 bifaces, and only 7 pieces of milling equipment, and may indicate that the location was used by logistically organized groups sent out to procure resources in support of the McKee Flat site or some other nearby residential base.

The temporal disjunction between interior and coastal occupation may be graphically illustrated by comparing the frequency of chronological indicators obtained from the two areas. Within the interior, McKee unifaces (ca. 4000–2000 RYBP) and Willits/Mendocino series points (ca. 3000–1500 RYBP) are dominant, while on the coast Gunther series projectile points (post 1500 RYBP) are the predominant form recovered (fig. 10.4). Parallel patterns occur among radiocarbon dates: 78 percent of the dates from coastal sites postdate 1500 RYBP, whereas all of the interior dates are earlier (fig. 10.5). Source-specific hydration data also conform to the above relationships (fig. 10.6). Over 90 percent of the Medicine Lake Highlands sample from the coast measures less than 2 microns, while this is the case for only 25 percent of the interior assemblage. Napa obsidian, although hydrating at a slightly higher rate (see Basgall and Hildebrandt 1989; Origer 1982, 1989), follows a similar pattern, with over 90 percent of the coastal sample exhibiting rims less than 3 microns and only 25 percent of the interior assemblage registering comparable readings.

Geographic differences in the mix of obsidian sources provide additional support for the chronological relationships outlined above (table 10.2). Whereas 64 percent of the interior obsidian originated from the south (that is, Borax Lake, Napa, and Annadel), the later sites along the coast show a dominance of the northern, Medicine Lake material (70%). Stronger ties to more northerly areas during the late period are consistent with the archaeolinguistic perspectives

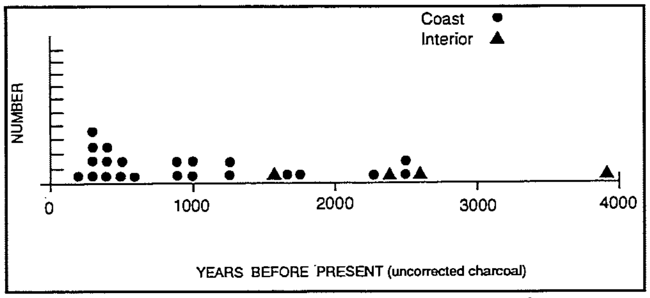


FIGURE 10.5 Distribution of King Range radiocarbon dates

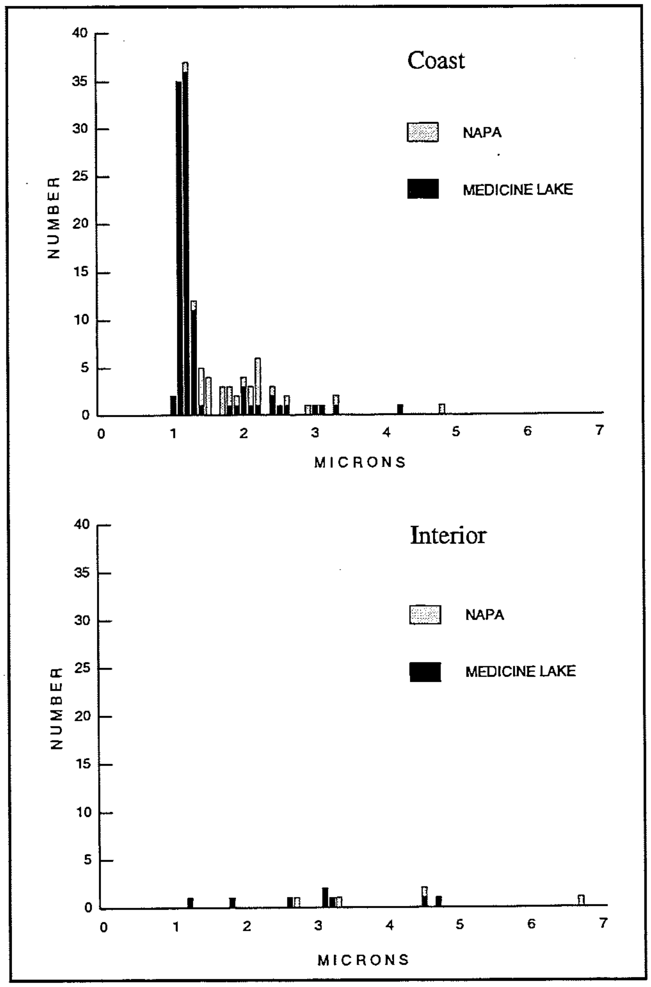


FIGURE 10.6 Distribution of King Range obsidian hydration readings

of Bennyhoff (1950) and Whistler (1979). They argue for a late intrusion of Algic and Athabascan speakers from the north, who subsequently occupied habitats previously underused by the indigenous (Hokan speaking) people of the area (see also Fredrickson 1984).

When the above data are combined, it seems clear that between 4000 and 2000 RYBP the interior was occupied by a people practicing a "collector-like" adaptive strategy that made little use of coastal resources. Although marine foods were no doubt consumed to some degree during this interval (and earlier), their value relative to interior resources (deer, elk, anadromous fish, etc.) was low and did not have a strong influence on the local subsistence-settlement structure until quite late in time (see also Gmoser 1993). Whether Late period intensification in the use of coastal resources resulted from an intrusion of immigrants (see Bennyhoff 1950; Whistler 1979) or was the outcome of in situ cultural development, it probably reflects a response to increased population pressure. During the earliest stages of sedentism (ca. 4000–2000 RYBP), interior settings were the primary choice of occupation due to the spatial convergence of anadromous fish, acorns, and, to a lesser extent, deer and elk. Coastal settings, having more limited access to at least anadromous fish, acorns, and deer, were not used for village locations until population increases prevented settlement of the more productive interior, riverine settings. The higher cost of coastal sedentism in northwest California is clearly illustrated by the capital investment and risks associated with the construction and use of oceangoing canoes for the exploitation of offshore marine mammal rookeries (Hildebrandt and Jones 1992; T. Jones and Hildebrandt 1995), and the need by several ethnographic groups to travel several miles into the interior to obtain winter stores of acorns (see Gould 1975). This sequence of settlement pattern change should not be all that surprising, particularly given comparable shifts in land use documented in other parts of California such as the Owens Valley/White Mountains region where intensive use of upland habitats did not occur until relatively late in time (see Bettinger 1991; Bettinger and Baumhoff 1982).

## SUMMARY AND CONCLUSIONS

The near absence of Middle Holocene sites on the north coast of California is probably not the result of poor archaeological visibility (that is, Holocene rise in sea level or inadequate excavation strategy), but the outcome of latitudinal differences in the balance of marine and terrestrial resource productivity. Due to differences in annual precipitation, the abundance and diversity of anadromous fish and large land mammals decrease from north to south, raising the relative importance of marine resources in the south and the antiquity of their initial use. Several lines of archaeological evidence support this position, including strong north-to-south increases in the proportion of small versus large game and the distance shellfish were carried from coastal to interior settings. Moreover, large-scale excavations in the King Range, where coastal uplift has outpaced Holocene sea-level rise, clearly document a time lag between the occupation of interior settings and the regular use of coastal habitats.

The implications of this general proposal obviously extend beyond the boundaries of California. For example, if our analyses of these relationships are correct, the antiquity of marine resource use should increase as one moves north into Oregon, Washington, and Canada. Just as terrestrial productivity decreases in the south due to increased aridity, the abundance and diversity of terrestrial foods decreases to the north due to changes in climate and growing season. Except for anadromous fish, which were available in most areas, the low-productivity Sitka spruce forests of the northwest coast and the spruce-tundra lands of the extreme northerly latitudes probably created an incentive for relatively early marine resource use. This perspective was originally postulated by Schalk (1981) while measuring variability in land use and organizational complexity among ethnographic groups along the northwest coast. With respect to terrestrial habitats, Schalk states that "latitudinal gradients in temperature and precipitation combine to produce a northward decline in terrestrial productivity" (1981:53). He also found that measures of terrestrial productivity actually accounted for much of the adaptive variability observed among people who relied significantly on marine resources, suggesting that "dependence on marine resources will be as great as the terrestrial ecosystem is poor" (Schalk 1981:70).

From a cursory review, chronological sequences for the more northerly areas appear to be in general agreement with these perspectives. Notwithstanding a couple of early sites recently reported along the Oregon coast (for example, Indian Sands, Moss and Erlandson 1995; Blacklock Point Lithic site, Minor and Greenspan 1995), there is little evidence for human occupation predating 4000 RYBP south of the Canadian border (Lyman 1991; Lyman 1995:67; Moss and Erlandson 1995:14). Moving further north, however, several Early Holocene sites have been reported (Moss and Erlandson 1995) and fully maritime adaptations clearly emerged by at least 5000 RYBP (Carlson 1990; Lightfoot 1993).

Before closing, a final note regarding the value of estuary environments is warranted. T. Jones (1992) convincingly argued that estuaries are more productive than most outer coast habitats and therefore should have been used earlier in time. His hypothesis is supported by chronological differences observed between outer coast and estuary settlement on Monterey Bay (Dietz, Hildebrandt, and Jones 1988; T. Jones and D. Jones 1992) and by the presence of what he considers to be a paleoestuary at Duncans Landing along the Sonoma coast (Schwaderer 1992). It follows, therefore, that future research along the large estuaries of Northern California (Lake Earl and Humboldt Bay, for example) may produce occupational sequences predating those of the outer coast. Given the differences in terrestrial productivity outlined above, however, we would not expect these occupations to be of equal magnitude or antiquity to those in similar estuarine settings in Central and Southern California.

**Acknowledgments.** We thank volunteers and members of field schools from the University of California-Davis, Santa Rosa Junior College, and Sonoma State University, as well as the Bureau of Land Management for their labor and financial assistance during the years of work in the King Range. We are also grateful to Jon Erlandson, Mike Glassow, Rick Fitzgerald, and Terry Jones for insightful comments on this chapter.

❀ CHAPTER 11

# Research Issues of Importance to Coastal California Archaeology of the Middle Holocene

*Michael A. Glassow*

THE CHAPTERS IN THIS VOLUME address a wide variety of issues of concern to archaeologists interested in Middle Holocene archaeology of coastal California. Some issues are local, but many are common to large segments or all of coastal California. After identifying some of these cross-cutting issues, I will offer some comments on their significance for current and future research.

## MIDDLE HOLOCENE RESEARCH ISSUES

The issues fall into three general but somewhat overlapping categories: chronology, middle-range theory, and determinants of cultural variation. All the chapters focus largely on subsistence of coast dwellers during the Middle Holocene, giving only limited attention to other realms of culture because of the nature of the archaeological record. Subsistence remains, in the form of shells and bones, frequently are well preserved in coastal California sites and typically are the most common category of cultural items. Moreover, most manufactured artifacts typically encountered in coastal California sites are closely related to subsistence activities. Yet the archaeological record contains relatively direct information regarding other realms of culture, and chapters 3, 4, and 8 consider the implications of the presence of exotic stone materials to Middle Holocene exchange systems. Chapter 4 also documents what appears to be an interaction sphere based on the geographic distribution of a distinctive type of shell bead.

A largely neglected realm of culture, social organization, deserves more attention than it received in this volume. Over the last few decades considerations of social organization during the Middle Holocene have been based on mortuary goods present in cemeteries. Although this aspect of the archaeological record remains the most informative on social (and political) organization, other archaeological phenomena also may shed light on this subject. An interesting paper by Jackson (1991) should fertilize thinking about social organization during the Middle Holocene, even though Jackson is concerned with a much later time period in the southern Sierra Nevada. The initiation of a significant dependence on acorns in the Sierra Nevada meant that women's subsistence activities, Jackson points out, rather than men's affected the location of residential bases and many aspects of social relations. The introduction of mortars and pestles, or more specifically the increasing dependence on acorns during the Middle Holocene, may have had comparable social repercussions.

Also giving explicit attention to gender roles in prehistoric California, McGuire and Hildebrandt (1994) argue that gender roles of males and females during the Milling-Stone horizon (in which they include many Early and Middle Holocene site components) had substantial overlap and that relatively strong male-female gender distinctions evolved after the end of this time period. Although the evidence used to support their contention could be interpreted differently (Glassow 1996:130–131), there is little question that gender roles underwent significant changes sometime during the Middle Holocene. Clearly the associations between gender and different characteristics of the archaeological record, and the implications these associations have for change in social organization, are well worth our scrutiny.

## DATING MIDDLE HOLOCENE SITES

Because Middle Holocene sites commonly are associated with only one to three dates, knowledge of the occupational history of sites—relevant to understanding settlement shifts and regional population fluctuations—currently is inadequate. Radiocarbon dates cost money, however, and a dating program sufficient to identify each of several components at sites with complex occupational histories easily could cost a few thousand dollars. With other aspects of archaeological data collection competing for scarce dollars, radiocarbon dating often loses out. Nonetheless, site chronology is fundamental to many research problems and to establishing the significance of a site; perhaps we should be allocating a larger proportion of available funds to radiocarbon dating.

It is gratifying to see that several sites that are the focus of attention in this volume are associated with suites of radiocarbon dates that provide a reasonably clear picture of site chronology. Of particular note are lists of dates for ORA-665 and ORA-667 in chapter 4 and the list for the Little Harbor site on Santa Catalina Island in chapter 3. The dates for the Little Harbor site are of special interest because the dates now available reveal a much more complicated site chronology than was apparent from the original two dates obtained in the 1950s (see also Raab et al. 1995a).

Some of the contributors used distinctive artifact forms as time-markers for dating sites. Used in chapter 4, this approach to dating—traditionally called cross-dating—is used to assign sites to a time interval. Although they were unable to distinguish between Early and Middle Holocene sites in the absence of radiocarbon dates, Gamble and King in chapter 5 propose that sites with large, deep-basin metates and a wide variety of mano shapes are distinctive of the Middle Holocene sites of the Santa Monica Mountains region. In contrast, Early Holocene metates apparently were smaller and presumably did not have such deep basins. Gamble and King's chronology is similar to one proposed by Gibson (1993:32), based on his summary of data from a number of sites of varying ages in the territory occupied by the Chumash.

The chronology of changing metate (and associated mano) forms is not quite so simple as either Gamble and King or Gibson propose. For instance, manos with relatively flat working-surface profiles occur in sites dating to both the Early and Middle Holocene and probably are largely the result of metates beginning their life with relatively flat working surfaces. What we typically find in archaeological sites, in other words, are metates and manos at the end of their useful life. Nonetheless, changes in metate and mano forms through time are worth documenting, not only to aid in dating sites where no organics exist for radiocarbon dating but also to help us understand aspects of subsistence change, which may very well be the basis for changes in metate and mano form. A metrical analysis of form and size attributes of well-dated metates and manos in museum collections would be an appropriate first step in identifying what some of these changes might have been.

The presence of mortars and pestles also has been used as a time-marker, largely because these milling implements seem to have had their origin at a specific time during the earlier part of the Middle Holocene. However, contributors to this volume use different dates for the first occurrence of mortars and pestles. In chapters 1 and 7, Erlandson proposes a date of around 5800 RYBP, based on the presence of mortars and pestles in a western Santa Barbara Channel site associated with a radiocarbon date of this age. Jones and Waugh believe mortars and pestles first appeared around 3500 BC (about 5000 RYBP) in Central California south of San Francisco. Erlandson and Colten (1991b:7) assert that mortars and pestles are "absent or rare until after about 7000 CYBP." However, I am unaware of any conclusive evidence for a date of occurrence as early as this. Erlandson's proposed date of 5800 RYBP certainly is a possibility, but the association between the radiocarbon dates and the mortars and pestles needs to be verified. For now, it seems that a date of first use sometime between around 5800 and 5000 RYBP is most reasonable, based on relatively well-dated contexts where mortars and pestles are abundant, such as at SBA-53 in the central Santa Barbara Channel region. Our knowledge of their first occurrence in the San Francisco Bay region and in Northern California is obscured by the considerable difficulties surrounding the dating of sites occupied during the earlier part of the Middle Holocene (see chapter 9).

Some fairly obvious changes in the forms of mortars and pestles during the Middle Holocene might serve as time-markers, but the chronology of these changes is not well known, and there may be some regional differences along the California coast. The first mortars and pestles of the central Santa Barbara Channel region were unshaped except for their working surfaces (chapter 6), and basket hopper mortars first appeared around 4500 to 4000 RYBP (although Erlandson cites in chapter 7 an occurrence of a hopper mortar apparently dating to 5800 BP). Perhaps about the same time shaped globular and hemispherical mortars without basket hoppers came into use. Shaped mortars generally are associated with carefully shaped, tapered pestles. I suspect there is yet much to be learned about the change in mortar and pestle forms during the Middle Holocene.

Another artifact form used as a time-marker is the large side-notched projectile point (presumably a dart point), dating to the earlier part of the Middle Holocene, perhaps 5500 to 4500 RYBP. Jones and Waugh indicate that variants of this form occur throughout Central California. Indeed, its distribution appears to be continuous from Monterey Bay southward into San Diego County, as documented in chapters 2 through 7. However, this point form apparently does not occur in the San Francisco Bay area or in Northern California. In chapter 2 these large side-notched points are called Elko points, and chapter 4 states that they resemble Elko points (see also Koerper et al. 1994). These points do resemble Elko points (although large side-notched points of the California coast generally are not as carefully flaked). However, California coastal side-notched points and Great Basin Elko points do not have the same morphological range. In fact, archaeologists working in the Great Basin have included a great diversity of point forms in the Elko series. It is not surprising, therefore, that in some chronological schemes Elko points span a period from the terminal Early Holocene to the introduction of the bow and arrow around 1500 RYBP (Holmer 1986).

Bettinger (1989:60-61) summarizes the rather confusing classification of point types within the Elko series, pointing out that side-notched and corner-notched forms grade into each other to some extent. This is also true of the California coastal side-notched points, which also include corner-notched variants. However, Bettinger believes that Elko points of the southern Great Basin date between roughly 3200 and 1500 RYBP, that is, the early segment of the Late Holocene (see also Thomas 1981). He also points out that Elko Side-notched points may be confused with Northern Side-notched points, which date between about 7000 and 3500 RYBP. In order to facilitate synthetic research into the prehistory of large segments of western North America, California archaeologists might be advised not to confuse the already confusing typology and chronology of Great Basin Elko points by including within the series the coastal side-notched points. The large coastal side-notched points clearly are of Middle Holocene age, and their duration may be much shorter than the 1000-year interval cited above. If indeed they do date to a relatively narrow bracket of time, they may serve as a useful time-marker. The problem is, however, that they are rare in most sites where they occur, and small-scale testing programs are not likely to encounter them. As a result, their utility as a time-marker seems restricted to fortuitous encounters or to relatively large-scale excavations.

The same dilemma pertains to distinctive shell bead forms. Erlandson proposes that the rectangular *Olivella* shell bead (type L2 in the Bennyhoff and Hughes' [1987] typology) may be distinctive of Middle Holocene contexts. However, they occur so infrequently in sites (outside of mortuary contexts) that they are rarely useful as a time-marker. Raab proposes that another distinctive bead form occurs during a restricted period of time. Found in sites on the southern Channel Islands and along the Orange County coast, it is known as the *Olivella* grooved rectangle (type N in Bennyhoff and Hughes' typology) and dates sometime between around 5000 and 4500 RYBP. Again, this bead type is rare even in collections from relatively large volumes of excavated deposits.

The final time-marker I wish to highlight is the single-piece circular shell fishhook in its various forms. On the basis of data from the Eel Point site, Raab proposes that circular shell fishhooks began to be used on San Clemente Island about 3300 RYBP. This date is much earlier than their first-known occurrence in the Santa Barbara Channel, where King (1990:83) dates the earliest circular shell fishhooks to around 2500 RYBP, and their common occurrence after around 2100 RYBP. Aside from the Eel Point finds, Strudwick (1985:58-59, 1986:267) lists several sites with shell fishhooks in apparent association with Middle Holocene dates. However, Strudwick cautions that radiocarbon dates are not definitively associated with any of these occurrences. Orr (1968:184–187) also proposed that circular shell fishhooks occurred very early, based on an apparent association at a site on Santa Rosa Island with two radiocarbon dates of 5400 and 4800 RYBP. However, he failed to recognize a Late period component at this site, with which the fishhooks almost certainly were associated. At this point in our growing knowledge of the chronological distribution of circular shell fishhooks, the San Clemente Island finds are clearly the earliest well-documented occurrence, but as Raab points out, these fishhooks began to be used at the very end of the Middle Holocene. Although circular shell fishhooks are probably not a Middle Holocene time-marker, it will be interesting to learn how early they are on the other southern Channel Islands and adjacent mainland coast of San Diego and Orange counties.

Even though this discussion of artifacts as time-markers has been focused on the utility of distinctive artifact forms in dating archaeological sites, the accurate dating of the time interval during which an artifact form was used is important also to understanding their articulation with cultural systems. Indeed, the enterprise of reconstructing a cultural system existing at a specific time depends on accurate dating of contemporaneous artifact forms and other cultural remains. In other words, we should never lose sight of the value time-marker artifacts have in elucidating human behavior.

## ISSUES OF MIDDLE-RANGE THEORY

### Developing Behavioral Inferences from Artifact Forms

Determining the marine fishing techniques and paraphernalia in use at particular times and places during the Middle Holocene is another issue, for it is fairly clear that fishing became increasingly important during the course of the Middle Holocene and that the diversity of habitats fished and the species taken generally increased. This elaboration may have been associated with changes in fishing techniques, although not necessarily with changes in fishing gear. Raab wonders, for instance, whether dolphins (a cetacean rather than a fish) and tunas, both of relatively large size, were taken with nets by inhabitants of Little Harbor on Santa Catalina Island. This is an intriguing idea, but I wonder about the investment of time and materials needed to construct nets strong enough to hold these animals. If tunas and dolphins come as close to shore as Raab proposes, then it seems equally plausible that they could be caught by hook (presumably the compound bone hook or the gorge) attached to a heavy line.

There is also the question of the use of watercraft in fishing. Raab demonstrated that fishing for sheephead can be very productive from shore locations on San Clemente Island, which means that abundant sheephead bones in San

Clemente Island sites do not imply the use of boats for fishing. Fish remains in the Orange County sites Mason, Koerper, and Langenwalter studied are predominantly of kelp-bed species. Were they also caught from favorable locations along the coast that give access to these species, or were they caught from boats? They do not address this question, probably because available data provide few clues. Unfortunately, artifacts associated with fishing or with manufacture of fishing gear are typically quite rare in sites. Consequently, as we learn more about the species of fish taken at particular times during prehistory, we seem to be generating more questions about how they were taken than we can answer.

Stone weights (or sinkers) found in many Middle Holocene sites from the San Francisco Bay southward undoubtedly were associated with fishing, as indicated in chapters 2, 4, 7, 8, and 9. Indeed, Middle Holocene sites yielding stone weights may be more abundant than available information implies, because many stone weights are not shaped and have no circumferential groove. Instead, they may simply be casually notched cobbles that are otherwise unmodified. Many assume that these weights were attached to nets, but their comparative rarity in most sites does not seem consistent with this interpretation. If the weights were used with nets, large numbers presumably would be necessary since a seine net would require weights spaced at relatively close intervals along its whole length. If weights are rare in a site, they are more likely to have been line weights. Shore fishing of the type described by Raab, for instance, would have required line weights. Caution is needed in interpreting the use of stone weights.

Another important question regarding behavior associated with artifacts concerns the kinds of food products processed with the earliest mortars and pestles. Mortars and pestles in use around 5000 RYBP were, I proposed in chapter 6, for crushing root products rather than acorns. Up to now, many California archaeologists have assumed that mortars and pestles were used from the time of their inception primarily for crushing acorns (see, for instance, chapters 5, 8, and Glassow, Wilcoxon, and Erlandson 1988), but there is no clear evidence to support this position. To evaluate hypotheses regarding their use, we would like to have remains of the food products processed with mortars and pestles. Carbonized acorn hulls and nutmeats or the carbonized remains of other plant products processed with the mortar and pestle would be one realm of evidence. Other potential realms might be fossil pollen or protein residues clinging to the working surfaces of the implements (Sutton 1993, but see Downs and Lowenstein 1995; Eisele et al. 1995).

### Identifying Contexts of Sites in Settlement Systems

Most contributors to this volume were comparatively cautious in discussing the nature of Middle Holocene settlement systems, and more specifically, the place of individual sites in settlement systems. Nonetheless, some of the contributors did make an effort to identify whether sites were residential bases. With regard to the western Santa Barbara Channel, Erlandson distinguishes between "primary villages," "secondary villages," "campsites," and lithic sites. None of the primary village sites of either the western or central Santa Barbara Channel appears to contain the quantities and diversity of artifacts present in SBA-53, a site on the ancient Goleta Slough to which I devoted considerable attention in my chapter. I proposed that this site was a principal residential base, that is, a site that served as a logistical focal point in a "collector" type (see Binford 1980) of settlement system.

Gamble and King propose that sites in the Santa Monica Mountains region with cemeteries were permanent settlements and that sites having both house floors and cemeteries "were central to the lives of their occupants." They appear to mean that these sites were residential bases, but Gamble and King obviously are shying away from defining their precise settlement system context. Similarly, Raab identifies the Nursery site on San Clemente Island as a residential base because of the presence of a series of semisubterranean houses. He feels that the investment in their construction implies a relative degree of residential permanence consistent with Binford's "collector" form of settlement system.

Lightfoot proposes other kinds of settlement types in addition to residential bases. He suspects that certain sites on the margins of San Francisco Bay containing very little habitation refuse but abundant human burials may have been "specialized cemeteries," whereas those with abundant habitation refuse and house floors surely were residential bases. Also of interest is his proposal that regularly spaced sites of the East Bay, dating to the terminal Middle Holocene, may have served as "territorial symbols" of distinct, territory-holding groups.

Mason, Koerper, and Langenwalter devote explicit attention to both settlement type and settlement system context. They argue that the two sites that were the focus of their chapter were residential bases because of their diverse tool assemblages reflecting a variety of domestic and industrial activities, but they suspect these residential bases were used by relatively mobile foragers. Their fish otolith data imply occupation at least during summer months, leading them to propose that these two sites were summer residential bases occupied by people who spent much of their time at a site or sites on the margin of Newport Bay, which provided a great diversity of food resources.

Raab points to evidence that a site on San Clemente Island served as a relatively permanent residential base in large part because of the presence of a series of semisubterranean houses, obviously entailing considerable investment in construction, and such associated features as storage cists. In Raab's analysis, the population living at this site was relatively sedentary, as would be expected if one residential base was the focus of a settlement system.

As a group, the chapters in this volume attest to the relatively minimal knowledge we have of Middle Holocene settlement systems and the difficulties of defining the settlement system context of sites. There are two obvious reasons why our knowledge is limited and often tentative. First, we have very little systematic regional information on the distribution of sites dating to specific time intervals during the Middle Holocene. Most archaeologists are acutely aware of this problem and would agree with the position taken by Gamble and King in their chapter regarding the dangers of inferring characteristics of regional distributions of residential bases in the absence of adequate dating of sites. Second, excavations in most Middle Holocene sites typically are comparatively limited, and even in cases where collections are sizable, analyses frequently are not focused on those data that would be most informative regarding settlement system context. It is not surprising that we know most about the settlement system context in cases where sites underwent relatively large-scale excavations and data analysis focused on such issues as seasonality. Here again, Gamble and King caution us in their chapter about making inferences in the absence of sufficient information. They point out that excavations in some Early and Middle Holocene sites in the Santa Monica Mountains area are too limited to determine whether indicators of a residential base such as house floors and cemeteries are present.

The dilemma is that archaeologists interested in Middle Holocene sites seldom have the resources to undertake relatively large-scale excavations and fund relatively specialized analyses such as identification of macrobotanical remains and determination of season of capture from fish otoliths. Nonetheless, surely we can be more conscientious in allocating scarce resources to the sorts of data collection and analysis that would provide information about settlement system context. In the meantime, we must continue to be cautious about how far we can take available data in making inferences.

In concluding this discussion, I would like to point out one of the more important problems we face in identifying the context of coastal Middle Holocene sites in settlement systems. We all seem relatively confident of our ability to identify whether a site was a residential base, that is, a site where complete, or nearly complete, family units actually lived for a while, if only for several weeks during a given year. We look at such characteristics mentioned above as the presence of house floors and cemeteries, the amount of organics in the midden, diversity of artifact categories, and presence of maintenance-related artifacts. However, even if a site meets most of our criteria for a residential base, we have no good way of determining whether this residential base was a logistical center of a collector type of settlement system, one of many residential bases used by foragers, or one belonging to a type of settlement system falling between these two extremes. I have to admit that my contention that SBA-53, which contained perhaps the largest archaeological deposit along the Santa Barbara Channel dating circa 5000 RYBP, was a principal residential base does not have strong support. If the vicinity of this site was the most optimal locality for obtaining a variety of food resources, it could be that people who moved fairly regularly among a series of residential bases spent somewhat more time at this site during the course of a seasonal round and more regularly occupied this site over a period of years.

If there is one criterion clearly indicative of a site being a principal residential base, it would be the presence of well-built houses entailing substantial investments of time in construction, much like those on San Clemente Island that Raab describes. However, the absence of such houses in sites of coastal California does not necessarily mean that a site was not a principal residential base. The type of house in use at the time of European contact, having a minimally prepared floor and a pole framework covered with thatch, would have provided sufficient protection from the mild temperatures and moderate rainfall along the coast of Central and Southern California. Another critical criterion would be the abundant remains of a variety of food resources that must have been obtained at some distance from the site. Again, however, the absence of such resources does not preclude a site from being a principal residential base, because abundant resources may have been close-at-hand. Progress in understanding the place of a site in a Middle Holocene settlement system depends on developing a theory-based model of the settlement system and its relationship to resource distributions (see D. Jones [1992] for a similar argument). Testing the model inevitably must be based on comparisons between well-dated site assemblages and seasonal indicators.

### Delineating Interaction Spheres

Raab proposes in chapter 3 that the restricted distribution of *Olivella* grooved rectangle beads (mentioned above with reference to artifact time-markers) reflects some type of interaction sphere. Raab is cautious in proposing the kind or kinds of interaction that correlate with these beads, mentioning only that it was socioeconomic. He notes that the interaction sphere apparently did not extend as far north as the Santa Barbara Channel. Conversely, according to King (1990:110), *Olivella* rectangular beads with drilled holes, an analogous type dating to the same time period, appear to be very rare south of the Santa Barbara Channel. Interestingly, there is another set of distinctive artifact forms with a more southerly distribution along the California coast, although it does not include the southern Channel Islands. These are the cogged stone and discoidal. According to Moratto (1984:149), these appear to date sometime between 6000 and 3000 RYBP, and so there is a possibility that they are coeval with *Olivella* grooved rectangle beads.

C. King (1990:106–114) notes other geographic differences in Middle Holocene bead types along the California coast, particularly between the Santa Barbara Channel and the San Francisco Bay/Sacramento Delta region. However, many of these differences are in proportional abundance of types rather than between types, which leads King to conclude that the variations between the Santa Barbara Channel and Central California are largely the product of differences in sociopolitical and socioreligious organization. The intervening section of the Central California coast, considered in chapter 8, undoubtedly holds some clues to the northward extension of Santa Barbara Channel interaction spheres and the southward extension of San Francisco Bay interaction spheres. For that matter, there may have been separate interaction spheres between these two regions. As Jones and Waugh point out, however, the data on Middle Holocene exchange systems and manufacture of beads and ornaments is still quite scanty for this section of the California coast.

**Measuring Paleoenvironmental Change and Its Impacts**

Practically all the chapters in this volume are concerned to a greater or lesser extent with paleoenvironmental change and its impact on cultural development. The available paleoenvironmental information reveals that the Middle Holocene was a period of relatively significant climatic and paleoenvironmental fluctuations, although the type and magnitude of these fluctuations varied from one section of the California coast to another. Taken as a group, the chapters in this volume reflect two different perspectives regarding the role of paleoenvironmental change in inducing cultural change. Focusing on the cultural responses to major paleoclimatic events, I argue in chapter 6 that paleoclimatic fluctuations would have had so generalized an impact on food resources that human population density and ultimately cultural systems would adjust. In chapter 8, however, Jones and Waugh argue that paleoclimatic fluctuations did not necessarily have an impact on resources important to human populations living at the coast. Instead, they emphasize the role of local environmental changes not related (or not closely related) to paleoclimatic fluctuations.

Regarding paleoclimatic fluctuations, a number of the contributors cited the sea-water paleotemperature record produced by Pisias (1978) on the basis of species variations in fossil radiolaria from a sediment core obtained from the bottom of the Santa Barbara Channel. Because there has been a tendency to use this paleotemperature record uncritically, a few words about its basis are in order. The sediments from which the core was extracted are varved, with each varve representing one year's sediment accumulation and an individual varve being Pisias' unit of analysis. As a result, the paleotemperature record is calibrated in calendar years. However, Pisias extracted radiolaria only from varves spaced approximately twenty-five years apart. Consequently, only longer-term trends in temperature change may be discerned. Furthermore, Pisias had to extrapolate across a number of unvarved segments of the core, which means the dating of the record may be increasingly in error with increasing age. Indeed, I suspect the record may be off by as much as a couple hundred years by about five thousand calendar years ago.

Strictly speaking, Pisias' paleotemperature record pertains to water temperature near the ocean surface. However, because pericoastal air temperature and water temperature are fairly closely correlated, the record may be used to infer air temperature as well. Unfortunately, there is no evident association between long-term fluctuations in air temperature and precipitation, despite claims of cool-dry/warm-wet association by Pisias (1979) and a cool-wet/warm-dry association by me and my colleagues (Glassow, Wilcoxon, and Erlandson 1988). Nonetheless, as Jones and Waugh point out, there appears to be a consensus of sorts with regard to a period of very warm and probably dry weather during the earlier segment of the Middle Holocene, which extended back in time into the latter part of the Early Holocene. Jones and Waugh refer to this as a "mid-Holocene warming." It should be emphasized, however, that there were some very cool intervals and some additional very warm intervals later on during the Middle Holocene, and so Jones and Waugh's term is somewhat misleading.

In fact the terms used in the published literature to refer to this "mid-Holocene warming" are very confusing. In my writings (Glassow, Wilcoxon, and Erlandson 1988, for example), I have used the term "Altithermal," originally proposed by Antevs (1955). However, a number of other terms also have come into use, and as Jones and Waugh point out, a number of archaeologists in California and the Great Basin have used the term Altithermal to refer to an interval of time shifted forward as much as two thousand years. I prefer to continue using the term to refer to the climatic event Antevs originally defined, that is, to a warm, arid interval around 7000-4500 BP. Certainly paleoclimatic data and chronological information for the Holocene were sparse and in some instances unreliable back in the early 1950s, when Antevs prepared his Holocene paleoclimatic synthesis. Nonetheless, the paleoclimatic event he defined as the Altithermal, as well as its approximate dating, seems to have gained a good deal of additional support in recent years.

Perhaps the source of confusion regarding the dating of the Altithermal is the later recognition of additional very warm periods dating later during the Middle Holocene and into the Late Holocene. If Pisias' sea-water paleotemperature record is any indication, a very warm peak occurred around 3500 RYBP, which falls into the later time interval attributed by some archaeologists and others to the Altithermal.

Jones and Waugh's summary of paleoenvironmental information for the Central California coast reveals that vegetation change documented in several fossil pollen records is not obviously correlated with temperature change. Indeed, this may be seen by comparing Pisias' paleotemperature record with Heusser's vegetation record based on fossil pollen from the same core from which Pisias extracted the fossil radiolaria for his study. There are several possible reasons for this lack of correlation. First, because precipitation is not strongly correlated with temperature, the response of vegetation to both temperature and precipitation may be quite complex. Second, some of the pollen records may pertain to relatively local rather than regional vegetation. Third, many pollen records are not well dated, and proposed chronologies of vegetation change may therefore be in error. Finally, there is some possibility that the temperature record is in error, at least with regard to its chronology.

Regardless of the nature of the relationship between temperature and other environmental variables, it seems reasonable to expect that significant fluctuations in water temperature would have significant effects on the availability or accessibility of certain marine resources. In turn, these might affect the size of regional populations depending on marine resources, as well as the species of marine fauna exploited. I proposed in chapter 6 that a correlation between periods of relatively higher population density and lower water temperatures also were periods when terrestrial resource productivity was relatively higher. It is possible, however, that it was only fluctuations in marine resource productivity that were affecting coast-dwelling population density. Similarly, Raab proposes in chapter 3 that water temperature, and its effect on availability of particular species of marine fauna, account for changes in both shellfish and cetacean species exploited from certain sites on the southern Channel Islands. Water temperature changes may only result in shifts in the relative importance of marine species exploited rather than a net increase or decrease in quantities of marine resources obtained by a group of maritime fisher-hunters (Raab et al. 1995a:30).

The most intriguing commonalty cross-cutting nearly all the chapters in this volume is the attention given to the significance of estuaries and similar enclosed coastal bodies of water along the California coast. Citing a proposal published earlier by T. Jones (1991:435), Hildebrandt and Levulett point out in chapter 10 that the few estuaries along the Northern California coast would be likely places to find the earliest coast-dwelling populations. Lightfoot highlights the attractions of the margins of San Francisco Bay, which contained many of the same resources found in estuaries. Jones and Waugh compare the settlement histories of the Elkorn Slough and Morro Bay with each other and with those of other environmental zones of Central California. Erlandson discusses the impact of sedimentation of relatively small estuaries along the western Santa Barbara Channel, which were a significant source of shellfish to Early Holocene populations. I proposed that the Goleta Slough was perhaps the most attractive resource area along the central Santa Barbara Channel. Making a similar argument for Newport Bay, Mason, Koerper, and Langenwalter discuss how the evolution of this estuary system affected settlement locations. Finally, Masters and Gallegos note the changing significance of lagoonal shellfish to Middle Holocene populations of the San Diego County coast as the lagoons began to fill with sediments.

Of course, the resources of estuaries, lagoons, and enclosed bays also were important to coastal California populations during the Early Holocene (Erlandson 1994; T. Jones 1991; see also various papers in Erlandson and Colten 1991a). Indeed, through the course of the Middle Holocene these environments in general were becoming increasingly less important as they became filled with sediments. Nonetheless, as Jones and Waugh point out, there was a good deal of variation in the evolution of these aquatic environments, and some appear to have reached their maximum resource potential during the Middle Holocene. Estuaries, lagoons, and enclosed bays were important to coastal populations for a variety of reasons. The chapters of this volume place emphasis on the shellfish they harbored, but this is largely because shellfish remains are usually abundant and well-preserved in sites next to these bodies of water. Perhaps equally important in some instances are many different species of fish. Because of the quiet waters of estuaries, lagoons, and bays, these fish were accessible from simple tule boats or rafts. The importance of fish to Middle Holocene diets is yet to be fully appreciated since recovery of small-sized fish remains, which would include those of most fish inhabiting enclosed bodies of water, has not been systematic. In addition, a variety of plant food resources from peripheral marshlands may have been very important, although the archaeological record is still silent regarding this possibility. Aquatic birds (some being migratory) may have been important to occupants adjacent to some of the larger estuaries and lagoons. Finally, we should not forget that near many of these bodies of water are some of the most reliable sources of fresh water along major stretches of coastline. For these reasons, estuaries, lagoons, and enclosed bays at times may have served as refuges for populations coping with periods of lowered productivity of terrestrial resources, and perhaps also lowered productivity of intertidal resources of the open coast.

Not only were enclosed bodies of water along the coast evolving during the Middle Holocene, but open coastlines were as well. Jones and Waugh, Erlandson, and Masters and Gallegos all argue that during the Early Holocene and in the initial portion of the Middle Holocene rocky shorelines were more prevalent along the open coast than later. With the significant slowing of rise in sea level around 6000 to 5000 RYBP, according to their argument, sandy beaches began to cover the rocky shorelines, and as a result, the productivity of rock-perching shellfish such as California mussels decreased. Responding to this decrease, rock-perching shellfish of the open coast became less important to subsistence at many coastal localities during the course of the Middle Holocene. This model of open-coast evolution makes a good deal of sense, and it is consistent with the bulk of available archaeological data pertaining to proportions of open-coast and estuarine shellfish species.

I have always wondered, however, whether open-coast evolution actually was more complicated than this model implies. If seacliffs similar to those we see today along many stretches of California coastline existed at the beginning of sea level rise, these may have been subject to erosion from pounding surf that was even more rapid than the historically documented rate of 15 m per century for the Santa Barbara Channel mainland coast (Norris 1968). Models of coastal dynamics such as those presented by Masters and Gallegos in chapter 2 and Inman (1983:12) assume that seacliffs did not exist during rapid Early Holocene sea-level rise, but no explanations are given for their apparent absence. If seacliffs did exist, their erosion may have produced quantities of sand sufficient to maintain sandy beaches. At the same time, however, headlands with bedrock bases were being eroded, and habitats for rock-perching shellfish may have been more extensive at these locations until the bedrock was leveled by wave action and eventually became submerged below the low-tide level.

Regardless of whether rocky coastline was more extensive during the period before around 5000 to 6000 RYBP, the argument that a shift from open-coast to estuarine shellfish is largely a result of a decrease in rocky-shore habitats neglects the possibility that the economics of shellfish collection may have changed through time. Rock-perching shellfish such as California mussel are easy to collect, and they grow relatively rapidly to a useful size. If they were abundant along sections of open coast, they may have been preferred to the less accessible estuarine clams or open-coast Pismo clams, all of which burrow in mud, gravel, or sand. As human populations increased, however, open-coast shellfish may not have been able to satisfy demand completely, and so less favored estuarine shellfish would have become increasingly important. This argument is not new, of course (see, for example, chapter 9).

Not every shift from rock-perching to burrowing shellfish necessarily results from changing coastline characteristics or, for that matter, the evolution of enclosed bodies of water such as estuaries. If we feel that one of these two opposing arguments best accounts for the available data, we should have good reasons for rejecting the other. Colten (1989), for example, attempts to evaluate two opposing hypotheses, one proposing overexploitation and the other environmental change, in accounting for the decrease in the relative importance of the rock-perching California mussel through the course of prehistory of the Goleta Slough. Although his rejection of the overexploitation hypothesis is not entirely convincing, his analysis does attempt to evaluate the relative merits of the economic versus environmental arguments.

To conclude this discussion of paleoenvironmental change and human response to it, it is worth emphasizing that our knowledge of Middle Holocene paleoenvironments is still quite sketchy. Furthermore, although there is general consensus that some very significant environmental changes did take place, there still is substantial disagreement about the details of these changes, not only among archaeologists but also among natural scientists concerned with Holocene paleoenvironments. Added to this, archaeologists often disagree on the kind and degree of impact paleoenvironmental changes had on cultural systems. It would seem, therefore, that paleoenvironments and cultural responses to paleoenvironmental change will occupy much of the attention of archaeologists interested in the Middle Holocene for many years to come.

### Measuring Population Growth and Identifying Its Distribution

Many of the contributors used the distribution of radiocarbon dates, or radiocarbon-dated sites, as a rough measure of population growth, decline, or geographic shifts in density. The number of radiocarbon dates for sites in some regions or localities of coastal California has reached a point that most archaeologists feel comfortable using date distributions as a relative measure of human population numbers—within certain limits. Sample size and biases remain vexing problems. In particular, analytical attention must address biases caused by dating programs focused on particular time periods, and by significant changes through time in the number of sites per capita population. Such problems are not insurmountable, however, and it should be clear from the applications in this volume that all California archaeologists interested in the Middle Holocene populations should promote obtaining radiocarbon dates from all investigated sites yielding datable material in reasonably decent contexts.

Patterns of Middle Holocene population change inferred from radiocarbon date frequencies clearly varied along the California coast. Hildebrandt and Levulett point out that coastal populations in Northern California appear to have remained extremely low throughout the Middle Holocene. Lightfoot suspects that the perimeter of San Francisco Bay did not witness much occupation—at least by people who created shell middens—before circa 6000 RYBP, when the estuarine habitats were stabilizing. Jones and Waugh believe that population growth beginning circa 5000 RYBP in Central California south of San Francisco Bay resulted in territorial circumscription. Erlandson believes Middle Holocene populations of the western Santa Barbara Channel probably were somewhat larger than Early Holocene populations. Population along the central Santa Barbara Channel region grew, I argued, significantly beginning circa 5400 RYBP but fluctuated through the remainder of the Middle Holocene. Aside from arguing that Early and Middle Holocene sites exist in interior areas of the Santa Monica Mountains despite the absence of sites with radiocarbon dates, Gamble and King do not deal with issues of population size or change. For that matter, the number of coastal sites adjacent to the Santa Monica Mountains associated with either radiocarbon or shell-bead dates is quite small and therefore not appropriate for developing inferences of population change. Raab also is not directly concerned with population growth in his consideration of southern Channel Islands archaeology. Mason, Koerper, and Langenwalter propose a rise in coastal populations along the Newport coast beginning 5800 RYBP and a decline after around 4300 RYBP. Masters and Gallegos propose that populations along the San Diego County coast remained relatively steady from before the beginning of the Middle Holocene until around 3500 RYBP. Changes in population through the course of the Middle Holocene varied considerably from one section of the California coast to another. Nonetheless, there are some general patterns worth considering.

The distribution of all Santa Barbara County radiocarbon dates shows a fairly clear depression in frequencies of dates between about 6500 and 5000 RYBP. This depression also shows up in the date distributions for other coastal counties for which the total number of dates is sufficient to see a pattern—specifically, Monterey, San Luis Obispo, and Orange. The San Diego County date distribution has a much narrower depression centering around 6000 RYBP (Breschini, Haversat, and Erlandson 1992). Similarly, at or shortly after the end of the Middle Holocene, around 3000 RYBP, a narrower but usually more distinct depression occurs in date frequencies for most counties south of San Francisco Bay. These two depressions are so consistent that they are unlikely to be the result of chance or the whims of archaeologists selecting site deposits to date. Consequently, despite many local variations in peaks and depressions in radiocarbon date frequencies, such as those discussed in chapter 8, there are some patterns that are geographically quite widespread and are reflective of equally widespread fluctuations in Middle Holocene population density along the California coast. As my colleagues and I argued, such population fluctuations probably are related to major environmental events that affected all or a major section of the California coast (Glassow, Wilcoxon, and Erlandson 1988).

Measurement of population sizes or fluctuations through time will never be an easy task for California archaeologists. Radiocarbon date frequencies are the most accessible data set for generating this information, and the chapters in this volume demonstrate their potential. As I mentioned earlier, it is important that we devote more attention to dating sites than has been the case. At the same time, we need to be more responsible in reporting dates so that archaeologists may gain ready access to them. The best way to do this is to submit dates and references to associated reports for inclusion in *California Radiocarbon Dates*, published more-or-less annually by Coyote Press (see Breschini, Haversat, and Erlandson 1996).

## NATURE AND CAUSES OF CULTURE CHANGE

In one way or another, all the chapters in this volume are concerned with reasons why Middle Holocene cultural systems developed in particular ways. Chapters 3 and 6 take a more generalist viewpoint by considering fundamental bases for Middle Holocene cultural evolution, whereas the others are concerned with factors accounting for local developments. Cross-cutting essentially all of the chapters is a concern for the effects of change in coastal environments on aspects of cultural systems, particularly settlement.

Raab proposes that cultural change during the Middle Holocene may have been a response to an increased productivity of marine environments, especially during times and at locations of particularly high productivity. He proposes that cultural developments occurring during the Middle Holocene may be the result of populations in low numbers encountering increased marine resource productivity. If I am understanding his argument correctly, Raab is proposing an explanation of cultural change that is nearly the opposite of that proposed in my chapter. I emphasized the role of environmental degradation and marginality in my explanation for increased cultural complexity rather than expanded resource opportunities. Our differing arguments are not necessarily contradictory; perhaps both are useful in accounting for some of the variety of cultural developments that occurred during the Middle Holocene.

I think it important to be aware that we can not always be sure that a cultural development such as relatively greater sedentism implied by the substantial houses at San Clemente

Island's Nursery site, described by Raab, is permanent and indicative of an aspect of cultural evolution. Such developments simply may have been a temporary response to a change in such factors as the availability of food resources or, in the case of the San Clemente Island houses, cooler weather. Other possibilities come to mind. C. King (1990:95) argued that mortuary practices at a terminal Early period cemetery (Middle-Late Holocene transition) on western Santa Cruz Island indicated that hereditary political status positions had come into existence. In the absence of other cemetery data clearly showing the same pattern, can we be sure that the development on western Santa Cruz Island was region wide and permanent? Or alternatively, did this localized development become region wide and permanent a few hundred years later? Answers to such questions depend on regional data.

Chapters 8 and 10 take regional analysis a step further. They present examples of the interregional comparative approach that has characterized some earlier work by these authors (for example, T. Jones 1991, 1992; Hildebrandt and Jones 1992). Whereas the other chapters in this volume are concerned with the archaeology of relatively small geographic regions, these two papers compare the archaeology over lengthy stretches of the California coast. Indeed, Hildebrandt and Levulett consider data from practically the whole length of the California coast in their effort to understand the reasons why the Northern California coast seems to have been so sparsely occupied during the Middle Holocene. This comparative geographic approach clearly has great utility in our efforts to understand cultural processes operating in coastal California. Indeed, as chapter 10 demonstrates, some research problems can not be addressed effectively without such large-scale geographic comparisons.

In concluding this discussion of the nature and causes of culture change, it seems appropriate to consider the process of intensification mentioned by Jones and Waugh in chapter 8. They indicate that subsistence intensification, reflected in part by the mortar and pestle and an increasing focus on more localized resources, is a hallmark of the period following 5000 RYBP. Further, they characterize the shift at this time as one "from extensification to intensification," citing Beaton's (1991) use of these terms. I certainly agree with their characterization of subsistence changes following circa 5000 RYBP as being an example of intensification, but I have wondered about just what the process of extensification is. Beaton (1991:951) defines extensification as "inclusion of replacement resources attendant with geographical shifts without additional labour or technological costs." Following this definition, I can envision extensification occurring as a human population expanded into a new habitat, but if we are speaking of a resident population that is not growing and, at most, shifts resources in response to seasonal and annual fluctuations, I see no process of extensification. Instead, we have a subsistence system that is simply more extensive than intensive. In considering subsistence changes occurring at any time during California prehistory, I find it difficult to envision an example of extensification, although I presume there are instances.

## CONCLUSIONS

The chapters in this volume document some of the definitive cultural changes that took place during the Middle Holocene of coastal California. Through the course of this period, subsistence became more diverse, technology more elaborate, and sociopolitical organization more complex. Both geographically broad and localized environmental changes affected coastal California populations and had impacts on cultural development. Human population numbers were expanding, and as a result, territories from which resources were obtained were shrinking.

Yet, throughout most of the Middle Holocene many aspects of Early Holocene cultural systems persisted. Until relatively late in the Middle Holocene milling implements typically were dominated by the metate and mano, implying that subsistence still depended to a large extent on gathering small seeds. Shellfish continued to be the most important marine food resource in many regions, and fishing technology was unchanged, although circular shell fishhooks began to be used on San Clemente Island by the end of the Middle Holocene. Population numbers remained relatively low even though noticeable growth occurred beginning 5500 to 5000 RYBP, and sociopolitical organization remained relatively simple despite some apparent increase in complexity. As a consequence, Middle Holocene cultural developments clearly were transitional between the relatively stable Early Holocene cultural systems and the rapidly evolving cultural systems of the Late Holocene.

Although we have learned a great deal about Middle Holocene cultural systems along the California coast, our overall knowledge is still meager. Comparatively few sites have witnessed more than small-scale test excavations, and the number of sites associated with radiocarbon dates is still small. Furthermore, because of problems with identifying Middle Holocene sites, which generally requires obtaining radiocarbon dates, the nature of settlement systems remains obscure. A good deal of information is reported in this volume about different classes of animal foods important to Middle Holocene coastal populations, but the types and importance of plant foods generally is based only on indirect evidence provided by milling implements. Unfortunately, flotation as a technique for recovery of macrobotanical remains does not yield useful results at many coastal Middle Holocene sites, as exemplified by its application by Mason et al. to one of their Orange County sites.

Much may be done to address these deficiencies in knowledge. In addition to increasing the quantity and diversity of data from coastal Middle Holocene sites, we should devote attention to the development of theory appropriate to understanding the nature of Middle Holocene cultural systems and the determinants of their origins and change. All of the chapters in this volume have focused most attention on the relatively descriptive goal of determining what happened during the Middle Holocene prehistory of particular coastal California regions, and a few have gone a step further to explore the determinants of cultural change or geographic variations in cultural sytems. The contributors to this volume have grappled with such aspects of middle-range theory as the identification of residential bases, the nature of subsistence systems, and change in regional population size. General cultural theory, which is necessary for developing a true understanding of the nature and diversity of Middle Holocene cultural systems of the California coast, has been largely neglected.

This is not to say, however, that general theory has not played a role in the various arguments proposed by contributors to this volume. Aspects of optimal foraging theory or analogous economic theories are behind arguments about the selection by Middle Holocene populations of certain food resources, or resource areas, over others. One of the more definitive inferences derived from economic theory concerns the rising importance of fishing. Jones and Waugh make the point that fish are essentially the only marine resource that "can withstand intensification," an argument also reflected in Raab's discussions regarding the first use of fishhooks on San Clemente Island. In other words, we would expect that fishing would become relatively more important through time because other food resources, specifically sources of animal protein, could not be intensified as economically as fishing could.

As an example how general theory can deepen our understanding of Middle Holocene cultures of coastal California, I point to the many ideas about the nature of settlement systems that have been proposed in this volume's chapters. It is not enough to use middle-range theoretical premises to posit that presence of cemeteries, housefloors, or artifacts related to maintenance are indicative of a residential base. Such an argument has validity and in fact is implicitly based on general theory about the nature of hunter-gatherer settlement systems. However, middle-range theory does not help us much in distinguishing between a residential base that was one of two or three occupied during an annual cycle and a residential base that was the sole focal point of a settlement system. To deal effectively with distinctions of this sort, we must develop models that specify what kinds of settlement systems are expectable under certain circumstances of environment, population, subsistence resources, and technology. On the one hand, these models necessarily must depend on a series of general theoretical premises that link such circumstances to particular settlement system outcomes; on the other, they allow us to develop a series of expectations about what the archaeological record should look like if the model is valid.

In conclusion, contributors to this volume have demonstrated the pivotal role played by cultural developments during the Middle Holocene of coastal California. This is a significant advance, for no longer is this time interval being characterized simply as sequences of artifact forms, nor are Middle Holocene cultural systems being just characterized as intermediate between what preceeded and what followed in time. At the same time, however, much is left unresolved regarding the nature and evolution of cultural systems of the Middle Holocene and the determinants of cultural variability in both time and space. Some challenging archaeology awaits those archaeologists who decide to study coastal California's Middle Holocene cultures.

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