

# Hunter-Gatherers OF Early Holocene Coastal California

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Edited by  
JON M. ERLANDSON AND ROGER H. COLTEN



Perspectives in California Archaeology, Volume 1

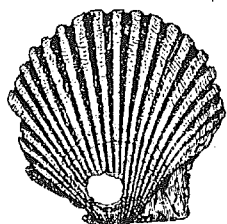
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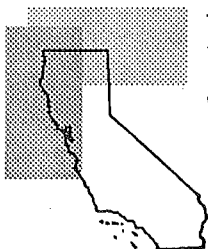
Institute of Archaeology, University of California, Los Angeles, 1991

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EDITED BY Jon M. Erlandson and Roger H. Colten



WITH A FOREWORD BY Jeanne E. Arnold



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1991

With this volume, we are pleased to begin a series of monographs and edited volumes entitled *Perspectives in California Archaeology*. The series will encompass a broad range of subject matter pertaining to archaeology in the state of California, both prehistoric and historic. Topics of broad interest for professionals and students within as well as outside the West Coast region may include theoretical contributions, methodological or technological studies, regional or chronological themes, or interpretations of data for important sites or regions. New volumes in the series will be published about once a year. Prospective authors are encouraged to contact the Editorial Board, Publications, Institute of Archaeology, University of California, Los Angeles, CA 90024-1510, to obtain guidelines for submission of manuscripts.

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## Contents

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Foreword	<i>Jeanne E. Arnold</i>	v
Preface		vii
Chapter 1	An Archaeological Context for Early Holocene Studies on the California Coast <i>Jon M. Erlandson and Roger H. Colten</i>	1
Chapter 2	Early Holocene Environments and Paleoecological Contexts on the Central and Southern California Coast <i>Larry A. Carbone</i>	11
Chapter 3	Antiquity and Adaptation at Agua Hedionda, Carlsbad, California <i>Dennis Gallegos</i>	19
Chapter 4	Early Holocene Adaptations and the Transition Phase Problem: Evidence from the Allan O. Kelly Site, Agua Hedionda Lagoon <i>Henry C. Koerper, Paul E. Langenwalter II, and Adela Schroth</i>	43
Chapter 5	Early Holocene Maritime Adaptation at Eel Point, San Clemene Island <i>Roy A. Salls</i>	63
Chapter 6	Fishing During the Millingstone Horizon? New Data from the Glen Annie Canyon Site, Santa Barbara County <i>Roger H. Colten</i>	81
Chapter 7	Shellfish and Seeds as Optimal Resources: Early Holocene Subsistence on the Santa Barbara Coast <i>Jon M. Erlandson</i>	89
Chapter 8	Early Maritime Adaptations on the Northern Channel Islands <i>Jon M. Erlandson</i>	101
Chapter 9	Early Holocene Adaptations on Vandenberg Air Force Base, Santa Barbara County <i>Michael A. Glassow</i>	113
Chapter 10	Early Holocene Occupation of the Central California Coast <i>Gary S. Breschini and Trudy Haversat</i>	125
Chapter 11	Perspectives on Early Hunter-Gatherers of the California Coast <i>Roger H. Colten and Jon M. Erlandson</i>	133
	References	141



## Foreword

Jeanne E. Arnold

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**T**here is considerable scholarly interest in Early Holocene adaptations of North America, stemming from diverse perspectives. Many scholars, and indeed the general public, are intrigued by the evidence for early occupations in specific territories of the New World. Current research centers on Holocene chronology and the challenges and opportunities met by human populations as they adapted to unfamiliar, perhaps changing, sets of resources. Some of the most fundamentally important studies focus on the issue of environmental reconstruction, including sea level fluctuations, terrestrial paleoclimate, and the human-environment relationship, particularly as it pertains to food provisioning. Other research is concerned principally with technological developments during this relatively early stage in the occupation of North America. Demography, paleodiet, patterns of emigration and immigration, the scale and scope of social ties expressed through exchange relations: these constitute some of the most significant issues that form the foundation of Early Holocene research.

This volume is the first to bring together a number of studies on the Early Holocene of the California coast (ca. 10,000 to 6600 BP). Erlandson and Colten have assembled contributions that may be of interest to a broad spectrum of scholars whose research pertains to any of the following: early sites in the Americas, coastal adaptations, hunter-gatherer adaptations, general Pacific coast prehistory, and the specific

history of research on pre-6600 BP occupations of coastal California. Most of the chapters concern Early Holocene evidence from the southern half of the state where, for reasons discussed in the volume, there appear to be many more Early Holocene sites. The rarity of sites of this antiquity north of San Francisco Bay is an interesting problem in itself, one that this set of papers cannot fully resolve because data are still inadequate to do so from these regions. As the data base expands with continuing archaeological research focused on earlier Holocene sites north of the bay, this inadequacy will certainly be addressed.

Controversial positions expressed in the volume will, we hope, stimulate discussion and further research. Divergent views regarding, for instance, the scale and importance of Holocene environmental change, result in quite different interpretations of Holocene human-ecosystemic relationships. It is clear that increasing attention must be given to the impacts of changing marine currents, upwelling, and El Niño cycles on marine biomass productivity and resultant prehistoric coastal adaptations. Marine biologists and oceanographers add to available information on these phenomena almost daily, so archaeologists must increasingly take advantage of progress in these disciplines. It may be difficult to measure processes of change in coastal waters of Early Holocene age, and thus to interpret changes in distributions of food remains in the middens, especially

where there are preservational problems or questions regarding the accuracy, continuity, or spacing of suites of radiocarbon dates. This makes it particularly important to closely examine the evidence from both paleoenvironmental sources and excavation contexts to best reconstruct how people used and responded to their ancient environments.

A topic of great interest to proponents of "Early Man" theories for the Americas is the proposed great antiquity of human occupation across parts of the southern coast and on the northern Channel Islands (to perhaps 30,000 BP). In this volume, the multiple problems with these unsubstantiated claims are summarized, and purported pre-12,000 BP Pleistocene age human occupations and human-mammoth associations are effectively dismissed. However, considerable credible evidence is presented for some of the earliest legitimate maritime adaptations that existed in the New World, those dating to between 10,000 and 6600 BP along the southern California coast.

Researchers who have investigated the immediately post-Pleistocene era elsewhere in North America, as I did a number of years ago during research on Early Archaic adaptations in the Great

Lakes region, will see that many of the central research issues cross regional boundaries and are the same for California and elsewhere. Problems that require resolution include: (i) adequate documentation of environmental change or stasis; (ii) characterization of population size and settlement distribution; (iii) determination regarding whether subsistence was specialized or diversified, and whether reliance was greatest on smaller or larger food packages; (iv) characterization of the nature of exchange relations and other indicators of social integration; (v) delineation of broad patterns of migration; and (vi) acquisition of a sufficient number of radiocarbon dates to accurately place important developments in a secure chronological framework.

As many of these issues are addressed in this volume as available data permit. The interesting new information and broad spectrum of radiocarbon dates presented here provide important reference materials for researchers concerned with early Pacific coast prehistory. Interpretations of these data are likely to stimulate continuing discussion and research into this fascinating era of California prehistory.

## Preface

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**M**ost of the papers in this volume first were presented in the "Early Holocene" symposium we organized for the 1988 Society for California Archaeology annual meeting in Redding, California. The symposium was organized to provide a forum for the presentation of recent research on the Early Holocene archaeological record of the California coast. The symposium, like this volume, was organized around a series of issues related to the origins, adaptations, and paleogeographic context of early coastal hunter-gatherers of the region. Claude Warren of the University of Nevada, Las Vegas, served as a discussant for the symposium and provided valuable comments used by many of the authors in the revision of their papers. Pandora Snethkamp and Daniel Guthrie also discussed "The Early Holocene Occupations of Daisy Cave, San Miguel Island" in the symposium but elected not to provide a paper for the published volume.

To broaden the geographic and theoretical coverage of the symposium papers, we solicited manuscripts from several authors conducting research on Early Holocene archaeological sites or problems. This resulted in additional contributions by Salls (SCLI-43B), Erlandson (northern Channel Islands), and Koerper, Langenwalter, and Schroth (SDI-9649).

This volume is the collective work of all the authors, the editors, anonymous reviewers, and the editorial staff of the Institute of Archaeology at UCLA. Our sincere thanks to each of these contributors. At UCLA, our special thanks to Jeanne Arnold for en-

couraging us to submit the manuscript to the Perspectives in California Archaeology series and for her editorial guidance. Also at UCLA, special thanks to Pattie Rechtman, Carol Leyba, Pat C. Healy, and Ernestine Elster for their help in guiding the editing and production of the volume. Finally, we thank our home institutions, the Department of Anthropology, University of California, Santa Barbara, and the Lompoc Museum and the Fowler Museum of Cultural History at UCLA, respectively, for partial support during the editing and production of this volume. The University of Alaska-Fairbanks also provided some administrative and financial support during the final production of the volume. Larry Wilcoxon helped translate diverse word processing formats into more uniform versions.

The California coast is an ideal laboratory for studying the development of coastal adaptations, the evolution of cultural complexity among hunter-gatherers, and the effects of environmental changes on prehistoric cultures. It is our hope that the papers in this volume will stimulate further research and synthesis related to the archaeological and paleoecological record of the Early Holocene. The papers build on the contributions of archaeologists David Banks Rogers, Malcolm Rogers, Phil Orr, William Wallace, Claude Warren, Roberta Greenwood, and many others. Without their work the papers presented here could not have been written.

*Jon M. Erlandson  
Roger H. Colten*

## Chapter 1

# An Archaeological Context for Early Holocene Studies on the California Coast

Jon M. Erlandson and Roger H. Colten

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**T**his volume examines the origins, adaptations, and paleogeographic contexts of Early Holocene hunter-gatherers of the California coast. This chapter provides a broader context for the others, including (1) a definition of the spatial and temporal boundaries of the study, (2) an overview of previous research on early cultures of the California coast, (3) an introduction to some major issues in the study of early archaeological sites of the region, and (4) brief synopses of the chapters in the volume. Archaeological issues discussed include the origins and antiquity of California's early coastal cultures, problems posed by some site formation processes common in archaeological sites of the area, and the nature of Early Holocene tool assemblages, settlement patterns, and subsistence.

In recent years, impressive new data have been collected that may revise traditional notions of the nature of the earliest cultures of the region. Scattered coastal sites between 9,000 and 10,000 years old are now known from Baja California and San Diego County on the south to at least San Luis Obispo County on the north, including several of the offshore islands (Erlandson 1988a). The Scotts Valley site

(SCR-177),<sup>1</sup> located in the Coast Range near Santa Cruz, and Duncan's Point Cave (SON-348/H) on the Sonoma coast (Schwaderer et al. 1990) may extend the spatial distribution of these early sites. The paucity of early coastal habitation sites on the northern California coast remains problematical and may be due to the lower intensity of archaeological work conducted in the area or to environmental factors such as differential coastal submergence (Bickel 1978).

As defined in this volume, the Early Holocene spans the period between approximately 6650 and 10,000 radiocarbon years BP (RYBP).<sup>2</sup> The sites discussed in the following papers, however, are limited primarily to those dated in excess of 7000 RYBP. This arbitrary cutoff aids in isolating sites or site components that date strictly to the Early Holocene, avoiding a plethora of others that span the transition between the Early and Middle Holocene. The division of the Holocene into three equal parts (Erlandson 1988b) is not entirely an arbitrary distinction. In much of California, the Early-Middle Holocene transition, roughly dated to between 6000 and 7000 RYBP, is when mortars and pestles first appear widely, presumably for processing acorns and other plant

C <sup>14</sup> Years	Rogers 1929	Wallace 1955	Warren 1968	King 1981	Calendar Years	Geological Time Scale
AD 1000	HISTORIC CHUMASH	HISTORIC CULTURES	HISTORIC CULTURES	LATE PERIOD <i>Phase 3</i>		
				LATE PERIOD <i>Phase 2</i>	AD 1782 (168 BP)	
			LATE	- AD 1500 -	AD 1670 (280 BP)	
			PERIOD	LATE PERIOD <i>Phase 1</i>		
				- AD 1150 -	AD 1380 (570 BP)	
			(Yuman/ Shoshonean)	MIDDLE PERIOD <i>Phase 5</i>		
				- AD 900 -	AD 1170 (780 BP)	
			(Chumash)	MIDDLE PERIOD <i>Phase 4</i>		
				- AD 700 -	AD 980 (970 BP)	
				MIDDLE PERIOD <i>Phase 3</i>		
AD 0				- AD 300 -	AD 580 (1370 BP)	
				MIDDLE PERIOD <i>Phase 2</i>		
				- 800 BC -	800 BC (2750 BP)	
			CAMPBELL	MIDDLE PERIOD <i>Phase 1</i>		
			TRADITION	- 1400 BC -	1490 BC (3440 BP)	
				EARLY PERIOD <i>Phase Z</i>		
				- 2400 BC -	2850 BC (4800 BP)	
				EARLY PERIOD <i>Phase Y</i>		
				- 4500 BC -	5250 BC (7200 BP)	
				EARLY PERIOD <i>Phase X</i>		
3000 BC				- 6000 BC -	6630 BC (8580 BP)	
				?		
					8600 BC (10,550 BP)	
8000 BC						

Figure 1.1. Some southern California chronological sequences. Ages in columns 1-4 are based on uncalibrated C<sup>14</sup> dates; calibrated "calendar ages" follow Stuiver et al. 1986.

foods. Hunting and fishing technologies also diversify in many areas about this time, and the importance of sea mammals, land mammals, and fish seems to increase relative to shellfish. During the Middle-Late Holocene transition (ca. 3000 to 3500 RYBP), a further diversification in subsistence, technology, and ornaments occurs in many coastal areas, changes that led C. D. King (1981) to divide his Early and Middle periods at approximately this time (fig. 1.1).

Over 75 archaeological sites of the southern and central California coast have been radiocarbon dated in excess of 7000 RYBP (see Breschini et al. 1990). Though a few of these may be included erroneously due to anomalous C<sup>14</sup> dates (see Erlandson 1988a), the vast majority appear to have been correctly attributed to the Early Holocene. Erlandson (1988a: 383) and Glassow et al. (1988:69) have noted a general increase in the number of dated early sites

through time, suggesting a gradually expanding population. The spatial distribution of early shell middens is also interesting. Clusters of sites dating between 7500 and 9000 RYBP have been identified along the San Luis Obispo coast, the northern and western Santa Barbara coasts, the north coasts of Santa Rosa and San Miguel Islands, and around the ancestral lagoons of the San Diego coast. In contrast, the intervening coastal areas of Orange, Los Angeles, and Ventura counties have produced relatively few early sites. At present, it is unclear whether the density of early sites in the northern and southern areas of the southern California coast reflect biases in the archaeological record or true patterns of paleodemography during the Early Holocene.

Until recently, there were no known Early Holocene coastal middens from San Francisco Bay northward to the Oregon border. There have been isolated finds of probable terminal Pleistocene or Early Holocene age found in northern California's coastal or peri-coastal zone (Simons et al. 1985; T. Jones 1990), however, and sites of this age are known from interior areas not far from the coast (e.g., Harrington 1948). Recently, a rockshelter (SON-348/H) on the Sonoma County coast was tested by Department of Parks and Recreation archaeologists and produced a stratified shell midden deposit nearly 3 m deep (Schwaderer et al. 1990). Though only preliminary analyses of the recovered materials have been completed, the lowest shell-bearing levels of the rockshelter have produced  $C^{14}$  dates of  $8610 \pm 110$  (Beta-34844) and  $8620 \pm 420$  (Beta-35229). The SON-348 materials promise to add important new data on the origins and evolution of California's earliest maritime hunter-gatherers and to fill a major spatial gap in the archaeological record. Future research along the northern California coast undoubtedly will find additional evidence for coastal occupations dating at least to the Early Holocene, despite problems associated with sea level change and coastal inundation.

Despite the relatively large number of sites and substantial amount of research conducted at many of them, little is known of the origins and antiquity of the earliest hunter-gatherers that occupied the region, the structure of their economies, or the ecological context of their adaptations (Moratto 1984:104). This is a critical gap in California prehistory, one that must be addressed by further research and more careful excavation and analysis. It is increasingly

apparent that some attributes long thought to be associated with the early phases of California prehistory are intrusive (Erlandson 1988a; Erlandson et al. 1988; chaps. 6 and 8, this vol.), a problem related to inadequate dating of many sites and insufficient recognition of mixing in multicomponent sites.

What route did these early groups follow to the California coast and what knowledge and technologies did they carry with them? What environments did they encounter and how did they adapt to the dynamic and diverse ecological habitats of the coastal zone? Finally, how did these early cultures evolve over the Early Holocene (and beyond) and what processes led to such changes? These and other questions are addressed in the chapters that follow. To place subsequent chapters in a broader context, we summarize the development of research on the early cultures of the California coast and explore some issues relevant to understanding the origins, environmental context, cultural ecology, and evolution of such cultures.

#### DEVELOPMENT OF EARLY HOLOCENE STUDIES IN COASTAL CALIFORNIA

Prehistorians have been studying the archaeological record of coastal California for over 100 years, with changing methods and theoretical orientations reflecting general developments in American archaeology and anthropology. Late nineteenth-century researchers like Schumacher (1875), Bowers (1878), and de Cessac (1882) essentially mined archaeological sites for museum-quality artifacts, with no research design as we know it. This was "an era when harvesting relics took precedence over stratigraphic excavations or efforts to reconstruct culture histories" (Moratto 1984:123). In their defense, the early antiquarians worked without knowledge of relative or absolute age for the sites they excavated, and the antiquity of the human presence in the New World was thought to be relatively brief (Daniel 1976).

In the early twentieth century, the antiquity of human occupation of North America was extended dramatically with the discovery of artifacts associated with the remains of extinct mammals at the Folsom site (Figgins 1927). A few years later, fluted Paleo-Indian points were found at the Borax Lake site in northern California (Harrington 1948). During the same era, the first chronological schemes for ordering California prehistory were developed by

David Banks Rogers (1929) in the Santa Barbara area and Malcolm Rogers (1929) in the San Diego area. Although these two cultural sequences have been modified by subsequent researchers (e.g., M. J. Rogers 1939; Wallace 1955; Warren 1968), 60 years later they retain their general validity and remain widely in use.

Not until radiocarbon dating became fairly common in the 1950s were claims of terminal Pleistocene or Early Holocene age validated for California sites. A number of coastal California "sites" of even greater antiquity have been proposed over the years (see Moratto 1984 for an excellent summary), but none of these have gained general acceptance among the scientific community. Some of the best known and most controversial "early man" sites are reported in Orr's (1968) discussion of Santa Rosa Island prehistory (see also Berger and Orr 1966; Orr and Berger 1966; Berger 1980, 1982) and are discussed by Erlandson (chap. 8, this vol.). A series of supposedly very early human skeletons from coastal California (e.g., Laguna Woman, C<sup>14</sup> dated to >14,800 and 17,150 ± 1470 RYBP [Berger et al. 1971]; Del Mar Man, dated by amino acid racemization to between 41,000 and 48,000 BP [Bada et al. 1974]) recently have been re-radiocarbon dated via accelerator mass spectrometry (AMS) and found to be less than 8,000 years old (Taylor et al. 1985:137).

During the late 1960s and early 1970s, research in the San Diego area (Warren 1966; Moriarty 1967), on Santa Rosa Island (Orr 1968) and in the San Luis Obispo area (Greenwood 1972) demonstrated that much of the southern and central California coast probably was occupied by about 8500 to 9500 RYBP. More recent research has extended the list of early sites to Daisy Cave (SMI-261) on San Miguel Island (Snethkamp 1987), SBA-931 on the northern Santa Barbara coast (Glassow 1981; chap. 9, this vol.), SCLI-43B (Eel Point) on San Clemente Island (chap. 5, this vol.), and possibly SCR-177 (Scotts Valley) in the foothills of the Santa Cruz coast (Cartier 1988a; chap. 10, this vol.). A host of additional sites throughout the region have been dated between 7500 and 8500 RYBP (Erlandson 1988a).

Moratto (1984:75-114) recently summarized the early cultures of California, noting the presence of the Paleo-Indian Fluted-Point tradition and the later Western Pluvial Lakes tradition (WPLT), both confined primarily to interior regions of California.

Contemporary coastal sites he places in the Paleo-Coastal tradition (Moratto 1984:104), which bears a resemblance to the WPLT in terms of lithic technology and an adaptation relying partly on wetland and marsh habitats. Moratto provisionally brackets the Paleo-Coastal tradition between 11,000 and 8,000 years ago, though confirmed sites older than 10,000 RYBP have yet to be located. The economic focus is on littoral resources including molluscs, waterfowl, sea mammals, fish, and land mammals.

Since the publication of Moratto's summary, isolated fluted points have been reported from the California coast for the first time, one from the Mendocino coast (Simons et al. 1985) and one from the Santa Barbara coast (Erlandson et al. 1987). Though little is known about the broader cultural context of these finds, they may provide evidence for the earliest precursors to coastal groups of the terminal Pleistocene and Early Holocene, as well as common ancestry for the Western Pluvial Lake and Paleo-Coastal traditions.

Throughout the southern and central California coast, the Paleo-Coastal tradition is followed by the Millingstone horizon (D. B. Rogers 1929; Wallace 1955; Warren 1968; Meighan 1978; Moratto 1984), though the nature of the transition remains a major source of debate in the San Diego area (Moriarty 1967; Gallegos 1987). As its name implies, the Millingstone horizon is marked by the appearance of milling tools probably used primarily for grinding small seeds. In a recent synthesis of Millingstone horizon adaptations, William Wallace states:

That much, if not most, of the Milling Stone Horizon peoples' food came from the harvesting of wild seeds and other edible plant parts is demonstrated by the plentiful milling stones and mullers. Some hunting was always carried on, for a few projectile points and animal bones occur in the occupational debris. The virtual absence of marine shell and fish and sea-mammal bones in the refuse of certain village sites suggests that the earlier coast dwellers had not yet realized the full possibilities of ocean resources. They soon acquired a taste for sea foods, however.

A lack of variety characterizes the artifact assemblages. Heavy, deep-basined mills and handstones predominate. The rare pro-

jectile points are typically heavy, indicating continued employment of darts and throwing sticks. Crude service tools fashioned from cores or thick flakes commonly occur. Bone and shell items are scarce. Polished stone disks, some with notched edges ("cogstones"), and simple charmstones are occasionally found. [Wallace 1978:28]

Today, it is known that some of the very earliest Millingstone sites, like the few Paleo-Coastal sites that preceded them, contain abundant shellfish refuse, as well as the remains of a variety of land mammals, fish, sea mammals, birds, and other animals. Millingstone horizon subsistence appears to have been relatively eclectic, though few quantitative studies are available with which to judge the relative importance of various faunal classes (Erlandson 1988a). Millingstone sites with little or no faunal refuse are also common, but it is not clear at present if these are middens degraded through soil acidity, sites focused on the terrestrial aspects of mixed economies, or both.

#### SOME ISSUES IN EARLY HOLOCENE ARCHAEOLOGICAL STUDIES

In synthesizing data from Early Holocene sites of the California coast, a number of problems are encountered. For many sites, little research has been done, the results are unpublished, or they are described only in technical reports that are difficult to access. At other early sites, excavations emphasized the recovery of large tools rather than small artifacts or an unbiased sample of faunal remains. Often, little or no data is available about the cultural affiliation of the site occupants, much less the specific nature of their diet or subsistence economy. Some reports give valuable data on the subsistence technology of early groups but little or no data on the ecological or economic context of the artifacts. Other early sites contain multiple components mixed by various site formation processes, with several prominent examples unrecognized until recently (e.g., Wallace et al. 1956; Owen et al. 1964; Orr 1968:115-135). At a few sites, radiocarbon dates are anomalous in the cultural context in which they were found, though this is often difficult to judge from available reports.

As a result, only a handful of Early Holocene sites on the California coast have produced adequately

dated, relatively unbiased, and systematically quantified assemblages of both artifacts and faunal remains. The lack of comparability among site assemblages seriously inhibits the resolution of our reconstructions of Early Holocene cultural ecology. In the future, a broader understanding of Early Holocene adaptations on the California coast requires more and better archaeological data, especially from early sites uncontaminated by later components. New data can come from a variety of sources, including (1) publication or wider dissemination of CRM reports, (2) additional analysis of existing collections, (3) further work at known sites to recover classes of data not collected by earlier research, (4) more thorough  $C^{14}$  dating and chronological evaluations of key sites, and (5) meticulous excavation of newly discovered sites. More and better data will help fill the spatial and temporal gaps in the current data base and help resolve some of the problems discussed in the following sections.

#### The Origins and Antiquity of California's Coastal Cultures

By at least 9500 CYBP much of the central and southern California coast appears to have been settled by hunter-gatherers already adapted to a coastal environment. If early dates from Santa Rosa Island, San Miguel Island, and San Clemente Island are accepted, the sequence may be extended by as much as a millennium. Where did these early groups come from and how did they adapt to life along the California coast? Three primary models have been proposed for the initial settlement of the California coast: (1) in situ development from much earlier occupants of the region, (2) a coastward migration by interior hunter-gatherers responding to increased aridity associated with the onset of the Altithermal circa 8000 RYBP, and (3) a terminal Pleistocene or Early Holocene coastal migration of maritime peoples southward from the north Pacific coast (Erlandson 1988a: 393).

Claims for very early human occupation have been numerous in California (Carter 1957; Orr 1968; Leakey et al. 1972; Bada et al. 1974; Davis 1975; Berger 1982), though most have been discredited, are poorly documented, or await comprehensive description. Most recent claims for an early occupation of California rely on controversial upper Pleis-



tocene localities (Calico Hills, Texas Street, Santa Rosa Island "fire areas," etc.) and purportedly early radiocarbon and amino acid racemization dates on human skeletal remains (Laguna Woman; Del Mar Man, Yuha Man, etc.) or associated organic remains. Moratto (1984:39-73) and Fagan (1987) recently reviewed the evidence for an upper Pleistocene peopling of California and the New World, respectively, and found no compelling evidence for a human presence predating 15,000 BP. As mentioned previously, redating of several "Pleistocene" human skeletons by AMS radiocarbon analysis indicate that all date to the Holocene (e.g., Bada 1985; Taylor et al. 1985; Stafford et al. 1987).

Many discussions of southern California prehistory (Wallace 1955, 1978:28; Warren 1968; Kowta 1969; Meighan 1978) propose that the earliest coastal groups derived from interior hunter-gatherer traditions. Kowta (1969:52) postulated a coastward migration of Millingstone groups adapted to arid conditions, in response to the Altithermal spread of xeric plant communities into the southern California coastal region. Outside of the San Diego area (where the San Dieguito complex is relatively well documented), there is a minimum of evidence for pre-Millingstone occupations. Nonetheless, the increasing time depth associated with early sites may argue for an in situ development, since the earliest Millingstone assemblages (ca. 9000 CYBP) now appear to predate the onset of xeric conditions (Glasow et al. 1988). These early coastal Millingstone sites are found in the southern and the northern extremes of their range (the San Diego coast and northern Santa Barbara and San Luis Obispo counties), precisely where mesic coniferous plant communities probably persisted the longest.

The hypothesis that the California coast initially was settled by maritime groups who migrated from the north during the Late Pleistocene or very Early Holocene (see Fladmark 1979) is attractive, in part, because it could explain the early and rapid development of maritime adaptations on the California coast, including the virtually simultaneous settlement of the Channel Islands, which required seaworthy watercraft. Furthermore, as the initial settlement of the California coast is pushed progressively back in time, the more likely it appears that such groups were not descended from the terminal Pleistocene hunting cultures of the interior (Chartkoff and Chartkoff

1984:33; Meighan 1989). A major problem with the coastal migration theory is that early assemblages of the California coast resemble interior assemblages more than contemporary Northwest coast assemblages. Meighan (1989) recently noted similarities between the earliest California industries and basal bifacial assemblages at Namu (British Columbia) and Ground Hog Bay 2 (southeast Alaska), however, and G. Fenenga (personal communication, 1990) has suggested that the Scotts Valley site (SCR-177) in Santa Cruz County may contain a microblade technology similar to early assemblages to the north.

### Site Formation Processes

On the California coast, a variety of natural and cultural site formation processes (plowing, bioturbation, downslope movement, etc.) have been implicated in the disturbance of archaeological deposits (Erlandson and Rockwell 1987). In sites that contain multiple occupational components, such processes can mix the contents of discrete archaeological strata, causing difficulties in the reconstruction of the structure, chronology, function, economy, and environmental context of a site. Consequently, a relatively careful assessment of the chronology of each investigated site is required if mixing of discrete strata is to be identified.

A different kind of problem is posed by the addition of noncultural elements (fossil or recent faunal remains, natural chert spalls, etc.) to archaeological assemblages in the area. In many middens, distinguishing between bone fragments of natural and cultural origin can be very difficult, since a wide variety of birds, reptiles, and land mammals live on or in soils of the region. After death, their skeletal remains often are deposited in surface soils, where they may be redistributed by a variety of processes. The problem of natural bone accumulation is particularly severe in old terrace soils common on the California coast. Where such soils are naturally alkaline, bones of noncultural origin may be incorporated into soils over tens of thousands of years and may even be burned by incidental contact with wildfires or campfires. When such bones are mixed with the food refuse from a prehistoric settlement, they may be extremely difficult to differentiate, complicating or even precluding accurate dietary reconstructions.

Another problem is posed by differential preservation of key elements of the archaeological record. In archaeological sites of most regions of the world, much of the refuse from plant foods selectively disintegrates. In such cases (including the present one), analyses of artifacts or human skeletal remains are the only means of estimating the relative importance of plant foods in the prehistoric diet. At other California sites, faunal remains are extremely rare, raising questions about the function of such sites in a larger settlement system. These sites, containing exclusively lithic artifacts, are intriguing, in part because they lack the abundant faunal remains present in contemporary midden sites. Are lithic sites a functionally specific aspect of the Early Holocene settlement system (e.g., plant processing sites) or are they former middens where faunal remains have disintegrated?

### Early Holocene Technologies

Tool assemblages from early sites of the California coast generally lack diversity in comparison to later assemblages, reflecting the relative simplicity of the economy in which they were used. The low diversity of early tool assemblages may be related to the importance of shellfish collecting. As Moriarty (1967) proposed, the presence of rich shellfish beds obviates (to some extent) the need for vertebrate protein sources, eliminating the incentive to produce and maintain elaborate fishing and hunting equipment.

Apart from flake and core tools used in a variety of functions, tools associated with milling activities (i.e., manos, metates, core hammers) are often the most common in mainland sites. These are rare or absent in early island sites, but "donut-stones" used for digging roots may be present (Glassow et al. 1988). In some southern or inland sites, scraper planes are common, perhaps reflecting the processing of agave or yucca (Kowta 1969). Although found in some early sites containing multiple components (see Owen et al. 1964; Greenwood 1972), mortars and pestles are absent or rare until after about 7000 CYBP. Current evidence suggests that the earliest milling tools appear roughly simultaneously on the San Diego, Santa Barbara, and San Luis Obispo coasts around 9000 CYBP.

Hunting tools usually constitute a small percentage of early coastal assemblages, although they may

become more abundant through time. Leaf-shaped points and bifaces often are present, but usually in relatively low frequencies. Points similar to Pinto, Lake Mojave, and Silver Lake types are occasionally found. Contracting stem or side-notched points recovered at some northern sites (e.g., Owen et al. 1964; Greenwood 1972) may be intrusions from more recent components (Erlandson et al. 1988), not a part of Early Holocene assemblages.

Direct evidence for an early fishing technology is limited. Small numbers of pointed bone tools are found in some early sites, although the function of these is sometimes difficult to ascertain. Bipointed fish gorges are known from the earliest levels at both Daisy Cave (SMI-261) and Eel Point (SCLI-43B), however, suggesting that marine fishing was conducted by the very earliest occupants of the Channel Islands (Meighan 1989). Other bone artifacts may have served as compound hook parts or barbs for fish spears (King 1981:355), although it is now uncertain whether some of these date to the Early Holocene. Occasional examples of cordage have been recovered from early contexts (Snethkamp 1987), and some of these may be fragments of fishing nets.

Enigmatic artifact types of uncertain function also occur in some early coastal sites. Prominent among these are the notched or "eccentric" crescents, found in San Dieguito and Millingstone sites although rarely north of Orange County or on the islands (Fenenga 1987). Cigar-shaped charmstones, usually interpreted as ceremonial objects, also are found in some sites.

Ornaments of shell, bone, or stone are rare in Early Holocene assemblages. Shell beads are the most common ornament, especially *Olivella* spire-removed, barrel, and rectangular types (King 1981:409). Shell ornaments found in smaller numbers include clam disc beads, and possibly *Dentalium* shells and perforated *Trivia* and *Mitra* shells (Orr 1968:126). Stone beads may be found occasionally (e.g., C. D. King 1981:176), but these are documented poorly at present.

### Settlement Patterns

It is common for early sites of the southern California coast to be located on elevated knolls, terraces, ridges, or other landforms. Various authors have attributed this pattern to a variety of causes. Along

the Santa Barbara coast, D. B. Rogers (1929:343) believed early sites were located by ancient oak forests (the "Oak Grove People") that were important sources of food. For the same area, C. D. King (1981:150) proposed that elevated settlements reflect defensive needs and the more terrestrial focus of early economies, while Moore (1985) hypothesized that early sites were located optimally to balance the marine and terrestrial aspects of mixed economies. Finally, Erlandson (1988a) suggested that early settlement on elevated landforms often may reflect instability in canyon bottom landforms, the result of submergence, erosion, and sedimentation in coastal canyons.

It is likely that a variety of environmental and cultural factors played a role in determining settlement location during the Early Holocene. At present, it is not even clear that the known distribution of early sites is representative of patterns of settlement. Hudson (1977) suggested that many early sites have been inundated by sea level rise or destroyed by sea cliff retreat. Glassow et al. (1988:68) and Erlandson (1988a) suggest that many early sites located in canyon bottoms have been buried by fluvial processes and that sites lacking substantial midden deposits or abundant milling stones may remain unrecognized. Until recently, small low-density sites rarely were excavated on the California coast, limiting our knowledge of human settlement patterns in the region. A systematic examination of early settlement patterns, including a review of known site locations, natural and cultural factors affecting the selection of settlement locations, sources and effects of processes that bias the archaeological record, and previous explanations for early settlement patterning, would contribute much to our knowledge of the subject.

### Subsistence and Dietary Reconstructions

Study of the effects of sampling and recovery techniques on the representation of shell midden constituents has a long history in California. It is widely known that some small or fragile faunal constituents (e.g., the remains of fish, small mammals, or fragile shells) are subject to selective loss through processing of midden through coarse ( $1/4$ -inch or larger) screen mesh (e.g., Koloseike 1968; Thomas 1969). When excavating in clay soils, field sorting of screen residuals can have similar effects. Despite these

widely acknowledged problems, many archaeologists continue to rely on field sorting and coarse-screen recovery to characterize the faunal assemblages of coastal midden sites. In the absence of column samples, or some other method of systematic fine-screen sampling, their reconstructions of prehistoric subsistence are tenuous at best.

It is recognized less widely that reliance solely on water screening and laboratory sorting of  $1/8$ -inch screen residuals can cause significant biases in the representation of some fauna in a site assemblage. Fitch (1969:58) states that the remains of some fish taxa may be recovered only in  $1/32$ -inch screens, and Erlandson (1988a) has shown significant differences between dietary reconstructions based on  $1/8$ -inch versus  $1/16$ -inch screen residuals. Due to intersite differences in midden constituents and formation processes, the effects of such recovery biases vary from site to site.

Other problems are encountered when conversions from shell or bone weight to meat or protein yields are attempted (Erlandson 1989). Shellfish generally have much higher shell to meat ratios than the bone to meat ratios of vertebrates. Consequently, in comparison to shell weight, relatively small adjustments in the gross weight of fish or mammal bone recovered in a midden sample can dramatically alter estimates of the dietary contribution of various faunal classes. In one recent example from the Santa Barbara coast (SBA-75), marine shell constituted over 93% of the faunal assemblage by weight but contributed less than 23% of the estimated meat yield and only 16% of the estimated protein yield after nutritional conversions (Erlandson 1988d:60).

For lack of more specific data, previous studies of nutritional yields from raw shell and bone weight often have relied on generic conversions published by earlier researchers (e.g., Cook 1946), resulting in a variety of problems (Koloseike 1969). Considerable data are now available on the meat yields of various shellfish taxa (Erlandson 1988a; Dietz et al. 1988), as well as the protein and caloric yields of various wild foods (e.g., Watt and Merrill 1975; Sidwell 1981; Gilliland 1985).

### ORGANIZATION OF THE VOLUME

The ten chapters that follow address issues of the origins and cultural ecology of Early Holocene cul-

tures of the central and southern California coast. After an initial discussion (chap. 2) by Larry Carbone on relationships between paleoenvironmental changes and cultural developments, the chapters are arranged according to their geographical focus, from south to north. Carbone's paper sets the paleoenvironmental stage for terminal Pleistocene and Early Holocene cultural developments, focusing on sea level change and its effects on coastal paleogeography, and sea temperature fluctuations and their impact on climate and biological resources. Citing independent terrestrial and marine climatic indicators, Carbone notes a correlation between a warming trend (the Altitheirml or Xerothemic) beginning approximately 7,500 years ago and changes in human subsistence, especially the adoption of ground stone artifacts and the development of more intensive maritime adaptations.

In chapter 3, Dennis Gallegos summarizes recent evidence for the origin and adaptation of Early Holocene groups of the San Diego and Orange County coasts. Judging from the density of early sites in the San Diego area, productive estuaries of the Early Holocene supported relatively populous groups of hunter-gatherers. Gallegos believes these early groups spread to the coast when increasing aridity reduced the productivity of interior pluvial lakes and that they were preadapted to coastal habitats due to their similarity to lacustrine environments of the Great Basin. His paper provides a logical argument for the origin of early coastal cultures of the San Diego coast and a cogent explanation for the relatively rapid development of marine resource use on the California coast.

In chapter 4, Henry Koerper, Paul Langenwaller, and Adelle Schroth address the San Dieguito-La Jolla transition problem, a controversy yet to be resolved (see Gallegos 1987), by focusing on an assemblage from the Allan O. Kelly site (SDI-9649), located on the margin of Agua Hedionda Lagoon in San Diego County. The authors provide a comprehensive summary of artifactual and faunal materials recovered from the site and document a relatively eclectic subsistence economy based on a combination of both marine and terrestrial resources. The presence of artifacts previously considered diagnostic of La Jolla and San Dieguito assemblages in a single site component lead Koerper et al. to conclude that an in situ evolution from San Dieguito to La Jolla best explains the early culture history of the region.

In chapter 5, Roy Salls describes the evidence for marine resource use at one of the earliest coastal sites in California, Eel Point (SCLI-43B) on San Clemente Island. Though the earliest  $C^{14}$  dates from Eel Point have been questioned (Erlandson 1988a: 335) due to a wide gap between the oldest charcoal and shell dates, the site was occupied by at least 8500 CYBP (and perhaps a millennium earlier) and provides some of the best evidence for an early maritime adaptation on the California coast. Finding little evidence for local environmental change on San Clemente Island, Salls uses a provocative model of "multiple stable-state communities" to explain temporal shifts in resource exploitation at Eel Point.

In chapter 6, Roger Colten uses previously unanalyzed faunal remains and recent radiocarbon dates to question the nature of Early Holocene adaptations at the Glen Annie Canyon site (SBA-142), which played an important role in the definition of Millingstone adaptations in southern California (e.g., Owen 1964, 1967; Owen et al. 1964; Curtis 1965; Warren 1967). Colten provides new data on the fish remains collected during site excavations in the 1960s and demonstrates that SBA-142 contains multiple components mixed by postdepositional processes (see also Erlandson et al. 1988). Though marine and estuarine resources appear to have been important to the Early Holocene site occupants, aspects of the assemblage thought to be diagnostic of the Millingstone horizon cannot be attributed with confidence to this early component.

In chapter 7, Jon Erlandson describes the faunal remains and artifacts recovered from three sites of the Santa Barbara coast that were occupied between approximately 7800 and 8800 CYBP. Using general dietary reconstructions, Erlandson believes the sites may represent seasonal aspects of a semisedentary settlement strategy. Resource exploitation appears to have focused on a series of small estuarine embayments which no longer exist in the study area. Data from the Santa Barbara coast are used to evaluate earlier models of subsistence during the early Millingstone horizon and the development of coastal economies in general.

Chapter 8, also by Erlandson, summarizes available data on early occupations of the northern Channel Islands of Santa Cruz, Santa Rosa, and San Miguel. Concluding that there is "no firm evidence for a Pleistocene association of humans and mam-

moths on the Northern Channel Islands," he focuses on several terminal Pleistocene and Early Holocene sites to evaluate the evidence for the antiquity and nature of maritime adaptations on the islands. New radiocarbon dates are presented for Cemetery A at SRI-3 (Tecolote Point), previously described as being over 7,000 years old (Orr 1968), documenting the presence of intrusive burials associated with an overlying midden dated to circa 4000 RYBP. The possibility that two early "shell middens" on San Miguel Island may represent natural accumulations of marine shell is suggested as a hypothesis needing further study.

In chapter 9, Michael Glassow summarizes the evidence for Early Holocene adaptations and local coastal paleogeography from five shell middens located along a small stretch of coast on Vandenberg Air Force Base in northern Santa Barbara County. He describes an apparent pre-Milling or Paleo-Coastal site (SBA-931) dated as early as 9150 RYBP and notes the initial appearance of milling tools in the area approximately 8500 RYBP, the latter possibly signaling a shift from a foraging to a collecting lifestyle. Unlike the more protected Santa Barbara County coast to the south and east, the Vandenberg area appears to have been characterized during the Early Holocene by a predominance of rocky shorelines, with no evidence for the existence of productive estuaries. Shellfish appear to have been an important part of the diet throughout the Early Holocene, though exploitation of ungulates, sea mammals, fish, and birds also occurred. Glassow concludes with a provocative examination of variation in the antiquity of sites in various parts of the Santa Barbara Channel area, a discussion which may be relevant to other areas of the California coast.

In chapter 10, Gary Breschini and Trudy Haversat

summarize evidence from early coastal sites of the San Luis Obispo, Monterey, and Santa Cruz areas. Their summary of the data available from the important Scotts Valley site (SCR-177) illustrates the urgent need for a comprehensive description of the archaeology of the site, for it remains unclear what the true antiquity of the site is and what artifacts are associated with various strata. Breschini and Haversat conclude with a summary of the havoc wreaked on early sites of the area by uncontrolled development and a cogent appeal for more effective management of archaeological resources by cities and counties of the central California coast.

We conclude the volume (chap. 11) with a synopsis of the implications of the data presented in the individual chapters for understanding broader issues related to the early prehistory of the California coast.

## NOTES

1. The California State Historic Preservation Office now requests that county abbreviations be capitalized in all archaeological site designations.

2. Radiocarbon ages in this volume are given in both radiocarbon years before present (RYBP) and calendar years before present (CYBP). Calendar ages refer to dates fully corrected and calibrated via published dendrocalibration curves (e.g. Stuiver et al. 1986). Most  $C^{14}$  dates from archaeological sites of the California coast are based on the analysis of marine or estuarine shell. For the Early Holocene, fully corrected and calibrated shell dates generally give calendar ages approximately 600 years older than uncorrected radiocarbon ages. Shell dates already adjusted for isotopic fractionation ( $C^{13}/C^{12}$  ratios) generally provide calibrated ages approximately 200 years older than uncalibrated ages.

## Chapter 2

# Early Holocene Environments and Paleoecological Contexts on the Central and Southern California Coast

Larry A. Carbone

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**T**he Early Holocene period was a time of significant environmental changes in several physiographic regions of California, especially the littoral. The forceful ecological changes that occurred left empirical biotic and geomorphic evidence, and contemporary cultural patterns certainly reflect ongoing interaction with the environment. Archaeologists must investigate this record using models that accommodate both environmental and cultural parameters. This chapter examines the kind and degree of environmental change which occurred during California's Early Holocene and suggests implications regarding cultural interactions.

It has long been postulated that Holocene environmental changes had an effect on prehistoric cultural patterns in certain North American areas (e.g., Buchner 1980; Butzer 1978; Mackey and Holbrook 1978), whether adaptive or responsive in nature. This assumption often is not evaluated for tenability in specific regions, in large part because paleoenvironmental data are lacking. Discussion of Early Holocene adaptations and environments of the central and south coast involves a diverse account of cultural, biological, and geophysical processes in a

wide region. From an archaeological perspective, paleoenvironmental data are sometimes sufficient to reconstruct climatic sequences in certain California areas with good temporal resolution.

Although the Holocene incursion reflects a general warming trend, evidence shows it has varied in magnitude and duration throughout the past 11,000 years or so. It is clear that a period of comparative aridity began in California and other areas between 8,000 and 7,500 radiocarbon years ago (RYBP). This warming trend, variously referred to as Altithermal (Antevs 1953), Hypsithermal (Deevy and Flint 1957), or Xerothermic (Axelrod 1981), is one of a few Holocene climatic trends affecting marine and terrestrial environments. Others, both warm and cool, occurred later (e.g., Glassow et al. 1988; Koerper, Killingsly, and Taylor 1986) but apparently not with the same intensity.

Environmental shifts in the coastal region may have been more significant compared with most interior areas in California. There was a transition in ecozones (see Axelrod 1981; Heusser 1978), and the rise of sea level had a tremendous impact upon drainage patterns and the availability and kind of

species inhabiting the littoral. The large mammal populations that Paleoindian hunters of the terminal Pleistocene exploited gradually died out; the latest California megafauna dated thus far occur on the Channel Islands at 7800 BP (Orr 1968) and the Mojave desert circa 8300 RYBP (G. Jefferson, personal communication, 1988).

During the Early Holocene, most recent larger game species migrated to the mountain hinterland as ecological niches were displaced. In coastal areas, the rocky foreshores that supported limited shellfish fauna changed to estuarine and lagoon configurations which fostered an increase in marine, avian, and small terrestrial species. Around these estuaries, ecological zones were centralized (Desgrandchamp 1976; Yesner 1980) and new floral taxa were introduced into the local regimes. These changes spurred the development of more diversified subsistence economies.

#### SEA LEVEL CHANGE

Rapid sea level rise is one of the most significant events that influenced Early Holocene coastal environments, from both biological and geomorphic standpoints. Sea level variation is caused by numerous factors including eustatic and isostatic effects, tectonic movements, and gravitational displacements, all operating at varying rates (Marcus and Newman 1983). Shorelines of equal age rarely are found at identical levels over widely scattered areas. Eustatic sea level variance, due largely to changes in glacial ice volume, affects geography, local and regional climate, and human food-gathering strategies.

For California archaeologists, the rate of sea level fluctuation is of interest for establishing and correlating regional stratigraphies. After the last glacial, accelerated sea level rise during the Late Pleistocene and Early Holocene markedly altered land areas along the California coast (fig. 2.1). It is difficult to quantify the varying rates of sea level rise after the last glaciation (Cronin 1982), but it is estimated that the coast of California experienced a rapid rise of about 1 meter per century from about 16,000 to 6,000 RYBP followed by a more gradual rise of about 10 cm per century (Inman 1983). Tide-gauge records show that gradual sea level rise continues on a world-wide scale (Hicks 1981), contributing to sea cliff erosion that is destroying many archaeological sites along the California coast.

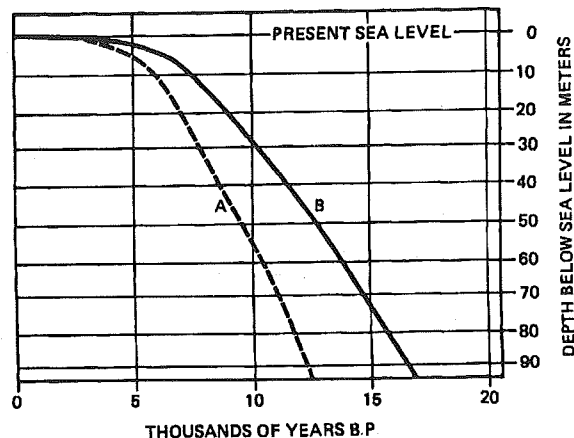


Figure 2.1. Graph showing sea level changes for the past 17,000 years. "A" denotes the ME curve of Milliman and Emery (1968: fig. 2); "B" shows the S curve of Shepard (1964: fig. 2).

As a result of the marine encroachment, large portions of continental shelf were submerged along the entire California coast. From northern California to the Baja border, approximately 17,000 km<sup>2</sup> of land area has been inundated since the end of the last glacial (calculation derived from correlation of sea level curves with bathymetric charts). Thus, the coastal settlement and subsistence patterns observed in the archaeological record are incomplete and biased in favor of later Holocene adaptations.

Sea level change controls the type and amount of sediment brought to the coast through its effect on stream gradients, erosion, and transport capacity. Rapid sea level rise may transform stream-cut valleys into deep embayments that trap fluvial sediments and limit sedimentation along the outer coast (Inman 1983). Along much of the mountainous California coast, this led to terrace formation and cobble beaches. Since sand beaches generally develop during times of relatively stable sea level following the silting of lagoons and estuaries, sand beaches characteristic of much of the modern California coast formed during the Middle and Late Holocene.

After the last glaciation, coastal drainages with associated terrace systems were partially or completely submerged, and onshore aggrading of stream and river channels deposited as much as 35 m of alluvium in some valley floors (R. Shelton, personal communication, 1988). Estuaries and lagoons were uncommon features during the Late Pleistocene in the New World, and it was not until the postglacial that

they developed on the shoreline of the continental shelves (Emery 1967; Russell 1967). The particular configuration of the California shelf resulted in a heyday of estuary and lagoon development between circa 8,000 and 5,000 years ago (Emery 1967). As sea level rose, estuarine habitats would have been created and obliterated in relatively quick intervals (Bickel 1978; Pierson et al. 1987). The geological evidence is corroborated by the archaeological record, and in the majority of shell midden sites estuarine molluscs do not appear as an exploited resource until this time (Kaldenberg 1982; Bingham 1978; Warren 1968).

Although rarely observed, considering the present sea level stand, some coastal shell middens are dated as early as 9000 RYBP at certain California localities (e.g., Greenwood 1972; Glassow et al. 1981). However, most of these are composed of rocky coast, not estuarine, species. Researchers must be mindful that sea level at any given period dictates what evidence of prehistoric coastal occupation is potentially observable, short of underwater archaeology. It is logical that most coastal sites date to times when coastal terraces attained their maximum stability.

## PALEOCLIMATE AND ENVIRONMENT

Numerous sources of paleoclimatic data can contribute to environmental reconstructions that are relevant to interpretations of Early Holocene cultural patterns. When considering prehistoric climatic and environmental trends occurring along the California littoral, information must be correlated from both interior and coastal areas to provide a more comprehensive account of regional data.

### Inland Data

Evidence of Early Holocene treeline movements is noted in the White Mountains of south-central California. If certain qualifications are observed, changes in treeline elevation can be interpreted in terms of climatic variation. Standing snags and other remnants of *Pinus longaeva* have been radiocarbon dated, indicating that a warming trend effected, by way of air temperature and moisture availability, a major alteration of the treeline circa 7500 BP (LaMarche 1973).

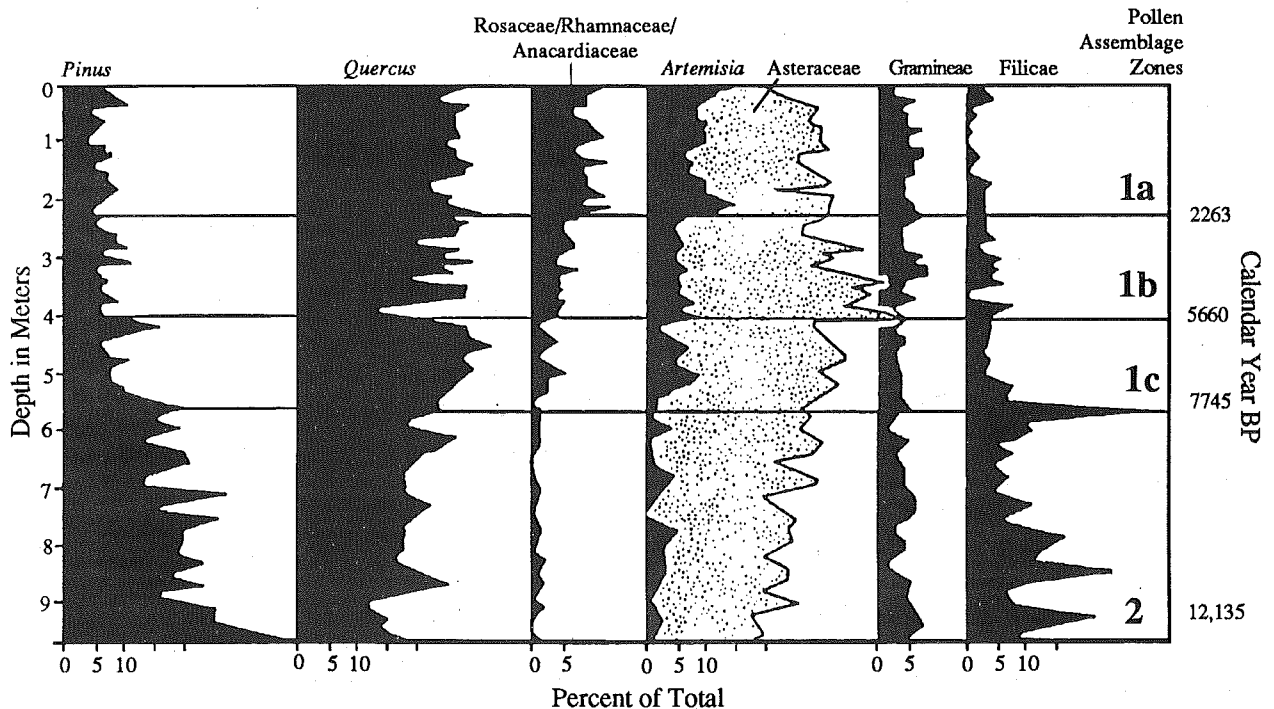


Figure 2.2. Fossil pollen percentages in Santa Barbara Basin (from Heusser 1978:675).



Fish remains recovered from California lake sediments support the treeline data. Casteel et al. (1977) estimated that growth increments in scales from *Hysterocarpus traski* (Tule perch) contain a record of Holocene temperature variation. This assessment is possible because fish metabolism is regulated by the temperature of their environment. Comparison of growth rates through time implies a warming trend commencing between 8,000 and 7,000 years ago.

Floral communities also were affected by an Early Holocene climatic shift, since vegetation diagrams from many California areas denote an arid interval at approximately the same time. Pollen recovered from nearshore Santa Barbara Basin cores (fig. 2.2) indicates major changes in the distribution of upland and lowland plant communities at circa 8000 RYBP (Heusser 1978), when pine forest was generally replaced by woodland and chaparral. Agave, sage, and buckwheat, rare in early levels, became plentiful and represent resources from a biome newly opened to human adaptation. New pollen data from the Santa Ynez Valley coincide well with trends noted in the Santa Barbara Basin sediments (C. Woodman, personal communication, 1988).

Many interior regions also experienced major changes in plant distributions during the Early Holocene, with previously lacustrine environments transformed into deserts. The conifer record from the Lucerne Valley area of the Mojave denotes that a cool, moist climate persisted until 7800 RYBP, followed by a desert environment (T. J. King 1976). Van Devender and Spaulding (1979) conclude that southeast California forest communities declined rapidly after 8,000 years ago. These authors note that at Newbury Cave, packrat middens containing uriniferous creosote, a modern desert vegetation, became common after 7500 BP. Southern California floral communities appear to have responded quickly to climatic change compared to the relatively gradual response of central and eastern United States forest communities.

The pollen record of the high Sierra also illustrates a prominent change in plant distributions during the Early Holocene. In a depositional sequence from Osgood Swamp, *Artemisia* and *Ericaceae* (indicators of cool conditions), disappear or become minimal at the same time that *Alnus* (indicative of warm, dry summers) first appears and dramatically increases (fig. 2.3). These events are bracketed

stratigraphically between a Mazama ash layer dated to circa 6600 RYBP and a  $C^{14}$  date of  $9900 \pm 800$  RYBP (Adam 1967). Sedimentation rates suggest that these floral changes likely happened between 8,000 and 7,500 years ago. A similar pattern is repeated in continuous pollen core sequences from the coastal side of the Sierra at Balsam Meadow, central California, where cool temperature indicators decrease while warm temperature indicators increase (Davis et al. 1985). Most notably, the frequency of *Pinus* decreases to a minimum by 7300 RYBP. The accuracy of this record is supported by a comparatively large number of radiocarbon dates.

Johnson (1977) suggests that the littoral area was affected similarly by temperature increase, a view supported by covariation with the marine climatic record of the coastal Borderland (Point Conception to Baja California). Axelrod (1981) and other workers are confident that an Early Holocene warming trend is supported by present paleoecological

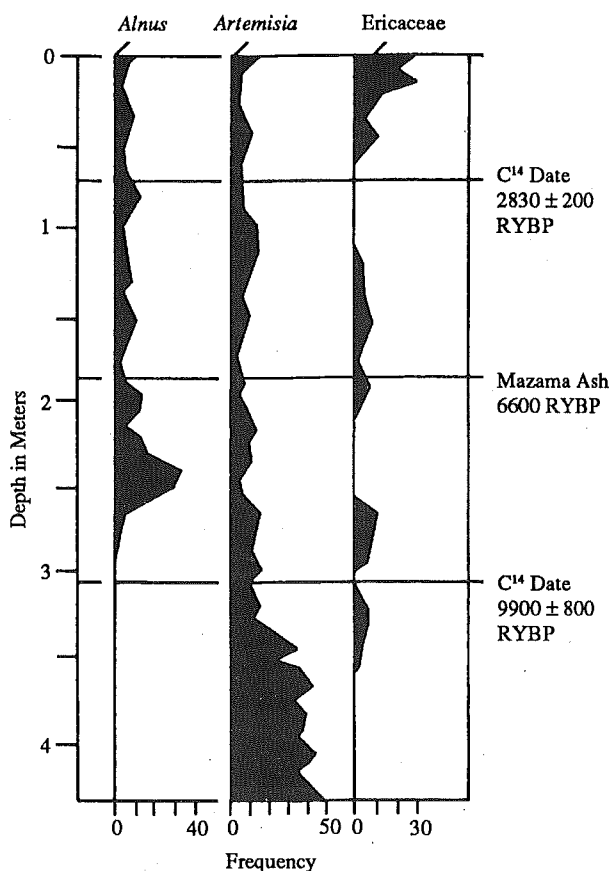


Figure 2.3. Osgood Swamp, California, pollen (from Adam 1967:287).

evidence. The evidence supports distributional measurements that show more arid, interior, woody taxa spreading into the coastal strip of California as well as northward in the Coast Ranges approximately 8,000 years ago (Axelrod 1967:302).

### Marine Data

The paleomarine record offers convincing evidence not only that a pronounced climatic shift occurred in the Early Holocene but that it can be assigned a rather precise temporal limit. The acute sensitivity of some marine organisms to temperature fluctuation, coupled with the potential for high resolution studies in varved ocean sediments, allows reconstruction of sea temperatures and other variables. Since changes in sea and air temperatures are closely correlated (Hubbs 1960), marine changes can be indicative of adjacent terrestrial events.

Because they accumulate sediments from both marine and terrestrial sources, the California marine basins are excellent sources of data relating to changes in sea temperatures and environmental shifts (Dunbar 1981). Specific examples, such as Santa Barbara Basin sediments, are especially useful paleo-environmental indicators because bioturbation does not affect the varved record.

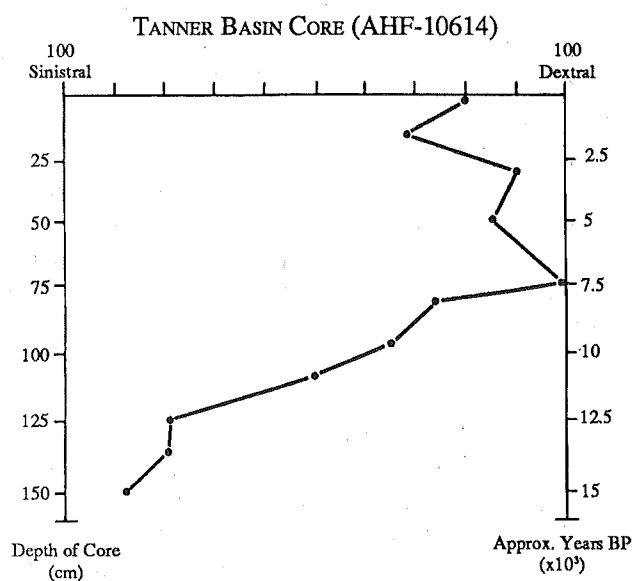


Figure 2.4. Coiling ratio of *Globobulimina pachyderma* (modified from Kahn et al. 1981:487).

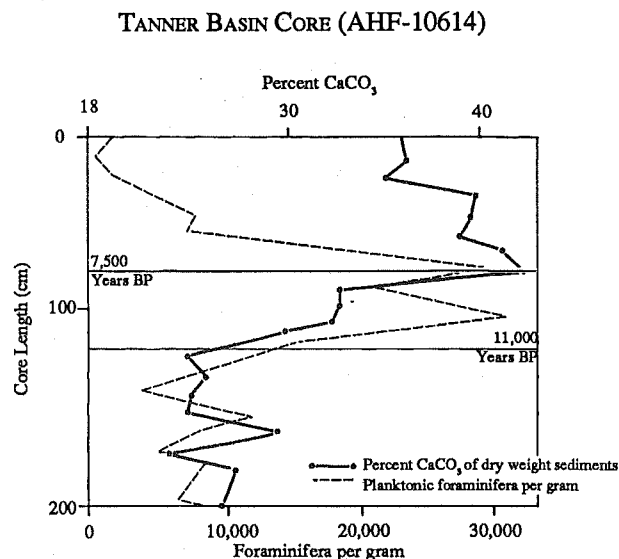


Figure 2.5. Percentage of calcium carbonate and planktonic foraminiferal numbers (from Kheradpir 1970:105).

Correlated with a radiocarbon chronology, analyses of numerous nearshore sea basin cores show a marked increase in Early Holocene sedimentation relative to the Late Glacial (Dunbar 1981). This indicates a pivotal change in numerous biotic and geomorphic processes. For example, an onset of warmer climate is implied by changing frequencies and types in radiolarian assemblages observed in varved Santa Barbara Basin sediments (Pisias 1979). Varying proportions of these fauna indicate a sharp temperature increase between 7400 and 7200 RYBP, although temperature was generally warm until 5,500 years ago. This is extrapolated as a rise in the annual February land temperature from 16.5 to 25.5° C, representing a pronounced period of aridity (Pisias 1979:377).

Sea water temperatures are also estimated from oxygen isotopic analysis of benthic foraminifera contained in cores from Tanner Basin, west of San Diego. According to  $O^{18}$  values, a significant temperature threshold occurred about 7500 RYBP (Kahn et al. 1981). Coiling patterns of Tanner Basin planktonic foraminifera, which are directly dependent on water temperature (Kennett 1976), also indicate a continuous warming trend spanning the Flandrian transgression. Core samples show that at 15,000 RYBP, approximately 90% of *Globobulimina pachyderma* specimens were coiled sinistrally from cool ocean temperature (fig. 2.4). As sea water

warmed, coiling orientation shifted, and by 7500 BP virtually all of the specimens were dextrally (oppositely) coiled (Kahn et al. 1981).

Evaluations of other marine cores from the south Borderland show that foraminifera productivity and calcium carbonate content vary according to temperature, oceanic circulation, and nutrient level (Kheradpir 1970). By correlating radiocarbon dated core segments with calcium carbonate and foraminiferal abundance, similar patterns have been noted among different researchers (Gorsline and Barnes 1972; Gorsline and Prensky 1975; Kheradpir 1970). Most analyses show a peak post-Pleistocene warming trend demonstrated by several variables at 7500 RYBP (fig. 2.5). Thus the paleoenvironmental data from the ocean correlates closely with evidence from terrestrial sources.

#### RESEARCH CONSIDERATIONS

The Early Holocene was a period of complex climatic and environmental change, both terrestrial and marine. Human populations were widely distributed on the southern and central California coast between 9,500 and 7,500 years ago (Moratto 1984). Archaeological data from these early sites should be evaluated with the consideration that extensive areas now submerged were previously above sea level. Sites located along the modern coast were in some instances far removed from Early Holocene shorelines. Significant portions of land that are now inundated provided living space as well as productive catchment areas which were important to Early Holocene economies. There are no doubt sites containing midden refuse, inhumations, features, and even the remains of extinct fauna presently submerged (see Masters 1983). Increased efforts are now being extended to secure information from difficult-to-access, submerged resources (e.g., Edwards and Emery 1977; Kraft et al. 1983; Masters 1983).

Social scientists can formulate hypotheses and research questions to compensate for submerged sites. We are confronted with a problem not encountered in interior archaeology, which makes the research attractive in a different way. That is, isolated data in these circumstances need innovative methods of recovery. Unfortunately, some of the models most widely employed in interpreting culture change are those that hold the environment constant while attributing variation in the archaeological record to

cultural dynamics in a seemingly stable environment (McMillan and Klippel 1981).

There may be contradictory interpretations regarding the degree and duration of environmental changes and their effects on human adaptations. Behavioral changes are evident; however, the causes of these changes must be evaluated by correlating data from numerous sources. I believe that biotic and geophysical environmental changes on the California coast had a gradual yet decisive impact upon cultural adaptations. Although the general consequences of climatic shifts are fairly well understood, new studies continue to delimit the range and effects of environmental changes and their influence upon biological adaptations. The search for additional data continues, as new climatic studies with snails (Neck 1987) and freshwater invertebrates (Walker and Mathewes 1987) show.

To accurately assess how environmental changes affected cultural adaptations, we must use models which view humans and natural phenomena as interacting systems. As debate continues on such matters as whether the San Dieguito people significantly exploited shellfish as did the succeeding La Jollans (see Warren 1987) and whether these traditions were discrete cultural groups, we must turn our focus toward environmental parameters that explain adaptations and predict cultural responses. Human populations are active participants in a biotic and geophysical system and respond to the same types of external regulatory mechanisms as other organisms (King and Graham 1981). Interpreting culture change is complicated and should be approached by comparing environmental with social mechanisms, which are far from well understood. Workers should be aware that there are randomizing effects of human conscious choice, often seemingly illogical, and these may have affected the patterns of remains in the archaeological record.

#### SUMMARY

Several independent lines of evidence show that a pronounced shift in a variety of biotic and physical variables occurred between approximately 8,000 and 7,300 years ago. Those studies with the highest resolution indicate a peak of alteration at circa 7,500 BP. However, the timing and effects of the warming trend varied depending on latitude and other paleoclimatic and biogeographic influences (Wright

1976). If the changes are viewed within an archaeological perspective, then related cultural changes may be observed. Previous correlations of climatic and archaeological data demonstrate that changes in environmental and cultural patterns on the California coast are linked (Carbone 1984; Glassow et al. 1988; Kaldenberg and May 1975). For instance, technological and environmental changes coincided when groundstone implements became prominent tool types during the Early Holocene. Although not the only explanation, the fact that numerous Millingstone tradition sites appeared contemporaneously in different areas of California argues for environment being a causal factor.

Changes in the composition of shellfish assemblages in California coastal middens provide important evidence of cultural activity. Reinman (1964) views dietary preference as a major contributing factor governing what appears as exploited resources in archaeological middens. From the Early Holocene record it appears more likely that such changes result from varying species availability as coastal ecosystems gradually changed (e.g., from predominantly rocky foreshore to estuarine habitats).

Early Holocene economies are often difficult to reconstruct because many early sites were occupied for short periods and contain food remains of limited diversity, if they are preserved at all. The big-game hunting tradition frequently is contrasted with the Millingstone horizon and contemporary maritime economies, and these different manifestations sometimes are envisioned as representing discrete populations. I believe that continual prehistoric occupations by the same people occurred in many regions with productive environments, whether changing or not. An important consideration is to what extent (and with what degree of accuracy) climatic changes were actually perceived by early populations. There is no doubt that the Early Holocene populations of the California coast adapted to dynamic environmental systems. Yet, specific quantitative data re-

lating to how these changes affected cultural groups remain in the early stages of refinement.

When viewing changes in the archaeological record it is important to consider the interaction of the contemporaneous environment. For the Holocene sequences in southern California, biotic data are paramount. In this scheme, climate and interrelated environmental events played a major role. The warming trend of the Early Holocene certainly had an impact upon cultural adaptations, viewed from both marine and terrestrial data. Middle and later Holocene shifts logically influenced human responses to natural resource availability. This appears to be substantiated by the present cultural evidence from archaeological sites within related regions. Implications of cultural activity must be interpreted with all of these factors appraised. The Early Holocene was marked by a warming trend that appears to have peaked in intensity circa 7500 RYBP. Climate remained generally warm until about 5500 RYBP when cooling periods commenced. The archaeological record indicates that major cultural developments (e.g., groundstone technology and evolution of maritime economy) occur coincidentally with environmental shifts. Future research directed toward explaining this problem should produce evidence to strengthen or refute the hypothesis that environmental change was responsible.

It is noted that the temporal framework advanced in this chapter is derived from raw  $C^{14}$  age determinations and, as applied, shows a general chronological trend, not an absolute fixing of interrelated events. It is important to accumulate additional evidence so archaeologists can aid in validating models developed in other sciences and also independently discover environmental trends and conditions. Archaeological evidence shows that significant cultural changes took place on the California coast during the Holocene. These occurred in the context of a dynamic environment and appear to have been adaptive in nature.

## Chapter 3

### Antiquity and Adaptation at Agua Hedionda, Carlsbad, California

Dennis R. Gallegos

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**T**he focus of this paper is a descriptive account of Early Holocene occupation at Agua Hedionda Windsong Shores site SDI-10965 (San Diego Museum of Man site #W-131) and its relationship to Early Holocene (7000 to 10,000 BP) sites in San Diego County and the Great Basin. Early Holocene sites in San Diego County are located near bays, lagoons, sloughs, and coastal valleys. These coastal sites contain large quantities of shellfish and fish remains and include finely worked stone tools such as bifaces and crescentics, milling tools, bone tools, and cobble tools. The Harris site (SDI-149) dated to 9030 RYBP contains finely worked stone tools, but no evidence of coastal resource exploitation and may be "a special-purpose site, primarily devoted to the exploitation of a localized natural resource" (Ezell 1987). The Early Holocene coastal sites are not associated with "big game hunters" but with hunters and gatherers who milled plant seeds, ate shellfish, fish, deer, rabbits, and birds, and made biface tools, crescentics, and cobble tools.

Many of the resources of coastal lagoons, bays, and sloughs were probably similar to past lacustrine environments of the Great Basin. Coastal lagoons

were created as sea level rose; this occurred at the same time (ca. 9,000 years ago) as the drying of the Great Basin lacustrine environments. It may well have been the similarity of coastal estuaries to lacustrine environments that allowed Great Basin peoples to quickly adapt to coastal resource-rich habitats.

Poor preservation around these Great Basin lakes indicates that we may be missing the rest of the story in that much of the floral and faunal remains have been destroyed, leaving only the finely worked stone tools. The presence of only San Dieguito (Western Pluvial Lakes tradition) stone tools in the Great Basin and absence of faunal remains certainly supports the "Big Game Hunting" association of pluvial San Dieguito sites, but the occupation of the Great Basin 10,000 years ago may have been more similar to coastal San Diego County approximately 7,000 to 9,000 years ago, when a wide variety of floral and faunal resources were exploited.

The Early Holocene occupation of coastal estuarine environments in San Diego County demonstrates the presence of a people from the Great Basin who adapted to the coastal resources of shellfish, fish,

birds, land mammals, and local plants. A good example of this early adaptation is the occupation of the Windsong Shores site SDI-10965 at Agua Hedionda.

### WINDSONG SHORES SITE SDI-10965

The first archaeologist to conduct fieldwork at Agua Hedionda was Malcolm Rogers of the San Diego Museum of Man. Rogers recorded nine large archaeological sites on the knolls and flats above Agua Hedionda (M. J. Rogers n.d.). Rogers was the original recorder of site SDI-10965, which he described as a slough terrace midden of rather constant occupation, containing milling tools, scraping tools, a bowl or mortar fragment, shell, and three bowling stones. Rogers apparently was impressed with the archaeological potential of Agua Hedionda sites and sought to relate them to other similar deposits at coastal lagoons and estuaries in southern California.

Three major Early Holocene sites have been investigated at Agua Hedionda (fig. 3.1). In 1966, James R. Moriarty III tested site SDI-210 (UCLJ-M-15), a site just east of Windsong Shores (SDI-10965). His work provides little information as to the number of units excavated or type or quantity of materials recovered but does provide a basal depth of 170 cm and a date for this level of 9020 RYBP (Moriarty 1967) (table 3.1). This site produced a substantial amount of cultural debris, including artifact types that led Moriarty to conclude that the site was occupied by a "pre-desert transitional culture." Moriarty states:

The antiquity of the basal date at UCLJ-M-15, plus the occurrence of green felsitic implements of the San Dieguito type, indicates that UCLJ-M-15 at the base is a transition phase of the La Jolla and the San Dieguito and may be related to the "Pauma Complex" which was discovered further inland and contains the suggestion of a similar mixing of San Dieguito and La Jolla within its artifact assemblage at its lowest levels. [Moriarty 1967:555]

The third Early Holocene site at Agua Hedionda is SDI-9649, the Allan O. Kelly site reported by Koerper (1986; see also chap. 4, this vol.). This site contains a wide range of artifacts including bifaces,

crescentics, shell beads, bone tools, milling tools, obsidian, core tools, cobble tools, and faunal remains of shellfish, fish, reptiles, birds, and mammals. This site, radiocarbon dated from 6850 to 7520 RYBP, is unique in the diversity of tools and faunal remains, indicating a complex subsistence system using both cobble and inland quarry-base tools to exploit a wide range of resources at this lagoon habitat.

The Windsong Shores site (SDI-10965) provides a rich source of information concerning the period 7000-8500 BP. This archaeological site offers not only a wide range of stone tools, obsidian, and radiocarbon dates, but also shell, bird, mammal, and fish remains, and a pollen record for the period. One example of the wealth of data provided is the recovery of a flightless sea duck (*Chendytes lawi*) extinct for the past 2,000 years. It is the first *Chendytes lawi* that has been found as far south as Carlsbad, California. Obsidian (Coso and Casa Diablo), a Silver Lake point and biface points/knives from SDI-10965 suggest that the first occupants of Agua Hedionda traveled from inland California.

The food resources at SDI-10965 are evidenced by fish, shellfish, mammal and seed remains. Tools include points, points/knives, crescentics, scraping tools, milling tools, bone tools, choppers, and cobble tools. The presence of cores, flakes, and microflakes suggests both tool production and tool maintenance at SDI-10965.

The goal of the Windsong Shores study was to investigate the potential for single or multiple occupation and, more generally, to address the existing chronology for San Diego County as to early settlement, diet, trade, and travel.

The work conducted at SDI-10965 included a field survey, subsurface testing, and a data recovery program wherein 37 1 x 1 m units were excavated using 1/8-inch mesh (fig. 3.2) (Gallegos and Carrico 1984). In addition, backhoe trenching of 46 m<sup>2</sup>, of which 15 m<sup>2</sup> were screened for diagnostic artifacts, was conducted as part of the data recovery program. Due to the high quantities of small bone and microflakes, screen remains from select units were wet-screened using window mesh screen. North-south and east-west soil profiles were compiled using trench and unit strata profiles and are provided on figure 3.3. Note the fill cap near the south edge of the site and north edge of the lagoon as well as the increase in midden depth in this area.

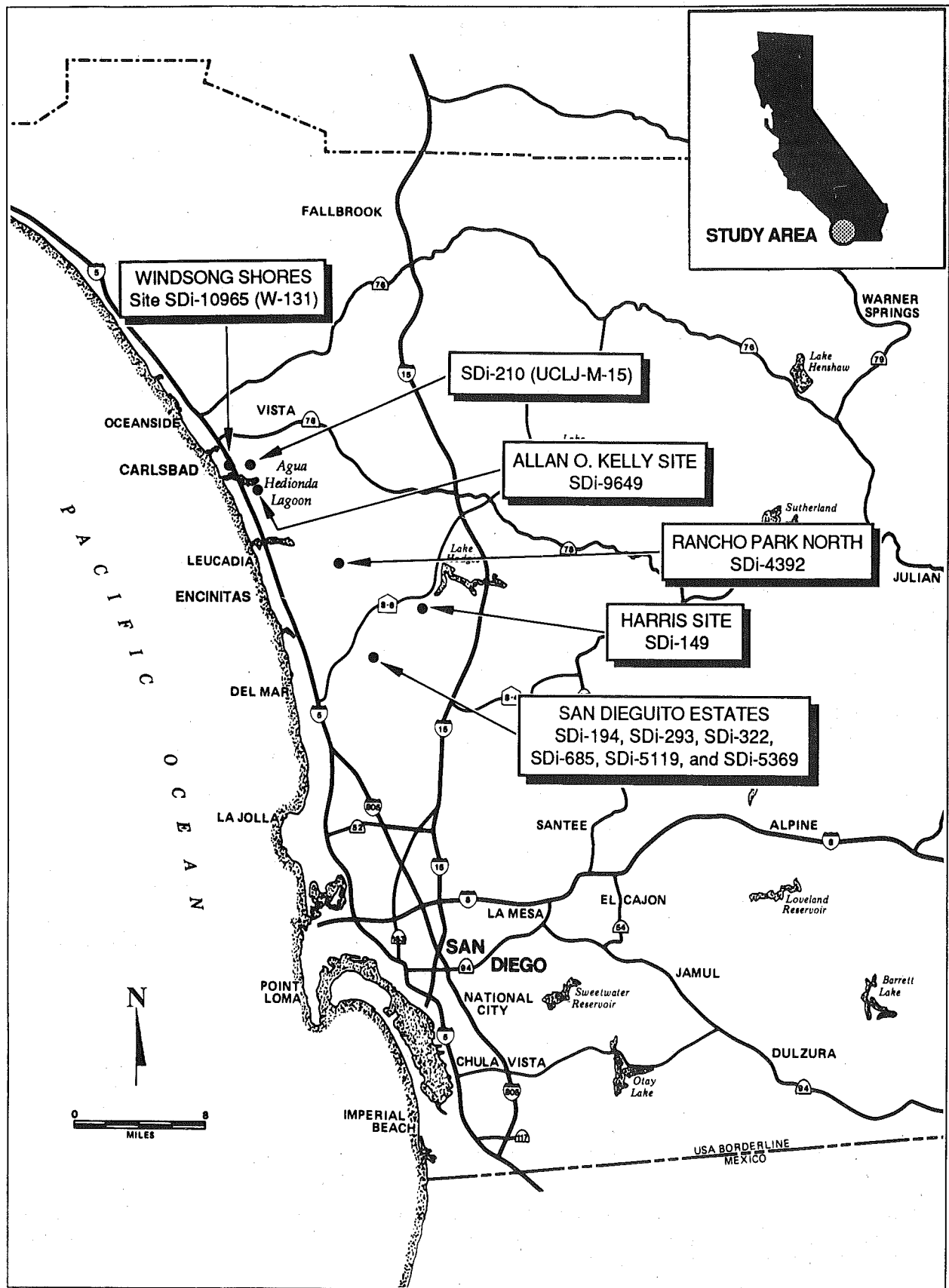


Figure 3.1. General location of Early Holocene sites.

Table 3.1. Early Holocene Radiocarbon Dates (San Diego County)

Site SDI-W-/Other	Site name <sup>1</sup>	RYBP	Lab no. <sup>2</sup>	Material dated <sup>3</sup>	Unit/ level (cm)	Reference	
Agua Hedionda Lagoon							
10965	131	WS	7040 ± 80	B-9130	S	35/60-70	Gallegos and Carrico 1984
10965	131	WS	8060 ± 90	B-9128	S	14/30-40	Gallegos and Carrico 1984
10965	131	WS	8280 ± 100	B-9129	S	18/30-40	Gallegos and Carrico 1984
10965	131	WS	8390 ± 110	B-9127	S	6/10-20	Gallegos and Carrico 1984
9649		AOK	7090 ± 90	B-13440	S	Q/30-40	Koerper 1986; chap 4, this vol.
9649		AOK	7200 ± 100	B-13438	S	Q/10-20	Koerper 1986
9649		AOK	7260 ± 90	B-13442	S	Q/50-sterile	Koerper 1986
9649		AOK	7270 ± 90	B-13439	S	N/20-30	Koerper 1986
9649		AOK	7520 ± 90	B-6954	S	—	Koerper 1986
210	UCLJ-M-15		7420 ± 350	LJ-961	S	130-140	Hubbs and Bien 1965
210	UCLJ-M-15		7450 ± 370	LJ-966	S	130-140	Hubbs and Bien 1965
210	UCLJ-M-15		9020 ± 500	LJ-967	S	160-170	Hubbs and Bien 1965 <sup>4</sup>
Batiqitos Coastal Valley							
4392	49A	RPN	7075 ± 110	UGA-3571	S	40	Kaldenberg 1982
4392	49A	RPN	8010 ± 90	LJ-3244	S	50	Kaldenberg 1982
4392	49A	RPN	8030 ± 80	LJ-3160	S	80	Kaldenberg 1982
4392	49A	RPN	8040 ± 80	LJ-3243	S	40	Kaldenberg 1982
4392	49A	RPN	8060 ± 90	LJ-3245	S	60	Kaldenberg 1982
4392	49A	RPN	8110 ± 80	LJ-3246	S	120	Kaldenberg 1982
4392	49A	RPN	8280 ± 80	LJ-3161	S	110	Kaldenberg 1982
San Dieguito River Valley							
149	198	CWH	7620 ± 360	A-0723	C		Haynes et al. 1967 "Postdates San Dieguito occupation"
149	198	CWH	8490 ± 400	A-0725	C		Haynes et al. 1967 "Samples date San Dieguito artifact bearing unit"
149	198	CWH	8490 ± 400	A-0724	C		Haynes et al. 1967 "Samples date San Dieguito artifact bearing unit"
149	198	CWH	9030 ± 350	A-0722A	CR		Haynes et al. 1967 "Sample was 25 cm below erosional contact & predates San Dieguito artifacts"
194	1586		8600 ± 110	LJ-4614	S	E210/N98:20-30	Norwood and Walker 1980
293	1585		7400 ± 100	LJ-4612	S	20-30	Norwood and Walker 1980
293	1585		8420 ± 100	LJ-4613	S	E101/N78:30-40	Norwood and Walker 1980
322	1588		7720 ± 100	LJ-4615	S	E106/N205:70-80	Norwood and Walker 1980
322	1588		8290 ± 100	LJ-4607	S	E111/N210:80-90	Norwood and Walker 1980
685	1584		8030 ± 100	LJ-4611	S	E112/N91:80-90	Norwood and Walker 1980
685	1584		8450 ± 180	LJ-4610	S	E110/N100:40-50	Norwood and Walker 1980
5369	40		8650 ± 110	LJ-4609	S	E89/N87:40-50	Norwood and Walker 1980

<sup>1</sup> WS = Windsong Shores; AOK = Allan O. Kelly; RPN = Rancho Park North; CWH = C. W. Harris

<sup>2</sup> B = Beta

<sup>3</sup> S = Shell; C = Charcoal; CR = Carbonaceous residue

<sup>4</sup> "Provides a breakthrough date for the inception of shellfish gathering along mainland coast of California. Because green felsite implements of the San Dieguito type increased as base level was approached, Moriarty concluded that he had encountered a transition between San Dieguito and La Jolla cultures" (Hubbs and Bien 1965).

Note: Only dates over 7000 RYBP are shown on this table. Recent dates from the La Jolla lab (for SDI-4392, -194, -293, -322, -685, and -5369) include C<sup>13</sup>/C<sup>12</sup> corrections, adding about 430 years not included in the other uncorrected dates.



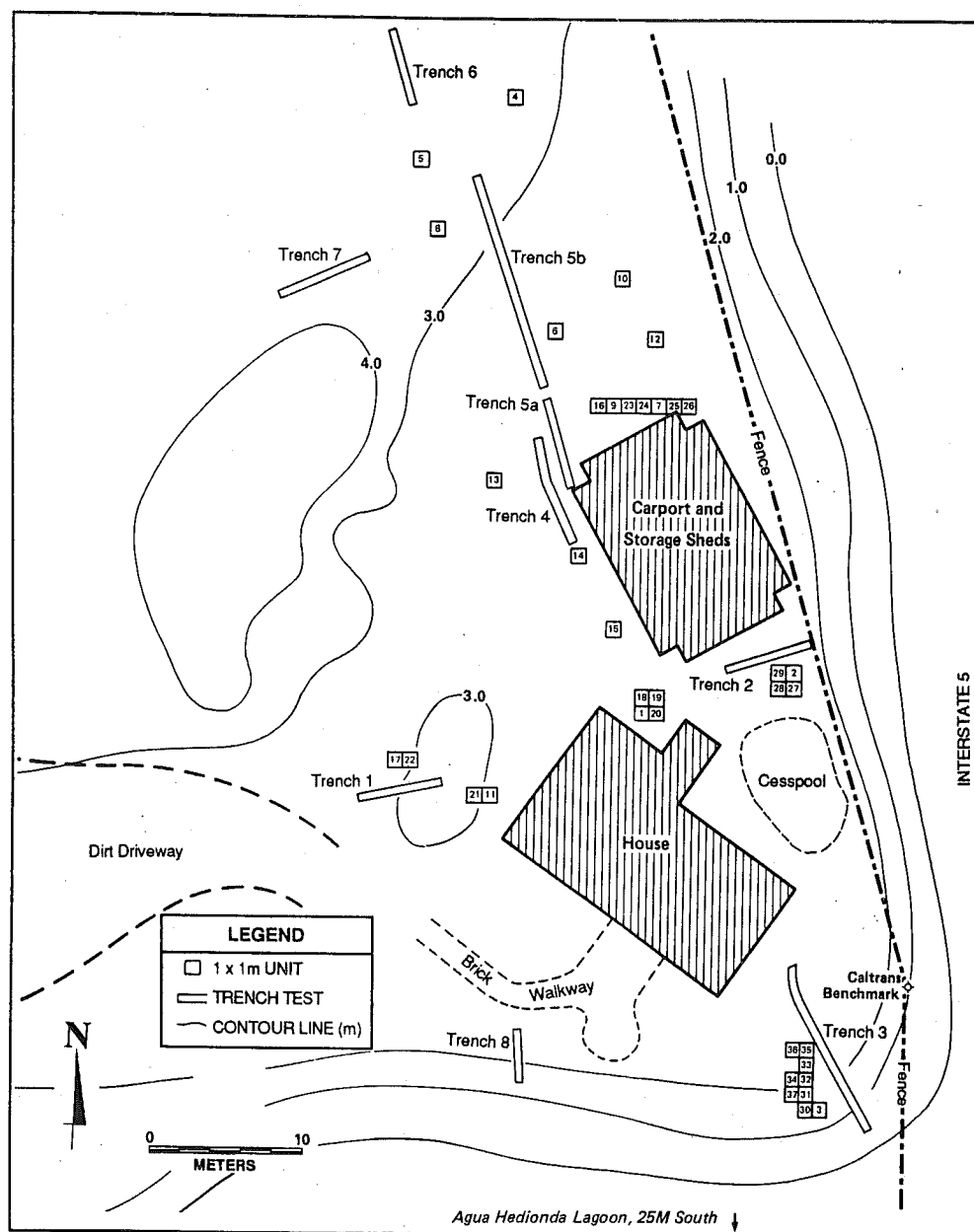


Figure 3.2. Site map showing location of excavation units and trenches.

## RESULTS

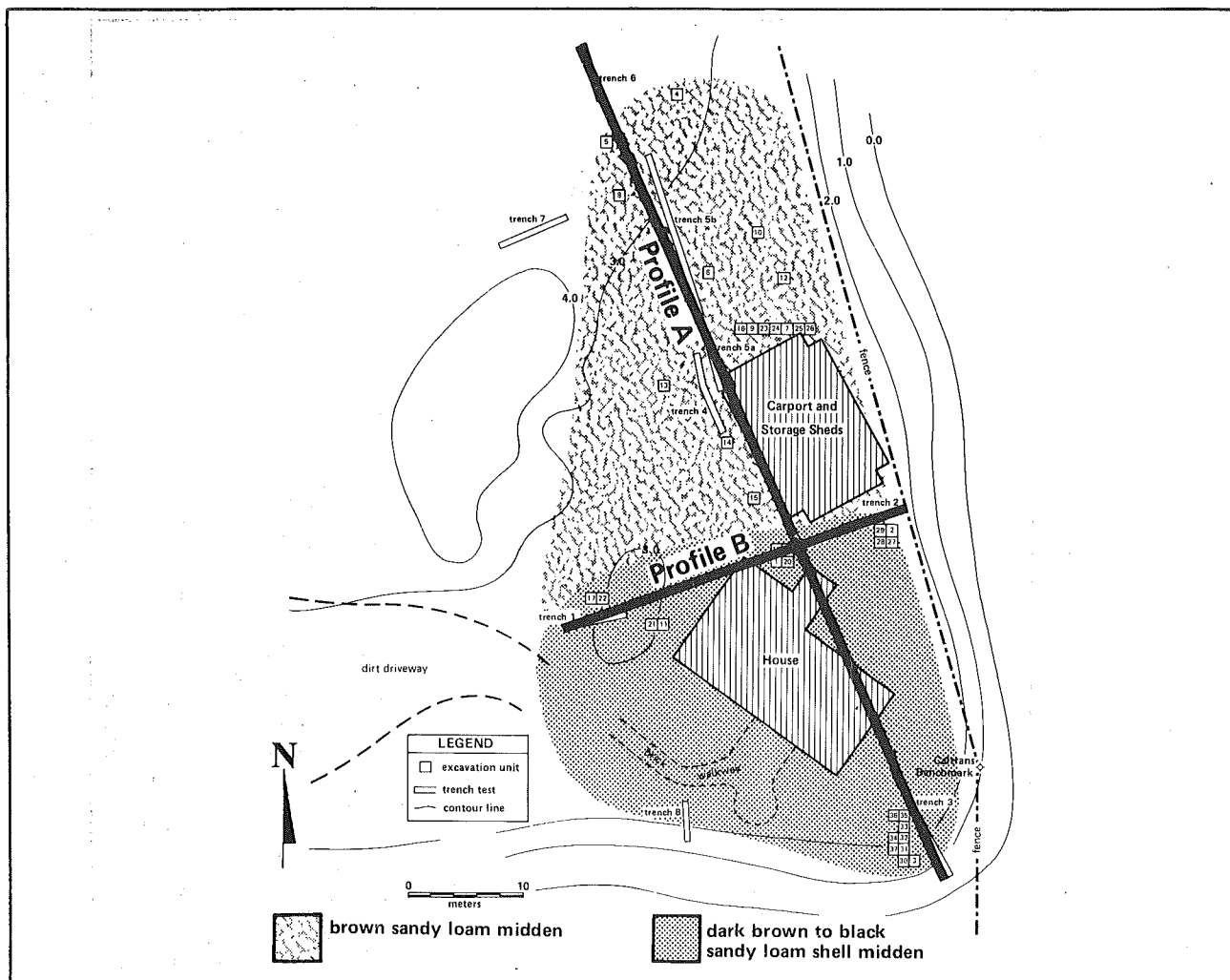
In all, 7,882 artifacts were recovered from SDI-10965 (tables 3.2, 3.3). Of this total, 37 were collected from screening trench backdirt. Over 98% of the lithic artifacts are flakes and angular waste. The remaining 150 artifacts include cores, projectile points, points/knives, scrapers, crescentics, a drill, utilized flakes, choppers, cobble tools, hammerstones, manos, a metate fragment, grinding/pounding tools, round-elongated granitic stones, and bone tools. The majority of artifacts (94%) were found between 0 and 50 cm. These artifacts are discussed below by type.

## Cores

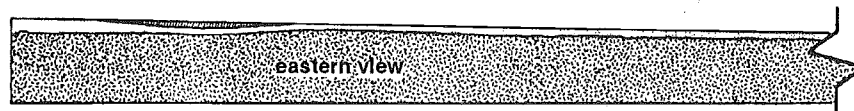
Five of the nine cores are split cobbles with the split face used as the platform, two are core fragments, and two are expended cores. Six of the cores are made of basalt, two of fine-grain metavolcanic material, and one of quartzite. Only one core was found near the bluff; all remaining cores were located in the central to northern portion of the site.

## Biface Points

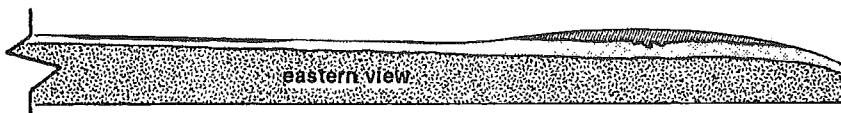
Biface tools from Windsong Shores (fig. 3.4) include



Profile A  
(north half)



Profile A  
(south half)



Profile B



0 10  
METERS

fill dirt

brown sandy loam/  
black sandy loam (midden)

orange/brown sandy clay

Figure 3.3. Site soil profile based on trench and excavation unit data.

Table 3.2. Artifacts by Unit

	Unit																									
Material	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Projectile point												1		1												
Point/knife		1								1		1						1		1			1		1	
Scraper	1	2		2	1	4	1		3	2	1	1	1	3		1			1	2	3		1		2	2
Crescentic				1	1	1										2										
Utilized flake							3		1	2				1			1		1							1
Drill fragment		1																								
Core	1	1					1																			
Flake/angular waste	117	562	43	83	139	354	512	170	453	570	244	473	178	221	130	435	204	140	141	318	164	162	422	213	111	239
Cobbletool			2			1																				
Chopper	1		1							1																
Teshoa flake						1																				
Hammerstone	1	1	3									1						1							1	
Mano												1								1					1	
Metate																										
Grinding/pounding tool				1																						
Round/elongated stone	1	1					1			1																
Bone tool	1									1	1						1			1	1	1				
Total	123	569	50	86	141	361	518	170	457	578	246	478	179	226	130	438	206	142	143	323	168	163	424	213	116	242

	Unit																	Trench							Total	With angular waste(%)	Without angular waste (%)
Material	27	28	29	30	31	32	33	34	35	36	37	1	2	3	4	5	6	7	8	*							
Projectile point																							2	0.03	1.3		
Point/knife																1							8	0.10	5.3		
Scraper	1		2		2	1	1	1	1					3	10	4				1		61	0.77	40.7			
Crescentic																1						6	0.08	4.0			
Utilized flake															1							11	0.14	7.3			
Drill fragment																						1	0.01	0.7			
Core										1							1	4				9	0.11	6.0			
Flake/angular waste	184	275	124	41	39	28	38	32	100	46	27											7,732	98.10	—			
Cobble tool	1														1				1			6	0.08	4.0			
Chopper																						3	0.04	2.0			
Teshoa flake										2												3	0.04	2.0			
Hammerstone														1	1	1	1		2			14	0.18	9.3			
Mano							1							1								5	0.06	3.3			
Metate		1																				1	0.01	0.7			
Grinding/pounding tool						2													1			4	0.05	2.7			
Round/elongated stone																1	2					7	0.09	4.7			
Bone tool										1							1					9	0.11	6.0			
Total	187	275	126	41	41	31	40	33	103	48	28	1	4	1	15	13	0	0	4	1		7,882	100	100			

\* No provenience

Table 3.3. Artifacts by Level (in cm)

Artifact type	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	Trench	Total
Projectile point	1			1							2
Point/knife	1	1	1	3	1					1	8
Scraper	3	15	15	5	3	2				18	61
Crescentic	1	3	1							1	6
Utilized flake	4	2	2	2						1	11
Drill						1					1
Core	2		1	2						4	9
Flake/angular waste	944	1,794	2,086	1,574	848	337	89	58	2		7,732
Teshoa flake	1				1			1			3
Chopper	1	1								1	3
Cobble tool			2							4	6
Hammerstone		1	3	1						9	14
Mano		1	3	1							5
Metate					1						1
Grinding/pounding tool			2	1						1	4
Round/elongated stone			4							3	7
Bone awl		3	2	2			1			1	9
Total	958	1,821	2,122	1,592	854	340	90	59	2	44	7,882

two points. One of these (fig. 3.4a) is a Silver Lake point (M. J. Rogers 1966:169; Davis et al. 1969:34); made of basalt, it is similar to a point recovered by Davis (Davis et al. 1969:33, 34) at INY-20 in the Panamint Valley, dated to approximately 8,000 to 10,000 years ago. The level containing our Silver Lake point (unit 14, 30-40 cm) was radiocarbon dated to  $8060 \pm 90$  RYBP. The other biface point (fig. 3.4b) was recovered from unit 12 (0-10 cm) and is made of rhyolite material; it is similar to a point described by M. J. Rogers (1966:169).

#### Points/Knives

Eight broken artifacts are categorized as points/knives (fig. 3.4c-g; three not illus.). All are made of basalt and were recovered from the central and northern portions of the site. The Windsong Shores biface points/knives are small, thin, well-worked, and generally similar to those recovered from the Panamint Valley (Davis et al. 1969:26, 27, 34) and the Harris site (Warren 1966). One (fig. 3.4d) is similar to a Panamint stemmed point from INY-20 (Davis et al. 1969:34); it was recovered from unit 23 (20-30 cm) which was dated to  $8060 \pm 90$  (Beta-9128). The level for the point/knife in figure 3.4c (unit 18, 30-40 cm) was dated to  $8280 \pm 100$  RYBP (Beta-9129).

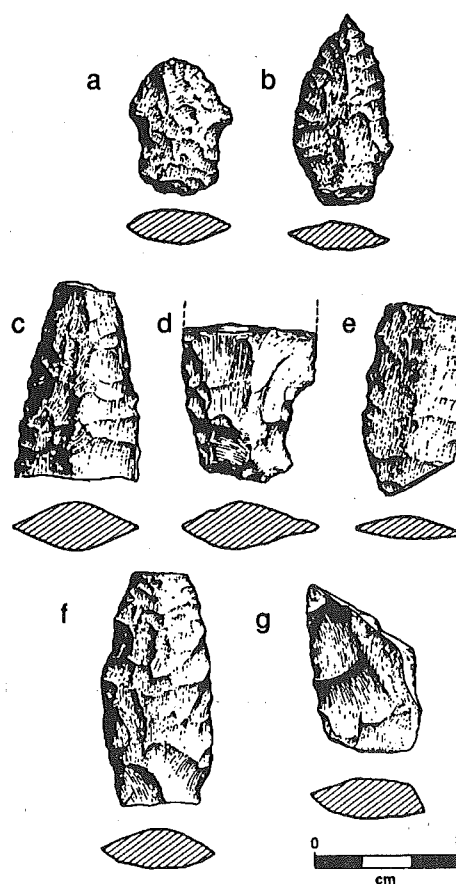


Figure 3.4. Points and point/knife fragments from SDI-10965 (W-131).

## Scrapers

The 61 scrapers are composed of basalt (25%), fine-grain metavolcanic (44%), chert (20%), chalcedony (5%), rhyolite (2%), and quartzite (5%). The wide variety of shapes include domed, ovoid, beaked and tabular (fig. 3.5). Scrapers were found throughout the site, and 88% were recovered above 40 cm.

## Crescentics

Five of the six crescentics are shown in figure 3.5. Three are composed of basalt, two of fine-grain metavolcanic, and one of chert. All six were located in the northern portion of the site. Crescentics are distributed widely across the western U.S. (Bowers and Savage 1962; Butler 1970; Cressman 1936; Daugherty 1956; Tadlock 1966; Warren 1968). In California, they are usually associated with dry lake or desert sites but have been found at a number of coastal sites within San Diego and Orange counties (Campbell et al. 1937; Davis et al. 1969; Drover et al. 1983; Fredrickson 1973; Harrington 1948; Jertberg 1978; Koerper 1983; M. J. Rogers 1939, 1966). It has been variously suggested that this artifact is a transverse point, a scarification tool, a scraping tool, a hunting amulet, or simply representational art (Davis and Panlaqui 1978; Jertberg 1978; Koerper 1986; M. J. Rogers 1929, 1966). Crescentics are generally dated to the Early Holocene, circa 9000 to 12,000 BP (Davis et al. 1969; Davis and Panlaqui 1978; Fredrickson 1973; Jertberg 1978; Warren 1966, 1968). A bear-shaped crescentic was recovered from the Allan O. Kelly site (SDI-9649) and dated 7260 RYBP (Koerper 1986). This more recent date agrees with the crescentics recovered from Windsong Shores.

## Drill

One chert artifact, recovered from unit 2 (50-60 cm) is typed as a drill fragment.

## Utilized Flakes

All 11 utilized flakes were from the central and northern portions of the site. Materials are fine-grain metavolcanic (45%), chalcedony (27%), basalt (18%), and chert (9%). Utilized flakes were identified on the basis of general edge damage. No use-wear analyses of flakes were conducted.

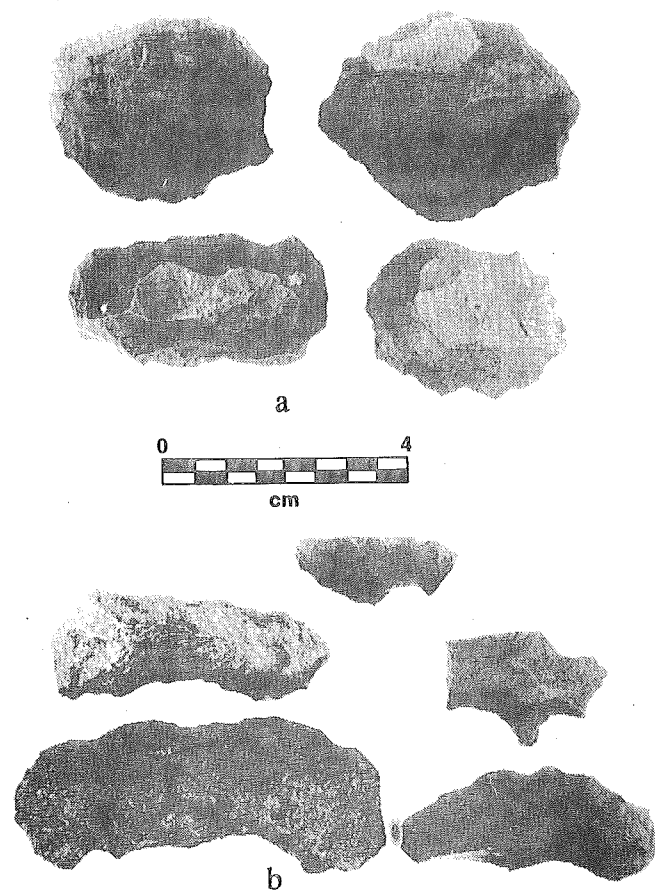


Figure 3.5. (a) Domed scrapers and (b) crescentics.

## Flakes/Angular Waste

Flakes and angular waste flakes were combined and totaled as shown in figure 3.6. A wide range of materials includes basalt, fine-grain metavolcanic, quartz, chalcedony, obsidian, and chert.

Some units show high percentages of flakes/angular waste weighing less than 0.1 g (fig. 3.6). A high proportion of flakes less than 0.1 g suggests pressure flaking for tool finishing or tool maintenance. The amount and percentage of flakes weighing less than 0.1 g decreases for units near the bluff (units 3, 30-37).

## Choppers

The three choppers were found above 20 cm from units 1, 3, and 10. Materials include basalt and fine-grain metavolcanic. Size range for these three choppers is from 8.1 to 12 cm (length), 6.2 to 9 cm (width), and 3.3 to 5.0 cm (thickness).

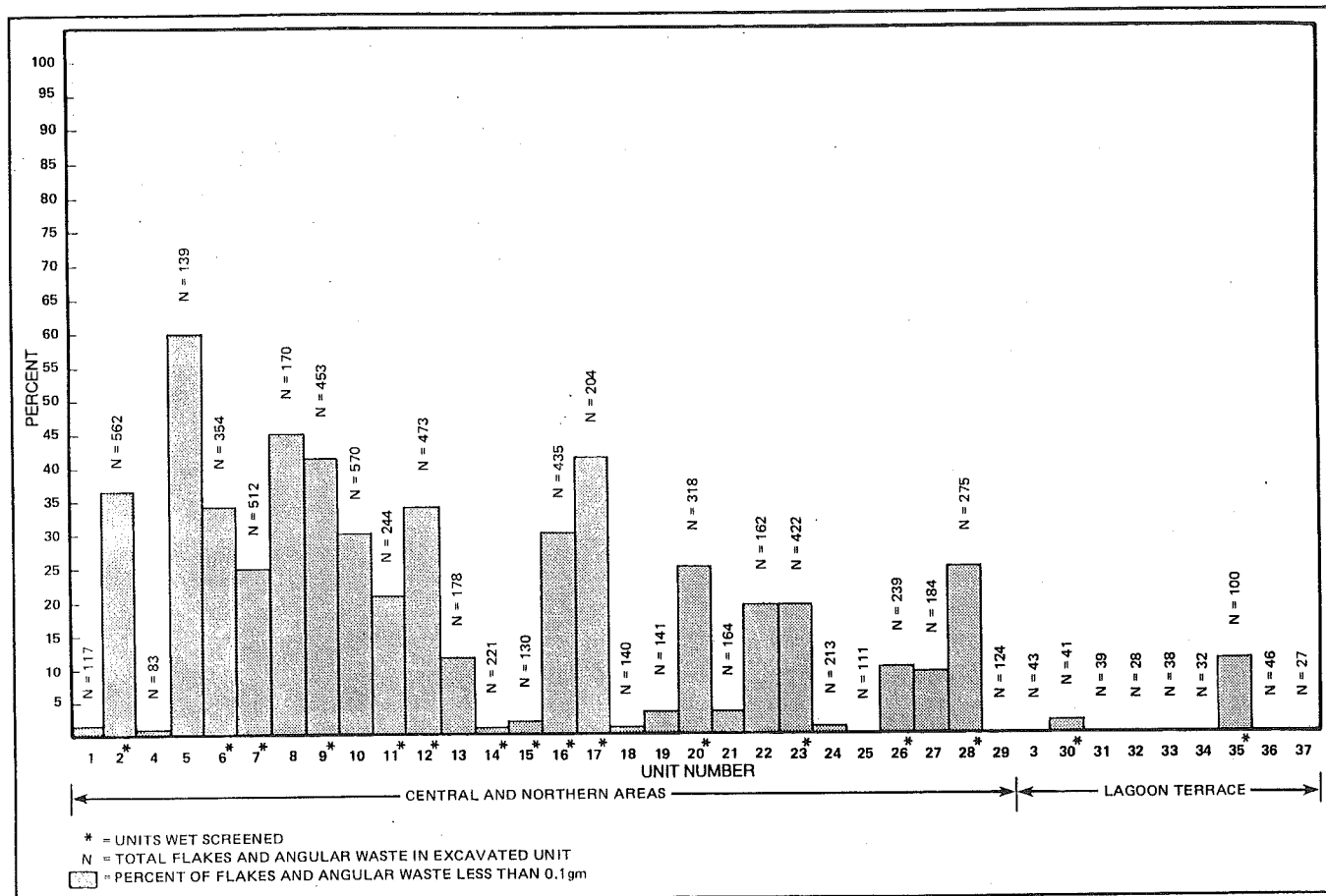


Figure 3.6. Count and percent of flakes/angular waste less than 0.1 g.

## Hammerstones

All 14 hammerstones exhibit end or edge battering. The material is primarily basalt (57%), followed by quartzite (7%), conglomerate (7%), fine-grain metavolcanic (7%), granitic (7%), and other undetermined materials (14%). Three of the hammerstones were completely removed of cortex on one side and showed both edge and end battering.

Five hammerstones are split cobbles with end battering. One fine-grain metavolcanic core was quite small, measuring 2.4 cm in length, 2.0 cm in width, and 1.4 cm in thickness, with battering on ends and edges. Hammerstones were found throughout the site from 0 to 40 cm. Three hammerstones were found in unit 3 with a cluster of fire-affected rock.

## Cobble Tools

Six artifacts are typed as split cobble tools. These may have been used for scraping or chopping. Manufacture entailed splitting the cobble to provide a working edge.

## Milling Tools

The ten milling tools are of granitic material and include manos (five), a metate fragment, and grinding/pounding tools (four). Milling tools were found above 50 cm, with six of ten in the 20-30 cm level. All manos were identified as unifacial or non-diagnostic. One mano appeared to be shaped. The metate fragment was an elongated midsection fragment used only on one side (fig. 3.7). Grinding/

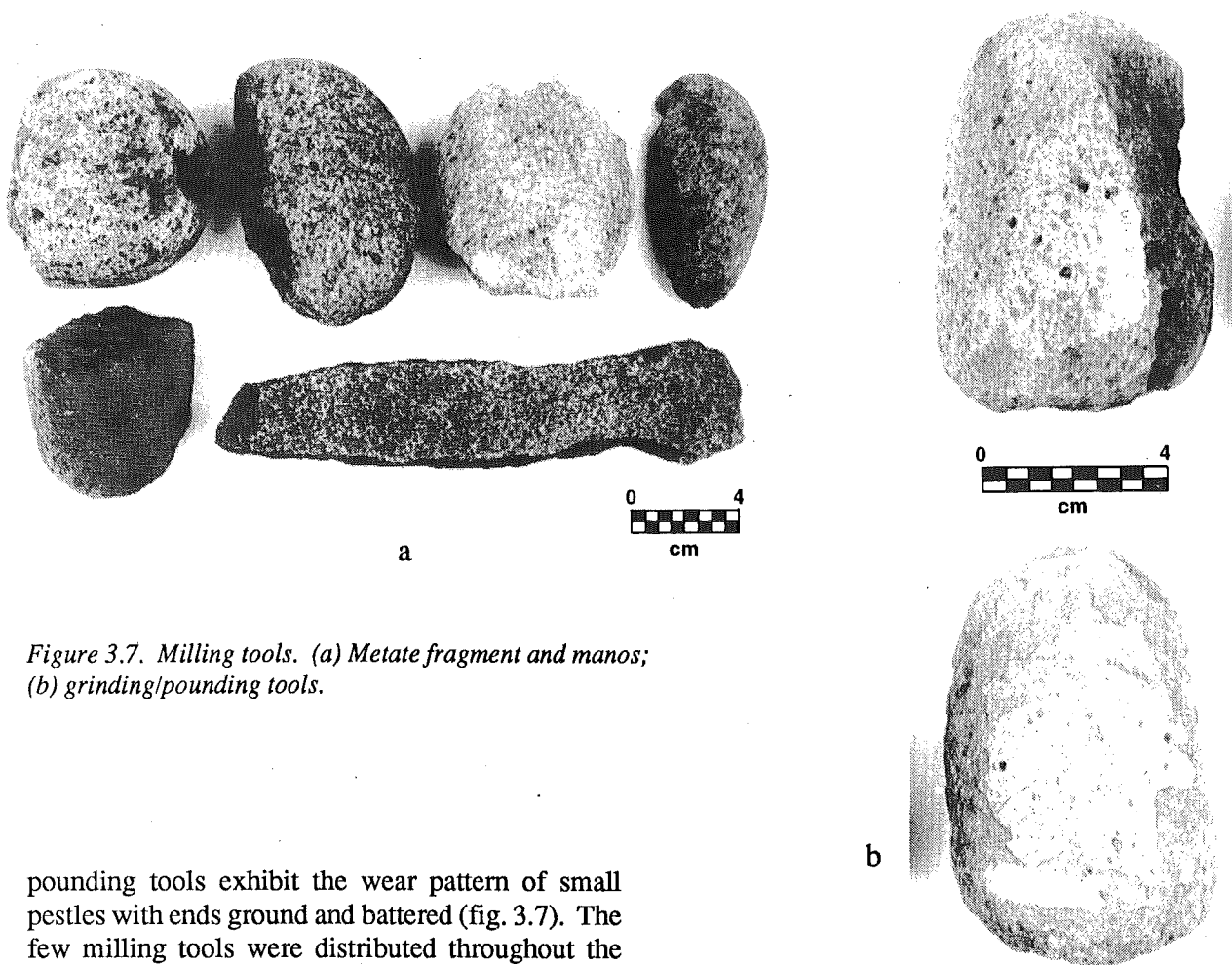


Figure 3.7. Milling tools. (a) Metate fragment and manos; (b) grinding/pounding tools.

pounding tools exhibit the wear pattern of small pestles with ends ground and battered (fig. 3.7). The few milling tools were distributed throughout the site.

#### Round/Elongated Stones

Round granitic stones were first reported for SDI-10965 by M. J. Rogers (n.d.). An additional seven artifacts of this type were recorded during this study. These stones may have been used as hammerstones or gaming stones or perhaps were heated and placed in a cooking container to shorten cooking time (fig. 3.8).

Round stones have been found at Topanga Canyon, Tank Site (Treganza and Malamud 1950:50); VEN-294, an inland Chumash village site (Rosen 1978); Batiquitos Lagoon (Crabtree et al. 1963); Scripps Estate site (Shumway et al. 1961); Zuma Creek (Peck 1955); and at the Browne site (Greenwood 1969).

#### Bone Tools

Bone tools, including rabbit tibia and deer antler, were found throughout the site from 0 to 70 cm (fig. 3.8). Only one of the nine worked bone fragments is burned. None of these were noted as painted or diagnostic.

#### Ocher

Ocher, a mineral used for paint, was found in lagoon bluff units 32 and 37 from 0 to 40 cm. The four small ocher nodules are bright yellow.

#### Obsidian

All obsidian was found in the northern portion of the site (units 7, 9, 10, and 14) from 20 to 60 cm. The

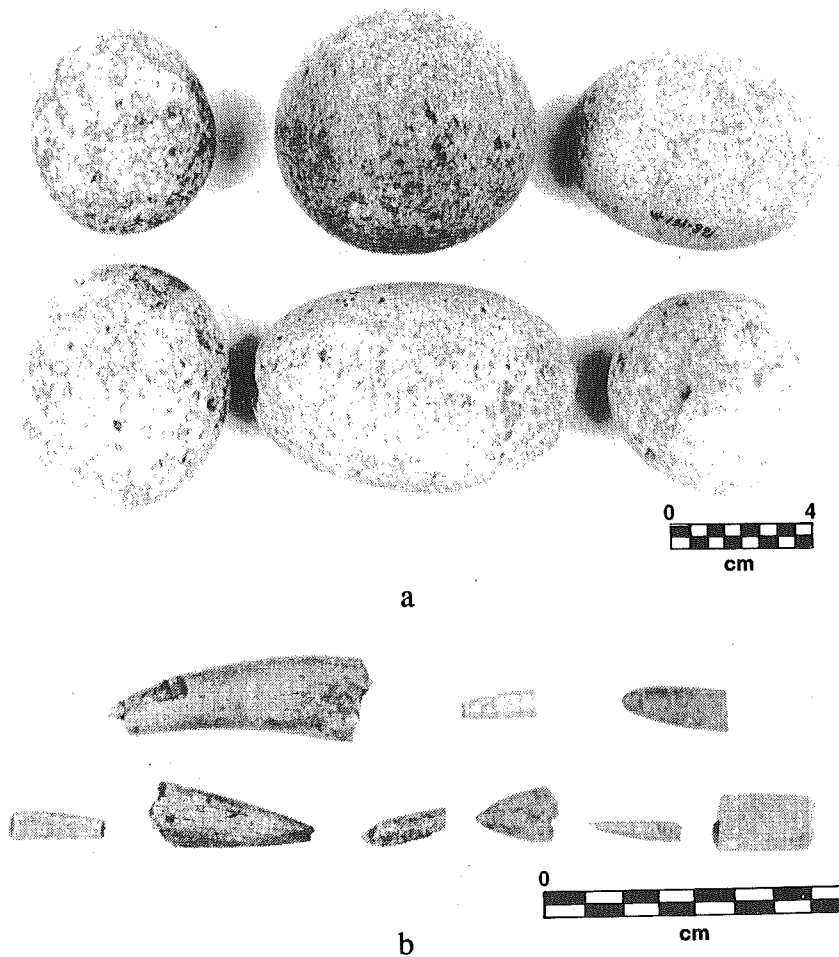


Figure 3.8. (a) Round/elongated stones; and (b) bone tools.

five small obsidian flakes were submitted for sourcing and hydration. Obsidian sourcing revealed that three of the five samples are from Coso; one sample is possibly from Casa Diablo Mountain; and one sample could not be sourced. Coso is 280 km north of Agua Hedionda Lagoon, and Casa Diablo Mountain is 480 km north. The presence of obsidian from these sources identifies trade to site SDI-10965 or travel to the obsidian source by the site occupants. Obsidian hydration analysis provided the following micron measurements: 4.8, 5.3, and 5.8 for Coso obsidian; 5.2 for Casa Diablo obsidian; and 3.4 for the fifth obsidian fragment with no known source. These hydration measurements are small, given the radiocarbon dates for site SDI-10965 and may be due to site location, temperature, or site disturbance.

#### ECOFACTUAL REMAINS

Ecofactual remains include shellfish, fish, land mammals, seeds, and pollen. These topics are individually discussed below.

#### Shellfish

Shellfish remains were found in every unit, increasing in quantity near the edge of the bluff. Shellfish were varied (26 taxa) and large in size (table 3.4). Whole *Chione* spp. were measured and analyzed, resulting in no apparent size variation either vertically or horizontally, thereby suggesting a rich period for quantity and variety of shellfish with no major environmental problem during site occupation. As



expected, the shellfish assemblage was dominated by estuarine taxa.

### Fish Remains

Numerous fish vertebrae were collected through wet-screening. The differences between wet-screened units and non-wet-screened units is apparent in totals ranging from 2 for a non-wet-screened unit (unit 24) to 176 vertebrae (unit 23) and 382 vertebrae (unit 7) for wet-screened units (table 3.5). Fish vertebrae, teeth, and bone samples include *Paralabrax* sp. (kelp or sand bass), barred surfperch, California halibut, a tuna-like fish (Scombridae), barracuda, shark, a salmonid, herring or sardine (Clupeidae), a sheephead or porgy, and ray. Fish remains were found as deep as 80 cm, primarily in the central to northern portion of the site. Given the numerous fish vertebrae (over 3,000) and their small size, it is suspected that fish were netted or trapped in some manner.

### Mammals

The mammal remains recovered from 37 1 x 1 m units at SDI-10965 are representative of a highly fragmented bone assemblage. Most of the identifiable elements were ascribed to the small mammal category. There was a preponderance of rabbit bone and to a lesser extent small rodent and deer bone (table 3.6). Faunal elements identified as *Thomomys bottae* (southern pocket gopher) were relegated to an "intrusive category" because few of these bones show signs of butchering or burning and probably represent "burrow dead" individuals. Historic intrusives, such as cattle and swine, are indicative of historic disturbance.

Evidence of butchering at SDI-10965 was consistent with other San Diego County sites (Christenson 1981). Generally the skeletal material was lightly to heavily burned and reduced to an extremely fragmented condition, probably during food preparation. Most of the long bones in the sample were restricted to metapodials (traditionally associated with low meat mass, slaughtering waste) and distal epiphyses of the humerus, radius, ulna, femur, and tibia. The epiphyses of these long bones are more compact and might have differentially survived aboriginal butchering treatment as well as postdepositional destructive forces.

Most of the mammalian fauna as judged by

weight was concentrated in the northern portion of the site, with concentrations in the area west of the house (table 3.7). However, butchering treatment and representative taxa were homogeneous across the site.

### Bird

Bird bone, listed by catalog number and unit (tables 3.8, 3.9), was recovered primarily from the central and northern portions of the site. The presence of *Chendytes lawi* is interesting, but not unexpected. These flightless sea ducks are known as fossils throughout most of the Pleistocene, occurring in association with beach terraces from Santa Barbara to Newport Bay; one fossil was also reported in southern Oregon (Morejohn 1976). Specimens are also known from Santa Cruz County midden sites, but this is the first specimen from San Diego County.

Bones of this species exhibit a phenomenon known as pachyostosis, having bone of great density, making it difficult to distinguish fossil specimens from recent ones. Specimens from sites on San Nicholas Island and at Santa Monica had been discounted as not associated with artifactual remains until recently, when numbers of these bones were found in middens at Laguna Creek (SCR-7, radiocarbon dated between  $3780 \pm 95$  RYBP and  $5390 \pm 100$  RYBP), Año Nuevo Point (estimated ca. 2500 RYBP), and San Miguel Island (SMI-1, radiocarbon dated 4,750 to 1,450 years ago; SMI-261, dated 3,120 to 500 years ago) (Morejohn 1976).

### Seed Analysis

Twenty-two seeds including Pinaceae (pine), *Ceanothus*, and manzanita (*Arctostaphylos*) were identified. The results of this analysis are presented in table 3.10.

### Pollen

Pollen analysis was conducted to identify plant communities which may not be present today due to environmental or historic disturbance. Four soil samples were analyzed for palynomorphs. Pollen and spore abundance ranged from 2 to 238 grains per slide. Pollen preservation was fair; three samples contain moderate to heavily oxidized palynomorphs. Three intervals yielded sufficient pollen for climate

Table 3.4. Shellfish by Unit and Weight (g)

Species	1	2	3	4	5	6	7	8*	9*	10*	11	12	13	14	15*	16	17	18*	19	20*
<i>Chione</i>	4,852.5 (87.2)	547.2 (87.3)	2,617.3 (81.7)	142.5 (89.3)	102.1 (89.9)	555.2 (91.6)	327.4 (91.7)			3,432.9 (87.8)	127.6 (88.4)	303.1 (85.1)	1,695.7 (82.9)		245.8 (77.7)	1,065.7 (90.1)		2,258.7 (88.9)		
<i>Argopecten</i>	394.7 (7.1)	45.4 (7.2)	410.2 (2.2)	12.0 (7.5)	6.1 (5.4)	15.2 (2.5)	12.6 (3.5)			228.1 (5.8)	9.7 (6.7)	21.4 (6.0)	162.6 (7.9)		15.2 (4.8)	62.8 (5.3)		110.8 (4.4)		
<i>Ostrea</i>	7.9 (0.1)	1.0 (0.2)	10.7 (0.3)	0.1 (0.06)	0.3 (0.3)	6.0 (1.0)	4.9 (1.4)			77.4 (2.0)	3.4 (2.4)	8.4 (2.4)	64.3 (3.1)		1.4 (0.4)	10.4 (0.9)		55.5 (2.2)		
<i>Tagelus</i>	12.6 (0.2)	0.4 (0.06)	3.0 (0.1)	0.3 (0.2)	—	2.9 (.5)	—			0.7 (0.02)	0.7 (0.5)	6.8 (1.9)	22.2 (1.1)		2.0 (0.6)	5.6 (0.5)		5.6 (0.2)		
<i>Astraea</i>	38.4 (0.7)	12.1 (1.9)	44.9 (1.4)	1.3 (0.8)	—	—	0.9 (0.9)			—	—	—	—		—	0.9 (0.08)		1.1 (0.04)		
<i>Saxidomus nuttalli</i>	11.0 (0.2)	—	—	—	—	—	2.4 (0.7)			—	—	—	3.6 (0.2)		—	1.6 (0.1)		—		
<i>Sanguinolaria nuttalli</i>	29.2 (0.5)	5.1 (0.8)	21.3 (0.7)	—	—	—	0.4 (0.1)			23.8 (0.6)	—	6.3 (1.8)	13.0 (6.6)		1.5 (0.5)	5.2 (3.7)		10.3 (0.4)		
<i>Tresus nuttalli</i>	38.4 (0.7)	3.1 (0.5)	9.7 (0.3)	0.4 (0.3)	1.4 (1.2)	7.5 (1.2)	—			30.4 (0.8)	—	3.0 (0.8)	8.0 (4.4)		—	3.7 (0.3)		9.4 (0.4)		
<i>Protothaca staminea</i>	13.9 (0.2)	2.4 (0.4)	6.9 (0.2)	2.1 (1.3)	0.3 (0.3)	3.1 (0.5)	4.0 (1.1)			1.0 (0.03)	0.9 (0.6)	0.4 (0.8)	8.8 (4.4)		1.0 (0.3)	1.6 (0.1)		11.6 (0.5)		
<i>Mytilus</i>	50.6 (1.0)	0.5 (0.08)	35.5 (1.1)	0.6 (0.4)	3.3 (2.9)	2.5 (0.4)	0.6 (0.2)			50.9 (1.3)	0.3 (0.2)	2.7 (0.8)	24.3 (1.2)		1.2 (0.4)	5.2 (0.4)		10.3 (0.4)		
<i>Donax</i>	1.6 (0.03)	—	1.6 (0.05)	—	0.1 (0.09)	0.2 (0.03)	—			0.8 (0.02)	0.6 (0.4)	0.5 (0.1)	0.5 (0.02)		0.1 (0.03)	3.7 (0.3)		9.4 (0.4)		
<i>Polinices</i>	50.8 (1.0)	8.7 (1.4)	—	—	—	12.7 (2.1)	—			—	—	—	—		—	1.6 (0.1)		11.6 (0.5)		
<i>Anomia peruviana</i>	58.5 (1.1)	—	23.8 (0.7)	—	—	—	0.1 (0.03)			38.2 (1.0)	0.4 (0.3)	2.2 (0.6)	39.9 (2.0)		0.3 (0.1)	6.2 (0.5)		18.2 (0.7)		
<i>Chiton</i>	0.4 (0.01)	—	0.4 (0.01)	—	—	—	—			0.6 (0.02)	—	0.6 (0.2)	—		—	0.6 (0.05)		0.5 (0.02)		
<i>Conus californicus</i>	0.4 (0.03)	—	—	—	—	—	—			—	—	—	—		—	—		43.8 (1.7)		
<i>Iselica ovoidea</i>	1.1 (0.1)	—	—	—	—	—	—			—	—	—	—		—	9.9 (0.8)		9.3 (0.4)		
<i>Pseudochama exogyra</i>	—	0.7 (0.1)	12.9 (0.4)	0.3 (0.2)	—	0.3 (0.05)	—			—	—	—	—		—	—		0.5 (0.02)		
<i>Solen rosaceus</i>	—	0.1 (0.02)	0.3 (0.01)	—	—	0.3 (0.05)	—			0.1 (0.002)	—	—	—		—	—		4.0 (0.2)		
<i>Cardium</i>	—	—	2.0 (0.6)	—	—	—	—			—	—	—	1.5 (0.07)		—	—		—		
<i>Chama arcana</i>	—	—	2.0 (0.6)	—	—	—	—			3.9 (0.1)	—	—	—		—	—		—		
Cockle	—	—	—	—	—	0.4 (0.07)	—			—	—	—	—		—	—		—		
<i>Ocenebra</i>	—	—	—	—	—	—	3.6 (1.0)			0.3 (0.01)	0.7 (0.5)	0.7 (0.5)	—		—	—		—		
<i>Polinices reclusianus</i>	—	—	—	—	—	—	—			0.3 (0.1)	0.7 (0.5)	—	—		—	—		—		
<i>Cerithidea</i>	—	—	—	—	—	—	—			22.4 (0.6)	—	0.6 (0.2)	1.2 (0.06)		—	—		0.2 (0.01)		
<i>Bursa californica</i>	—	—	—	—	—	—	—			—	—	—	—		—	7.6 (0.6)		—		
Subtotal	5,562.0 (7.97)	626.7 (0.90)	3,202.5 (4.59)	159.6 (0.23)	113.6 (0.16)	606.3 (0.87)	356.9 (0.51)	133.2 (0.19)	364.1 (0.52)	279.5 (0.40)	145.0 (0.21)	356.7 (0.51)	2,045.6 (2.93)		2,798.3 (4.01)	316.2 (0.46)		3,458.7 (4.95)	2,570.8 (3.64)	3,615.1 (5.18)
Percent Unidentifiable	734.3	150.4	344.1	11.4	3.2	23.9	31.3			161.5	28.3	70.6	88.9			26.7		53.4		
Total	6,296.3	777.1	3,546.6	171.0	116.8	630.2	388.2	133.2	364.1	279.5	173.3	427.3	2,134.5	2,798.3	342.9	1,248.1		3,458.7	2,624.2	3,615.1

Note: Percentages shown in parentheses.

\* Shell not speciated

Species	21*	22*	23*	24*	25*	26*	27*	28	29*	Unit	30	31*	32*	33*	34*	35	36*	37*	Total	(%)
<i>Chione</i>								549.6 (96.8)		1,902.9 (89.5)						4,136.2 (86.9)			24,862.4	87.00
<i>Argopecten</i>								13.6 (2.4)		184.3 (8.8)						521.7 (11.0)			2,226.4	7.79
<i>Ostrea</i>								1.4 (0.2)		15.2 (0.7)						49.4 (1.0)			317.7	1.11
<i>Tagelus</i>								—		0.3 (0.01)						1.3 (0.03)			64.9	0.23
<i>Astraea</i>								0.1 (0.02)		4.0 (0.2)						16.1 (0.3)			119.8	0.42
<i>Saxidomus nuttalli</i>								—		—						—			18.6	0.07
<i>Sanguinolaria nuttalli</i>								—		1.3 (0.06)						1.8 (0.04)			119.2	0.42
<i>Tresus nuttalli</i>								0.7 (0.1)		—						—			115.7	0.40
<i>Prothaca staminea</i>								2.0 (0.4)		1.7 (0.08)						1.1 (0.02)			62.8	0.22
<i>Mytilus</i>								0.2 (0.04)		8.2 (0.4)						20.7 (0.04)			226.5	0.79
<i>Donax</i>								—		—						0.2 (0.04)			7.3	0.03
<i>Polinices</i>								—		—						—			116.0	0.41
<i>Anomia peruviana</i>								—		2.4 (0.1)						2.5 (0.05)			187.5	0.66
<i>Chiton</i>								—		—						1.2 (0.03)			3.1	0.01
<i>Conus californicus</i>								—		—						—			4.4	0.02
<i>Iselica ovoides</i>								—		—						—			1.1	0.01
<i>Pseudochama exogyra</i>								—		4.7 (0.2)						5.1 (0.1)			24.0	0.08
<i>Solen rosaceus</i>								—		—						—			2.4	0.01
<i>Cardium</i>								—		—						—			2.0	0.01
<i>Chama arcana</i>								—		—						—			7.8	0.03
<i>Cockle</i>								—		—						—			0.4	0.01
<i>Ocenebra</i>								—		—						—			5.7	0.02
<i>Polinices reclusianus</i>								—		—						—			70.1	0.25
<i>Cerithidea</i>								0.2 (0.01)		—						—			2.3	0.01
<i>Bursa californica</i>								—		—						—			7.6	0.03
<i>Homolopoma luridum</i>								—		—						1.2 (0.03)			1.3	0.01
Subtotal	3,757.0	797.3	211.9	229.0	212.1	261.9	539.1	567.8	512.7	2,125.0		4,833.6	3,542.2	4,086.1	5,132.2	4,758.5	3,103.0	3,382.0	—	100.00
Percent	5.38	1.14	0.30	0.33	0.30	0.38	0.77	0.81	0.73	3.04		6.92	5.07	5.85	7.35	6.81	4.44	4.84	—	
Unidentifiable								47.6	60.0							141.6			2,032.5	
Total	3,757.0	797.3	211.9	229.0	212.1	261.9	539.1	615.4	512.7	2,185.0		4,833.6	3,542.2	4,086.1	5,132.2	4,900.1	3,103.0	3,382.0	71,899.3	

Note: Percentage shown in parentheses

\* Shell not speciated

Table 3.5. Fish Vertebra by Unit and Level

Level (cm)	Unit																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
0-10	1	1					30		8			13							
10-20		2				38	59		22	7	2	36			2		18	2	
20-30						62	57	3	51	1		24	2	1	2	78	24		
30-40	1	61				24	241		109	1	11	38		1	1	255	50		
40-50		134			9	201				6	25	17		7		34			
50-60		150								3	70								
60-70		19									42								
70-80											50								
Total	2	367			9	325	387	3	190	18	200	128	2	9	5	367	92	2	

	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	Total
0-10	3			26			12		13		7				2	3			119
10-20	19			19			27	1	17		6					1			278
20-30	30		3	51	1		54		39	1	2					4			490
30-40	41	1	1	80	1				60	2						3			982
40-50	339	1						3	152				1			2			931
50-60		1						1								8			233
60-70																17	1		79
70-80																5			55
Total	432	3	4	176	2		93	5	281	3	15		1		2	43	1		3,167

Table 3.6. Identified Taxa by Number of Skeletal Elements

Element	Rabbit	Hare	Ground squirrel	Gopher	Rodent	Deer	Reptile	Total
Cranium	144	1	5	6	4	1	2	163
Humerus	83	9	3	7		1		103
Radius	25	2		1				28
Ulna	15	8		2				25
Pelvis	25	4		2	2	1		34
Vertebra	6	1	5	1		2	38	53
Femur	17	7	6	6	2			38
Tibia	26	3		3	1	2		35
Metapodial	466	18	11	4	4	14		517
Scapula	19	8	1	1				29
Total	826	61	31	33	13	21	40	1,025

Table 3.7. Mammal Remains by Unit and Weight (g)

Size	Unit											
	1	2	3	4	5	6	7	8	9	10	11	12
Small	4.8	102.0	1.1	0.2	19.8	47.8	54.2	17.1	48.8	69.0	37.8	86.4
Medium	0.8	12.6	1.4	4.4	4.1	7.3	12.9	3.1	8.5	17.6	20.8	16.5
Large	4.9	3.0	0	0	0	3.3	10.1	0	9.2	2.5	13.8	7.5
Total	10.5	117.6	2.5	4.6	23.9	58.4	77.2	20.2	66.5	89.1	72.4	110.4
	13	14	15	16	17	18	19	20	21	22	23	24
Small	9.0	12.8	4.6	66.5	31.2	3.8	0.3	62.0	10.9	9.1	55.5	16.9
Medium	2.0	1.6	1.9	9.5	1.3	0.9	2.3	0.6	0	0	0.9	0
Large	1.7	9.0	4.6	0	8.8	2.6	0.9	11.1	29.2	10.3	7.8	8.0
Total	12.7	23.4	11.1	76.0	41.3	7.3	3.5	73.7	40.1	19.4	64.2	24.9
	25	26	27	28	29	30	31	32	33	34	35	36
Small	6.4	16.7	11.2	46.6	4.6	4.7	0.2	0.3	0	0.3	17.3	0.3
Medium	0	3.5	0.5	1.8	3.6	0	1.7	0.7	1.5	0.5	1.4	2.6
Large	1.2	4.6	2.8	0.7	0	6.0	0	0	0	2.6	10.0	0.8
Total	7.6	24.8	14.5	49.1	8.2	10.7	1.9	1.0	1.5	3.4	28.7	3.7
	37	Total	Percent									
Small	0	880.2	72.8									
Medium	0	148.8	12.3									
Total	3.5	180.5	14.9									
Total	3.5	1,209.5	100.0									

Table 3.8. Bird Bone by Unit and Weight (g)

Level (cm)	Unit																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
0-10							0.3					0.1							
10-20										1.2						0.5			
20-30										0.7		0.1			0.3	0.2	0.1	0.9	
30-40	1.5				0.1	0.1				8.4*			0.1	0.1				0.3	
40-50		0.7				0.1										0.1			
50-60											3.7								
60-70																			
Total	1.5	0.7	—	—	0.1	0.2	0.3	—	—	10.3	3.7	0.2	0.1	0.1	0.3	0.8	0.4	0.9	—
	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	Total
0-10											0.6								1.0
10-20	1.6			0.2			0.2				0.4								4.1
20-30			0.1		0.5			0.4	0.3	0.5				1.2					5.3
30-40	0.4									0.2									11.2
40-50						2.5		0.3											3.7
50-60																			3.7
Total	2.0	—	0.1	0.2	0.5	2.5	0.2	0.7	0.3	0.7	1.0	—	—	1.2	—	—	—	—	29.0

\*Historic bird bone

Table 3.9. Bird Remains from SDI-10965

Catalog no.	Unit	Level (cm)	Description
302	11	50-60	<i>Chendytes lawi</i> , an extinct flightless sea duck. Proximal femur.
554	23	10-20	Possibly <i>Chendytes</i> . Proximal scapula.
602	25	40-50	A loon, probably <i>Gavia immer</i> , the common loon. Distal humerus, mineralized.
—	7	0-10	Large fragment, no identification. If avian, from a very large bird, possibly an extinct taxon. Not mineralized.
475	20	10-20	Very large rib, possibly from an extinct taxon. Not mineralized.
262	10	10-20	<i>Anas platyrhynchos</i> , mallard. Carpo-metacarpus, entire. Not mineralized. Could be wild or domestic.
—	10	40-50	Probably domestic fowl. Almost complete skeleton. Not mineralized.
275	10	20-40	As above. Proximal tarsus from above individual; ulna from smaller individual.
458	18	20-30	As above. Distal coracoid.
676	30	0-10	Probably same. Proximal scapula. Looks fresher than other bones.
738	33	20-30	Probably same. Distal coracoid.

Table 3.10. Seed Identification by Unit and Level

Unit	Level (cm)	Description
2	50-60	1 fresh-looking seed, possibly <i>Ceanothus</i> (contaminant?)
7	30-40	2 nearly whole seeds, 7 fragments of possible piñon pine "nuts" <sup>1</sup>
9	0-10	1 fragment of possible pine nut; 2 yellow wrinkled fruits (probably modern contaminants), not identified
12	0-10	1 whole pine nut (?); 1 fresh contaminant, not identified; 1 burned fragment, not identified
17	10-20	1 grape seed, possibly <i>Vitis girdiana</i> , a native of the Coastal Sage Scrub. (Might also be a weathered specimen of cultivated grape.) <sup>2</sup> Also, 1 fresh contaminant seed, unidentified.
26	20-30	1 fragment of possible pine nut; one-half seed of lupine, <i>Lupinus</i> sp. (fresh contaminant)
26	20-30	1 fragment of possible pine nut
35	20-30	1 small immature fruit of manzanita ( <i>Arctostaphylos</i> ) <sup>3</sup>

<sup>1</sup> Since "pine nuts" are 5-6 mm smaller than the size given for modern species of piñon pine seeds and adequate modern comparative material is not available, this identification should be considered tentative.

<sup>2</sup> The grape seed appears weathered and is the right size for the native grape, *V. girdiana*, but since this is a disturbed site, the possibility of cultivated grape must be mentioned.

<sup>3</sup> The manzanita fruit might be a fossil. The other seeds are probably modern contaminants.

Table 3.11. Taxa and Climate by Unit and Level

Taxa	Unit 35						Unit 31	
	50-60 cm		60-70 cm		70-80 cm		40-50 cm	
	No.	%	No.	%	No.	%	No.	%
Asteraceae	13	38.2	19	25.7	16	6.7	1	50
Pinaceae	13	38.2	10	13.5	20	8.4	1	50
<i>Quercus</i> sp.	4	11.8	15	20.3	33	13.9		
<i>Artemisia</i> sp.	1	3.1	1	1.3	129	54.2		
<i>Eriogonum</i> sp.	1	3.1	20	27.0	36	15.1		
<i>Lycopodium</i> sp.	1	3.1	1	1.3	3	1.3		
Poaceae	1	3.1						
<i>Salix</i> sp.			1	1.3				
Chenopodiaceae			2	2.7				
<i>Ilex</i> sp.			4	5.4				
<i>Salvia</i> sp.					1	0.4		
Total	34	100	73	100	238	100	2	100
Fungal Spores	Frequent		Frequent		Frequent		Rare	
Oxidation	Moderate		Moderate		Slight		Heavy	
Climate	Subtropical		Subtropical (Dry)		Subtropical (Dry)		Intermediate	

Note: The three intervals of unit 35 were assigned a subtropical relative climate. Due to relatively high percentages of *Eriogonum* sp. (wild buckwheat), two intervals were thought to represent generally dry conditions. These intervals of unit 35, 60-70 cm and 70-80 cm, contained 27.0% and 15.1% *Eriogonum* sp. pollen respectively. *Quercus* sp. (oak) appeared to have an unusually high percentage of over 10%. The deepest sample of unit 35 (70-80 cm) had an anomalously high relative percentage of *Artemisia* sp. pollen: 52.4% of 238 grains (129 specimens). Pollen and spore abundances were treated as in situ palynoflora, not deposited under abnormal conditions.

determinations. One sample contained only two pollen grains and was not assigned a relative climate determination. Eleven taxa representing ten botanical families were noted and include *Ilex* sp. (holly), *Artemisia* sp. (sagebrush), Chenopodiaceae (goosefoot), *Quercus* (oak), *Salvia* sp. (mint sage), *Lycopodium* sp. (clubmoss), Pinaceae (pine), Poaceae (grass), *Eriogonum* sp. (buckwheat), and *Salix* sp. (willow) (table 3.11).

#### Disturbance

SDI-10965 has been disturbed by historic intrusions of farming/ranching and is presently overlain by a house, garage, cesspool, and various pipes for water and gas. Site disturbance affected the analysis and research orientation, as the potential to identify two separate cultures or cultural continuity may be mixed through bioturbation and historic disturbance.

The radiocarbon dates ( $7040 \pm 80$ ,  $8060 \pm 90$ ,  $8280 \pm 100$ ,  $8390 \pm 110$  RYBP) for SDI-10965 are fairly consistent, suggesting a continuous occupation within the 7000 to 8500 BP temporal range. No evidence of late period occupation such as pottery, small projectile points, or cremations was recovered.

#### CULTURAL CONTINUITY

Cultural material from SDI-10965 is similar to assemblages of the San Dieguito tradition, Western Pluvial Lakes tradition, Paleo-Coastal tradition, and Encinitas tradition, based on the radiocarbon dates, the Silver Lake point (fig. 3.4a), tools, and general comparison to other work (Davis et al. 1969; Moratto 1984; Kaldenberg 1982; Warren 1966).

Assuming cultural continuity from San Dieguito to Encinitas tradition, artifact and ecofact distribution as discussed below provides an interesting view of intrasite patterning by one people over the period of

occupation. Patterning of cultural material within the site is reflected by grinding/pounding tools and shellfish remains found along the southern edge of the site on the lagoon terrace edge, though shell continued to the central portion of the site. Milling tools, including one metate fragment and five manos, were located along the eastern portion of SDI-10965 overlooking a relic creek terrace. Cores, hammerstones, and flakes/angular waste were recovered primarily from the central site area, while scraping tools and chopping tools were found throughout the site. The central to northern site area produced bifacial points, points/knives, crescentics, round/elongated stones, utilized flakes, and a drill tip. Both fish and mammal remains were more common in the central and northern portions of SDI-10965.

The main activity area was the central to northern site area which includes units 2, 6, 7, 9-16, 18-20, and 23-29. Processing of fish and mammals was performed in this area. The majority of stone tool making and tool maintenance is also apparent in the central to northern site area, given the high number of flakes/angular waste and small flakes (less than 0.1 g). The lagoon terrace above Agua Hedionda to the central site area of SDI-10965 was a refuse area for shell. Food preparation (i.e., milling, grinding, and pounding) took place along the lagoon terrace and creek terrace.

Additional evidence for cultural continuity between San Dieguito and the Millingstone horizon is found at San Dieguito Estates. Norwood and Walker state:

In considering the content of the sites, there is no criteria for suggesting occupations representing culture patterns other than La Jolla. No artifacts were recovered which are exclusively diagnostic of the San Dieguito culture pattern. At the other end of the spectrum, no evidence of an occupation representative of a Late Prehistoric culture pattern was recovered at San Dieguito Estates. . . . The substantial antiquity of six of the eight sites is especially interesting. The advent of milling technology is documented as occurring prior to 8000 B.P. and perhaps as early as 8650 B.P. Moreover, a tool assemblage typically characterized as representing the La Jolla culture pattern, rather than the San Dieguito culture pattern, is asso-

ciated with these early dates. Thus, sites of contemporary or later dates which lack milling and have elements characteristic of the San Dieguito culture pattern may simply represent different adaptive modes of an Early Milling culture pattern. In essence, the San Dieguito culture pattern may not be either temporally or culturally distinct as it is often considered to be. [Norwood and Walker 1980: 260]

#### AGUA HEDIONDA SITE COMPARISON

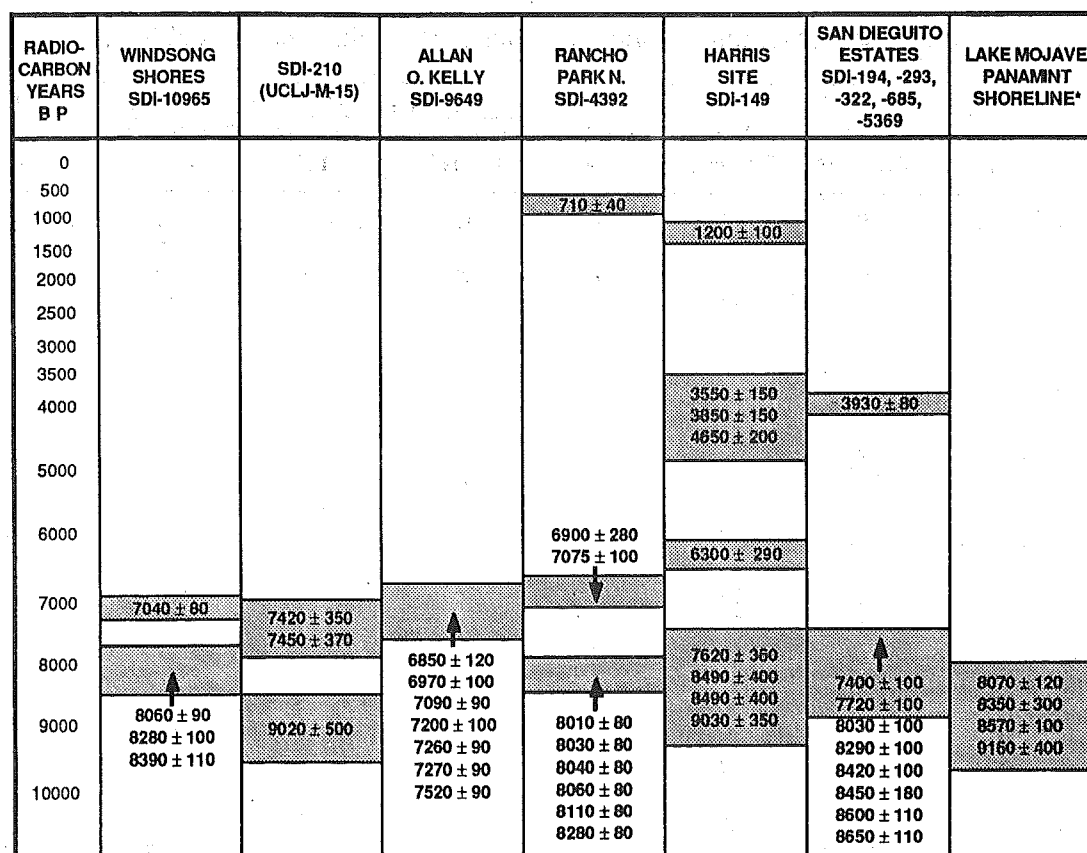
In comparing Windsong Shores (SDI-10965) to SDI-210 and SDI-9649, one finds that all of these sites are dated 7000 to 9000 RYBP (fig. 3.9) and contain finely made biface tools and scrapers, cobble tools, and a wide range of faunal materials (table 3.12). The Windsong Shores and Allan O. Kelly sites both contain crescentics, milling tools with evidence of grinding and battering, hammerstones, split cobble tools, bone tools, and Coso and Casa Diablo obsidian.

The ecofactual remains are also similar, with large quantities of shellfish (over 4 kg per m<sup>3</sup>), numerous fish bones, and the remains of small, medium, and large mammals. Shellfish remains at SDI-10965 are dominated by *Chione* spp. (87%) and *Argopecten* sp. (8%), with 24 additional taxa constituting the remaining 5%. Fish from both the Windsong Shores site and Allan O. Kelly site are primarily (over 60%) sardines. Other fish species include croaker, surfperch, mackerel, sheepshead, and halibut. Over 90% of land vertebrate remains come from small mammals (i.e., rabbits and rodents), with black-tailed deer being the only identifiable large mammal. Unique to Windsong Shores is the recovery of a flightless sea duck, *Chendytes lawi*, presently extinct.

Given the data from the Windsong Shores and Allan O. Kelly sites, Early Holocene campsites at Agua Hedionda primarily represent coastal exploitation of shellfish, small fish (sardines), small to large mammals, and the milling of plant seeds.

How well do the Windsong Shores and Allan O. Kelly sites compare with other Early Holocene sites in San Diego County? Very well, except for the Harris site (SDI-149) dated from 8490 to 9030 years BP (Haynes et al. 1967). No faunal remains are reported for the Harris site (SDI-149), although it is identified as a habitation site on the basis of second-





\*Lake Mojave dates from Ore and Warren (1971); Panamint Valley dates from Davis et al. (1969). Shading shows the range of time for radiocarbon dates. Radiocarbon dates have not been corrected.

Figure 3.9. Chart showing similar radiocarbon dated site studies.

ary stages of tool production, maintenance, and discard (Vaughn 1982). Warren (1987) believes it may be a special-purpose site such as a hunting camp. Ezell (1987) interprets the Harris site as atypical of the San Dieguito horizon, a factory or tool production site primarily devoted to the exploitation of a localized lithic resource, and finds it counterproductive to compare this assemblage as the "type site" with other sites of San Dieguito antiquity. In either case, SDI-149 may simply reflect a special-use inland campsite activity by the same people who occupied the Agua Hedionda region, circa 7,000 to 9,000 years ago, given that sites at Agua Hedionda also contain San Dieguito-like tools as well as evidence of coastal resource exploitation.

Two additional studies of sites dated over 8000 RYBP were conducted at Rancho Park North (Kaldenberg 1982) and San Dieguito Estates (Norwood and Walker 1980). These sites are situated within

five miles of a lagoon and contain shellfish, small mammal remains, milling tools, and finely made biface tools and cobble tools.

Rancho Park North (SDI-4392), a multicomponent site situated in a coastal valley near Batiquitos Lagoon, has been dated to 8280 RYBP (Kaldenberg 1982). It is best known as the first major site where San Dieguito tools were found in association with shellfish, fish, and aquatic bird remains, the production of lithic implements (both primary and secondary), the processing of animal and plant foods, and the use of *Olivella* spire-lopped beads for decoration (Kaldenberg 1982).

The San Dieguito Estates project, located west of the Harris site in the San Dieguito River Valley, produced five sites dated from 3930 to 8600 RYBP (Norwood and Walker 1980). These sites contained points/knives, cores, hammerstones, scraping tools, bone tools, milling tools, small mammal bone, shell-

Table 3.12. Comparison of Cultural Materials among Early Holocene Localities

Cultural material	WS SDI-10965	AOK SDI-9649	SDI-210 UCLJ-M-15	CWH SDI-149		RPN SDI-4392 Levels 3 to 12	SDE SDI-194, -293, -322, -685, -5369
				E-Stratum Locus I	Strata IIIA to IIIC		
Biface point/knife	9	11	X	36	61	15	3
Crescentic	4	2		1	1	1	
Scraper/scraper plane	43	57	X	49	102	132	249
Chopper	2	18	X	1	2	21	
Cleaver				1			
Drill	1						
Flake tool	10	643				224	35
Combination tool		56					
Core/cobble tool	2						
Core	3	24		1	2	123	291
Hammerstone	5	95	X		6		259
Flakes/angular waste	7732	NA	X			4339	13650
Stone ball	4						
Metate	1	22				3	10
Mano	5	74				10	201
Pestle		15					
Grinder/pounder	3	35					
Stone bead		1					
Quartz crystal		6					
Shell bead		32				5	
Bone bead		1					
Bone tool	9	8				2	5
Shell (weight: gram)	71899.3		X			48172	17508
Shell (number)		22590					
Bone (number)	1025	6377					
Bone (weight: gram)						X	363
Fish bone (number)	3167	888					X
Total artifacts	7833	1100	NA	89	174	4875	14703
Number of 1 by 1 m units excavated	37	68	4?	Trench data	NA	59	227.5
Source:	This report	Koerper 1986	Moriarty 1967	Warren 1966	Warren & True 1961	Kaldenberg 1982	Norwood & Walker 1980

Site abbreviations: WS = Windsong Shores; AOK = Allan O. Kelly; CWH = C. W. Harris site; RPN = Rancho Park North; SDE = San Dieguito Estates

X = Present

NA = Not available

Information taken from unit data only except for SDI-149 and SDI-210

fish, and the earliest dated use of milling tools in San Diego County (Norwood and Walker 1980).

### SUMMARY

The Early Holocene occupants of San Diego County exploited a wide range of resources, including shellfish, fish, birds, small to large mammals, and milled plant seeds. The earliest date for this occupation is circa 9,000 years ago, and occupation by one people throughout the Early Holocene is supported by the continuous record of radiocarbon dated sites (Breschini et al. 1990; Gallegos 1985); the presence of environmental data identifying San Diego County lagoons rich in shellfish (Hubbs et al. 1962:928; Warren and Pavesic 1963; Miller 1966; Kaldenberg 1982; Gallegos 1987); and the presence of a diverse tool kit with both quarry- and cobble-base tools to exploit coastal and inland habitats over a long period of time (ca. 9000 to 1300 BP).

The Windsong Shores site SDI-10965 provides evidence of a people who abandoned the drying Great Basin lacustrine habitat in favor of estuarine habitats created by the rise in sea level circa 9,000 years ago. Windsong Shores contains a wide variety of tools including biface points/knives, a Silver Lake point, cores, scrapers, crescentics, a drill, choppers, hammerstones, cobble tools, milling tools, round elongated stones, utilized flakes, Coso and Casa Diablo obsidian, worked bone, and a large quantity of small flakes suggesting pressure flaking for tool finishing and/or maintenance. These tools and the remains of shellfish, fish, birds, and mammals reflect a habitation site occupied circa 7,000 to 8,400 years

ago, wherein a wide range of activities were conducted and resources exploited. The Windsong Shores site provides us with evidence to support a continuation of the Western Pluvial Lakes tradition and a better understanding of the tool kit, diet, trade pattern, and resources exploited for Early Holocene occupation at a southern California coastal lagoon.

### ACKNOWLEDGMENTS

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Faunal analysis was conducted by Dayle Cheever (land mammals), Camm Swift, Ph.D., and Mark Roeder (fish bone specialists), and Stuart Warter, Ph.D. (bird bone specialist); seed analysis by Janet Warter, Ph.D.; pollen analysis by David Vork, Ph.D.; obsidian hydration by Rob Jackson, Ph.D., and sourcing by Richard Hughes, Ph.D.; artifact photography by Ken Jacques; radiocarbon dating by Beta Analytic; graphics by Doug Shields and Vicki Cypher; and word processing by Suzette Rojas and staff. Also acknowledged are Jon Erlandson, Roger Colten, and Pattie Rechman for their editorial comments.

Cultural material, except for fish and bird bone, are curated at ERCE, 5510 Morehouse Drive, San Diego, California. The fish bone is on loan to Mark Roeder and the bird bone to Stuart Warter.



## Chapter 4

### Early Holocene Adaptations and the Transition Phase Problem:

Evidence from the Allan O. Kelly Site, Agua Hedionda Lagoon

Henry C. Koerper, Paul E. Langenwalter II, and Adella Schroth

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**I**n 1985, excavation of a San Dieguito-La Jolla "Transition Phase" midden, the Allan O. Kelly site (SDI-9649) (figs. 4.1, 4.2), recovered data bearing on the material conditions of existence over seven millennia ago. After first placing SDI-9649 into a chronological/cultural setting, we will describe the recovered materials in a cultural ecological approach, focusing on subsistence and settlement at the site. Our conclusions are considered in the context of a controversial topic of San Diego prehistory, that is, the relationships between San Dieguito and La Jolla complexes. This problem is relevant to Early Holocene transitions throughout the southern coast of California and is of importance in determining the relationship between the Paleo-Coastal tradition and the Western Pluvial Lakes tradition, found in the deserts of inland California and the Great Basin.

In western San Diego County, the earliest complex with recognizable artifacts, credible absolute dates, and clear stratigraphic context is the San Dieguito, a manifestation of the Paleo-Coastal tradition (see Moratto 1984:90-92, 104). An artifact assemblage possibly ancestral to La Jolla ("Pre-La Jolla") reportedly predates the San Dieguito on the coast (Moriarty 1987) but lacks firm data. The San

Dieguito complex may first appear near the Pleistocene-Holocene interface, circa 11,000 years ago (Warren and True 1961:261), although the earliest known coastal sites date to circa 9400 BP. Along the coast, the culture's florescence wanes during the mid seventh millennium BP (e.g., Haynes et al. 1967; Warren 1968), although San Dieguito-like components may continue for a millennium or more (Gallegos 1987:23).

Since M. J. Rogers first described (1929), and later renamed (1939), the San Dieguito, the concept has undergone considerable refinement (e.g., Warren 1967a, 1968). Added to the artifact inventory are such things as manos and metates (True 1958:262; Ezell 1983), ornamentation (Kaldenberg 1982), and asphaltum-hafted tools (Ezell 1977). Chipped stone tools include large leaf-shaped points; a variety of leaf-shaped knives; large ovoid, domed and rectangular end or side scrapers; engraving tools; and crescentics (Warren 1967a:177). In eastern desert regions as well as certain coastal sites (chap. 3, this vol.), stemmed and shouldered points of Lake Mohave and Silver Lake types are found. Knapped tools were fashioned primarily from "felsites" and basalts (e.g., Warren 1987:75).

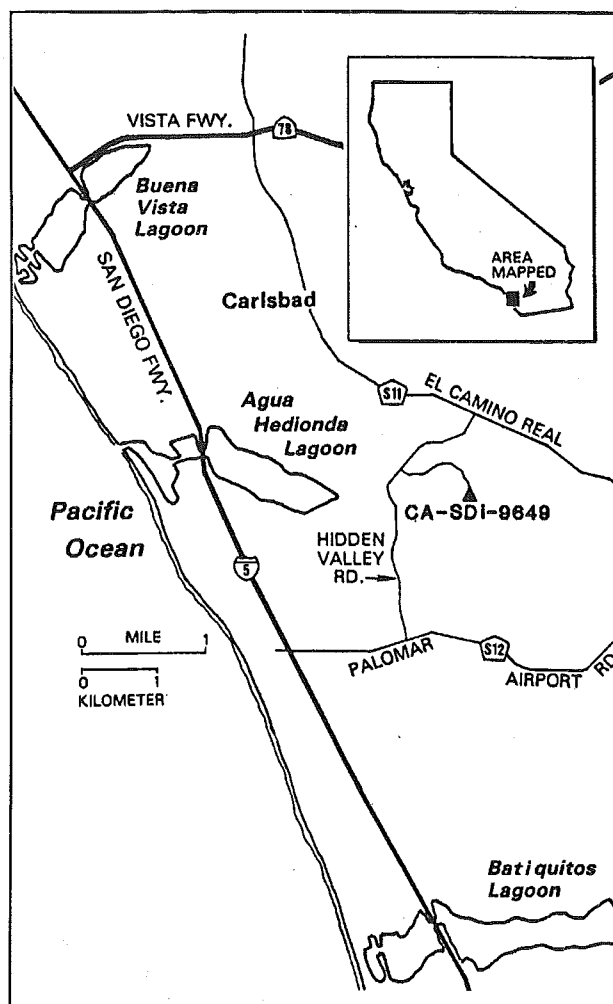


Figure 4.1. Map showing location of SDI-9649.

The La Jolla complex, a coastal San Diego manifestation of the Millingstone horizon (Wallace 1955), generally postdates the San Dieguito. At various sites—SDI-149, C. W. Harris (Warren 1967b); SDI-210 (UCLJ-M-15; Moriarty 1967); SDI-525, Scripps Estates (Shumway et al. 1961); and SDI-4392, Rancho Park North (Kaldenberg 1982)—La Jolla components are stratigraphically above the San Dieguito. The most often cited beginning for the La Jolla complex is 7500 RYBP (e.g., Warren and True 1961:261) but La Jolla shell middens have been dated to before 8000 RYBP (Norwood 1980, cited in Bull 1987:39). Basin metates, manos, crude choppers, scrapers, cutting tools, and hammerstones are salient features of the La Jolla complex. Unlike San Dieguito, La Jolla knapped tools tend to be manufactured from cortical flakes and split cobbles whose edges are modified by percussion. Also unlike the San Dieguito, raw material for La Jolla lithic technology in coastal San Diego County consists mostly of “well rounded, macrocrystalline cobbles derived from the Poway Conglomerate, the ancient marine terraces and presumably from the base of the sea cliffs” (Warren 1987:75). Pinto-like projectiles, “donut stones,” discoids, and cogstones often are present but bone and antler tools such as awls, flakers, and atlatl hooks are rare. Basketry is inferred by the presence of tarring pebbles and known from basketry impressions on asphalt fragments. Loosely flexed burials are more common than extended burials and reburials (Warren 1968:2).

Table 4.1. Radiocarbon Dates for SDI-9649

Lab.No. Beta-	Provenience Unit	Level (cm)	C <sup>14</sup> age years BP	C <sup>13</sup> /C <sup>12</sup> ‰ wrt PDB	Adjusted age BP
6954			7520 ± 90	+0.35	7940 ± 90
13437	N	0-10	6850 ± 120	+1.18	7280 ± 120
13438	Q	10-20	7200 ± 100	+1.89	7640 ± 100
13439	N	20-30	7270 ± 90	+1.64	7710 ± 90
13440	Q	30-40	7090 ± 90	+1.35	7520 ± 90
13441	N	40-50	6970 ± 100	+1.77	7410 ± 100
13442	Q	50-sterile	7260 ± 90	+2.11	7710 ± 90

Note: All are shell dates. The adjusted ages do not reflect correction for the reservoir effect; the suggested reservoir correction is -530 years. Beta-6954 was submitted by David Van Horn (Ultrasytems Inc. 1983).

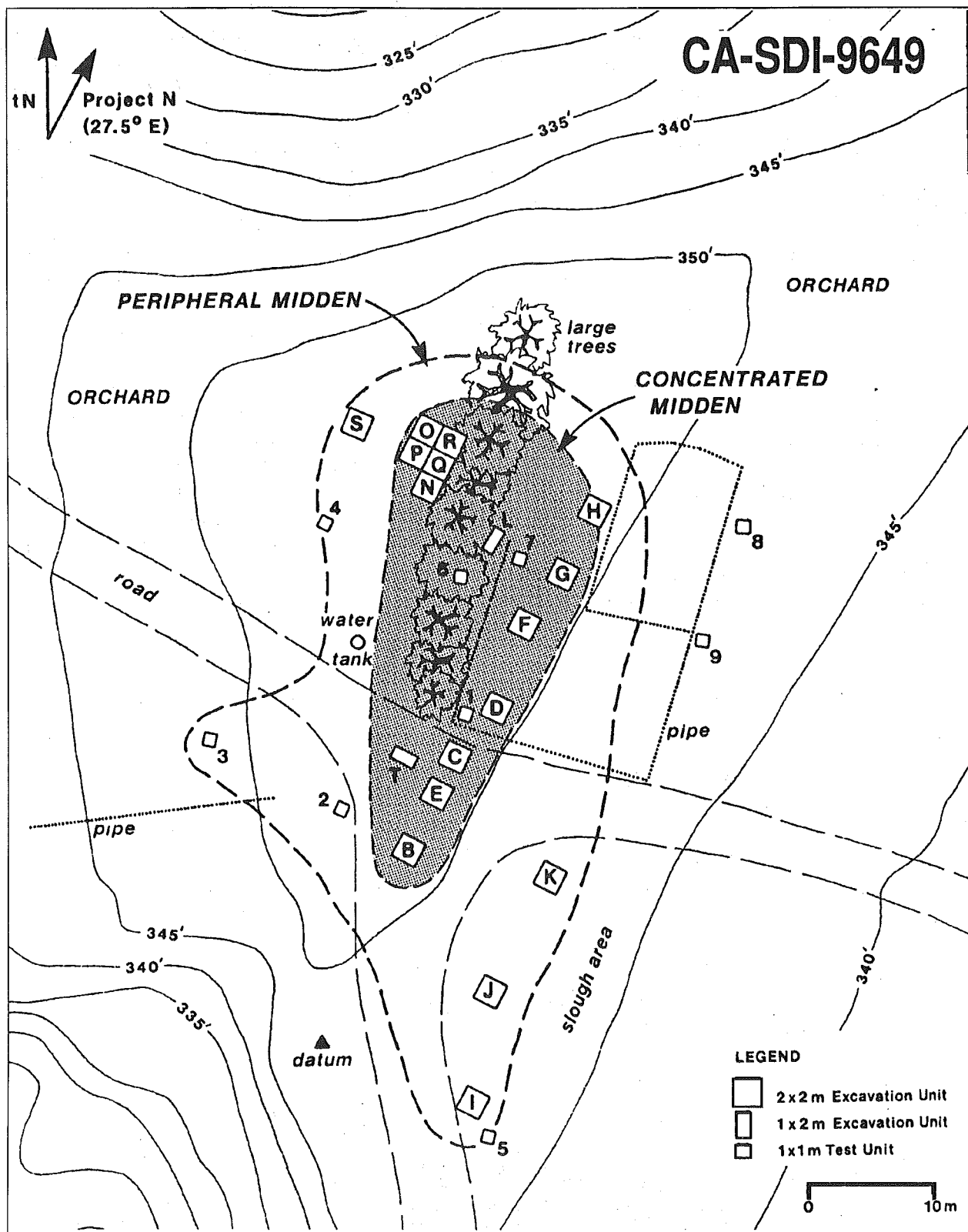


Figure 4.2. Map of SDI-9649. Numbered units are test units not included in this study. Maximum midden depth was about 100 cm. Average depth of excavated units was 57 cm.

A stratigraphic continuum from San Dieguito to La Jolla at Agua Hedionda Lagoon prompted Moriarty (1967:553-554) to propose a new chronological/cultural concept—the Transition Pre-Desert phase. Presently, the term “Transition phase” applies to a period circa 8000 RYBP, when both San Dieguito and La Jolla manifestations are evident in San Diego County (B.F. Smith 1987:61). With reference to the controversy regarding relationships between San Dieguito and La Jolla, interpretations of the Transition phase cover the range “from cultural evolution to amalgamation, and very often are based upon the data from a particular site” (Smith 1987:62). SDI-9649 dates to this period (table 4.1) and includes in all levels both San Dieguito-like tools of quarried “felsites” and basalts, and La Jolla-like tools percussion-flaked from rounded macrocrystalline cobbles.

### HABITAT AND BIOME

The land surrounding Agua Hedionda Lagoon, and on either side of Agua Hedionda Creek east to El Camino Real (fig. 4.1), was an area of comparatively intense

prehistoric settlement. At its maximum easterly extension, the lagoon presently adjoins mud and salt flats. The major freshwater source for the lagoon is Agua Hedionda Creek, although runoff from surrounding low hills spills into the lagoon flats and marshes in the rainy season. The highest elevation of these hills is the location of SDI-9649, which sits on an ancient marine terrace 110 m above sea level.

Prehistoric activities at SDI-9649 occurred during an Early Holocene general warming trend (Moratto et al. 1978) which increased semi-arid open environments (Heusser 1978). SDI-9649 was occupied at a time when the sea level in the area was rising slowly (Gallegos 1987:30). Shellfish recovered from SDI-9649 reflect this change. The remains of native oyster (*Ostrea lurida*) and mussel (*Mytilus californianus*) decrease in frequency through time at SDI-9649 (fig. 4.3). Oysters are affected adversely by lagoon silting (Greengo 1951:8), and California mussels may have been reduced as rising sea levels inundated previously exposed rocky habitats. Clams (*Chione* spp.) and scallops (*Argopecten circularis*), common in mud flat habitats, flourished with the changing conditions (fig. 4.4).

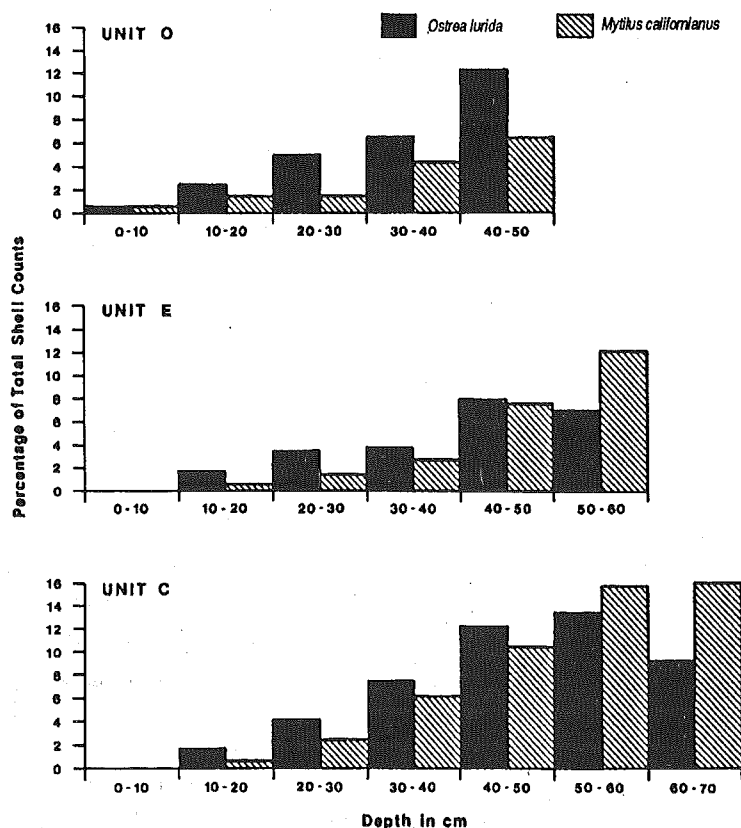


Figure 4.3. Oyster and mussel frequencies by 10 cm levels from three excavation units at SDI-9649.



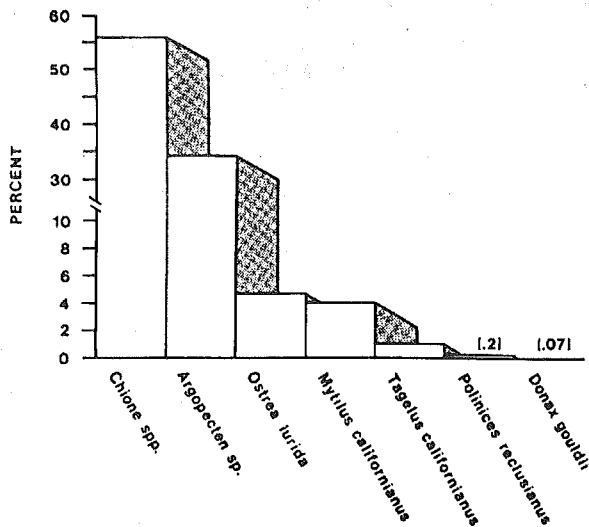


Figure 4.4. Most frequent shellfish species at SDI-9649, based on MNI.

Pollen was poorly preserved in the soils from SDI-9649, but several vegetation communities are near the site. Most of the procurement activity from SDI-9649 was probably focused within nearby Freshwater Marsh, Salt Marsh, Coastal Sage Scrub (with low elevation chaparral mix), Grassland-herbland, and Riparian Woodland communities. Perhaps only minimal use was made of nearby Oak Parkland associations and the Beach and Coastal Strand community.

Tall rushes characterize the lowland Freshwater Marsh, whose vegetation provides more food resources than Salt Marsh habitats. Freshwater marshes contain a tremendous variety of water birds (some seasonal), and some small and large mammals. Low herbs or shrubs and succulents are common in the Salt Marsh community. This tidal environment of mud and sand flats includes some of the richest sources of shellfish and fish. The ecotone between these two communities contains plants and animals characteristic of, and sometimes restricted to, the transition zone ("edge species"). Further, the number of species and the population density of some species can be greater in the ecotone ("edge effect") than in the adjoining biotic communities (see Odum 1959:207).

The richness of these marshlands is due to "pulse stability," a phenomenon which maintains ecosystems at an intermediary point between production simplicity (the production, growth, and quantity of a young successional stage) and production diversity (the protection, stability, and quality of a mature successional stage). "Pulse stability" results from fluctuating water levels caused by dry season drawdown and tidal action. Drawdown in freshwater marshes promotes aerobic decomposition of accumulated organic matter, thereby releasing nutrients. With rising water levels, these nutrients promote a productive wet-season bloom. Tidal action provides for rapid nutrient cycling, which increases productivity in estuarine habitats (see Odum 1969:262-267).

The Coastal Sage Scrub community contains 1- to 5-foot tall shrubs and somewhat larger, woodier plants. Animals frequently hunted here include quail, rodents, and rabbits. The composition of the rabbit and rodent remains attributable to human activity suggests that SDI-9649 was located in or adjacent to fairly heavy brush similar to the dense stands of Coastal Sage Scrub that cover slopes and unaltered flat areas in the region today. Brush rabbits and cottontails, both brush dwellers, comprise over 71% of the rabbit assemblage, although jackrabbits are present in sufficient numbers to imply use of a local open grassland with its many spring flowering annuals (tables 4.2, 4.3). The most important grassland-herbland crop was grass seeds.

Riparian Woodland communities, with their alders, willows, sycamores, and cottonwoods, may be located along streams (e.g., Agua Hedionda Creek), around permanent seeps and springs, or along marshy lands. Riparian Woodlands provided abundant material for tools but would not have provided as much plant food as the marshes.

Oak Parkland habitats contain dispersed trees 20 to 60 feet tall (e.g., live oaks and black walnut) with grasses and low shrubs between them. Seeds and nuts from trees would be found here, along with several animals that might be hunted or trapped.

A Beach and Coastal Strand community, containing low or prostrate plants, witnessed some mollusc collection, and sea mammal hunting was carried on here. Abundant pelagic fishes, sea mammals, and crustaceans are concentrated "renewable" food sources characteristic of the marine biotic zone.

Table 4.2. Vertebrate Taxa Recovered from Excavation Units, SDI-9649

Common Name	Scientific Name	1/4-inch	Mesh	1/8-inch	Mesh
		TS	MNI	TS	MNI
Fish					
Bat ray	<i>Myliobatis californica</i>	22	—	36	—
Shovel-nosed guitarfish	<i>Rhinobatos productus</i>	7	—	12	—
California halibut	<i>Paralichthys californicus</i>	3	—	1	—
Spotfin croaker	<i>Roncador stearnsii</i>	1	—	1	—
White seabass	<i>Atractoscion nobilis</i>	1	—	—	—
California corbina	<i>Menticirrhus undulatus</i>	—	—	1	—
Pile perch	<i>Rhacochilus vacca</i>	—	—	1	—
California sheephead	<i>Semicossyphus pulcher</i>	—	—	1	—
Smoothhound sharks	Triakidae	3	—	2	—
Herrings/sardines	Clupeidae	—	—	12	—
Mackerels and tunas	cf. Scombridae	5	—	3	—
Croakers	cf. Sciaenidae	4	—	3	—
Surfperches	cf. Embiotocidae	2	—	—	—
Unidentified bony fish	Teleostei	126	—	417	—
Unidentified fish	Pisces	—	—	1	—
Reptiles					
Western pond turtle	<i>Clemmys marmorata</i>	—	—	2	1
Rattle snake	<i>Crotalus</i> sp.	1	—	4	—
Constricting snakes	Columbridae	4	—	44	—
Unidentified lizard	Lassertilia	—	—	4	—
Unidentified snakes	Serpentes	—	—	9	—
Birds					
Arctic loon	<i>Gavia arctica</i>	2	1	2	1
Western gull	<i>Larus occidentalis</i>	1	1	—	—
California quail	<i>Lophortyx californicus</i>	—	—	5	1
Burrowing owl	<i>Athene cunicularia</i>	—	—	3	1
Green-winged teal	<i>Anas carolinensis</i>	—	—	2	1
Common gallinule	<i>Gallinula choropus</i>	—	—	1	1
Northwestern crow	<i>Corvus caurinus</i>	—	—	1	1
Chicken	<i>Gallus gallus</i>	—	—	/1	/1
Scaups and allies	<i>Aythya</i> sp.	1	1	1	1
Unidentifiable bird	Aves	3	—	8	1
Mammals					
Black-tailed jackrabbit	<i>Lepus californicus</i>	57	4	134	10
Mule deer	<i>Odocoileus hemionus</i>	19	1	21	1
Pocket gopher	<i>Thomomys bottae</i>	8/1	1/1	61/3	6/1
Brush rabbit	<i>Sylvilagus bachmani</i>	6	(4)	7	(2)
Desert cottontail	<i>Sylvilagus audubonii</i>	2	(2)	5	(2)
California ground squirrel	<i>Citellus beecheyi</i>	2/1	1/1	9	1
Badger	<i>Taxidea taxus</i>	2	1	—	—
California meadow mouse	<i>Microtus californicus</i>	—	—	3/13	1/1
Western harvest mouse	<i>Reithrodontomys megalotis</i>	—	—	/1	/1
Rabbit	<i>Sylvilagus</i> sp.	78	10	511/3	28
Dog or coyote	<i>Canis</i> sp.	11	1	21 2	—
Kangaroo rat	<i>Depodomys</i> sp.	2/1	1/1	1	1
Wood rat	<i>Neotoma</i> sp.	—	—	4	3
Deer mouse	<i>Peromyscus</i> sp.	—	—	1	1
Unidentifiable rabbit	Leporidae	21	—	225	—
Unidentifiable rodent	Rodentia	4	—	27	—
Unidentifiable carnivore	Carnivora	1	—	2	—
Unidentifiable artiodactyl	Artiodactyla	—	—	1	—
Unidentifiable mammals	Mammalia	219	—	331	—
Unidentifiable vertebrate	Vertebrata	66	—	4,445	—
Total		681/3		6,390/20	

TS = total specimens; MNI = minimum number of individuals. Numbers following "/" indicate non-prehistoric cultural bone. "( )" indicates that the MNI frequency previously given has already considered this count.

Table 4.3. Vertebrate Taxa from Column Sample of Unit E, SDI-9649

Common Name	Scientific Name	Mesh							
		1/2 inch		1/4 inch		1/8 inch		1/16 inch	
		TS	MNI	TS	MNI	TS	MNI	TS	MNI
Brush rabbit	<i>Sylvilagus bachmani</i>	-	-	-	-	-	-	1	(1)
California ground squirrel	<i>Citellus beecheyi</i>	-	-	-	-	1	1	-	-
Pocket gopher	<i>Thomomys bottae</i>	-	-	-	-	-	-	3	1
California meadow mouse	<i>Microtus californicus</i>	-	-	-	-	-	-	1	1
Rabbits	<i>Sylvilagus</i> sp.	1	1	-	-	5	1	-	-
Smoothhound sharks	<i>Triakis semifasciata</i>	-	-	-	-	-	-	2	-
Diamond stingray	<i>Dasyatis brevis</i>	-	-	-	-	-	-	1	-
Bat ray	<i>Myliobatis californica</i>	-	-	-	-	-	-	1	-
Pacific sardine	<i>Sardinops sagax</i>	-	-	-	-	-	-	2	-
California grunion	<i>Leuresthes tenuis</i>	-	-	-	-	-	-	1	-
Barred surfperch	<i>Amphistichus argenteus</i>	-	-	-	-	-	-	2	-
Rockfish	<i>Sebastes</i> sp.	-	-	-	-	1	-	-	-
Bass (unidentified)	<i>Paralabrax</i> sp.	-	-	-	-	2	-	-	-
Herrings/sardines	Clupeidae	-	-	-	-	1	-	33	-
Surfperches	Embiotocidae	-	-	-	-	-	-	1	-
Mackerels and tuna	Scombridae	-	-	-	-	-	-	1	-
Constricting snakes	Colubridae	-	-	-	-	1	-	-	-
Unidentifiable rabbit	Leporidae	-	-	-	-	5	-	4	-
Unidentifiable rodent	Rodentia	-	-	-	-	5	-	52	-
Unidentifiable snakes	Serpentes	-	-	-	-	1	-	2	-
Unidentifiable perching bird	Passeriformes	-	-	-	-	2	-	-	-
Unidentifiable bony fish	Teleostei	-	-	2	-	8	-	165	-
Unidentifiable amphibia	Amphibia	-	-	-	-	-	-	1	-
Unidentifiable bird	Aves	-	-	1	-	-	-	-	-
Unidentifiable lizard	Lassertilia	-	-	-	-	1	-	-	-
Unidentifiable mammals	Mammalia	-	-	-	-	-	-	16	-
Unidentifiable vertebrate	Vertebrata	2	-	1	-	116	-	410	-

TS = Total specimens; MNI = Minimum number of individuals. "( )" indicates that the MNI frequency given previously has already considered this count.

#### VERTEBRATE SAMPLE

The vertebrate sample used in this study consists of 7,265 specimens. A total of 6,410 specimens was recovered by wet screening sediments from three 2 x 2 m and one 1 x 2 m excavation units through 1/8-inch mesh. Another 684 came from dry screening through 1/4-inch mesh from thirteen 2 x 2 m and one 1 x 2 m units (table 4.2). Another 855 specimens were recovered from a 20 cm<sup>2</sup> column sample processed with 1/2-, 1/4-, 1/8- and 1/16-inch mesh screens (table 4.3).

Of 31 taxonomic categories identified from the 1/4-inch screen sample, a minimum of 22 species are attributed to human activity. A minimum of 32 species of the 46 taxonomic categories identified in the 1/8-inch screen sample are attributed to human occupation, and a minimum of 13 species are represented in the 1/16-inch fraction including sardines and grunion, which were not identified in the samples collected using larger mesh. The most significant finding of the vertebrate analysis is that fish, particularly sardines, were a major source of vertebrate food.

Based on the data from the column sample, the estimated abundance of sardines is 990 specimens or 66.3% of the total fish sample. In fact, the yield of sardine meat may have been equal to the combined yield of the other fish consumed at SDI-9649. Since sardines and other species in the sample are found primarily in nearshore open coast habitats, rather than in the lagoon, it is possible that the open coast was an important fishing area, although deep embayments during the Early Holocene may have contained many such nearshore taxa. Our study supports the hypothesis that fishing was important during the Early Holocene (Kaldenberg 1982; cf. Christenson 1981; see also Norwood and Walker 1980).

The 15 fish, 4 reptile, 9 bird, and 12 mammal species reflect a generalized hunting/fishing pattern from a variety of aquatic and terrestrial habitats. Such broad-based procurement supports Moriarty's (1966) hypothesis that the transitional San Dieguito-La Jolla culture practiced a generalized hunting and gathering adaptation. The extensive use of fish from both the surf zone and the lagoon also supports Moriarty's (1966) hypothesis that the transitional culture at Agua Hedionda Lagoon had adapted to exploitation of marine shoreline habitats. The minimum number of species (40) and the density of specimens is characteristic of central base habitations or fairly sedentary villages rather than intermittently or little-used camps.

While a variety of capture techniques may have been employed, the vertebrate assemblage could have been procured with relatively few tools (e.g., spear and atlatl, gorge and line, nets and a throwing stick) if slight variations on the techniques were used with different species. The fish required at least two capture techniques: net, and gorge and line fishing. The birds could have been captured by trapping, with projectiles, or even by hooking from a blind. The reptiles could have been captured by hand. Spears and atlatl darts probably accounted for most mammal captures except for small game, including rabbits, which could have been trapped or caught using other techniques. The diverse vertebrate assemblage, and specifically the focus on fishing at the site, indicate that many procurement tools used during the transitional period (e.g., nets) were made from perishable materials.

Very little evidence of bone processing and bone tool manufacture was found at SDI-9649. Aside from bone tools, tool fragments, and one bead, only two

specimens of large mammal bone bore blade marks, and a third specimen was identified as production waste from bone tool manufacture. About 8% of the sample was charred or calcined.

Incidentally, provisional identification of the northwestern crow, *Corvus caurinus*, is based largely on the size of one specimen relative to *C. brachyranchos* (common crow). *C. caurinus* has been reported in southern California from Late Pleistocene deposits at Rancho La Brea (Stock 1972) but never from the Holocene. Its presence at SDI-9649 implies the local persistence of the species up to the onset of the Altithermal. Since identification rests on a single bone element, corroborating data are needed to establish the survival of this species into the Holocene.

#### INVERTEBRATE SAMPLE

The major shellfish foods at SDI-9649 were chiones, pectens, oysters, and mussels (fig. 4.4). All other species account for a relatively small proportion of the diet. Quantification is based on MNI using hinge fragments and apical elements. The density of shellfish remains attests to an intense exploitation of the lagoon. Many unit levels yielded MNI counts well over 1,000 animals (Koerper 1986:296-298). Further, the molluscs were comparatively large; there is a marked decline in valve lengths and weights between *Chione californiensis* at SDI-9649 and at SDI-5353, a nearby Late Prehistoric site occupied when lagoonal conditions were less productive.

Following Erlandson (1988b) we suggest that molluscs were a dietary staple particularly important for their protein rather than their carbohydrate contribution. The abundance of milling equipment at SDI-9649, coupled with the nature of nearby habitats, points to plant foods as the major source of calories in the Early Holocene diet.

The invertebrate remains from SDI-9649 include numerous parts of crab exoskeletons. Six specimens are identified as *Callinectes arcuatus*, the swimming crab (Garth and Stephenson 1966). Three other specimens are attributed to the family Portunidae, which includes *C. arcuatus*. Swimming crabs occur along the open coast and in estuaries and may be seined at the mouths of sloughs from the low intertidal zone (Garth and Abbott 1980). It is likely that swimming crabs were taken either deliberately or incidentally during fishing activities.

## SEASONALITY

The vertebrate sample contained two categories of specimens which could be used for seasonality interpretations—the remains of migratory bird species and annular ring readings from fish otoliths. Two spot-fin croaker (*Roncador stearnsii*) otoliths were recovered in the sample. Examination of the annuli gave an “early to mid summer” reading in one specimen and a “latest summer” reading in the other (Huddleston, personal communication, 1986). Along the southern California coast the “early to mid summer” reading correlates to approximately May to July-August. The “latest summer” reading correlates to approximately October. These readings indicate that fish were brought to the site on at least two separate occasions between May and October.

The seasonal data based on migratory birds is ambiguous, owing in part to uncertainties inherent in extrapolating from modern annual residence patterns (see Cogswell 1977) to the Early Holocene. The arctic loon and green-winged teal are local winter residents which, in modern times, almost totally exit the region for several months midyear. The arctic

loon enters the region in significant numbers around the beginning of October and leaves by the end of May. Sightings of stragglers have been made during the remaining months, but in very small numbers and on an irregular basis. The green-winged teal enters the region in significant numbers in the earlier part of August and departs by the beginning of May, with the exception of a very small residual population. The presence of *Aythya* cannot be used in the seasonality analysis without knowing the species represented at the site.

The seasonality data suggest that the site may have been used during a substantial part of the year. If the possible extremes in the bird hunting and fishing activities are considered, the minimal time range would be August to October and the maximum range would be the 11 months between May and March. Due to the small sample size, the nature of the occupation (intermittent vs. continuous) cannot be determined.

## TECHNOMIC ARTIFACTS

The technomic artifacts reflect a great range of extraction and maintenance activities (table 4.4). Use-

Table 4.4. Summary of Artifacts from SDI-9649

Artifact type	Provenience												Total
	Surface	0-10	10-20	20-30	30-40	40-50	50-60	60-70	70-80	80-90	90-100	None	
Bifaces	0	1	4	1	4	1	0	0	0	0	0	0	11
Eccentrics	0	0	0	0	0	1	1	0	0	0	0	0	2
Ground stone													
Manos	19	20	22	10	11	7	3	1	0	0	0	0	93
Metates	13	4	6	5	3	3	1	0	0	0	0	0	35
Fragments	3	2	4	5	2	0	2	0	0	0	0	0	18
Core/cobble tools													
Hammers	34	18	26	22	13	11	4	0	0	0	0	8	136
Scraper planes	13	7	15	18	7	6	3	0	0	0	0	1	70
Hammer/scraper plane	7	5	10	6	8	5	4	0	1	0	0	2	48
Hammergrinders	5	5	9	6	6	4	1	3	0	0	0	1	40
Choppers	0	4	4	4	2	3	1	0	0	0	0	0	18
Chopper/combinations	4	4	3	3	3	2	2	0	0	0	0	2	23
Knappers	2	1	0	0	0	0	0	0	0	0	0	1	4
Flake tools	35	89	139	149	108	83	47	20	4	2	2	1	679
Cores	4	3	10	3	4	4	0	0	0	0	0	0	28
Bone tools	0	0	2	2	2	1	1	0	0	0	0	0	8
Tarring pebbles	0	3	1	4	0	0	0	0	0	0	0	0	8
<i>Olivella</i> spire-lopped	0	1	3	8	10	7	2	1	0	0	0	0	32
Other shell artifacts	0	0	4	4	4	0	1	1	0	0	0	0	14
Bone bead	0	0	0	0	0	1	0	0	0	0	0	0	1
Ocher*	0	0	2	0	5	1	1	0	0	0	0	0	9
Quartz crystals	1	0	1	0	0	3	0	2	0	0	0	0	7
Total	140	167	265	250	192	143	74	28	5	2	2	16	1,284

\* Levels of occurrence rather than number of pieces.

# EARLY HOLOCENE ADAPTATIONS AND THE TRANSITION PHASE PROBLEM

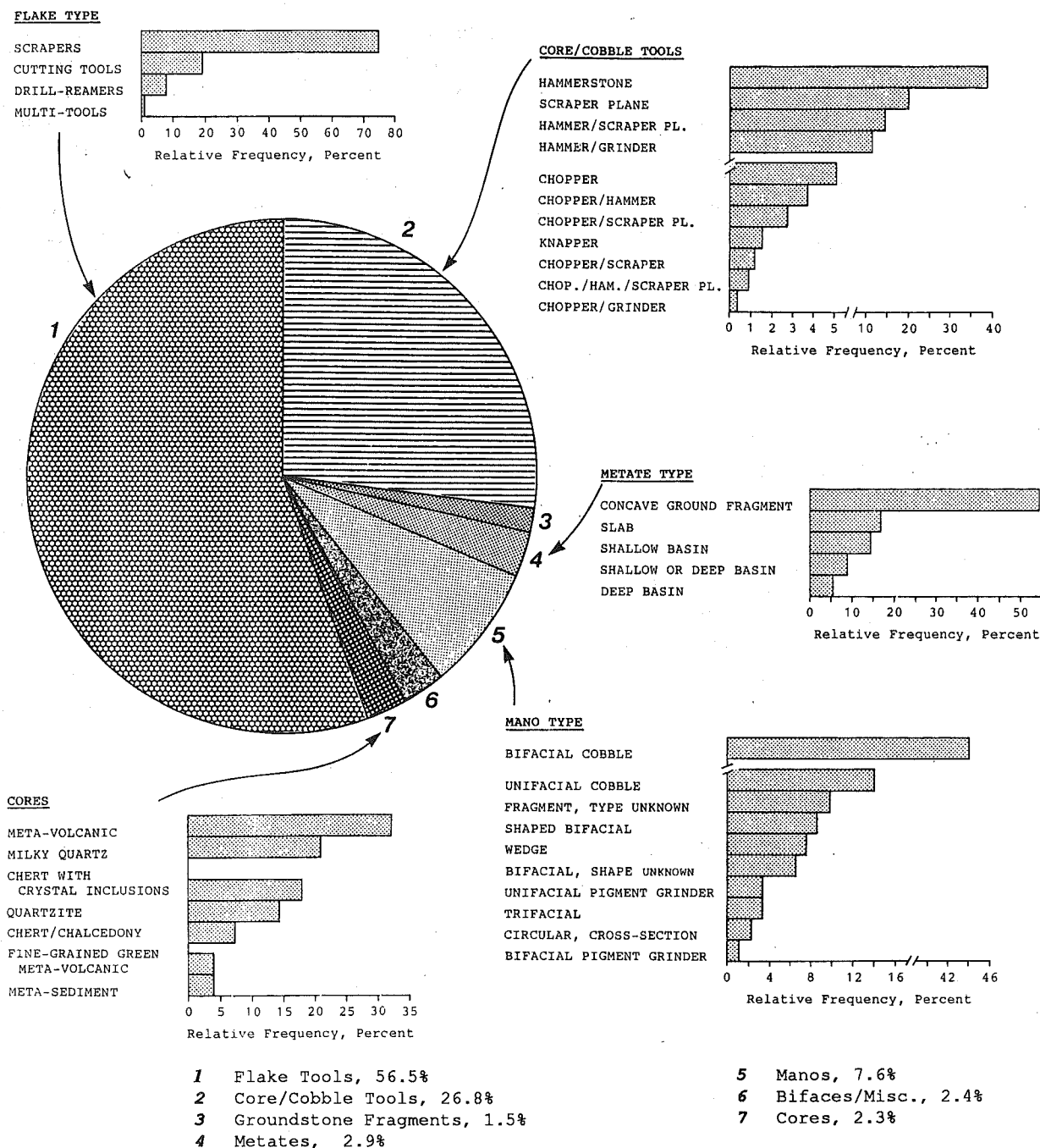


Figure 4.5. Frequencies of technomic artifacts. The biface/miscellaneous category includes two eccentrics, several other specimens, quartz crystals, tarring pebbles, as well as the point and biface fragments.

wear observed under 10x magnification was used to determine the functional categories of the stone tools, along with shape and modification types. Of the 1,229 stone tools, 56.5% are flake tools, 27% core/cobble tools, and 11% manos and metates (fig. 4.5). The rest of the assemblage includes 11 bifaces, 8 tarring pebbles, 2

eccentrics, and several other specimens described with the sociotechnic and ideotechnic artifacts.

The 11 biface fragments from SDI-9649 include 2 projectile point fragments, 4 tips, 4 midsections, and 1 square base. None are distinctive types although the two probable point fragments are typical

## Chapter 5

# Early Holocene Maritime Adaptation at Eel Point, San Clemente Island

Roy A. Salls

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**T**he Eel Point site (SCLI-43) on San Clemente Island is one of the most important shell middens ever excavated along the southern California coast. This is due to its undisturbed stratigraphy (no burrowing rodents or other bioturbation on the island), long occupation, and its midden volume. Archaeologists and students from the University of California, Los Angeles (UCLA) investigated the site during summer field schools in 1983, 1984, and 1986 as part of a larger research program conducted for the United States Navy.

This chapter has a tripartite purpose: first, to summarize the data from the Early Holocene component at Eel Point as a means of providing an important link between the so-called "Early Hunter period" and subsequent developments in southern California prehistory; second, to evaluate the evidence for climatic change during this period; and finally, to suggest a viable alternate to climatic variation in explaining subsistence change.

### SETTING

San Clemente Island lies 61 km (38 miles) from the mainland and 39 km (24 miles) south/southwest of Santa Catalina Island (fig. 5.1). The area of the island totals 145 km<sup>2</sup> (56 square miles), with a maximum elevation of 579 m at Mt. Thurst. The geologic history of San Clemente Island discloses that it is rising from the sea along its eastern escarpment, which forms the upthrown scarp of the San Clemente Fault. This volcanic island, chiefly andesite and basalt, was formed during the Miocene epoch; localized lenses of Miocene marine sediments are found at several locations on the island (Merifield et al. 1971). The east coast of San Clemente is very steep, plunging at some points over 1,500 feet to the ocean. The west coast comprises 20 wave-cut marine terraces uplifted by diastrophism (Emery 1954:107; McKusick and Warren 1959:109).

Eel Point is a narrow headland projecting from

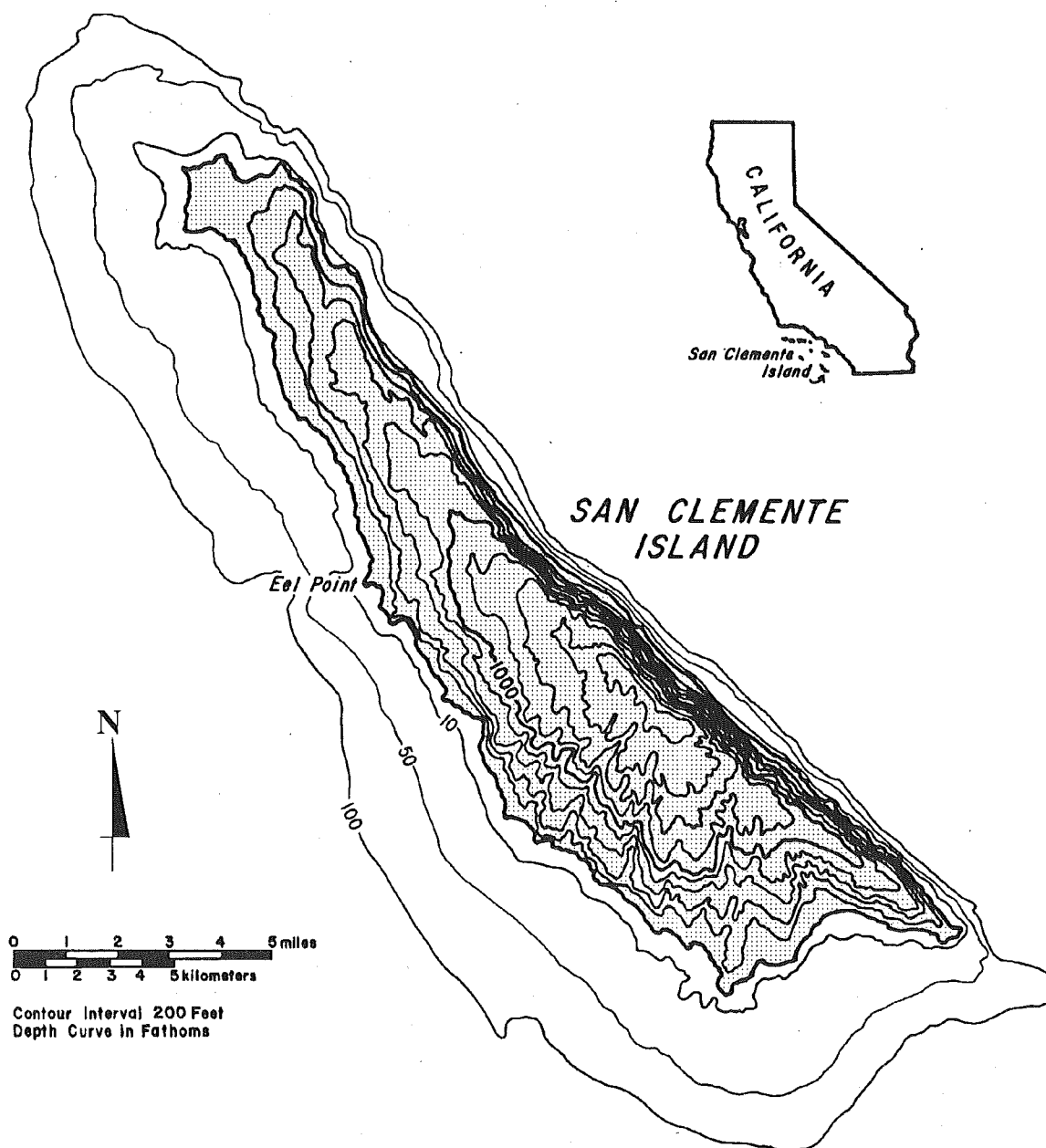


Figure 5.1. Map of San Clemente Island showing elevations and location of Eel Point.

the west coast of the island (fig. 5.1). This headland is an eroded remnant of the first coastal terrace formed approximately 127,000 years ago, which is capped by a calcareous sand dune. The dune contains a stratified shell midden which was intermittently occupied between 9775 years RYBP and the late prehistoric or early historic period. Spread over several acres, it contains three different cultural areas,

designated SCLI-43A, B, and C. Aboriginal population probably shifted over its vast surface when refuse accumulation created uncomfortable conditions at a particular location. This continuous pattern of movement, as well as depositional variations over the dune, presents differential stratigraphic patterns in conjunction with variations in radiocarbon dates in different parts of the site.



## SITE STRUCTURE AND CHRONOLOGY

The Eel Point dune midden is divided into three components: Areas A, B, and C. Area A is located on the uppermost and southwesterly portion of the dune and was tested in 1958 by McKusick and Warren (1959). Although no radiocarbon dates are available, the artifacts and the presence of an exposed house pit suggest a late prehistoric occupation. Due to the slumping of dune-sand, excavations were abandoned when a sterile level was reached (3-4 feet below datum). McKusick and Warren suggested that other midden deposits probably lay buried at Eel Point, which was confirmed when Area C was discovered beneath 150 cm of sterile wind-blown sand during UCLA's 1983 excavations.

At the base of the Eel Point dune is a dense midden containing the remains of a rich marine-adapted occupation designated as SCLI-43B. "This dark, almost black layer is somewhat greasy and can contain smaller lenses of almost solid shell" (Aycock 1983:8). Analyses of column samples indicate that shell contributes as much as 70% of the midden by weight, one of the densest shell accumulations known for California. These shell lenses mainly consist of pink and green abalone (*Haliotis corrugata* and *Haliotis fulgens*), California mussel (*Mytilus californianus*), and the wavy top shell (*Astrea undosa*). These strata are strongly cemented and date from the Early to Middle Holocene.

Area B was first sampled during a preliminary survey of the island by Michael Axford in 1977. Four shell samples were collected from the side wall of a then-recent military "fox hole" and submitted to the La Jolla Scripps Laboratory for radiocarbon dating. One of the samples yielded a date of  $8180 \pm 100$  RYBP (Axford 1981). In early 1983, Axford and Meighan obtained a column sample from the same fox hole during a preliminary survey of Eel Point. Noting similarities between the column at Eel Point and the samples collected at the Little Harbor site on Santa Catalina Island, Meighan decided to test Area B during 1983.

The research was designed to discover and record the stratigraphy at Eel Point and determine its position in the chronology of southern California prehistory. The test excavations of 1983 and 1984 provided data which separated Eel Point B from the overlying Eel Point C occupations, based on artifact

assemblages and radiocarbon dates. The 1986 tests were carried out in an area of SCLI-43C that appeared to overlie SCLI-43B. Radiocarbon dates from these excavations indicate intermittent occupation from 9775 RYBP for early Area B to 1090 RYBP for late Area C.

Area B is a highly consolidated dune deposit underlying the eastern section of the later, more friable dune at Area C. The site area is generally flat with the midden ranging from 1 to 2.5 m in depth. The cultural matrix lies conformably upon a sterile sand layer mixed with red-brown clay. This clay layer represents a soil that weathered from the andesitic wave-cut bench of the first marine terrace. Several andesite sea stacks (small eroded remnants of ancient points or headlands) intrude into the cultural matrix from the bedrock. The prehistoric occupants of the site, as well as of many other sites on the west side of San Clemente Island, used such stacks as windbreaks, as the southwesterly sides of these landforms are particularly rich in cultural remains.

Area C at Eel Point is a generally level area of the upper sand dune west of Area B and north of Area A. This site component appears to lie stratigraphically between Areas A and B in the center of the dune where earthmoving equipment and shoring would be required for safe excavation. As noted earlier, however, portions of Area C were encountered lying conformably over the basal midden in Area B.

The 1983 and 1984 excavations were carried out in the level area of the dune. "Some midden is visible in the terrace edge next to the beach, but inland portions show no surface remains, and on excavation the inland area proved to be buried under 150 cm of clean dune sand" (Meighan 1984:22). In 1986, an additional 16 m<sup>2</sup> were excavated down to the marine terrace bedrock to obtain a complete chronological series of radiocarbon dates. These excavations also led to a better understanding of the stratigraphy of the site (Meighan 1986:3).

Equivalent as well as disparate stratigraphic layers are scattered at different positions throughout the dune, and their similarity creates difficulties in interpretation. Evidence for variation in marine exploitation was obtained by a combination of cross-stratigraphic column sample assay, radiocarbon dates, and artifact and faunal analyses.

The Eel Point B midden provides the earliest date for maritime adaptations in the southern Channel

Islands. An earlier date has been recorded for the northern Channel Islands from Daisy Cave (San Miguel Island) at 10,700 RYBP—1,000 years earlier than Eel Point B (Snethkamp 1986). Testing various areas of this vast dune has yielded one of the longest continuous chronologies ever reported in southern California. Each successive season of excavation has yielded missing sections of the stratigraphic record. Although total excavation of the Eel Point dune is not practical, the site may possibly contain the most complete 10,000-year chronology of maritime adaptations in southern California.

Axford's "fox hole" radiocarbon samples yielded dates ranging from  $5650 \pm 90$  to  $8180 \pm 110$  RYBP (Ghiradelli 1984: table 2). As these were the earliest recorded dates for the southern Channel Islands at that time, the research strategy for the 1983 and 1984 field seasons was to verify this early occupation by testing Area B. Several test pits were excavated in the undisturbed midden adjacent to the foxhole. Six radiocarbon samples were collected and dated at the UCLA Radiocarbon Laboratory (table 5.1), which recorded dates very similar to those reported by Axford. "For example, a shell sample (UCLA-2532A), which dated  $7420 \pm 50$  years BP, was collected at the same level as Axford's  $8180 \pm 110$  (LJ 4130) and  $8000 \pm 80$  (LJ 3961) BP dates" (Goldberg and Titus 1986:8).

Two problematic dates were also recorded for Area B. The first was a shell sample from the 185-200 cm level, which yielded a  $3560 \pm 50$  RYBP date (UCLA-2532G). The date correlates with the beginning of the overlying Area C occupation and may have been labeled improperly during the cataloging process. The second questionable date,  $2430 \pm 75$  RYBP (UCLA-2532B), was derived from a charcoal sample from a hearth. Its 50-59 cm level probably indicates a redepositional intrusion from the overlying Area C (Goldberg and Titus 1986:8).

It became obvious that more information was required to further define the relationships and chronology at Eel Point; therefore additional work was carried out during the 1986 UCLA field season.

Although the early assemblage at Eel Point B is older than 8,000 years, the artifacts are few in number and simple in technology. There are very few points, beads, or other diagnostic artifacts. There are almost no grinding implements. The collection is dominated by a large number of coarse flakes and cores of basalt and other volcanic rock; many of these appear to be objects used in this form although the general appearance is of debitage or chipping waste rather than finished artifacts. [Meighan 1986:3]

Table 5.1 The Eel Point (SCLI-43) Radiocarbon Dates

Lab no.	Depth (cm)	Material	Adjusted $C^{14}$ years	Calibrated dates	Notes
LJ-4130	Unknown	Shell	$8180 \pm 110$ BP	7980 BP	(2)
LJ-3961	*	Shell	$8000 \pm 80$ BP	7800 BP	(2)
LJ-4131	*	Shell	$5810 \pm 90$ BP	5610 BP	(2)
LJ-4132	*	<i>Haliotis</i>	$5650 \pm 90$ BP	5450 BP	(2)
UCLA-2532A	90-120	<i>Mytilus</i>	$7420 \pm 50$ BP	7220 BP	(3)
UCLA-2532E	Burial-1	Collagen	$4365 \pm 55$ BP	5000-5400 BP	(3)
UCLA-2573	30-45	Fishhook	$3950 \pm 330$ BP*	3750 BP	(3-A)
UCLA-2578	60-75	Fishhook	$3380 \pm 280$ BP*	3189 BP	(3-A)
UCLA-2532B	50-59	Charcoal	$2430 \pm 75$ BP	2550-2800 BP	(3-B)
UCLA-2532G	185-200	<i>Haliotis</i>	$3560 \pm 50$ BP	3360 BP	(3-C)
UCLA-2758A	30-40	Charcoal	$3125 \pm 85$ BP	3400-3500 BP	(4-A)
UCLA-2758B	130-140	Charcoal	$8850 \pm 125$ BP		(4)
UCLA-2758C	140-160	Charcoal	$9775 \pm 165$ BP		(4)
UCLA-2758D	180-190	Charcoal	$9870 \pm 770$ BP		(4-B)
UCLA-2758E	250-260	Charcoal	$9655 \pm 325$ BP		(4-C)

Calibrations follow Suess (1979), Stuiver (1982), and Stuiver et al. (1986) adjusted ages corrected for  $C^{13}/C^{12}$  ratios

(2) After Ghiradelli 1984

(3) After Goldberg and Titus 1986; (3-A) Area C date; (3-B) intrusive; (3-C) see text

(4) Unit 3, 1986; (4-A) Base of 43C; (4-B) 1.7 g sample; (4-C) intrusive

\*Indicates area C (SCLI-43C) overlying strata

Several test pits were excavated to clarify the situation and determine the relationship of Area B to the overlying Area C. Unit 3 (1 x 2 m) was placed on the eastern slope of Area C where the deposit spreads out over the flat terrain containing Area B. This test pit exposed 2.6 m of cultural deposit before reaching the andesitic bedrock. Several newly discovered levels contain specific marine species that provide a type of "guide fossil" for cultural-level identification. For example, two turban shell (*Tegula* sp.) layers were encountered and led the field team to suspect that they were excavating a continuum of Area C. When charcoal samples were dated, however, it was discovered that only the upper 30 to 40 cm of the midden was Area C material.

The bottom meter of matrix from test unit 3 produced three hearth charcoal dates ranging from  $9775 \pm 165$  to  $9870 \pm 770$  RYBP (UCLA-2758C-D). Sample 2758D is somewhat problematic, as its very small weight (1.7 g) resulted in a high standard deviation.

## ARTIFACTUAL REMAINS

The first fishing artifact recovered from Area B was a small bone gorge (cat. no. 2249) from level I (fig. 5.2). This level has a radiocarbon date of  $9655 \pm 325$  RYBP (UCLA-2758) from what appears to be an intrusive cooking area or pit. Bone gorges continue to be the most abundant artifacts, other than debitage and large hard hammer flakes, until the 80 to 90 cm level, from which a fragment of a single-piece abalone shell fishhook was recovered. Although this level was radiocarbon dated to  $7420 \pm 50$  RYBP (UCLA-2532A), this shell fishhook fragment was probably intrusive.

It has been proposed that level I at Malaga Cove and the San Dieguito tradition of San Diego County can be attributed to Paleoindians or an Early Hunting tradition (Wallace 1955:218; Warren 1968:1). These early traditions are "characterized by a wide range of scraper types made from side-struck flakes and finished by well controlled percussion flaking, leaf

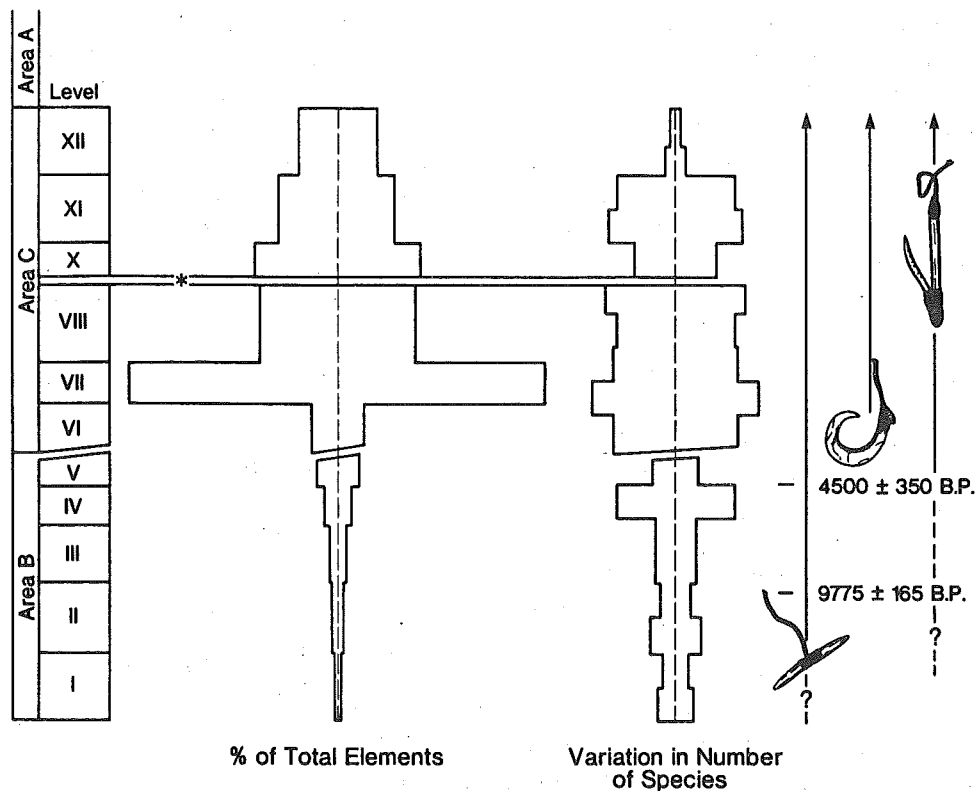


Figure 5.2. Relationship between species diversity and technological change at Eel Point (SCLI-43 B-C). \* Denotes sea urchin level: absence of all other marine fauna.

shaped knives or large points of several varieties. . . . [M]illing stones are few in number" (Warren 1968:1). Except for the presence of the bone fishing gorges, Eel Point B meets Warren's criteria as an Early Hunting tradition site.

The cultural midden within unit 3 at Eel Point B continues for another meter below the layer dated to  $9775 \pm 165$  RYBP. The midden material, mostly shellfish fragments, was very small and not conducive to accurate radiocarbon dates. However, additional excavation may provide even earlier dates for occupation of this site.

#### FAUNAL REMAINS AS INDICATORS OF MARINE HABITATS

The Eel Point B ichthyofaunal sample was obtained from six randomly scattered 1 x 2 m test units excavated during the 1984 UCLA Field School. The 14.4 m<sup>2</sup> of matrix from these units was passed through a 1/8-inch mesh. A 30% sample of the fish assemblage was obtained by the use of a random table of numbers. This sample of 7.97 m<sup>3</sup> of midden provided a total of 1,581 fish elements (table 5.2). This represents 198 elements per cubic meter excavated. The number of identified specimens (NISP) was 1,048 with a minimum number of individuals (MNI) of 165 (table 5.2). The NISP per cubic meter was 152. The site was excavated by arbitrary level within each stratigraphic layer. The MNI was determined from piscine aggregates within these cultural levels (Grayson 1984: 28; White 1953).

In an effort to discover the smallest possible elements (otoliths, etc.), column samples (15 x 15 cm) were taken from the analyzed units in Area B. These samples were processed over nested U.S. Standard Laboratory screens to 1/40 mm to recover the elements of the smaller species. The column samples yielded the same species that had been previously recognized in the test units. The remains of small fishes such as sardines and anchovies were absent.

The first step in reconstructing prehistoric fishing adaptations at a particular location is to recognize the various environmental parameters and their constraints on the local fishery. These parameters constitute the ecological systems and suggest a model of the prehistoric catchment area (Squire and Smith 1977:1). The second step is to identify the common fish which are diagnostic to each marine habitat. A comparative

collection for the identification of the Eel Point fish sample was collected by means of underwater spear and surf fishing from the shore of Eel Cove. The fish most commonly taken by these methods were also the most common found in the midden of Eel Point.

Ichthyofaunal studies in the last two decades have described a wide range of marine habitats along the Southern California Bight. Allen (1985) analyzed these studies and has suggested a synthesis of the southern California fish life assemblages by specific habitat type. These habitats are divided into two major classifications within nine habitat types. The first group is made up of the rock-substrate habitats which include: Rocky Intertidal (IT), Shallow Rock Reefs (SRRF), Deep Rock Reefs (RRF) and the Kelp Bed (KB). The second classification is made up mostly of soft substrate environments. They consist of Bay and Estuary (BE), Open Coast Sandy Beach (OC), Nearshore Soft Bottom (NSB), Midwater (MW), and Off Shore Pelagic (OP) (Allen 1985:133).

The present marine environment at Eel Point consists of extensive KB, RRF, SRRF, and MW habitats. The coastline exhibits sheer, 16 m (50 feet) cliffs immediately north of the site and a cobble beach (Eel Cove) to the south. The underwater geology consists of a gently sloping wave-cut terrace extending for approximately 0.5 km offshore where another terrace is encountered (fig. 5.1). There may have been a sandy beach at Eel Cove in prehistoric times, and the dune deposits are the result of lower sea level. This is suggested by several environmental factors. First, underwater surveys in the immediate area of Eel Cove disclose large sandy areas just offshore. Second, the dune midden extended into the littoral zone at one time, but has been dissected by wave action and forms part of the Eel Cove cliff. Finally, the cobble beach appears to be an erosional interface feature between the dissected dune and the sandy cove substrate. However, interpretations of sea level fluctuation are difficult because of the tectonic activity along the San Clemente Fault which has uplifted the Eel Point area, resulting in the 20 wave-cut marine terraces (Emery 1954:107; Birkeland 1972:432).

The archaeological sample contained all of the same fish species present in the area today; there were no exotic species identified in any of the Area B material. Evidence for short term climatic variation was not observed in the fish sample; for example, there was no indication of an increase in warm water

Table 5.2. Fish Species by Stratigraphic Level at Eel Point (SCLI-43B)

Taxa	Common name	Level					Total	MNI
		I	II	III	IV	V		
Elasmobranchi	Sharks and rays							
<i>Prionace glauca</i>	Blue shark					1	1	1
<i>Rhinobatos productus</i>	Shovelnose guitarfish		1		1		2	2
Osteichthyes	Bony fishes							
<i>Gymnothorax mordax</i>	California moray				1		1	1
<i>Sebastes atrovirens</i>	Kelp rockfish	1	2	10	3	8	24	8
<i>Sebastes carnatus</i>	Gopher rockfish					4	4	3
<i>Sebastes flavidus</i>	Yellowtail rockfish					5	5	3
<i>Sebastes goodei</i>	Chilipepper		1		5	1	7	3
<i>Sebastes melanops</i>	Black rockfish		1				1	1
<i>Sebastes paucispinis</i>	Bocaccio	1				3	4	4
<i>Sebastes rastrelliger</i>	Grass rockfish					20	20	6
<i>Sebastes serriceps</i>	Treefish				1	6	7	5
<i>Sebastes</i> sp.	Rockfish (unknown)	1	3	3	8	6	21	3
<i>Paralabrax clathratus</i>	Kelp bass	1	5	2	20	52	80	24
<i>Paralabrax maculatofasciatus</i>	Spotted sand bass	1					1	1
<i>Paralabrax</i> sp.	Bass (unknown)					1	1	1
<i>Caulolatilus princeps</i>	Ocean whitefish				6	1	7	3
<i>Seriola lalandi</i>	Yellowtail					2	2	1
<i>Trachurus symmetricus</i>	Jack mackerel		1		8	2	11	5
<i>Roncador stearnsii</i>	Spotfin croaker					1	1	1
<i>Medialuna californiensis</i>	Halfmoon					2	2	2
<i>Embiotoca lateralis</i>	Striped seaperch					1	1	1
<i>Rhacochilus toxotes</i>	Rubberlip seaperch			1			1	1
<i>Rhacochilus vacca</i>	Pile perch					1	1	1
<i>Sphyræna argentea</i>	Pacific barracuda	1	5	1	1		8	6
<i>Semicossyphus pulcher</i>	California sheephead	28	53	67	171	465	784	64
<i>Scomber japonicus</i>	Pacific mackerel				3	20	23	5
<i>Thunnus alalunga</i>	Albacore		1		2	1	4	4
<i>Paralichthys californicus</i>	California halibut	1	7	16			24	3
Unknown Osteichthyes			42	73	246	172	533	2
Totals		35	122	173	476	775	1,581	165
Total identified (at least to genera) elements							1,048	
Total unidentified (unknown Osteichthyes) elements							533	

Note: Levels I-III, 9775-8850 BP; Levels IV-V, 8850-4500 BP; see figs. 5.2 and 5.3.

species such as skipjack, bullet mackerel, or yellowtail (Salls 1988b). There was an increase in cold water rockfish during the Eel Point C occupation, but since these species also are present in deeper waters offshore, it is difficult not to rule out deepwater fishing. Although some general topographic features of the coastline have changed, the underwater habitats and fish species apparently have remained generally stable for at least 10,000 years.

The nearshore underwater habitats exploited at Eel Point B were calculated by the number of identified elements recovered from the site. Ninety-one percent of the identified sample were SRRF/KB species, with the MW and OC habitats presenting 4% each. The remaining habitats were indicated by 1% of the sample. The marine habitats (KB and RRF) remain very similar for many kilometers north and south of the site and make it difficult to determine the

site's catchment boundaries. The presence of the OC spotfin croaker (*Roncadora stearnsii*) indicates some fishing on a sandy beach. As suggested, a sandy beach probably was present in Eel Cove, or some fishing was conducted at beaches to the north or south of the site, though this latter model does not appear likely because of the distance involved. The few midwater fishes present indicate some procurement outside the kelp bed habitat, which currently extends to approximately 1 km offshore. It is possible to catch yellowtail, albacore, and barracuda in the outer kelp, since they were observed in this environment during an underwater survey of the area. Although present, these latter species were at no time abundant and were not a significant part of the fishery.

#### IMPLICATIONS OF THE DATA

Watercraft must have been present on San Clemente Island at least 9,775 years ago, as the island has never been connected to the adjacent islands or to the mainland, and there is a wide and deep channel separating it from the nearest land (Santa Catalina Island). The early occupants of Eel Point were involved in shellfish exploitation to a greater extent than in fishing: the abundance of mussels as well as pink and green abalone completely overwhelm the few littoral fish species present in the early levels (table 5.2). Although a few black abalone are present in all levels of the midden, their numbers are insignificant until the Middle Holocene at Eel Point C level VI (fig. 5.3). The littoral pink and green abalone, wavy top shell, and rock scallop (*Hinnites giganteus*) are the four largest shellfish available in the present marine environment; all four are present in the Early Holocene levels, I and II. With the exception of the black abalone and mussel, these species can only be obtained by diving and removing them from RRF, SRRF, and KB habitats.

Aboriginal fishing methods involved an intimate knowledge of the behavior of fishes in a given habitat. Underwater diving for shellfish at Eel Point probably increased the islanders' awareness of the fishing resource. For example, there is a profusion of sheephead elements throughout the occupation of Eel Point. The targeting of this species may reflect an early historic account of the Channel Island Indians' underwater spearfishing adaptation. "The Indians were such expert fishermen with spears and harpoons, that one of them went down diving and soon

appeared with a fish on the point of his spear" (Eisen 1905:9). This ethnohistoric observation becomes very important in the analysis of the sheephead remains at Eel Point. Sheephead make up 60% of the site's identified fish, interesting because the sheephead "generally occur solitary, although often with schools of other fish to which they probably are attracted by activity" (Feder et al. 1974:65).

This solitary behavior eliminates the possibility of catching large numbers in nets. Furthermore, sheephead inhabit KB, SRRF, and RRF habitats not conducive to gill or other large nets, although when a large gill net broke from its moorings and drifted into a kelp bed in 1987, numerous large male sheephead were found to be entangled in it upon its recovery (C. Swift, personal communication, 1987). The sheephead is a bottom dweller, frequenting caves and seldom leaving the protection of the rocks. If fishing—using hook-and-line or even nets—was practiced, the absence of other, more abundant, bait-feeding species can be explained by positing that the sheephead was more abundant than at present or that some efficient means of targeting the species was developed. Although the greater abundance model cannot be discounted completely, a solitary fish, inhabiting the same environment with numerous other species, must be selected in a process controlled by the fishermen. Sheephead may have been targeted by underwater spearfishing, although other methods cannot be ruled out completely.

Ames (1972) noted that sheephead consistently ranked at or near the top of the spearfishing catch for modern divers. Assuming catch per unit of fishing effort to be the best indicator of relative abundance of sheephead, Ames compared the difference in effort (day of fishing per person) between underwater spearfishing and hook-and-line angling. His analysis indicated that hook-and-line anglers catch a sheephead every 126.9 hours. An average diver obtains a fish every 22.7 hours, but competitive divers spear a sheephead every 4.8 hours because they search for and target the largest fish, which is most often the sheephead.

Ames's data suggest that fishing or diving for sheephead is inefficient in that a considerable amount of time is expended for each individual fish caught. At first blush this appears contrary to the tremendous amount of sheephead remains present at Eel Point. One must recognize, however, that the importance of fishing can often be deceiving when only archaeologically

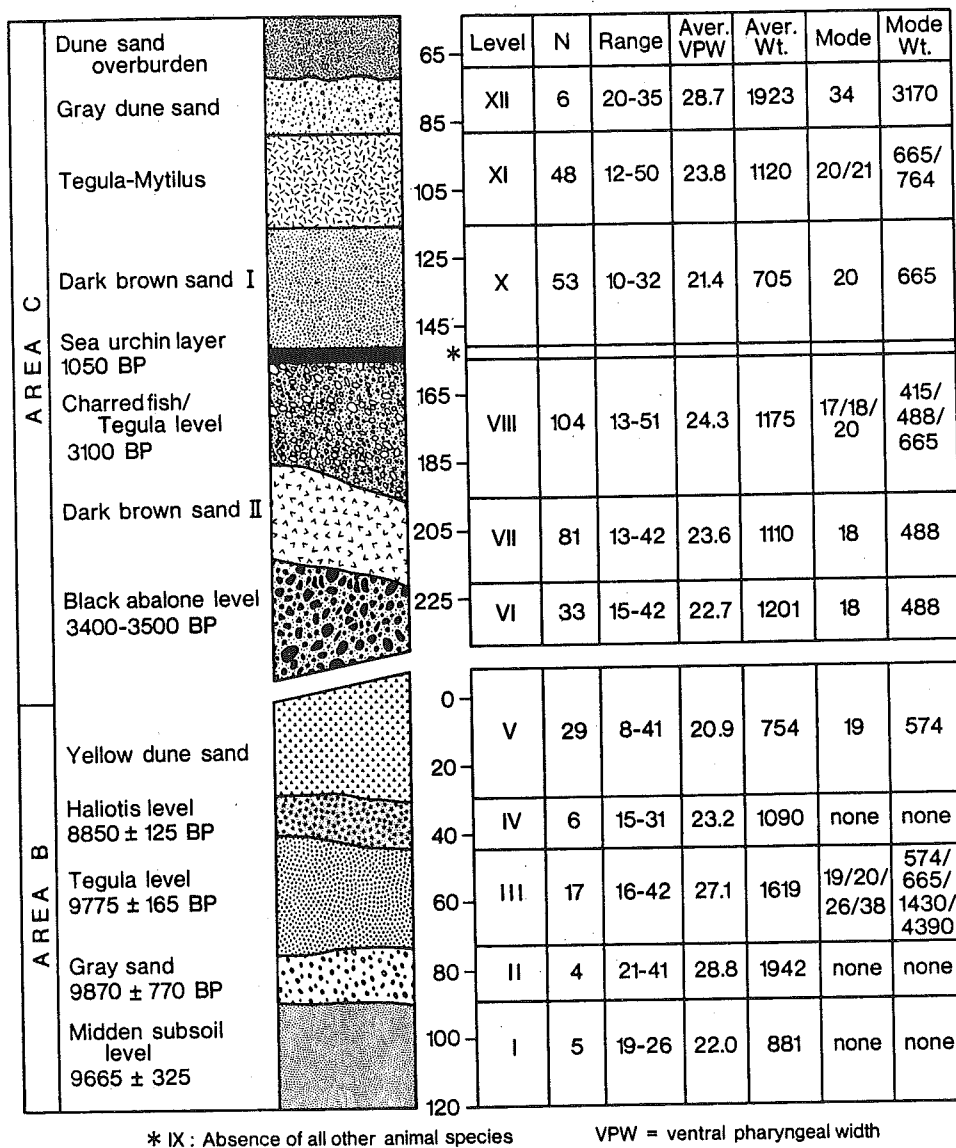


Figure 5.3. A chronology of Holocene sheephead exploitation at Eel Point, San Clemente Island.

recovered element abundance is considered. Courtemanche and Legendre (1985) list 205 named bones for fishes, many of which are paired (premaxilla, dentary, etc.), and some of which vary in number (ribs and vertebrae). If we consider the 205 named bones for one sheephead per fishing day added to the trash midden, 74,825 elements would be added each year.

It can also be argued that traps were used, as sheephead are known often to enter lobster traps. I have observed over the years, however, that almost every KB species will enter lobster traps. It is interesting to note that the California spiny lobster (*Panulirus interruptus*) is absent in Eel Point middens although common in the offshore habitats of San

Clemente Island. If traps were used, both lobsters and a wider range of nearshore fish would be present in the archaeological assemblage. The belief that the southern California coastal Indians utilized traps is based on observations near Santa Barbara by the Vancouver expedition in 1792:

There was a village of Indians close to the place where we daily landed from the vessels to whose industrious inhabitants we are greatly indebted for a regular supply of fish; they were always seen out by the dawn of the day either examining their fish pots in the bay or fishing in the middle of the channel. . . . [Menzies 1924:315]

However, this statement probably means they were checking their weir baskets, not lobster-type traps, in the nearby estuary. The term "fish pots" in 1700s English describes the small traps placed at the center of a weir to catch fish.

Whatever the method of targeting sheephead, the preponderance of all fish elements, including the sheephead, consisted of head bones, the atlas, second and third vertebrae, and the penultimate, ultimate, and hypural bones of the caudal (tail) area. The absence of central body vertebrae suggests that this was a location of specialized processing and that the fish body was transported off site.

Most of the fish remains recovered from Eel Point B currently are present in the site's resource zone throughout the year. The few albacore elements indicate a late summer/early fall occupation. The abundance of rockfish (*Sebastes* sp.) suggests fishing the outer kelp beds and the RRF habitats. No deepwater rockfish were identified, although they are presently available throughout the year in deeper waters. Overall, the species recovered from the Eel Point midden indicate a nearshore fishery with a concentration on the KB, SRRF, and RRF resources.

A research design for the interpretation of the prehistoric fisheries at Eel Point required a framework in which the broadest possible array of collected data could be interpreted. This included an analysis of various marine habitats and life assemblages available at a particular site location, as well as the site resource limitations. These factors must also be considered in light of changing human population patterns.

In general, there should be a positive relationship between resource diversity and population size. . . . At low densities a population will specialize upon a few low cost resources. The food niche will be narrow and of low diversity (meaning heavy dependence on a few resources), and the efficiency of labor in subsistence will be high. As the population grows, the use of these first resources will be intensified and new higher cost resources will be added. The food niche is now broader and more diverse and the efficiency of labor in subsistence lower. [Christenson 1980:36]

This intensification process may continue in an ever expanding cycle:

1. The population increases to a point of subsistence stress.
2. The stress creates an intensification in subsistence production and technology (i.e., new fishing tackle evolves).
3. The increased production allows for increased population.
4. Population growth creates a positive feedback system which leads to increased population and subsistence stress.

"It is worth noting, however, that while the process of intensification continues indefinitely, the process of resource diversification does not" (Hill 1985:21). There are questions as to the validity of this scenario when harsh environments are concerned. For example, intensification was not possible for the Paiute of the Great Basin or the Bushmen of the Kalahari Desert. Intensification of marine resource exploitation by hunter-gatherer societies is also limited with respect to species diversity. Therefore, the subsistence cycle is limited by site resource (local environment) restrictions. It is impossible for a human population to increase their subsistence niche beyond the limitations of their resources. "Ecological characteristics of species determine their carrying capacities and these equilibrium population densities in turn largely determine the probability of extinction" (Brown and Gibson 1983:471). If a site's resources are overexploited to a point beyond its carrying capacity, ecological change will occur. This change may create a new state in the environment which may not be conducive to economical human exploitation (Sutherland 1974:859).

The greatest change between Areas B and C appears to be a decreasing correspondence between primary use and discard locations resulting from the increasing intensity of site occupation (Gifford 1980:98). The use of shellfish at Eel Point C also differed in that the smaller intertidal species such as black abalone, turban, and limpets replaced the larger littoral pink and green abalone so prevalent at Eel Point B. Fishing increased dramatically with more emphasis on watercraft use rather than shore fishing, and there was an increased specialization in the exploitation of California sheephead.

Two basic measurements of human population growth and its pressure upon shellfish populations are apparent at Eel Point. First, initially the size and then the desirability of the molluscan sample continually



declines through time, supporting the argument that the site occupants were consuming these resources beyond the carrying capacity of the habitat, and resulting in decreasing species size and abundance as well as the utilization of less desirable species. Second, littoral (pink and green) abalone decrease in size and are replaced by smaller black abalone, which also decrease in size until replaced by *Tegula* sp.: "It may be argued that the species was exploited beyond its carrying capacity" (Cohen 1977:81). During these changes in molluscan utilization, fishing continues to expand in technology and species utilized.

"The main point is that for subsistence economies with a given technology, unit cost increases as strategy output approaches the limit of resource availability within a community's territory" (Earle 1980:11). The overexploitation of the pink and green abalone during occupation of Eel Point B created a situation where an efficient resource became progressively less efficient as the strategy intensified. As the return fell below an efficient level of energy expenditure, the inhabitants were required to switch to a more efficient resource: black abalone were then targeted. As black abalone are large meat packages requiring little energy to collect at low tide, the question immediately arises as to why they were not exploited before the littoral pink and green species, which require considerable energy expenditure.

One could speculate that as sheephead and pink and green abalone species are found in the same habitat, a greater energy potential can be realized. If you don't capture sheephead, you can always collect pink or green abalone, as well as rock scallops or wavy tops—all of these species providing large, easily prepared meat packages. Black abalone, although easy to collect, are considerably more energy intensive to prepare for consumption: the meat of black abalone is hard and unpalatable without considerable pounding to release the muscle—a factor which limited their modern commercial use until the overfishing of red, pink, and green abalone made the extra processing worthwhile.

Another indication of population pressure is the decreasing size of black abalone during Eel Point C occupation and its eventual replacement by *Tegula*. The time and energy costs for procuring *Tegula* within the present nearshore environment at Eel Point are much greater than for black abalone. One can gather 2 to 8 *Tegula* for each abalone, but the average abalone yields approximately 113 g ( $1/4$  lb.) of edible

meat (Howorth 1978:43) while the average *Tegula* sp. (mostly *T. funebris* and *T. gallina*) yields only 0.47 g of meat (Raab 1989:13); there is no information on the nutritional composition of *Tegula*. Similar molluscs in the same superfamily (Trochacea) are the turban (*Homalopoma* sp.); these species contain 20.3% protein and 99.8 cal. per 100 g portion (Gilliland 1985:62). Abalone contain 18.7 g of protein, 0.5 g of fat, 3.4 gm of carbohydrate and 98 cal. per 100 g of edible meat (Erlandson 1988b: table 1).

Black abalone as well as *Tegula* sp. are found in the same intertidal environment. However, one must collect 240 *Tegula* to equal the meat of one black abalone, and some of the *Tegula* levels at Eel Point C appear to resemble layers of crushed rock due to the abundance of this species. Although it is difficult archaeologically to measure costs—*Tegula* versus *Haliotis*, for example—"hopefully, a researcher can distinguish the primary objectives of a strategy, treating the additional items obtained as desirable but secondary by-products" (Earle 1980:3). The great increase in fishing at about the time that abalone gave way to *Tegula* may indicate that the latter was a secondary resource. For example, when prepared by boiling, *Tegula* has a very spicy flavor and may have been used to flavor fish (Bleitz, personal communication, 1988).

### Evidence of Fish Overexploitation

Changes in resource use at Eel Point reflect shifts in the surrounding habitats through time. Sutherland (1974) proposes the concept of stable-state communities as one possible explanation for ecological change. This model explains the present state of an ecological community by indicating that multiple stable-states (stable communities with different structures) exist at various points in time within a particular area. For example, a SRRF habitat may exist in a shallow bay at a particular point in time. A forest fire occurs which destroys the nearby watershed, creating a condition where erosion silts in the bay. The habitat is now changed to one of NSB and a new ecological community forms. Later, long shore movement (nearshore currents which constantly scour the southern California coast) return the bay to its original SRRF habitat, a process often taking hundreds of years (Kuhn and Shepard 1984; Salls 1988a:27-36). The bay, therefore, has passed through three stable states: Shallow Rock Reef, Nearshore

Soft Bottom, and a subsequent return to Shallow Rock Reef, each with its own particular species clusters at each phase. Stable states are only stable in the immediate neighborhood or locality of the point in question (Sutherland 1974:859).

Sutherland also suggests that multiple stable-state communities can occur within a single environment and that predation is an important factor in the structure and organization of alternate stable-states within natural communities.

... human societies have in fact grown throughout their history and have encroached progressively on their resources to the extent that the continuous development of new adaptive strategies and the continuous re-definition of ecological relationships were necessary. [Cohen 1977:16]

The influence of hunter-gatherers in establishing alternate stable-state communities is best illustrated by the research of Simenstad et al. (1978) in the Aleutian Islands. They found two alternate stable-state nearshore communities, one dominated by kelp and the other by sea urchins. These communities were present at the same time in the littoral zone of adjacent islands. These alternate stable-states were maintained by the presence or absence of dense sea otter populations. Faunal analysis of Aleut and pre-Aleut archaeological site middens on each island disclosed similar alternate stable-state indications in the prehistory of each island. For example, islands presently without otter populations provided archaeological middens containing otters with indications of several prehistoric alternate sea urchin/otter stable-states (Simenstad et al. 1978:404).

The midden profiles of these islands exhibited evidence of extensive exploitation of the sea otter—the “keystone predator” of the sea urchin. The reduction in the otter population allowed the sea urchin to overgraze the kelp, therefore creating an alternate stable-state condition in which the sea urchin dominated. The eventual overexploitation of the algae environment by an explosive population of sea urchins effectively eliminated this echinoderm, enabling the kelp to return and provide the otter and other species with a proper habitat. As time passed and the otter population increased to the point that its exploitation was economical, this cycle started again. Alternate stable-state communities have been experimentally

produced between sea urchins and algae (Paine and Vadas 1969; Estes and Palmisano 1974), coral-reef organisms and browsing fish (Stephenson and Searless 1960), Aleut Indians and sea otters (Harrold and Reed 1981; Simenstad et al. 1978), and lizards (*Anolis sagrei*) and spiders (*Meteteira*) (Schoener and Spiller 1987:949).

The California sheephead's effect on structuring subtidal marine communities was demonstrated by a large-scale experimental removal of this species from Dutch Harbor, San Nicolas Island (Cowan 1981). Following the artificial depletion of the sheephead, there was an increase in sea urchins (26% in a year) which was not experienced in the unaltered control area (Cowan 1981:225). Predation by sheephead appeared to have a strong effect on the abundance, spatial distribution, and behavior of the red sea urchin (Cowan 1983:76).

Historically, the targeting of sheephead along the Palos Verdes Peninsula during the late 1950s by sports divers resulted in a purple sea urchin (*Strongylocentrotus purpuratus*) invasion, which, in conjunction with rising water temperatures and possible pollution effects, eventually eliminated the kelp forest and consequently all other marine species (North 1983:153; Salls 1986b, 1988a:214). The 1960s and 1970s at Palos Verdes experienced the alternate stable-state of a dominant sea urchin community. The KB stable-state was reestablished in the 1980s at Palos Verdes by organized human efforts (Wilson and McPeak 1983:201), and the area has recently returned to the original stable-state marine community that existed in the 1950s (Salls 1986b).

The effect of these sea urchin population explosions is to create and maintain a “barren ground” stable-state (North 1983:148). For maritime adapted populations living in a catchment area experiencing a barren ground event, the only resource available is sea urchin. I believe the sea urchin layer between levels VIII and X at Eel Point is archaeological evidence of such a stable-state in prehistory (fig. 5.3). This is premised on the observation that the urchin layer contains no other marine species. Such stable-states occur when the “reduction in numbers of important urchin predators such as sea otters, lobster, and sheephead may have provided an opportunity for proliferation by urchins and other macro-invertebrates. Such proliferation introduced an element of instability to kelp beds where urchins are plentiful” (North 1983:160). The alternate stable-state occurs

when sea urchin densities are lowered by disease or starvation, followed by recolonization of the former urchin "barren ground" by various seaweeds including kelp varieties (Pearse and Hines 1979:84).

Not all marine biologists accept the keystone predator hypothesis in relation to kelp-sea urchin multiple stable-states, although they recognize that sea urchins do eliminate large sections of kelp forests (North 1983:148). They believe that the urchin/kelp stable-states are also influenced by water motion, light, nutrient levels, and substratum (Booth 1988:157). Despite the current debate, the stable-state model allows archaeologists to go beyond climatic change in explaining variance in subsistence patterns.

The archaeological evidence of the development of new marine-procurement methods, possibly in a response to the altered ecological relationships, is well preserved in the sand dune stratigraphy of the Eel Point sites on San Clemente Island (fig. 5.2). The dune stratigraphy is very distinctive, each level distinguished by the abundance or absence of a particular molluscan fauna. For example, the earliest deposit at Area B (level I), stratigraphically located below the level dated at 9775 years BP, contained heavy concentrations of mussels with small amounts of other littoral species such as abalone. A definite change was observed in the overlying layer (level II) which contained up to 85% littoral molluscs—mostly pink and green abalone and the wavy top shell; mussels were absent.

Paine (1966) found that by altering the stable-state between starfish (*Pisaster ochraceus*) and the California mussel, an alternate stable-state condition was created in the lower rocky intertidal zone as well. The removal of the starfish allowed the mussel to expand into the void and dominate the lower intertidal zone. The reintroduction of the starfish re-established the previous stable-state in spite of the potentially disrupting space competition from the mussel. Starfish can also eliminate mussel communities if the larger mussels are removed by human predator or other factors. Given enough time to reach proper size and strength, mussels become too large to be successfully attacked by starfish (Paine 1974). The abundance of particularly large mussel specimens at level I may explain the sudden and complete disappearance of this species in the later levels at Eel Point.

The fish remains in these early levels, with nearshore species predominant, are not as abundant

as in later levels (table 5.2). The faunal evidence from the subsequent occupation of Eel Point (Area C) indicates that the black abalone and *Tegula* sp. replaced the littoral abalone while fishing became the major subsistence activity (fig. 5.2). The littoral abalone and wavy top shell almost completely disappear from the stratigraphic record at Area C. They are replaced for a period of time at level VI by intertidal black abalone, which then also become rare. The highest concentrations of fish fauna are in the late (Eel Point C) occupation, associated with alternating layers of *Tegula* sp. and a scattering of very small black abalone at levels VII and XI.

### Evidence for Climatic Change

Changes in subsistence patterns, due in part to climatic fluctuations, are well documented in the historic record (Berger and Labeyrie 1987:3; Lamb 1988:165; Pearson 1978:228). Speculation on prehistoric climatic factors began early in the archaeological investigations along the Southern California Bight. D. B. Rogers (1929:343) proposed that the climate was much wetter during the post-Pleistocene because of the depth and calcareous nature of sites during his Oak Grove period. Rogers may have been correct in his speculation because there appears to be a general consensus that the Early Holocene was much warmer and wetter than the Late Holocene (Berger and Labeyrie 1987:10; Lamb 1988:19). Agreement on this model is not unanimous, however, and "there is currently no reason to believe that higher precipitation prevailed during the time when the sites were occupied" (Glassow et al. 1988:70). Others indicate that the climate may have been cool and wet during the Early Holocene (chap. 8, this vol.).

Orr (1967) observed that low energy subsistence resources were replaced by higher on Santa Rosa Island where red abalone strata dated at 7000 RYBP were replaced by black abalone in later levels. Orr postulated that this displacement in subsistence was due to climate change, as the red abalone was a cold water species and the black a warm water species. He suggested a drier and cooler climate during the Early Holocene. The Early Holocene data, however, indicate that rather than being cold, the climate was approaching the highest temperatures of the entire Holocene epoch (Lamb 1988: fig 6.3).

This hypothesis appears to be based on the observation that in northern California red abalone are

found from the intertidal to 35 m (Ault 1985:16). Along the Southern California Bight, however, red abalone are littoral, while the blacks are for the most part intertidal; although "the black abalone is an intertidal species that lives over broader latitudinal range than the red or green abalones, yet the thermal requirements of the red and black abalone are similar" (Ault 1985:15). In other words, some other factor than temperature is responsible for the lack of intertidal red abalone in southern California. Whatever the cause, it is still apparent that a gradient from red to black abalone is common on the northern Channel Islands and appears to occur during two distinct periods: 7000 RYBP and a later manifestation at 5000 RYBP (Glassow 1987).

A similar situation exists at Eel Point B with the littoral pink and green abalone and the wavy top shell predominating at approximately 8850 RYBP (fig. 5.3), while black abalone replaces these species during the later occupations. The intertidal black abalone, although also present in the earlier levels of Area B, are not abundant. As indicated above, there is a definite change from utilizing littoral species to intertidal species over time. The question, then, is why did subsistence change from low energy (large littoral) species to high energy (smaller intertidal) species at various times in the southern California Holocene? Climatic change requiring new subsistence strategies has often been used to explain this subsistence anomaly (Glassow et al. 1988:75; Kowta 1969:52-69).

Although archaeology has collected considerable data regarding subsistence change, the correlation with climatic research has been limited, owing to the conflicts and uncertainty of interpretation in climatic research. One has only to delve into the climatological literature to find a bewildering mass of conflicting and disjointed data (e.g., Berger and Labeyrie 1987; Lamb 1988; Pearson 1978). It is difficult to correlate archaeological data with the findings of a single or even several climatic studies with any degree of reliability.

For example, there is a general consensus that the Early Holocene was much warmer and wetter than the Late Holocene (Berger and Labeyrie 1987:10). This early Flandrian period warming melted Pleistocene ice sheets and glaciers which caused an approximate 40 m rise in sea level (Lamb 1988: fig. 6.1). Morrison (1976) plotted the data of numerous sea level studies on a single line graph; although every study indicated

a rise in Holocene sea levels, the graphic method did not produce a usable visual representation. It is apparent that circumspection must be used in applying such data to archaeological remains as no system of establishing a world average sea level rise has won universal acceptance (Lamb 1988:82; Putnam 1964:388).

Similar observations can be applied to rainfall patterns and temperature (Pearson 1978: fig 11). There is even disagreement on present temperatures despite modern instrumentation of the data. Global weather stations have indicated that a worldwide warming trend has occurred in the last decade (Kerr 1988:883), while satellite monitoring of world climates has produced evidence of a continuation of a cooling trend which began in the 1940s (Spencer and Christy 1990:1558).

Pollen studies suggest that essentially modern, climatically adapted plant communities have existed along the Southern California Bight since the Early Holocene (Axelrod 1978:1127; Heusser 1978:673). Mehringer (1967), however, has warned that pollen and alluvial data measure only "effective moisture" and not the total climate.

Effective moisture has a direct effect upon biota and, hence, man. Therefore, debate about temperature verges upon the irrelevant; the problem is effective moisture. By ignoring temperature and evaporation as variables and concentrating upon effective moisture, local conditions through time are easier to determine from botanical evidence. Such evidence has the strength of being empirical, not theoretical, whether it be palynological or macrofossil botanical specimens. [Jennings 1978:15]

The data for sea temperature change is open to as many interpretations as the terrestrial data. The analysis of deep sea cores for variations in the stable isotope ratio of  $O^{18}/O^{16}$  in foraminifera shells and the  $C^{13}/C^{12}$  in bottom organic sediments—which developed on the sea surface and precipitated into deep sea sediments after death—has provided a climatic record for the last 100 million years (Libby 1983:74). The size and structure of foraminiferan tests (shells) change in response to variations in ocean temperatures, and their calcium carbonate ooze deposits can be dated. Therefore, broad-scale climatic changes—

such as glacial and interglacial periods—can be accurately measured through the systematic analysis of protozoans preserved in sea basin ooze cores (Lerman 1986:130). The broad-scale factor creates limitations in the analysis of sea core varves for short term changes (D. Bleitz, personal communication, 1990).

Pisias (1978) postulated various short-term sea temperature changes for the last 8,000 years in the Santa Barbara Channel, based on the analysis of radiolaria from sea core varve samples. Another serious problem with analyzing fossil radiolaria assemblages outside the deep ocean is that the fauna may not represent the living assemblage of the overlying waters.

Selective dissolution of thin walled specimens at depth, differential removal of easily transported species by scouring bottom currents, and occasional contamination by exotic species transported over long distances by large-scale ocean currents all contribute elements of uncertainty. Because of these problems, sediments over much of the ocean floor are unsuitable for paleoclimatic reconstruction. [Bradley 1985:172]

Unfortunately, the shallow offshore Santa Barbara Channel is one of the unsuitable areas (Bradley 1985: fig. 6.2; Anikouchine and Sternberg 1973: fig. 14-9).

Recent discoveries in the geochemistry of sulphur compounds (Brassell et al. 1986:160) offer some indications of possible resolution of the problems of continental shelf sea core interpretation by tracing historic events such as the ENSO (El Niño Southern Oscillation) from documented historical times into the Pleistocene and beyond (S. C. Brassell, personal communication, 1990).

The Cooperative Holocene Mapping Project (COHMAP), a consortium studying late Quaternary environmental change, has produced what it believes to be a general-circulation model for the atmosphere and oceans which have permitted quantitative paleoclimate modeling. It was found that seasonal and latitudinal distribution of solar radiation at present is similar to that at 18,000 BP (COHMAP 1988:1044). Solar radiation is recognized by most climatologists as a major factor in the earth's overall climate. The COHMAP data indicate that "at about 9 ka average solar radiation over the Northern Hemisphere was 8% higher in July and 8% lower in January than it is today. After 9 ka these seasonal radiation extremes decreased towards modern values."

From the foregoing, somewhat conflicting, discussion, it is apparent that the results of climatic research are open to many interpretations, and it is difficult to apply a simplified *climate change* model to complex climatic data interacting with even more complex cultural adaptation. As archaeology seeks to describe and explain the events of the past, its major focus has been toward evolutionary concepts, system theory, and human adaptations to ecosystems (Willey and Sabloff 1980:181). The approach is a holistic systemic one of viewing human populations as part of a greater total ecosystem. The discipline has of necessity become multidisciplinary, utilizing the services of the physical, natural, and social sciences. Of particular interest has been the distribution of plant and animal species as entire communities because the typological history of humankind has been developed against the background of the natural world.

The results of such interdisciplinary studies must be analyzed in the context of the entire ecosystem that provided the site resource base—in the archaeological remains of prehistoric subsistence, not in deep sea cores or oxygen isotopes. Changes in deep sea foraminifera do not necessarily correspond with changes in intertidal species.

There is no question that subsistence remains in archaeological sites vary over the Holocene (Glassow 1987; Glassow et al. 1988; Salls 1988a). Therefore we must first examine our data set (the middens themselves) where we have already found the evidence of technological and population change. Variations in subsistence have many explanations. I believe, however, we must exhaust all cultural possibilities before using climatic, geological, or biological explanations or a combination thereof.

## OVEREXPLOITATION

Grotesfend (1837), the decoder of cuneiform writing, found evidence of a certain cultural uniformity in inscriptions on modern monuments of his day that spanned many generations. He reasoned that cultural behavior must have remained unchanged throughout long periods of time. Recognizing that "X the Great King" was part of the salutatory phrase on all modern Persian monuments, Grotesfend then applied the same measure to the ancient cuneiform and was able to recognize similar patterns that ultimately led to its decipherment.

Cohen (1977) cited a number of factors to account for changing subsistence patterns in prehistory. Noting that present-day ecological imbalance is usually due to human overexploitation, he notes that "only one possible explanation—actual population growth—could account for increasing demand or ecological imbalance which appeared to span a wide range of ecological zones and to embrace a large number of different cultures" (Cohen 1977:279).

Archaeologists and historians have long recognized the impact of agricultural and technological populations on the environment. The impact of hunter-gatherers on their environment was seldom considered until Martin (1967:72-120; 1984:354-403) suggested that early hunters may have been responsible for the extinction of the Pleistocene megafauna. However, the impact of small hunter-gatherer groups on the environment is difficult to determine from the archaeological sample. Archaeologists, especially American archaeologists, have also been hindered by the assumption that hunter-gatherer populations lived in harmony with nature while exploiting a stable and generally uniform resource base. Change in the resource base, therefore, was seen as the result of some other factor, usually climate, which prevented the prehistoric Indian ecologists from properly interacting with the environment. This naive view of the American Indian, which is still held by many, is the result of the "noble savage syndrome" instilled in the American consciousness by Jean Jacques Rousseau's 1754 *Discourse on the Origins of Inequality*. The noble savage model promoted the "ecological Indian" as a reality for most anthropologists. It was difficult, therefore, to recognize any human factor as an explanation of subsistence change.

Changes in subsistence are very obvious in the prehistoric midden at Eel Point. If only one species of fish or shellfish disappeared from the archaeological context, one would surmise that climate, probably sea temperature, may have been the cause—yet this is not the case. Mussels almost completely disappear from the record in the Early Holocene. The littoral wavy top shell and pink and green abalone then become the preferred species, only to disappear somewhat later in the Early Holocene. By the transition to the Mid-Holocene, black abalone become abundant. In the Middle Holocene the turban snail is found in layers resembling gravel lenses. In short, each succeeding level indicates a less energy-efficient means of subsistence.

As fish often are indicators of climatic change (Lamb 1988:159), Allen's (1985) work on modern fish clusters as indicators of habitat was utilized to determine if climatic change was indicated in the nearshore fishery at Eel Point. These archaeological fish remains were analyzed and habitat plotted (see Salls 1988a). The results of this analysis indicate that species clusters match modern distributions. Therefore, if particular clusters are indicators of particular habitats, it appears that the present nearshore habitat types of KB, SRRF, RRF, etc. have remained constant during the last 10,000 years (Salls 1988a:69). This is not to say that local environmental change has not occurred, but such change, no matter how extreme, was restricted to the limitations observed in the present marine environment.

The Ballona Escarpment sites (Santa Monica Bay), for example, indicate that the aboriginal population exploited a Bay and Estuary habitat (Salls 1988a:270). The area today is an Open Coast Sandy Beach (OC) habitat. Several explanations would have been possible from the archaeological evidence at Ballona Lagoon if the geological and historical data were unknown. The lowering of sea level or tectonic uplift, for example, are both viable possibilities (cf. Troxel 1954:45). The actual cause for the habitat change was the silting of the Ballona Lagoon and the change in course of the Los Angeles River in late prehistoric and historic time. It is important to note, however, that the nearshore fish clusters that once inhabited the Ballona Lagoon can still be observed in the remaining estuaries along the Bight.

The fish fauna data from Eel Point indicate that the same species clusters are present today in the nearshore marine habitat as are evident in each analyzed level of the Eel Point midden during the last 9,775 years. This continuum is not particular to Eel Point; I believe it can be seen all along the southern California coast (Salls 1988a). Underwater survey and catch data at Eel Point provided a sample of the nearshore fish community. The catch data indicated that the California sheephead, grass rockfish, opaleye, and the kelp bass are currently the most common fish in the site catchment (table 5.2). Opaleye (*Girella nigricans*), although extremely abundant, are rare in archaeological sites because of their herbivorous feeding habits (Feder et al. 1974:47).

The larger territorial male sheephead were observed offshore in the SRRF, RRF, and KB habitats beyond the reach of shore fishermen. These large

sheephead could only be reached by utilizing watercraft. The presence of barracuda and other offshore species in level I of Eel Point Area B indicated that watercraft were utilized at a very early period. Eel Point Area B reflects a gradual increase in the exploitation of this fish over time. The increase in the average size of sheephead is also indicated from the faunal remains. This increase in size suggests a movement away from shore-based fishing toward an effort which exploited the greater size range of sheephead available within the offshore population. This exploitation increases to the point at which there is a decrease in this species' overall average size (fig. 5.3), which is indicative of a continued pressure on this long-lived, territorial, but limited resource (Fitch and Lavenberg 1971:87).

Utilizing the predicted Total Length (TL) and weight formula based on Ventral Pharyngeal Width (VPW) measurements of sheephead (Salls 1988a: table 3) for the Eel Point sites, it was found that the archaeological sheephead produced mean weights which are somewhat lower than the modern catch. The sheephead, which were heavily exploited at Eel Point (table 5.2), averaged 1.2 kg (2.6 lbs.).

Although abundant at Area B, the sheephead soon became the dominant species in the higher stratigraphic levels at Area C, often comprising 75% of all fish species in a level. In level VIII, the specific targeting of sheephead reaches its greatest intensity (fig. 5.3). At this time a comprehensive size range was captured in conjunction with a low size modality, reflecting a specialized fishing venture which, based on the habits and contemporary capture data for this species, indicates underwater spearfishing.

#### SUMMARY AND CONCLUSIONS

As one of the oldest radiocarbon dated fishing sites on the Southern California Bight, Eel Point also has provided a long and well-stratified record of nearshore marine exploitation (fig. 5.3). The early Area B reflects a gradual increase in the exploitation of fish over time. The increase in the average size of sheephead in levels II and III suggests a movement away from shore-based fishing toward the exploitation of the greater size range of sheephead available within the offshore population. The decrease in this species' overall average size through levels IV and V is indicative of a continued pressure on this resource (Fitch and Lavenberg 1971:87).

The use of abalone and wavy tops follows a similar pattern of increased use, with a subsequent decrease in size through time. These molluscs never disappeared entirely from the middens, with very small individuals scattered within the remains of a *Tegula*-collecting/fishing strategy after 3100 BP (fig. 5.3).

These variations within the stratigraphic column have been explained in several ways. The differences in abalone exploitation may express climatic stress (Orr 1967). This change in only two species of abalone may, in fact, be due to climatic as well as subsistence pressures as suggested by Glassow et al. (1988:76). The data from Eel Point suggest these variations are due to human overexploitation within the biological concept of alternate multiple stable-state communities—in which climate may be, but is not necessarily, a factor. The evidence from Eel Point on San Clemente Island suggests that alternate stable-states may have existed at the site. The stratigraphic evidence revealed that abalone, the California sheephead, and the sea otter were all exploited by the aboriginal population. As the littoral abalone population crashed at early Eel Point B, the less energy-efficient *Tegula* sp. were exploited as fishing increased. As the sheephead reached its greatest abundance in the midden, there was an environmental "crash," possibly due to overexploitation of the sheephead as the keystone predator of urchins. The sea urchin then became dominant, creating a single resource base for the occupants of the site. The sea urchins, due to the lack of predators, overexploited the algae environment to the point where they themselves experienced a population crash, allowing the habitat to recover its original KB stable-state.

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## Chapter 6

# Fishing During the Millingstone Horizon? New Data from the Glen Annie Canyon Site, Santa Barbara County

Roger H. Colten

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**W**idely published analyses of data from the Glen Annie Canyon site (Owen et al. 1964) formed the basis of challenges to traditional interpretations of Millingstone horizon ecological adaptations. Various authors suggested that rather than a simple seed and shell gathering economy typical of other Millingstone horizon sites (Wallace 1955), the occupants of SBA-142 exploited diverse marine and terrestrial habitats and may have been nomadic (Owen 1964) rather than living in permanent villages (Curtis 1965; Wallace 1955). Interwoven with these divergent descriptions of Millingstone horizon subsistence are suggestions that SBA-142 was actually a multicomponent site.

This chapter includes a summary of what we know about the Glen Annie Canyon site, a description of how it varies from traditional views of the Millingstone horizon, new vertebrate faunal data, and new radiocarbon dates. Was fishing part of the Millingstone horizon adaptation, as Owen (1967) suggested, contradicting Wallace's (1955) description, or is SBA-142 actually a multicomponent site, with a later occupation with a maritime adaptation?

Why is it important to reexamine SBA-142? The data recovered during the 1960 excavation were broadly publicized, notably in *American Antiquity*, and therefore may have had a considerable influence on many archaeologists' understanding of Early Holocene adaptation in southern California. Owen (1967:238) actually referred to Glen Annie as the type site for Oak Grove, the local variant of the Millingstone horizon. Although most of the site has been destroyed (Owen et al. 1964:436), unanalyzed vertebrate faunal remains and datable material were in storage at the Anthropology Department of the University of California, Santa Barbara, making it possible to reassess the earlier interpretations.

### PREVIOUS EXCAVATIONS AND ANALYSIS

The Glen Annie Canyon site was located adjacent to the ancient Goleta Lagoon, on the coastal plain about 10 km west of Santa Barbara (fig. 6.1). At its maximum extent, the Goleta Lagoon was 18 km<sup>2</sup> in area, fed by six streams (Lohmar et al. 1980). The lagoon was a focus of prehistoric occupation from

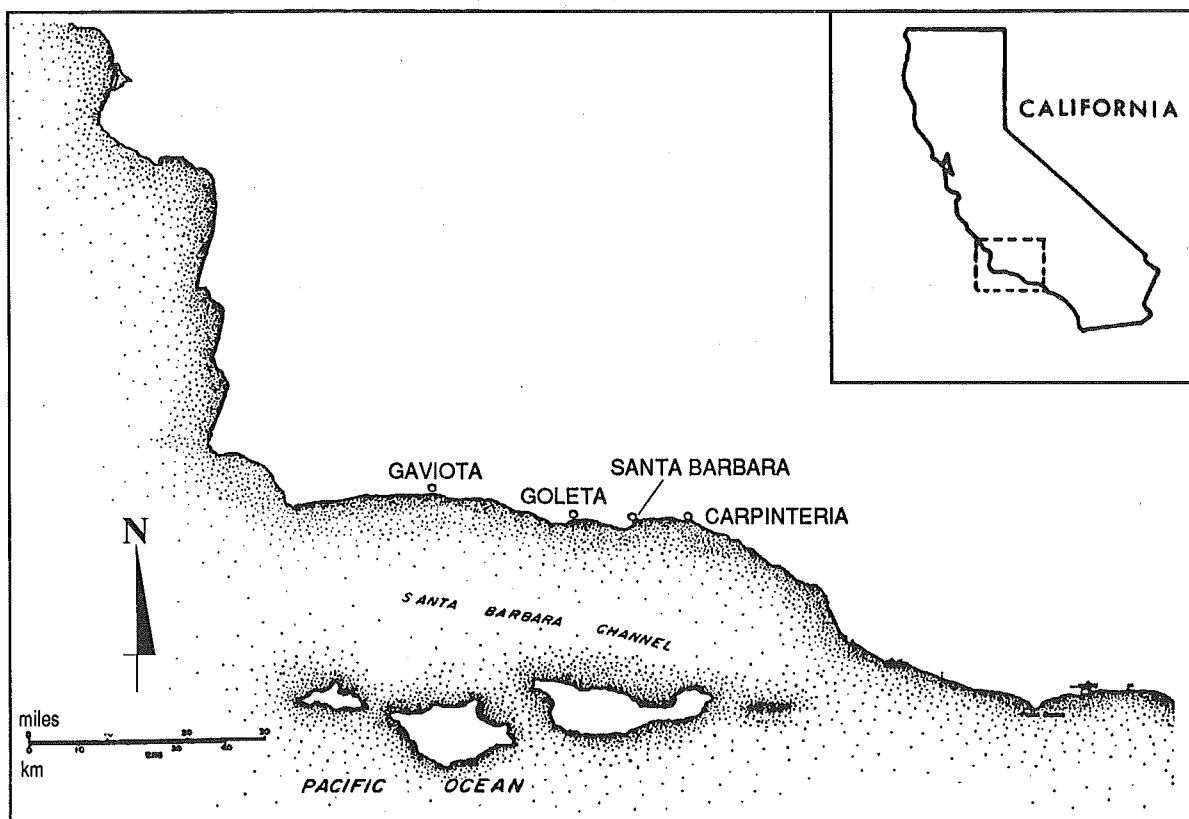


Figure 6.1. Map of general research area.

the Early Holocene until European contact, and many prehistoric sites were located along its shores (fig. 6.2). Exploitation of ecologically diverse, resource-rich environments such as the Goleta Lagoon helped support high population densities during the later prehistory of the region (Brown 1967).

SBA-142 was excavated prior to construction of a freeway onramp which completely destroyed the site (Owen et al. 1964:436). Glen Annie was excavated in 5-foot square units and 6-inch arbitrary levels (Owen et al. 1964:437), methods fairly standard for the era. Portions of the excavated material were screened through  $1/4$ - or  $1/8$ -inch mesh screens largely as an experiment in recovery techniques; not all soil was screened. Screen residues were returned to the laboratory for washing. The new data presented here are derived from the only two units completely screened over  $1/8$ -inch mesh, pits 17 and 18.

Excavation focused on several burials exposed in a road cut, eventually revealing eight burials localized in a cemetery area. The ground stone assemblage was dominated by manos and metates, al-

though several pestles were also recovered. The chipped stone assemblage included stemmed and side-notched points and a variety of flake and core tools, mainly of local materials. "Serpentine," or soapstone, artifacts included several charmstones, a bead, and a bowl. Shell beads were mainly of the whole *Olivella biplicata* type (spire-lopped or spire-ground), although clam disks, rectangular *Olivella biplicata* and dentalium beads were also recovered. Additional artifacts included worked bone, ocher, and asphaltum.

The faunal assemblage included the remains of 21 marine and estuarine molluscs, terrestrial and marine mammals, birds, and fish. A wide variety of fish were represented in the faunal assemblage, but the data were not quantified in the original site report. Bone was only systematically collected from the two "control units." Systematic bone collection and the use of  $1/8$ -inch mesh screens increased the faunal sample from these two units, both in quantity and diversity, thus giving a more accurate representation of faunal exploitation at SBA-142.

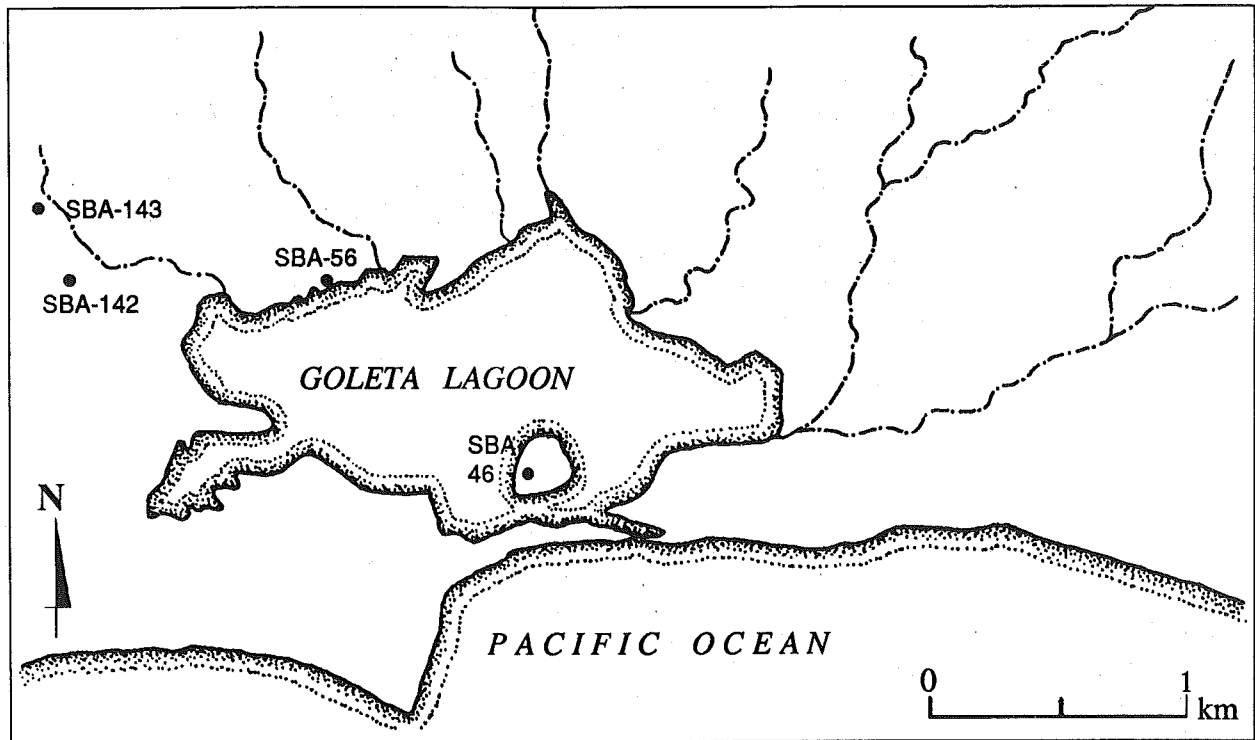


Figure 6.2. Map of approximate Goleta Lagoon boundaries and locations of some archaeological sites mentioned in the text.

### Chronology

SBA-142 has yielded some of the earliest radiocarbon dates along the Santa Barbara mainland coast, including one date (UCLA-607) of nearly 7300 RYBP. The four original radiocarbon samples were analyzed by the UCLA Radiocarbon Laboratory. All of these samples were relatively large collections of shell, mainly Washington clam (*Saxidomus nuttalli*), found in association with four different interments. The results of these analyses are shown in table 6.1. These four dates fall within D. B. Rogers's (1929:342-355) Oak Grove period.

Table 6.1. Radiocarbon Dates from SBA-142

Sample Number	Uncorrected Age
UCLA-605	6880 ± 120
UCLA-606	6980 ± 120
UCLA-607	7270 ± 120
UCLA-608	6380 ± 120
Beta-25150	1490 ± 80
Beta-25151	4490 ± 80

### Discussion of Previous Research

This artifact and faunal assemblage differs from Wallace's (1955) description of the Millingstone horizon in several ways. The anomalous features include: (a) stemmed projectile points, (b) pestles, (c) serpentine objects, (d) asphaltum, and (e) fish and shellfish.

These unusual characteristics, and the fact that all four radiocarbon dates were burial associations rather than from the overlying midden, suggested that this was a multicomponent site rather than a "typical" Millingstone horizon site. Owen (Owen et al. 1964:478) suggested that the burials might predate the midden but later emphatically stated that "this is Oak Grove" (Owen 1967:238).

More recent suggestions of the site's multicomponent nature were based on both the vertical differentiation in the distribution of faunal remains and soapstone artifacts at Glen Annie and the presence of similar, multicomponent sites nearby. First, the composition of the shellfish assemblage varies vertically within the deposit. The lower levels of the site contain primarily Washington clam (*Saxidomus*

*nuttalli*) while the upper levels are dominated by various clams of the genus *Chione* (Owen et al. 1964:495). This shift from the larger *S. nuttalli* to the smaller *Chione* spp. is a diachronic change noted at other sites in the area (Colten 1989). Second, soapstone artifacts tend to occur more frequently in the upper levels of the site (Owen et al. 1964:489). Third, the ratio of shell to bone varies vertically within the deposit (Erlandson et al. 1988), indicating a greater reliance on vertebrates during the deposition of the upper deposit. Finally, several other sites in the area, for example SBA-56 (Gerstle and Serena 1982) and SBA-143 (Colten 1987), are multicomponent sites including both Early Holocene and later occupations.

#### VERTEBRATE FAUNAL REMAINS

In order to quantify the faunal assemblage recovered from pits 17 and 18 at SBA-142 and to describe them in a manner suitable for comparison with other sites, I examined previously unanalyzed vertebrate faunal remains collected in 1/8-inch and 1/4-inch mesh from these two units. All previously unidentified vertebrate faunal remains from pits 17 and 18 were classified to the lowest taxon possible (table 6.2), tabulated and weighed. The fish remains were also counted. Most of the nonfish vertebrate remains were highly fragmented, and little of this material was identifiable beyond terrestrial or marine mammal categories. Although several additional categories, including human, deer, seal, sea lion, dog, hawk, other birds, and snake, were identified in this material (table 6.3), the fish remains are emphasized. The identifiable vertebrate remains were quantified as numbers of identified specimens (NISP), the most basic counting unit in faunal analysis (Grayson 1984).

The fish remains recovered were divided into elasmobranchs (cartilaginous fish) and teleosts (bony fish) (table 6.4). These two groups include six species of elasmobranchs, six types of teleosts, and a large number of elements only classifiable to the general groups. There are roughly 32% elasmobranchs and 68% teleosts. Table 6.5 shows the relative frequencies of elasmobranchs. The most numerous identified elasmobranchs are round stingray, 31%, California angel shark, 14%, and bat ray, 10%. Table 6.6 shows the relative frequencies of teleosts. The most numerous of the identified teleost remains are surfperch, 25%, and sardine, 10%.

Most of these species inhabit sloughs and estuaries (see table 6.7) (Eschmeyer et al. 1983; Fitch and Lavenberg 1971), which is not surprising given the proximity of SBA-142 to the ancient Goleta Lagoon. The overall fish bone assemblage has similarities both to Early Holocene sites such as those discussed by Erlandson (1988a) and to later Holocene, Middle period (C. D. King 1981) sites near Glen Annie (Bowser 1984; Johnson 1980).

The most interesting aspect of the assemblage is the group of species that are not typical of estuary environments. For example, soupfin shark is a species known to inhabit relatively deep water (Eschmeyer et al. 1983:34; McCormick et al. 1963:339). Lingcod, a deepwater species (Eschmeyer et al. 1983:156-157), and sheephead and giant kelpfish are three teleost taxa that inhabit rocky bottom kelp bed environments (Eschmeyer et al. 1983:237-243).

Table 6.2. Common Names and Taxa of Identified Animal Remains

Name	Taxa
Human	<i>Homo sapiens</i>
Deer	Cervidae
Canid	<i>Canis</i> spp.
Gopher	<i>Thomomys bottae</i>
Rodent	Rodentia
Rabbit	Leporidae
Mole	Talpidae
Pinniped	Pinnipedia
California sea lion	<i>Zalophus californianus</i>
Guadalupe fur seal	<i>Arctocephalus townsendi</i>
Hawk	Accipitridae
Bird	Aves
Snake	Serpentes
Round stingray	<i>Urolophus halleri</i>
California angel shark	<i>Squatina californica</i>
Bat ray	<i>Myliobatis californica</i>
Shovelnose guitarfish	<i>Rhinobatos productus</i>
California thornback	<i>Platyrhinoidis triseriata</i>
Soupfin shark	<i>Galeorhinus zyopterus</i>
Surfperch	Embiotocidae
Pacific sardine	<i>Sardinops caeruleus</i>
Lingcod	<i>Ophiodon elongatus</i>
California sheephead	<i>Pimelometopon pulchrum</i>
Giant kelpfish	<i>Heterostichus rostratus</i>
Jacksmelt	<i>Atherinopsis californiensis</i>

Table 6.3. Nonfish Vertebrate Faunal Remains from SBA-142

Type	Pit 17		Pit 18		Both pits	
	Frequency	Mass	Frequency	Mass	Frequency	Mass
Human	5	27.46	1	1.60	6	29.06
Deer	0	0.00	3	4.32	3	4.32
Seal	0	0.00	1	2.45	1	2.45
Sea lion	1	0.28	0	0.00	1	6.28
Pinniped	0	0.00	4	2.10	4	2.10
Fur seal	1	2.11	0	0.00	1	2.11
Canid	1	0.99	1	0.10	2	1.09
Small mammal	0	0.00	1	0.35	1	0.35
Gopher	2	0.06	31	1.81	33	1.87
Rodent	1	0.04	0	0.00	1	0.04
Rabbit	1	0.01	0	0.00	1	0.01
Mole	3	0.31	0	0.00	3	0.31
Hawk	0	0.00	1	0.50	1	0.50
Bird	2	0.22	1	0.25	3	0.47
Snake	3	0.14	4	0.23	7	0.37
Land mammal	-	45.11	-	68.13	-	113.24
Sea mammal	-	14.15	-	19.61	-	33.76
Undifferentiated	-	248.34	-	356.40	-	604.74
Total	20	339.22	48	457.85	68	797.07

Table 6.4. Frequency of Fish Remains from SBA-142

Type	Pit 17	Pit 18	Total	Percent
<b>Elasmobranchs</b>				
Undiff. elasmobranchs	5	11	16	10.32
Round stingray	6	9	15	9.67
California angel shark	2	5	7	4.51
Bat ray	1	4	5	3.22
Shovelnose guitarfish	1	2	3	1.93
California thornback	2	0	2	1.29
Southern shark	1	0	1	0.64
<b>Teleosts</b>				
Undiff. teleosts	31	31	62	40.00
Surfperch	11	15	26	16.77
Sardine	0	11	11	7.09
Lingcod	1	3	3	1.93
Sheephead	2	0	2	1.29
Giant kelpfish	1	0	1	0.64
Jacksmelt	0	1	1	0.64
Total elasmobranchs	18	31	49	31.61
Total teleosts	46	61	106	68.38
Total	64	92	155	100.00

Table 6.5. Relative Frequency of Elasmobranch Remains from SBA-142

Elasmobranchs	Frequency	Percent
Undiff. elasmobranchs	16	32.7
Round stingray	15	30.6
California angel shark	7	14.3
Bat ray	5	10.2
Shovelnose guitarfish	3	6.1
California thornback	2	4.1
Soupfin shark	1	2.0

Table 6.6. Relative Frequency of Teleost Remains from SBA-142

Teleosts	Frequency	Percent
Undiff. teleosts	62	58.5
Surfperch	26	24.5
Sardine	11	10.4
Lingcod	3	2.8
Sheephead	2	1.9
Giant kelpfish	1	0.9
Jacksmelt	1	0.9

Table 6.7. Habitats of Fish Recovered from SBA-142

Common name	Habitat
<b>Elasmobranchs</b>	
Soupfin shark	Offshore, coastal, bays, also deep water.
Bat ray	Common in sandy and muddy bays and sloughs; also on rocky bottom and in kelp beds.
Thornback	Fine sand to mud bottom, often near kelp beds, off beaches; to 150 ft. (46 m).
Shovelnose guitarfish	Sand or mud-sand bottom in shallow coastal waters, bays, sloughs, and estuaries. To 50 ft. (15 m).
Angel shark	Offshore and in bays; often on sand or mud bottom, near kelp, rocks, or canyons. Mostly at 10-150 ft. (3-46 m).
Round stingray	Sand or mud bottom off beaches and in bays and sloughs. At 3-70 ft. (0.9-21 m).
<b>Teleosts</b>	
Sardine	Pelagic, usually near shore; in large schools.
Surfperch	Inshore-surf zones; in kelp and tidepools.
Jacksmelt	Inshore (including bays); in schools.
Lingcod	Adults near rocks; inshore and to 1400 ft. (427 m). Young on sand or mud bottom of bays and inshore areas.
Sheephead	Prefers rocky bottom, particularly in kelp beds; to 180 ft. (55 m) but usually at 10-100 ft. (3-30 m).
Giant kelpfish	Among rocks with large seaweed, often in kelp. Subtidal to 132 ft. (40 m).

Note: After Eschmeyer et al. 1983.

### Discussion of Fish Remains

Although the sample size of fish is quite small, it is possible to make some tentative characterizations of the assemblage. The inhabitants of SBA-142 procured fish mainly from the estuary and nearshore environments, although they also caught fish in the kelp beds and in deeper water. Many of these fish were probably caught with hook and line or with spears (John Johnson, personal communication, 1987).

What is the significance of this assemblage of fish remains for understanding prehistoric adaptations in the Goleta area? Glassow (1975) has developed a model of maritime resource exploitation based on energy efficiency. His model is similar to a general patch choice model of optimal foraging theory (E. A. Smith 1983) in that resource zones are ranked in terms of the energy required for their exploitation. Glassow ranks these habitats from less to more expensive in the following order: the intertidal zone, the

surf zone, the rocky offshore zone, the kelp zone, the channel surface zone, and the greater pelagic zones. The presence of kelp bed and deepwater fishes suggests a relatively late maritime adaptation, including the "more expensive" marine resource zones, according to Glassow's model.

In summary, the fish remains from SBA-142 are largely derived from estuary or nearshore environments. The presence of soupfin shark, lingcod, sheephead and giant kelpfish imply exploitation of a wider range of habitats, particularly the kelp beds. This is a pattern typical of Middle period (C. D. King 1981) or Early Canalifo (D. B. Rogers 1929) sites in the Goleta area (Bowser 1984; John Johnson, personal communication, 1988). Although the small sample sizes limit the reliability of intrasite spatial analysis, some of the species typical of later time periods, particularly sheephead, are more common in the upper levels of pit 17.

#### RADIOCARBON DATES

In order to determine if a younger component existed at SBA-142, two samples from the 6 to 12 inch levels, one each from pit 17 and 18, were selected for further radiocarbon analysis. These levels were selected for two reasons. First, all the radiocarbon dates from the initial analysis (Owen et al. 1964:477) were selected from deeper levels, three from the 12 to 18 inch level, one from the 24 to 30 inch level. Samples from stratigraphically higher excavation levels should yield younger dates if there is a later overlying deposit.

Second, the uppermost level of pit 18 was disturbed, yielding little prehistoric material. In fact, Owen et al. (1964:471) state that "the major part of the first 6 inches was an accumulation of recent debris: cement, metal, wood, etc. As a matter of fact, the first level of pit 18 was practically devoid of aboriginal material."

Both of the recent radiocarbon samples were submitted to Beta Analytic, Inc., yielding dates of  $1490 \pm 80$  BP (Beta-25150) and  $4490 \pm 80$  BP (Beta-25151) (table 6.1). The younger, Middle period phase M3 (C. D. King 1981) date was derived from a sample of three well-preserved *Chione* spp. valves. The older, early period phase Eyb date was derived from a sample of 13 pieces of shell, 9 of which were heavily weathered. The discrepancy between these two dates probably is a result of the mixing of older and younger shell in the second sample.

#### COMPARISON WITH CONTEMPORANEOUS SITES

Is Glen Annie typical of other Millingstone horizon sites in the Santa Barbara area? Few of the numerous other sites in the greater Santa Barbara area containing Millingstone horizon components have been radiocarbon dated, and there is little quantified subsistence information from these sites. Of the many archaeological sites in the area immediately surrounding the Goleta Slough, several of which contain Millingstone horizon components, only a few have radiocarbon dates or quantified subsistence data.

SBA-46, on Mescalitan Island, has yielded a date of over 9000 years RYBP. However, since little cultural material is associated with this date, it may be anomalous (Erlandson 1988a:304).

SBA-56 is due east of the Glen Annie site on the northern shore of the ancient lagoon and has yielded dates of 6620 RYBP and 6700 RYBP (Breschini et al. 1990:37). D. B. Rogers (1929:156-157) noted the presence of both Oak Grove and Canalifo occupation here. Gerstle and Serena (1982) published a brief analysis of material from this site, including a detailed analysis of shellfish remains from a column sample. Although the sample size was quite small, the Oak Grove faunal material was similar to that from Glen Annie, including a high percentage of estuarine shellfish. No quantified vertebrate faunal data are available from this site.

SBA-143 (Colten 1987) is a multicomponent site located less than a mile to the north of the Glen Annie site. The older component yielded a date of 6620 RYBP, roughly contemporaneous with the older Glen Annie occupation. Faunal data suggest an adaptation with an emphasis on shellfish, although vertebrates are also present. Animal species represented are similar to those from Glen Annie, and change through time in shellfish remains is similar to that exhibited at Glen Annie and other Goleta area sites (Colten 1989). As with many California archaeological sites, information on floral resources is unavailable.

Tecolote Canyon, about 10 km west of the ancient Goleta Slough, contains sites spanning the prehistory of the region. SBA-71, D. B. Rogers's (1929: 181-187) Winchester No. 3, has an Oak Grove component. Recent analysis has yielded a date of approximately 7000 RYBP, but no other data concerning early ecological adaptations at the site are currently available (Jon Erlandson, personal communication, 1990).

SBA-5, D. B. Rogers's (1929:46) Bailard site, located in Carpinteria about 25 miles southeast of the Goleta area, has a Millingstone horizon component including manos and metates. Recent radiocarbon analyses (Nan Deal and John Johnson, personal communication, 1990) include dates in excess of 7,000 years. Staff and volunteers at the Santa Barbara Museum of Natural History are currently analyzing midden from an excavation unit from this site, and subsistence data should be available in the near future.

SBA-9 is another Millingstone site in Carpinteria with dates over 7000 BP. No quantified subsistence data from this site are available at this time (Erlandson 1988a:296-298).

#### GLEN ANNIE IN BROADER PERSPECTIVE

What do these data tell us about prehistoric subsistence adaptations, site structure and chronology at SBA-142 and about Early Holocene adaptations in the Santa Barbara area? Clearly the inhabitants of Glen Annie exploited a diverse array of resource zones. These new data demonstrate that fish were obtained from estuary, near shore, and kelp bed habitats, a pattern more typical of Middle Holocene sites than Millingstone horizon adaptations, as described by Wallace (1955).

The distribution of shellfish remains (Owen et al. 1964:495), soapstone artifacts (Owen et al. 1964:489), and the ratio of bone to shell (Erlandson et al. 1988) suggest the superposition of a later component at this site, a hypothesis supported by the recent radiocarbon analyses.

Although Owen erred in considering Glen Annie the type site for Oak Grove, he was correct in describing the Millingstone horizon as including a marine adaptation. Recent analyses of Early Holocene sites west of Glen Annie (Erlandson 1988a:386) show that shellfish and fish were part of the subsistence base 8,000 years ago. Data from other Early Holocene sites, such as Eel Point on San Clemente Island (chap. 5, this vol.) and Daisy Cave on San Miguel Island (chap. 8, this vol.) also indicate that marine resources were important in the earliest occupation of the southern California coast.

Many archaeological sites along the California coast contain multiple components; it is not surprising that the analysis of the Glen Annie material did not differentiate between the two occupations. A similar situation occurred at the Little Sycamore site,

VEN-1, another multicomponent site (Wallace 1954; Wallace et al. 1956) originally believed to typify the Millingstone horizon. This site was later radiocarbon dated and shown to have a Mid-Holocene component and differences in burial practices through time (C. D. King 1967:61).

The name Millingstone horizon implies a true "horizon" in the classic sense of the cultural historical approach—a group of prehistoric cultures with similar artifact assemblages that are roughly contemporaneous. As the research discussed in this volume demonstrates, the Millingstone horizon includes considerable variability in ecological adaptations and spans a considerable time period. The unifying aspect is the presence of manos and metates and a gathering economy supplemented by hunting and fishing. As Warren (1968) noted, the Millingstone horizon is perhaps best considered a "tradition" in the terminology of culture history—the long-term persistence of technological forms.

Wallace (1955) intended his chronological scheme to help archaeologists order their data and to stimulate research. Wallace's definition of the Millingstone horizon is still an important concept in California archaeology, even after 35 years. Although Glen Annie should no longer be considered the "type site" for the Millingstone horizon, it has continued to yield data relative to our understanding of Early Holocene adaptations.

#### ACKNOWLEDGMENTS

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## Chapter 7

### Shellfish and Seeds as Optimal Resources: Early Holocene Subsistence on the Santa Barbara Coast

Jon M. Erlandson

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**R**ecent syntheses of the evolution of human subsistence (Cohen 1977; Osborn 1977; Hayden 1981) have suggested that shellfish and small seeds require a high energy expenditure compared with their nutritional yield and were "last resort" resources turned to relatively late in prehistory or during periods when other resources were scarce. In contrast, the traditional view (e.g., Wallace 1955:220; Warren 1967b; Glassow et al. 1988) of California's coastal Millingstone horizon proposes that Early Holocene groups relied heavily on precisely these resources. In a concise summary of Early Millingstone subsistence, Claude Warren stated:

... the collecting of seeds was nearly as important to the economy as shellfish collecting, and perhaps more so. The numerous milling stones and shell middens are prime indicators of these activities at these sites. Fishing and the hunting of land or sea mammals all appear relatively unimportant to the economy, if the few quantitative analyses of middens and the field observations recorded can be considered valid. These observations seem to be substantiated by the

relatively rare occurrences of hunting and fishing equipment in Milling Stone horizon sites. [Warren 1967b:235]

This gathering or "collecting" model of subsistence has been applied to early hunter-gatherers occupying the California littoral from northern Baja California to San Luis Obispo County between roughly 7,000 and 9,500 years ago (e.g., Moriarty 1966:21; Greenwood 1972). If this reconstruction is correct, it contradicts some general theories of the evolution of human subsistence and the economics of marine resource exploitation (Erlandson 1988a: 402) since supposedly "high yield" terrestrial hunting pursuits do not appear to have intensified significantly until the Middle Holocene.

It has been suggested that the traditional view of Millingstone subsistence might not be entirely accurate. Owen (1964:212) used data from the Glen Annie Canyon site (SBA-142) to suggest that fishing and hunting were more important during the Millingstone horizon than previously recognized. Conversion of Owen et al.'s (1964) shell and bone weights to meat and protein yields supports this view, sug-

gesting that vertebrates contributed roughly 80% of the animal protein consumed at Glen Annie (Erlandson 1988a:301). However, a recent reanalysis of the SBA-142 assemblage (including new  $C^{14}$  dates) identified a Middle period component at the site, including intrusive faunal elements mixed into the Millingstone assemblage (Erlandson et al. 1988; chap. 6, this vol.).

Elsewhere, Koerper (1981:392) and his colleagues (Drover et al. 1983) have suggested that hunting and fishing provided the bulk of animal protein during the Millingstone horizon at ORA-64, located on the perimeter of upper Newport Bay on the Orange County coast. Their research demonstrates the eclectic nature of early economies, but their conclusions appear to be based on faunal data from both Early and Late Millingstone components and possibly from a more recent ceramic component. Furthermore, the faunal data from ORA-64 have not been converted to nutritional yields, and sampling methods prevent an accurate estimate of the importance of various faunal classes. Koerper et al. (chap. 4, this vol.) also document a diversified hunting and fishing economy for Millingstone groups at SDI-9649, though the dietary contribution of various faunal classes remains unclear.

Between 1984 and 1988, I directed excavations at three Early Holocene middens on the western Santa Barbara coast dated between 7,800 and 8,800 years ago. These three sites appear to represent different aspects of an Early Holocene settlement system and provide a unique opportunity to reconstruct the subsistence economy of Early Millingstone groups on the western Santa Barbara coast. In this chapter, I use data from these three middens to examine previous models of Early Millingstone subsistence, the role of shellfish in prehistoric economies, and the development of coastal adaptations. More detailed discussions of my excavation and analytical methods, as well as my results and interpretations, are presented elsewhere (Erlandson 1988a).

#### THE SITES AND THE SAMPLES

The three shell middens are located in the catchments of adjacent canyons on Hollister Ranch<sup>1</sup> approximately 50 km west of Santa Barbara and from 1 to 4 km west of Gaviota (fig. 7.1). In this area, the coastal plain is very narrow and rises rapidly into the foothills of the Santa Ynez Mountains. The relatively steep

gradient from coast to mountain crests provides access to a variety of habitats and resources within linear distances of less than 5 km. The shoreline of the western Santa Barbara coast is relatively straight and is dominated by high sea cliffs fronted by broad, rocky intertidal platforms. The high cliffs are punctuated periodically by stream canyons which often form shallow bays with sandy beaches. The mouths of the larger drainages often contain small marshes just behind the beach—small seasonal marshes at the mouths of intermittent streams and larger freshwater marshes for perennial streams. Significantly, none of the coastal drainages within 50 km of my study area support a productive estuarine fauna.

#### SBA-1807

SBA-1807 is a large Millingstone horizon site located west of Cañada de Alegria at the north end of a narrow coastal plain. The site once covered an area at least 150 x 250 m wide, including a shell midden encompassing about 16,000 m<sup>2</sup>. Fifty-one test units (42 m<sup>3</sup>) were excavated at the site, with approximately 15 m<sup>3</sup> removed from the shell midden. Eight units from various site areas were the subject of detailed faunal analyses and form the basis of my dietary reconstruction for the site. The size and complexity of the site, along with the density and diversity of the recovered archaeological remains, suggest that SBA-1807 served as a residential base. A suite of radio-carbon dates indicate that the site was occupied sometime between 8,300 and 8,800 years ago (table 7.1).

Through a combination of surface collection, test unit excavations, and intensive monitoring of mechanical trenching through peripheral portions of the site, a large artifact assemblage was recovered from SBA-1807. Pecked or ground stone artifacts recovered include 110 whole or fragmentary manos, 30 metate fragments, and a plummet-shaped charmstone. Hammerstones also were abundant, especially flaked and battered core hammers probably associated with the manufacture and maintenance of manos and metates (see C. D. King 1967). Only nine bifaces were recovered, none with diagnostic bases, including four probable biface preform fragments. Other chipped stone artifacts include 25 cores or core fragments, 52 retouched or utilized "flake tools" from the test units alone, a crude biconical drill, and a debitage assemblage dominated by Monterey chert

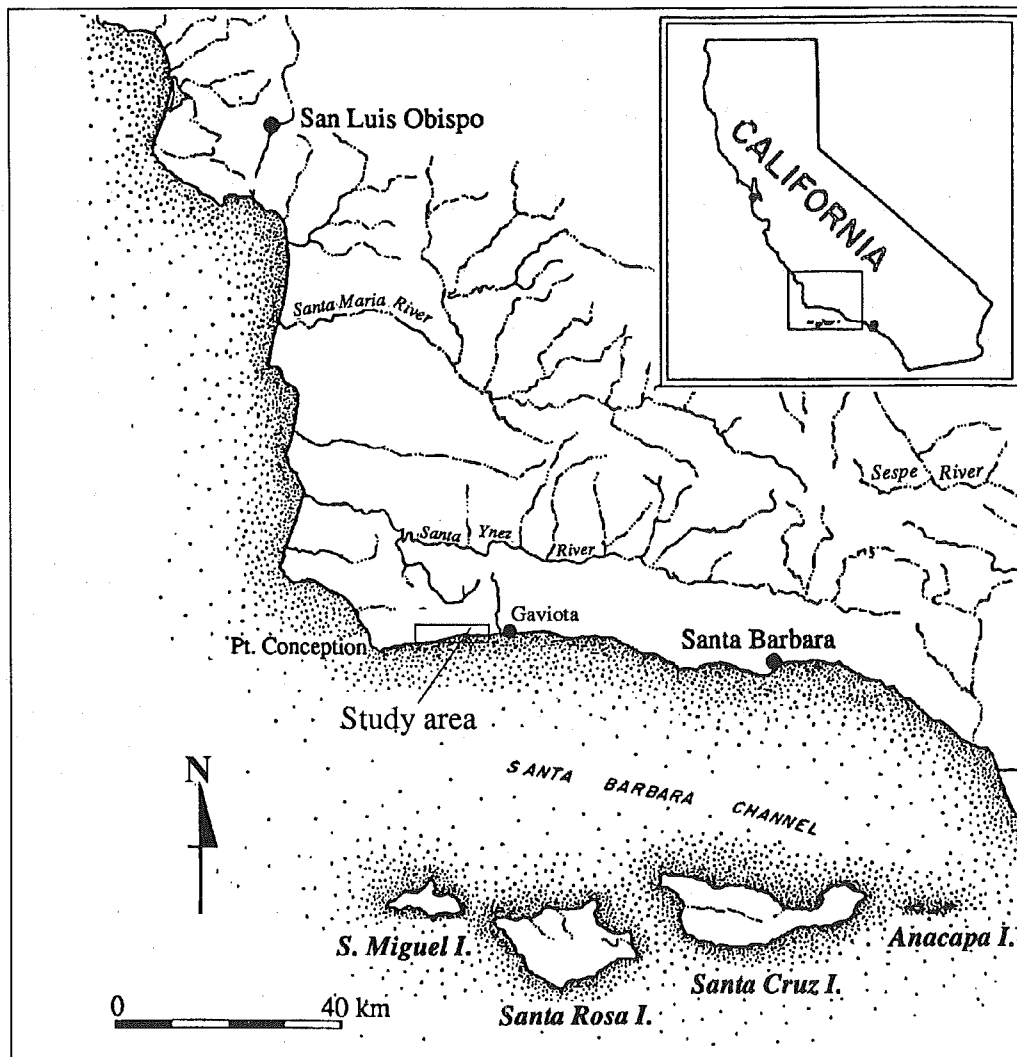


Figure 7.1. The study area and Santa Barbara Channel region.

flakes and angular debris. Fourteen small pieces of obsidian debitage were recovered, 11 of which were large enough to source. Nine of these came from the Coso Volcanic Field in Inyo County and two from an undocumented source (R. Hughes, personal communication, 1987). Hydration bands for the Coso obsidian artifacts varied between 5.4 and 6.6 microns, with a mean of 5.8 microns (T. Origer, personal communication, 1987). The limited thickness of the hydration bands may indicate that the site was used as a source of lithic material by later groups retooling their equipment (Erlandson 1988a:114).

Typical of Early Millingstone horizon sites, few shell or bone artifacts were recovered at SBA-1807. Only one definite shell artifact was found, a biconically drilled clam shell disc bead about 7.5 mm in diameter. Also recovered were nine whole or fragmentary *Olivella* shells that may represent detri-

tus from the manufacture of shell beads. Though no *Olivella* beads were recovered, they are known from other Early Holocene contexts on the California coast (Kaldenberg 1982; chap. 4, this vol.). Only three bone artifacts were collected at SBA-1807, all medial fragments of abraded bone splinters made from dense mammalian cortical bone. The fragmentary nature of these tools makes functional interpretation difficult, though they may be fragments of fish gorges similar to the bone bipoints recovered by Rozaire (1978) in the Early Holocene layers of Daisy Cave (SMI-261) on San Miguel Island (Snethkamp 1987).

Horizontally, various midden constituents were not distributed evenly across the SBA-1807 landscape (table 7.2). Since  $C^{14}$  dates from various site areas are similar, the differential distribution of midden constituents seems to be related to the spatial organization of activities by the site occupants. For

Table 7.1. Radiocarbon Chronology for Three Early Holocene Shell Middens

Site	Unit	Level (cm)	Uncorrected C <sup>14</sup> date	Calendar age (BP)*	C <sup>14</sup> Lab no.	Dated material
1807		surface	6340 ± 80 <sup>a</sup>	7065 ± 89	Beta-10736	<i>Polinices</i> fragment
1807	W2	20-30	7720 ± 90	8380 ± 98	Beta-10228	Mixed shell
1807	12	100-120	7770 ± 100	8390 ± 107	Beta-12950	<i>Saxidomus</i> fragment
1807	W2	30-40	7830 ± 70	8445 ± 80	Beta-12347	Mixed shell
1807	12	80-100	7840 ± 110	8420 ± 115	Beta-12949	Mixed shell
1807	12	120-140	8000 ± 110	8630 ± 116	Beta-12951	<i>Saxidomus</i> fragment
1807	10	40-60	8600 ± 125	8960 ± 131	Beta-16171 <sup>b</sup>	<i>Chione</i> fragment
1807	17	0-20	40,500 ± 1200 <sup>a</sup>	Not available	Beta-16172 <sup>b</sup>	Pelecypod fragment
2057	-	400	7550 ± 100	8085 ± 106	Beta-17753	<i>Saxidomus</i> fragment
2057	-	400	7630 ± 95	8195 ± 101	UM-1464	<i>Chione</i> shell
2057	-	400	7990 ± 100	8585 ± 106	USGS-535	<i>Chione</i> shell
2061	6	20-40	7300 ± 110	7925 ± 116	Beta-21001	<i>Chione</i> fragments
2061	6	80-100	7380 ± 110	8000 ± 116	Beta-21002	<i>Chione</i> fragments
2061		backdirt	7590 ± 110	8180 ± 116	Beta-21000	<i>Saxidomus</i> fragment
2061		backdirt	7610 ± 110	8200 ± 116	Beta-18533	<i>Saxidomus</i> fragment

\* Corrections follow Stuiver et al. (1986).

<sup>a</sup> Beta-10736 may be anomalous; Beta-16172 dates fossil shell.

<sup>b</sup> Accelerator Mass Spectrometry (AMS) dates include correction for isotopic fractionation.

Table 7.2. Density of Various Midden Constituents at SBA-1807\*

Midden constituent	CMA (3.7 m <sup>3</sup> )	SMP (11.2 m <sup>3</sup> )	SE locus (27.4 m <sup>3</sup> )	Site total (42.3 m <sup>3</sup> )
Faunal remains				
Shellfish (kg)	1.85	0.13	0.004	0.20
Fish bone (g)	1.73	0.23	0.01	0.21
Other bone (g)	20.04	6.08	5.56	11.63
Artifact frequencies (number)				
Manos (8)	0.27	-	0.26	0.19
Hammerstones (16)	0.54	0.09	0.47	0.38
Bifaces (4)	-	0.09	0.07	0.07
Flake tools (52)	3.06	0.98	1.13	1.23
Cores (25)	0.54	0.27	0.73	0.59
Debitage (1276)	198	68	128	143
Obsidian (14)	1.08	0.54	0.22	0.38
Bone tools (3)	0.54	0.09	-	0.07
Shell artifacts (10)	1.35	0.27	0.04	0.21

\* Per m<sup>3</sup>, based on 1/8-inch screening of test units. CMA = Central midden area; SMP = Southern midden periphery; SE locus = Southeast locus.

instance, the central midden area, located in the north and west portions of the site, contained relatively high densities of shell and bone and the highest densities of most artifact types. Despite limited excavation in this area, the diversity of artifact types was high. The density and diversity of midden constituents in the central midden area suggests that it was the main residential portion of SBA-1807.

In contrast, the density and diversity of midden remains in the southern midden periphery was limited. Despite the excavation of numerous test units and a pipeline trench across this area, no ground stone tools or burned rock clusters were found. This suggests that the southern midden periphery functioned primarily as a secondary refuse area. In the southeast site area, ground stone tools, hammers, and debitage were abundant, despite very low shell densities and moderate bone densities. This area may have served as a discrete activity area for tool manufacturing and maintenance, as well as for seed processing and other limited food preparation.

An extensive faunal assemblage was recovered from SBA-1807, including more than 8.4 kg of shell. The remains of 27 shellfish taxa were identified (Erlandson 1988a:149), but the assemblage is dominated by the estuarine clams *Saxidomus nuttalli* (28.5%), *Chione* spp. (20.1%), *Sanguinolaria nuttalli* (6.9%), *Protothaca staminea* (6.5%), and *Tagelus californianus* (4.2%). Among the identifiable shell, at least 92% comes from taxa common in estuaries of southern California. In contrast to the relatively abundant shell, only 9.03 g of fish bone were recovered in the 1/8-inch screen residuals from the test units at SBA-1807; the processing of column samples over 1/16-inch mesh showed that as much as 87% of the fish bone recovered had passed through 1/8-inch screen, seriously biasing the assemblage. Not surprisingly, many of the identified fish inhabit bays and estuaries, including elasmobranchs like the bat ray (*Myliobatis californica*), thornback (*Platyrrhinoidis triseriata*), shovelnose guitarfish (*Rhinobatos productus*), and round stingray (*Urolophus halleri*). Identified teleost fish include anchovy (Engraulidae), barracuda (*Sphyraena argentea*), pile perch (*Damalichthys vacca*), queenfish (*Seriphus politus*), black surfperch (*Embiotoca jacksoni*), dwarf surfperch (*Micrometrus minimus*), rockfish (*Sebastes* sp.), sardine (*Sardinops* sp.), sculpin (Cottidae), sheephead (*Pimelomepoton pulchrum*), white croaker (*Genyonemus lineatus*), white sea bass

(*Atractoscion nobilis*), yellowtail (*Seriola dorsalis*), and possibly steelhead (*Salmo gairdnerii*).

A sample of 107 g of other vertebrate (nonfish) remains was analyzed, including bone from test units in all three major site areas. Unfortunately, the other vertebrate bone was fragmented severely and difficult to identify. Identified taxa include ground squirrel (*Spermophilus beechyi*), wood rat (*Neotoma fuscipes?*), mole (*Scapanus latimanus*), deer mouse (*Peromyscus* sp.), meadow mouse (*Microtus californicus*), pocket mouse (*Perognathus californicus*), brush rabbit (*Sylvilagus bachmani*), pocket gopher (*Thomomys bottae*), weasel (*Mustela frenata*), domestic cow (*Bos taurus*), and the pond turtle (*Clemmys marmorata*). Many of these, especially the rodents and cow, clearly are intrusive in origin, representing natural or recent introductions into the midden. Among the less specific classes of mammals identified were the remains of large, medium, and small land mammals, along with small amounts of pinniped and other sea mammal bone. Snake, amphibian, and both large and small bird remains also were identified, although each made up less than 1% of total bone weight.

#### SBA-2057

SBA-2057 is a small shell midden located 1 km north of the current shoreline in the bottom of Cañada de la Agua Caliente. Here, a thin midden lens (between 2 and 20 cm thick) is exposed in the creek bank, buried beneath 3 to 4 m of stratified alluvium (fig. 7.2). The midden formed in a very weakly developed soil built in fluvial sediments and appears to have been buried shortly after site abandonment. This inference is supported by the lack of fragmentation among fragile midden constituents, the limited evidence for bioturbation or other disturbance processes, and the presence of articulated shell valves and sardine vertebrae in the midden. As well as protecting the site from extensive weathering and bioturbation, the overlying sediments prevented the mixing of the site contents with refuse from later occupations or the natural bone accumulations typical of many surface sites of the area. Despite excellent preservation of constituents within the midden remnants, the site has been damaged extensively by erosion caused by changes in the course of Agua Caliente Creek. Stream erosion has removed an unknown amount of the northern and eastern portions of the midden.

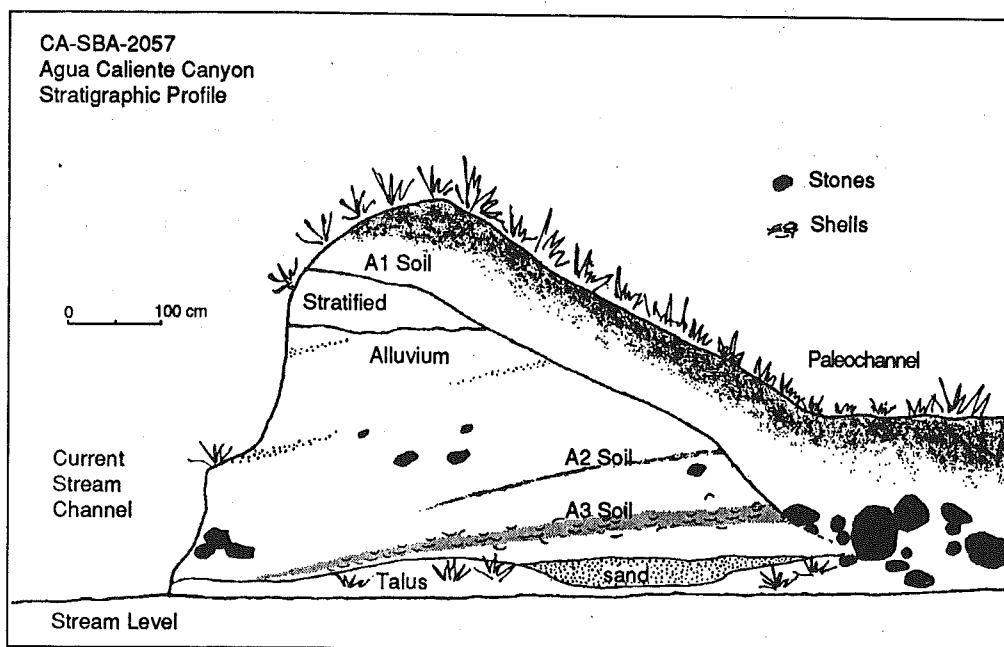


Figure 7.2. Stream bank stratigraphic profile, SBA-2057.

Only limited investigations have been conducted at SBA-2057.<sup>2</sup> The site was first identified as a paleontological locality by geologists from the United States Geological Survey and the Los Angeles County Museum of Natural History. Suspecting that the locality was a buried midden, I collected a small sample of the site matrix in 1986 and recovered small amounts of chipped stone debitage, confirming the cultural origin of the deposit. In 1987, I profiled the stream bank and collected two small midden samples of approximately 3,000 cm<sup>3</sup> each, which were water-screened over 1/16-inch mesh and analyzed in detail. They provide the data for my dietary reconstruction (Erlandson 1988a). The average age of three C<sup>14</sup> samples from SBA-2057 is approximately 8290 CYBP (table 7.1).

Though a number of pieces of debitage were recovered in the small midden samples, the only tools found during my 1986-87 investigations were a single metate fragment and a small bladelet that appears to have been used as a graver or other precision cutting implement. No artifacts of obsidian or other exotic materials have been recovered at SBA-2057, possibly due to the small size of the samples collected.

The faunal assemblage from SBA-2057 is dominated by shell, with 1,772.3 g in the two midden samples. The remains of estuarine taxa again domi-

nate the shellfish assemblage, the major contributors being *Saxidomus nuttalli* (46.1%), *Sanguinolaria nuttalli* (28.2%), *Ostrea lurida* (5.9%), *Chione undatella* (5.3%), and *Protothaca staminea* (4.8%). Limited amounts (7.62 g) of fish remains were recovered in the small midden samples. Most of these (85%) consist of small unidentifiable bone fragments, though the remains of bat ray, thornback, halibut (*Paralichthys californicus*), specklefin midshipman (*Porichthys myriaster*), pile perch, surfperch, sardine, spotfin croaker (*Roncadora stearnsi*), and white sea bass have been identified. Other vertebrate remains also were scarce (5.51 g), highly fragmented, and difficult to identify. The only identifiable land mammal was the pocket gopher, though undifferentiated bird, rodent, small mammal, and medium/large mammal remains also were recovered.

The small size of SBA-2057 and the limited soil development in the midden stratum suggest that it served as a short-term campsite, possibly occupied for a single season. Despite the apparently limited period of site use, midden constituent densities are comparatively high (table 7.3), partially because of the lack of the extensive bioturbation that has diluted densities at the two surface sites. The location of the settlement on the active floodplain of Cañada del Agua Caliente suggests that it was occupied during the dry season, probably during the summer or fall.

Table 7.3. Attribute Comparison for Three Early Holocene Sites

Variable	SBA-1807	SBA-2057	SBA-2061
Environmental			
Landform type	Canyon rim	Valley floor	Canyon rim
Elevation	30-50 m	16-17 m	35-45 m
Stream type	Perennial	Perennial	Intermittant
Km to -15m isobath	About 1.0	About 2.0	About 1.0
Soil context	Surface	Buried	Surface
Size and density			
Estimated site size	35,000 m <sup>2</sup>	1000 m <sup>2</sup>	7,500 m <sup>2</sup>
Average midden depth	120 cm	10 cm	100 cm
Estimated volume	42,000 m <sup>3</sup>	100 m <sup>3</sup>	7,500 m <sup>3</sup>
Shell density (wt/m <sup>3</sup> )	7.11	439.8	3.14
Bone density (wt/m <sup>3</sup> )	.112	4.0	0.06
Debitage density (number/m <sup>3</sup> )	0.34	4.0	0.17
Estimated dietary yields (%)			
Shellfish	59.3	77.3	94.4
Fish	15.4	17.5	2.4
Sea mammal	0.6	trace	0.1
Other vertebrates	24.7	5.2	3.2
Vertebrate total	40.7	23.7	5.6
Minimum marine component	75.3	94.8	96.9
Other faunal attributes			
1/16" shell to bone ratio	59:1	135:1	477:1
Burned bone	15.0%	24.2%	7.3%
1/16" shell	37.3%	6.5%	55.1%
1/16" bone	65.2%	65.1%	74.0%
Mean 1/8" bone (wt)*	.105	.112	.130
Inferred site function	Residential base	Dry season campsite	Specialized activity site

Note: Weights in grams; density and protein estimates based on 1/16-inch mesh recovery, except debitage at SBA-1807 and -2061; density figures are maxima; mean bone weight for large/medium mammal remains only.

### SBA-2061

SBA-2061 is located at the northern margin of the narrow coastal plain on the rim of a small unnamed drainage between Cañada de la Agua Caliente and Cañada de la Gaviota. Four C<sup>14</sup> dates indicate occupation between circa 7,800 and 8,300 years ago. The site encompasses an area roughly 75 x 100 m wide (7,500 m<sup>2</sup>), including a central midden area of roughly 1,600 m<sup>2</sup>. Just under 7 m<sup>3</sup> of sediment were excavated at the site, including two 25 x 25 cm column samples. Artifacts also were collected from the site surface, a trench cut across the long axis of the site, and extensive grading spoils.

Over 1,000 fragments of chipped stone debitage were recovered in our test units, but very few tools were found at SBA-2061. Despite a careful search of extensive trench profiles and grading spoils, only four mano fragments, five cores, three hammerstones, and two flake tools were recovered. The only evidence for long-distance trade by the site occupants was found in the form of five small obsidian flakes recovered from the test units. Four of these large enough to source were found to come from the Coso Volcanic Field (R. Hughes, personal communication, 1987). Hydration rinds on these ranged from 2.6 to 5.4 microns, with a site mean of 3.8 microns (T. Origer, personal communication, 1987). The

only other possible artifacts identified were a few fragments of *Olivella* shell that may represent bead refuse.

As was the case at the two other early sites, the faunal assemblage was dominated by the remains of estuarine shellfish. Of the 2.2 kg of shell analyzed, 78% of the total and nearly 93% of the identifiable shell came from taxa common in southern California estuaries. At SBA-2061, shellfish remains were dominated by *Sanguinolaria* (36.6%), *Chione* (18.3%), *Saxidomus* (12.0%), *Protothaca* (6.0%), *Tresus nuttalli* (2.4%), and *Polinices lewisii* (1.9%), with 15.6% of the assemblage unidentifiable.

Only 32 fragments of fish bone weighing 2.12 g were recovered from the excavated units at SBA-2061, including column 6. A large proportion (59% by weight) of the fish remains consist of shark teeth—most of which appear to be of fossil origin—derived from the weathered Monterey shale that lies under and upslope of the site. Of the fish remains that are clearly cultural in origin, jacksmelt (*Atherinopsis californiensis*), queenfish, rainbow surfperch (*Hypsurus caryi*), shiner surfperch (*Cymatogaster aggregata*), spotfin surfperch (*Hyperprosopon anale*), white croaker, and white sea bass were the only taxa identified (Erlandson 1988a:233; R. Huddleston, personal communication, 1989).

Excluding fish remains, 335 bone fragments weighing 18.21 g were recovered. Once again, the bone assemblage was fragmented and difficult to identify. Rodents constitute nearly 49% of the bone weight, including the pocket gopher which contributes almost 21%. After rodents, the most abundant mammalian classes (by weight) are small mammal (16.4%), undifferentiated mammal (13.7%), undifferentiated land mammal (9.2%), large terrestrial mammal (6.8%), and sea mammal (2.4%).

The density and diversity of artifacts and faunal remains recovered at SBA-2061 is relatively low, suggesting that the site was either occupied for a limited period, functioned as a specialized subsistence camp, or both. The location of the site adjacent to a small intermittent stream suggests that it was not occupied during the dry summer or fall months when water sources are restricted. A winter or early spring occupation seems more likely, this being a period when shellfish are abundant but availability of alternative terrestrial and marine resources is limited (Erlandson 1988a:237).

## PALEOECOLOGICAL CONTEXT OF THE SITES

The shellfish remains recovered from SBA-1807, -2057, -2061, and other early sites of the western Santa Barbara coast indicate that the structure of Early Holocene coastal habitats in the area was very different from the modern coastal geography. Between 8,000 and 9,000 years ago, sea levels appear to have been 10 to 15 m lower than at present and rapidly rising (Inman 1983:9). Submarine contours on bathymetric charts for my study area suggest that the open coast may have been between 500 and 1,200 m south of the modern shoreline during this time, an inference supported by independent lines of evidence (Erlandson 1988a:186). Consequently, prior to the sea level rise and marine erosion of the last 8,000 years, the coastal plain of the Early Holocene was considerably wider than it is today. The dominance of estuarine shellfish remains in early sites of the study area indicates that rich intertidal sand and mudflat habitats existed at the mouths of local drainages during the Early Holocene. These estuarine habitats appear to have been located at the head of marine embayments formed at the mouths of coastal canyons by rapidly rising sea levels (Hudson 1977; Inman 1983; Erlandson 1985). Sea level rise enriched the productivity of Early Holocene intertidal habitats by increasing the total length of the coastline and forming productive estuaries at the head of many canyons along the protected Santa Barbara coast. Between roughly 6,500 and 9,000 years ago, these estuaries appear to have supported a diverse and productive array of plant and animal resources and were a magnet for human settlement.

Geologically speaking, however, the estuaries of the western Santa Barbara coast appear to have been relatively ephemeral features, with no known shell middens dating after 6,500 years ago containing a major estuarine component. Farther east, large estuaries persisted throughout the Holocene and continued to support dense human settlement into the historic period. For other parts of the California coast, it should be noted that the formation of productive coastal estuaries was not universal during the Early Holocene. Many shellfish assemblages recovered from early sites of the Channel Islands and the coastal areas north of Point Conception contain little or no evidence for the existence or exploitation of a productive estuarine fauna.



## DIETARY RECONSTRUCTIONS

Reconstructing the contribution of various animals to the human diet was the ultimate goal of the faunal analysis at each of the three Early Holocene middens. Three primary problems that have plagued California archaeologists for years had to be controlled for in order to reach relatively accurate reconstructions: (1) differentiation between faunal remains of natural and cultural origin, (2) correction for the differential loss of faunal classes in standard screen sizes, and (3) conversion of shell and bone weights into meaningful nutritional units. Other problems have yet to be adequately compensated for (Erlandson 1988a:407-410), so the reconstructions should be viewed with caution. Elsewhere, I have argued that my site-specific dietary reconstructions should be interpreted as very general approximations, but that intersite comparisons of such data can identify broad patterns of spatial and temporal variation in subsistence (Erlandson 1989).

### Methods

Standard field and laboratory methods at SBA-1807 and SBA-2061 included water-screening of all  $1/8$ -inch field screen residuals, with careful laboratory sorting to insure recovery of small shell and bone fragments commonly lost by sorting in field screens. Column samples 25 x 25 cm in diameter were removed from representative test units and water-screened over  $1/16$ -inch mesh. Faunal remains from these columns were used to correct for the percentage of each faunal class lost by  $1/8$ -inch screening. These correction factors varied at each site, depending on the faunal taxa present and the formation processes that affected each assemblage (table 7.3). In column 6 at SBA-2061, for instance, 55% of the shell, 100% of the fish bone, and 73% of the other vertebrate remains were recovered from the  $1/16$ -inch fraction. In contrast, in the two samples from SBA-2057, 6% of the shell, 78% of the fish bone, and 65% of the other vertebrate bone was recovered in  $1/16$ -inch mesh.

While a few fossil shell fragments and shark teeth were identified among the faunal assemblages, distinguishing between faunal remains of biological versus cultural origin was primarily a problem with land vertebrate remains. A careful search of virtually any surface site of the Santa Barbara coast will find

bones of animals recently expired on or below the surface. Identifying noncultural bone is particularly critical at Early Holocene shell middens located on marine terraces (like SBA-1807 and SBA-2061), where old and alkaline soils may preserve the bones of biological fauna for millennia.

Since the severe fragmentation of the mammalian bone prevented study of the skeletal completeness for various taxa, an analysis of burning patterns was used to distinguish vertebrate taxa that were primarily of natural as opposed to cultural origin. Terrestrial vertebrate classes that exhibited low rates of burning (i.e., gophers and other rodents) were assumed to be largely of biological origin and were excluded from the dietary reconstructions. The remains of terrestrial fauna with moderate or high rates of burning were considered to be largely of cultural origin and were treated as food refuse, except for bones of obviously recent origin. Nonetheless, some bone of natural origin is undoubtedly included in the "cultural" categories, so the dietary contribution of land animals may have been overestimated at all three sites.

The conversion of raw archaeological data (MNI or shell and bone weights) into nutritional yields is critical because various faunal classes have very different ratios of edible meat or protein to skeletal weight. Due to the fragmentary and largely unidentifiable nature of the vertebrate remains, nutritional yields were calculated from previously established ratios of dry shell or bone weights to meat and protein weights (table 7.4). The vertebrate conversions are generic and probably mask considerable variety within faunal classes, but they represent the best data currently available.

### Results

The results of my dietary reconstructions for the three Hollister Ranch middens are summarized in table 7.5, along with approximations for the nutritional yields of  $1/8$ -inch midden samples from two other Early Holocene sites of the southern California coast: SCRI-109 (Glassow 1985a) and LAN-267 (C. D. King 1967). Based on the available data, the dietary reconstructions indicate that shellfish provided a majority of the animal protein at all five sites. At these sites, shellfish provide between 58% and 90% of the animal protein consumed, with fish, terrestrial mammals, and sea mammals serving as supplemental re-

Table 7.4. Conversions for Nutritional Estimates from Faunal Remains

Genus/species	Meat yield multiplier		Protein multiplier		Primary reference
Mollusca					
<i>Chione</i> ssp.	X	.171	X	.130	Erlandson 1988a
<i>Mytilus</i> sp.*	X	.360	X	.144	Erlandson 1988a
<i>Protothaca staminea</i>	X	.610	X	.135	Erlandson 1988a
<i>Ostrea lurida</i>	X	.292	X	.096	Erlandson 1988a
<i>Sanguinolaria nuttalli</i>	X	1.25	X	.130	Erlandson 1988a
<i>Saxidomus nuttalli</i>	X	.463	X	.130	Dietz et al. 1988
<i>Tagelus californianus</i>	X	1.24	X	.130	Erlandson 1988a
<i>Tivela stultorum</i>	X	.254	X	.112	Fitch 1969:69
<i>Tresus nuttalli</i>	X	1.70	X	.130	Dietz et al. 1986
Fishes (all)	X	27.7	X	.185	Tartaglia 1976
Land mammals (all)	X	10.0	X	.210	Tartaglia 1976
Sea mammals (pinnipeds)	X	24.2	X	.100	Glassow and Wilcoxon 1988

Note: Shellfish protein values are primarily from Sidwell (1981).

\* Based on average of *M. californianus* and *M. edulis* figures.

Table 7.5. Dietary Reconstruction for Early Sites of the California Coast

Faunal taxa	SBA-1807	SBA-2057	SBA-2061	SCRI-109	LAN-267
<b>Protein yield (%)</b>					
Shellfish	59.3	77.3	94.4	90.8	65.1
Fish	15.4	17.5	2.4	5.4	n/a
Sea mammal	0.6	-	0.1	3.8	n/a
Other vertebrates	24.7	5.2	3.2	-	n/a
Vertebrate (total)	40.7	23.7	5.6	9.2	34.9
<b>Other attributes</b>					
Minimum marine component	75.3	94.8	96.9	100.0	65.1
Shell to bone ratio	59:1	135:1	477:1	1121:1	92:1
<b>Radiocarbon age range (CYBP)</b>					
	8300-8800	8300 ± 200	7800-8300	7400-7600	6900-7600

Note: SBA-1807, -2057, and -2061 are based on 1/16-inch mesh recovery, the others on 1/8-inch. Vertebrate values for SBA-2057 inflated slightly by caliche. Data compiled from Erlandson (1988a), Glassow (1985a), and King (1967).

sources. Furthermore, marine resources appear to contribute a minimum of 74% of the animal protein at the four sites where adequate data are available. On Santa Cruz Island, where terrestrial foods are limited (Glassow 1985a), the contribution of marine animals probably approaches 100%. For the mainland sites, the contribution of shellfish and marine resources may be underestimated since the "other vertebrate" category in-

cludes unidentified bone remains that may be partially marine in origin, and the terrestrial vertebrates undoubtedly include some bone of natural origin.

Patterns of burning in the bone assemblages from the three Hollister Ranch sites provide some insight into the latter problem. SBA-2057 contains the highest percentage of burned bone fragments, suggesting that most of the bone is cultural in origin, a conclusion

consistent with the burial of the site not long after abandonment. If the SBA-2057 assemblage from this site is used as a measure of what a midden largely unbiased by the natural accumulation of bone looks like, then SBA-1807 appears to contain a mixture of biological and cultural bone, and the land vertebrate remains at SBA-2061 may be largely of natural origin.

My dietary reconstructions also provide some insight into the function of the three Hollister Ranch sites. The data suggest that the economy at SBA-1807 was diversified, consistent with the conclusion that the site served as a residential base. The SBA-2061 economy appears to have specialized in shellfish collecting, a conclusion supported by the low density and diversity of tools found. This site may have been occupied during the winter months, when the availability of alternative resources was limited. The small sample from SBA-2057 suggests a strong reliance on marine fauna, but the diversity of the economy appears to have been intermediate between SBA-1807 and SBA-2061. SBA-2057 appears to have been a seasonal campsite, and the dietary reconstruction may be consistent with occupation during the dry season, when a greater diversity of faunal resources would have been available.

### DISCUSSION

Estimating the quantitative contribution of plant foods in the Early Holocene diet is much more difficult because plant remains rarely are preserved in the archaeological record. The abundance of manos and metates in Early Millingstone sites, however, suggests that plant foods played an integral role in early economies of the California coast. While archaeologists disagree over the types of plant foods processed with millingstones (Corum 1977:22), it seems most likely that small seeds were the primary plant resource in many mainland areas (Glassow et al. 1988). Though the collection of seeds and other plant foods generally is perceived to be a labor intensive activity, nutritional studies indicate that many native plant foods such as chia, piñon nuts, and acorns are rich in fats and carbohydrates and are excellent sources of calories (Gilliland 1985). However, most of these are relatively poor sources of the complete proteins required to maintain human growth, reproduction, and metabolism (Erlandson 1988b).

Given the relative abundance of milling equipment in most Early Holocene sites, the comparatively low caloric value of shellfish and most fish taxa, and the high caloric yield of chia seeds, piñon nuts, and many other plant tissues, it seems likely that plant foods provided most of the energy requirements of coastal California hunter-gatherers during the Early Holocene. Under such circumstances, relatively small amounts of shellfish or other animal foods would be required to maintain optimum human health. Thus, shellfish could provide a relatively low cost and sustainable source of complete protein to fuel human metabolism, while seeds and other plant foods provided a rich source of energy.

Interestingly, plant foods and shellfish are resources collected primarily by females among most ethnographic hunter-gatherers. Men more often are engaged in hunting or fishing or the manufacture and maintenance of the technology associated with such pursuits. Given the evidence for a secondary role of hunting and fishing in many Millingstone economies, it seems likely that males played an active role in either shellfish collecting or the gathering of plant foods or both. If so, a less rigorous sexual division of labor may have contributed to a more egalitarian society with less social, economic, or political stratification.

My dietary reconstructions also suggest that the Early Holocene groups of the California coast can be classified as maritime hunter-gatherers, populations who derive the majority of their protein or calories from marine resources (Yesner 1980). Given the importance of shellfish and plant foods in these early economies, however, these groups might more appropriately be called "gatherer-hunter-fishers." My evidence suggests that these early groups practiced a mixed economy based on the exploitation of intertidal, terrestrial, and nearshore marine habitats.

### SUMMARY AND CONCLUSIONS

Faunal data from several early southern California shell middens support the traditional view of subsistence during the Millingstone horizon. Throughout much of this region, a subsistence strategy focused on the exploitation of shellfish and plant foods appears to have been established as early as 9,000 to 9,500 years ago. The existence of maritime groups

on the California coast at the inception of the Holocene contradicts earlier assertions about the role of shellfish in coastal economies and the reputedly late development of coastal adaptations. In fact, the data from five Early Holocene sites suggest that systematic shellfish and seed collection predates intensive deer hunting, sea mammal hunting, or fishing along this portion of the California coast. Rather than representing low return resources or starvation foods, the combination of seeds and shellfish may have provided a unique and balanced nutritional strategy. Under conditions of relatively low population density and high intertidal productivity, such an adaptation can be seen as an optimal strategy that minimizes the risk, search time, and technological investment associated with meeting the nutritional requirements of a population.

The dietary reconstructions presented in this study are best viewed as general approximations. The lack of specific conversions for certain taxa, problems inherent in distinguishing natural and cultural bone, and other factors continue to be significant sources of error (Erlandson 1989).<sup>3</sup> As better methods and more data become available, the dietary reconstructions will require adjustment. This should not discourage archaeologists from using similar techniques, however, for they provide a mechanism for the study of spatial and temporal variation in human ecology (Glassow and Wilcoxon 1988; Erlandson 1989). Within a comparative context, nutritional conversions may help identify changes in human subsistence and the function of various sites in a settlement system.

#### ACKNOWLEDGMENTS

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#### NOTES

1. A fourth midden (SBA-96) located at Gaviota also dates to the Early Holocene, circa 8,000 BP (Erlandson 1988c:31). SBA-96 contains multiple components that have been mixed and has been excluded from this paper.

2. In 1989, a 50 x 100 cm test unit was excavated at SBA-2057, and a considerably larger sample of faunal remains and artifacts was collected. No diagnostic tools were recovered, however, and the faunal remains currently are being analyzed. Specific results were not available for this publication.

3. Specific data are needed on bone weight to meat weight ratios for major vertebrate taxa and on seasonal variation among ratios for both shellfish and vertebrates. An especially vexing problem not addressed in this chapter is the possibility that weathering of faunal remains may cause differential weight loss among the skeletal remains of various taxa.

## Chapter 8

### Early Maritime Adaptations on the Northern Channel Islands

Jon M. Erlandson

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**T**he northern Channel Islands of Santa Cruz, Santa Rosa, and San Miguel provide some of the earliest and most tantalizing evidence for the occupation of the California coast. Along with the much smaller Anacapa Island, these islands lie between 20 and 40 km off the Santa Barbara coast (fig. 8.1). This distance was reduced significantly, however, by the lower sea levels of the terminal Pleistocene (Orr 1968:18), when the four islands coalesced to form a single land mass called Santarosae. There is no evidence that a land bridge ever connected Santarosae to the California mainland (Johnson 1972:137), resulting in an impoverished terrestrial flora and fauna. Despite these resource limitations, archaeological sites are abundant, with over 1,000 sites recorded, many of which contain multiple components.

The Channel Islands are important for understanding the development of coastal adaptations because they contain some of California's earliest coastal sites (Meighan 1989; chap. 5, this vol.), and their settlement required seaworthy watercraft and a partially maritime adaptation. Data from the few systematically excavated sites suggest that the Channel Islands were occupied at least 9,000 to 10,000 years

ago—some of the earliest evidence for coastal adaptations in the New World. Despite the length of the cultural sequence, our knowledge of the prehistory of the California islands is limited. In this chapter, I summarize and evaluate the data currently available about the earliest occupants of the northern Channel Islands, focusing on the Early Holocene period, between approximately 7,000 and 10,000 years ago. Though modern archaeological research on the islands has been limited, our knowledge of island chronologies and adaptations may be revolutionized in coming years as further excavations and absolute dating are carried out.

#### MAMMOTH BONES, FIRE AREAS, AND HUMANS?

The earliest putative evidence for the presence of humans on the Channel Islands comes from Pleistocene terrace deposits that contain isolated marine shells found far from the coast, bones of the dwarf mammoth (*Mammuthus exilis*) unique to the Channel Islands, localized patches of reddened sediments that appear to have been burned, and possible stone tools. During the height of the last glacial period,

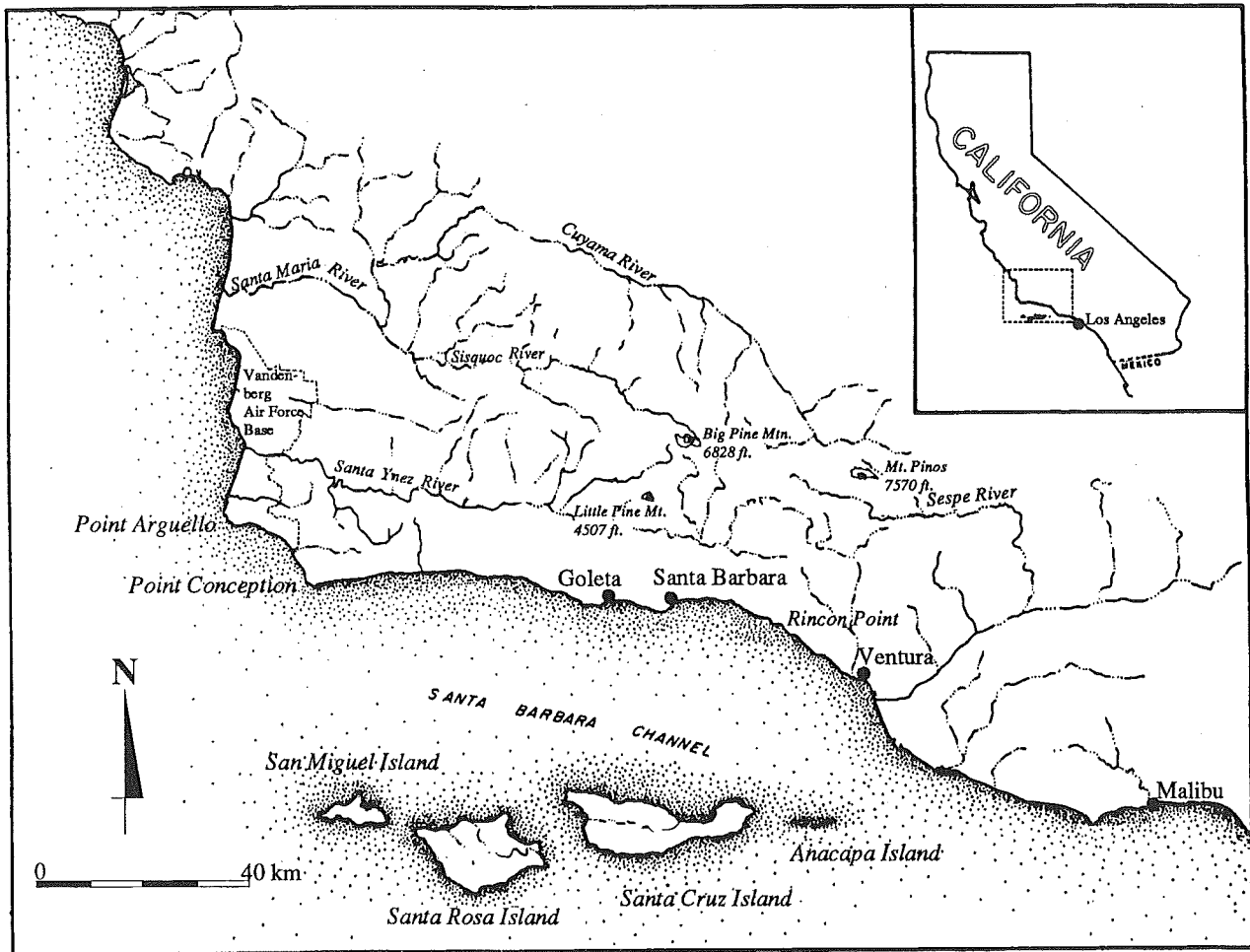


Figure 8.1. The northern Channel Islands and Santa Barbara Channel area.

between 17,000 and 25,000 years ago, the distance between Santarosae and the mainland was reduced to as little as 8 km (D. L. Johnson 1972:151), facilitating colonization by a limited terrestrial fauna, possibly including humans.

Mammoth remains have been found on Santa Cruz, Santa Rosa, and San Miguel islands, though the vast majority come from the latter two. A number of localities with possible associations between mammoth bones, fire areas, and (in some instances) stone tools have been found on Santa Rosa Island (Berger and Orr 1966; Orr 1968:49-86; Berger 1980, 1982) and San Miguel Island (D. L. Johnson 1981: 106). Orr and Berger argued that these were mammoth kill sites, butchering areas, or cooking pits. Dating between 15,000 and >40,000 years ago, these have been cited (Carter 1980:51-52; Goodman 1981:71-75) as evidence for an early entry of humans into the New World.

Unfortunately, the archaeological context of these mammoth localities is poorly documented. As a result, few archaeologists are convinced of their authenticity at this time (e.g., Moratto 1984:59). "Fire areas" are abundant in many Pleistocene terrace deposits on both the islands and the mainland. They can be found in a variety of forms, from seemingly isolated pockets to thin "stringers" extending for some distance. Many of these appear to be associated not with human occupation, but with natural wildfires that burn periodically over the California landscape. On the Channel Islands, where dwarf mammoth bones are relatively abundant, wildfires may have burned mammoth bones incidentally as they lay on contemporary ground surfaces. At the Woolley Mammoth site on Santa Rosa Island, preliminary investigations documented possibly burned mammoth bones and stone tools exposed in an eroded gully, apparently associated with a fire area dated in excess of 40,000

years RYBP (Berger 1980, 1982). Careful excavations, however, did not uncover in situ stone tools or mammoth bones but did document traces of a burned tree stump possibly associated with a wildfire (Wendorf 1982; Moratto 1984:58).

More recently, Cushing et al. (1986) suggested that many of the "fire areas" and "burned" mammoth bones may not be burned at all. They provide convincing arguments that many of these are sediments or bones stained by iron and manganese minerals deposited by percolating ground water or microbial activity and that associated "charcoal" has been carbonized by processes unrelated to fire. Given the frequency of natural wildfires on the southern California coast, however, at least some of the "fire areas" probably are burned (D. L. Johnson 1972). Nonetheless, the evidence supporting a cultural origin of such features remains tenuous at best.

At this time, it seems likely that various natural processes can account for claims for human occupation of the northern Channel Islands prior to about 12,000 years ago. For instance, we know little about the behavior of various birds (e.g., seagulls and ravens) and mammals that transport shellfish from the intertidal zone or the distributional patterns they produce.

Virtually all of the Pleistocene localities proposed as possible archaeological sites have been found on erosional surfaces—gullies, stream banks, or sea cliffs. Most of these localities have archaeological sites of Holocene age eroding from exposures stratigraphically above them. Under such conditions, exceptional care must be taken in interpreting and documenting the association of objects in various levels. Unfortunately, meticulous and careful study has been the exception rather than the rule at Pleistocene localities of the northern Channel Islands.

#### TERMINAL PLEISTOCENE AND EARLY HOLOCENE SITES

There is tantalizing, if scanty, evidence for a human presence on the northern Channel Islands at the very end of the Pleistocene. As is true in most parts of the world, it seems likely that we have yet to find the oldest site on the islands, and it is difficult to predict what future discoveries hold in store. The available data suggest, however, that it is not until the Early Holocene that the first unequivocal shell middens appear on Santa Rosa, San Miguel, and Santa Cruz islands (table 8.1). Unfortunately, little information

Table 8.1. Early C<sup>14</sup> Dated Sites of the Northern Channel Islands

Site number	Location	C <sup>14</sup> age (uncorrected)	Archaeological context of Early Holocene site components	Primary reference
SCRI-109	Punta Arena	4600 ± 150 7140 ± 210	Early Holocene: shell midden with sea mammal bone	Glassow 1985a; Glassow 1980
SMI-261	Daisy Cave	2990 ± 90 8470 ± 120 10,260 ± 90	Multicomponent shell midden: basal levels with some fish and sea mammal bone, fishing gear	Snethkamp 1987; Snethkamp and Guthrie 1988
SMI-350	Harris Point	6030 to 9750	Possible Early Holocene midden	Greenwood 1978
SMI-438	Simonton Cove	7940 ± 80	Possible shell midden	D. L. Johnson 1972
SMI-443	Simonton Cove	7580 ± 140	Possible shell midden	D. L. Johnson 1972
SRI-3	Tecolote Point	4000 to 7230 11,900 ± 200?	Red abalone midden with large cemetery beneath later midden	Orr 1968:115-130; C. D. King 1981:49
SRI-5	Survey Point	6350 to 7330 12,260 ± 200?	Red abalone midden over possible Pleistocene "midden"	Orr 1968:135-143
SRI-6	Arlington Point	6820 ± 160 7440 ± 200	Stratified red abalone middens, lowest undated	Orr 1968:145
SRI-116	Lobo Canyon	8615 ± 50 8815 ± 140	Isolated human burial located 2 m below surface	Morris 1987
SRI-173	Arlington Springs	2090 to 7350 10,080 ± 810	Multicomponent shell midden; isolated human skeleton at base	Orr 1968:87

Note: SCRI = Santa Cruz Island; SMI = San Miguel Island; SRI = Santa Rosa Island

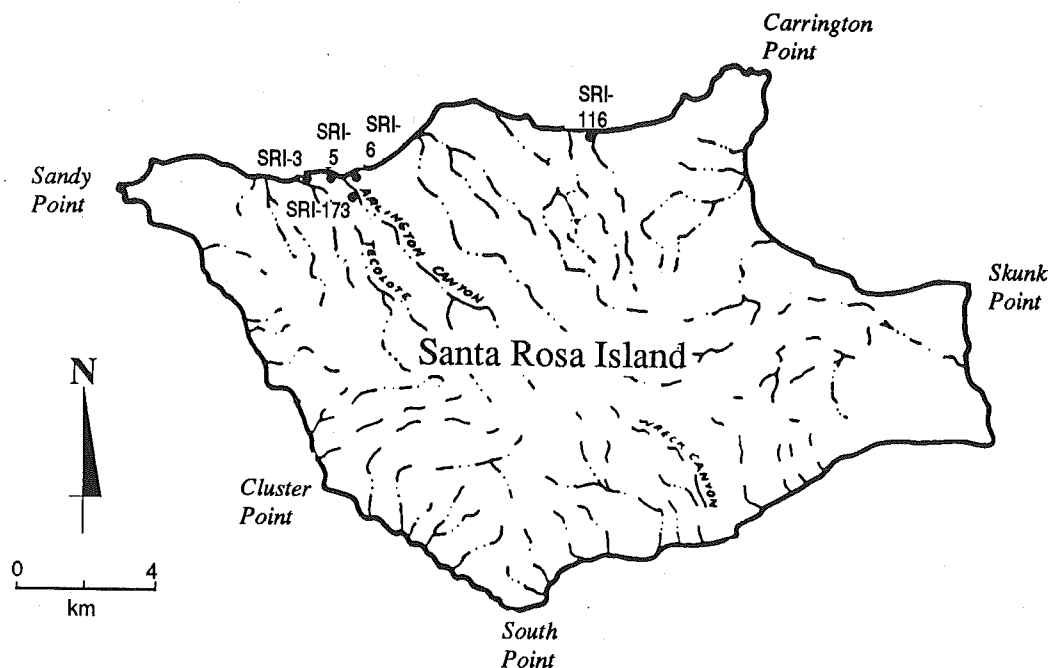


Figure 8.2. Dated Early Holocene sites of Santa Rosa Island.

is available on the artifact and faunal associations of those Early Holocene sites that have been investigated, and the available data raise more questions than they answer.

### Santa Rosa Island

Santa Rosa Island has seen the most extensive archaeological excavations of all the northern Channel Islands, thanks to Phil Orr's tireless efforts for the Santa Barbara Museum of Natural History during the 1940s, 1950s, and 1960s. With the exception of SRI-116, my discussion of the paleontology and archaeology rely largely on Orr's *Prehistory of Santa Rosa Island* (1968) and his unpublished field notes.

Orr (1968) described "Pleistocene middens" in a black humus soil (sometimes referred to in his field notes as "the Black Line") at Garanon Canyon (SRI-1), Tecolote Point (SRI-3), Survey Point (SRI-5), and Radio Point (SRI-26). Charcoal samples collected from this soil at Tecolote Point and Survey Point were dated to  $11,900 \pm 200$  RYBP (UCLA-661) and  $12,620 \pm 200$  RYBP (UCLA-141), respectively (Orr 1968:134-135), suggesting that the soil formed during the terminal Pleistocene, at the same time as the similar Simonton Soil on the northwest coast of San Miguel Island (see Johnson 1972).

Orr claimed that occasional shells, "evidence of fires, bits of asphalt, and a few chipped stones" were found in this Pleistocene soil, though little evidence was presented to support the claim. Even if cultural remains are documented for Orr's terminal Pleistocene localities, further dating will be required. Marine shells from the Simonton Soil on San Miguel Island have provided Early Holocene ages significantly more recent than charcoal from the same stratum (D. L. Johnson 1972, 1980), a fairly common problem on the California coast (Erlandson 1988e). Orr (cited in Crane and Griffin 1962:198) himself recognized a terminal date of  $7350 \pm 150$  RYBP for the formation of the Black Line on Santa Rosa Island, suggesting that cultural materials found in the soil might date to the Early Holocene. For now, the "Pleistocene middens" of Santa Rosa remain incompletely described, inadequately dated, and of uncertain cultural origin (Glassow 1980).

There is less equivocal evidence for human occupation about 10,000 years ago on Santa Rosa Island. Orr's (1968:96-99) summary of the Early Holocene sequence suggests that by 8,000 years ago, his early "Dune Dwellers" occupied Santa Rosa Island, settling primarily on large sand dunes located at some distance from the coast. Grinding implements such as metates and manos or mortars and pestles reportedly are



absent from these early sites, though the possible presence of "donut stones" (digging stick weights) may indicate a reliance on roots and tubers (Walker and Erlandson 1986). Other than a limited array of shell beads, artifacts of shell, bone, and stone are found in low frequencies. Faunal remains reportedly are dominated by red abalone shells, with "a limited amount of fish and marine mammal bone," including the remains of fishes up to 3 m in length (Orr 1968:98).

Five sites on Santa Rosa Island's north coast seem to have been dated securely to the Early Holocene (fig. 8.2). Two of the sites (SRI-116 and -173) appear to contain no cultural remains other than isolated human skeletons. For the three other sites (SRI-3, -5, and -6), except for the fact that red abalone shells are the most conspicuous faunal constituent, no specific economic data are available. It is clear from my recent examination of these early middens, however, that stone tools are rare and that an array of rocky shore shellfish are the dominant faunal constituents.

*SRI-173 (Arlington Springs).* Evidence for a terminal Pleistocene occupation of Santa Rosa Island comes from the Arlington Springs site (SRI-173), located approximately 500 m from the sea on the west side of Arlington Canyon. In 1959, Orr located isolated human bones eroding out of the canyon wall more than 11 m (37.5 feet) below the surface (Orr 1968:92). After careful exposure, the disarticulated bones (two femurs, a humerus, and a yet-to-be-identified bone) were found to lie in finely stratified layers of silt at the base of a refilled arroyo. The size of the long bones led Orr to conclude that the bones were those of a robust male, and the skeleton was dubbed Arlington Man. The sediments in which the human bones were found contained carbonized plant remains and hundreds of tiny mouse bones, suggesting a marshy setting (Orr 1968:91). Comparative analysis of the uranium, fluorine, phosphate, and nitrogen content of the human bone suggested that Arlington Man was "fossil" rather than recent in origin (Oakley 1963) and of considerable antiquity.

Charcoal taken from the sediments in which the human bones were found was dated to  $10,400 \pm 2000$  (L-568A) and  $10,000 \pm 200$  (L-650) RYBP, seemingly confirming a terminal Pleistocene age for Arlington Man (Orr 1968) and for the occupation of the northern Channel Islands. Skepticism about the true antiquity of Arlington Man has persisted, however,

largely because no dates for the human bone itself have been available. A sample of human bone from Arlington Springs, recently submitted for radiocarbon dating via accelerator mass spectrometry (AMS), was found to be unsuitable for a reliable date using currently available techniques (Don Morris, personal communication, 1988). Berger and Protsch (1989:59) recently published a radiocarbon date of  $10,080 \pm 810$  (UCLA-1899), however, based on the analysis of collagen from a long bone from the Arlington Man skeleton. Though  $C^{14}$  dates on human bone have produced notoriously unreliable results, the similarity of the charcoal and bone collagen dates from SRI-173 appears to confirm a human presence on the northern Channel Islands as early as 10,000 years ago.

At Arlington Springs, Orr (1968:87) also describes a lens of red abalone shells found within a "foot-deep dark humus band" located approximately 3.3 m (11 feet) below the surface. Analysis of an abalone shell from this lens produced an uncorrected  $C^{14}$  date of  $7350 \pm 350$  RYBP (M-1133), equal to about 8,000 years ago. Though the larger stratigraphic context of this abalone lens is unclear, Orr's field notes (1960) appear to associate it with his "Black Line," dated elsewhere (i.e., Survey Point, Tecolote Point) to the terminal Pleistocene.

*SRI-116 (Lobo Canyon).* Evidence for occupation of the northern Channel Islands during the Early Holocene also comes from an isolated human burial recently discovered eroding from the sea cliff near the mouth of Lobo Canyon (Morris 1987). The burial was found about 2 m below the ground surface in clean dune sand under a more recent shell midden (SRI-116). A sample of human bone from the skeleton was submitted for radiocarbon dating, resulting in three dates based on the analysis of different fractions of the organic remains. The dates range between  $8615 \pm 115$  (AA-251A) and  $8815 \pm 140$  (AA-251C) RYBP (Morris 1987), indicating a calendar age of approximately 9500 CYBP (Stuiver, Kromer et al. 1986). Though the burial reportedly eroded into the sea before it could be salvaged, it is thought to have been in a flexed position with no visible artifact associations (Morris 1987).

Berger and Protsch (1989:59) recently published a radiocarbon date of  $7650 \pm 580$  (UCLA-1973) derived from the analysis of a long bone fragment from a burial eroding from the vicinity of the mouth of

Lobo Canyon. It is not clear whether this sample came from SRI-116 or from the same burial dated and described by Morris (1987). According to Berger and Protsch (1989:60), the  $C^{13}/C^{12}$  ratio (-22.7‰) established for the human bone sample suggests that the individual consumed a diet rich in terrestrial foods. This appears to contradict the common assumption that the early residents of the northern Channel Islands relied heavily on marine resources.

*SRI-3 (Tecolote Point).* The best documented Early Holocene site on Santa Rosa Island is SRI-3, located at Tecolote Point on the northwest coast. Here, Orr (1968:115-129) excavated in Cemetery A, where 79 burials were interred in clean dune sand below a midden dated to circa 4300 CYBP. On the edge of Cemetery A, a large pile of red abalone shells was found. Four uncorrected  $C^{14}$  dates from two shells range between  $7070 \pm 300$  (L-290D) and  $7230 \pm 120$  (UCLA-663B) RYBP, indicating deposition as early as 7900 CYBP. The lack of midden in grave fills, the presence of red abalone shells with many burials, and the dominance of black abalone (*Haliotis cracherodii*) and mussel (*Mytilus californianus*) shells in the overlying midden led Orr to conclude that Cemetery A was associated with the early  $C^{14}$  dates. More recently, C. D. King (1981:49) analyzed the grave goods associated with these burials and concluded that they probably did date to the Early Holocene (Phase X of King's Early Period). In 1988, I wrote that Cemetery A "provides a rare glimpse of the artifacts associated with an Early Holocene occupation of the Channel Islands" (Erlandson 1988a:311).

Recent study of Orr's field notes and photographs, along with the burial positions and artifact associations of some of the interments, suggested that some of the skeletons in Cemetery A may have been associated with the overlying midden of Middle Holocene age. At least one of the field photographs depicts a burial (#51) that appears to contain black shell midden matrix in the grave fill, and others are associated with artifacts more characteristic of later periods of Santa Barbara Channel prehistory. Working with John Johnson of the Santa Barbara Museum of Natural History, I recently submitted for  $C^{14}$  dating two shell samples associated with burials thought to be from the two separate occupations. The first sample was a red abalone shell found with a flexed burial (#28) typical of the Early Holocene pattern. An 80 g sample of this abalone shell produced an

uncorrected date of  $7050 \pm 90$  (Beta-31788), consistent with Orr's dates from shells removed from the nearby red abalone feature. This seems to confirm that some of the burials in Cemetery A date to the Early Holocene.

A second sample consisted of numerous *Olivella* shells associated with Burial 8, located on the western margin of the cemetery. In his early field notes, Orr (1949) refers to Burials 8, 9, and 10 as potentially more recent than other burials. Our selection was based on the fact that Burial 8 was a rare example of an extended burial in Cemetery A, the association of several black abalone shells which were abundant in the overlying midden, and the presence of several bone tools, artifact associations being rare in Cemetery A. Analysis of the *Olivella* shells found with Burial 8 resulted in an uncorrected  $C^{14}$  date of  $4110 \pm 70$  (Beta-31789), confirming an association with the overlying midden and the presence of intrusive elements in Orr's Cemetery A skeletal population.

Our recent dating of the Cemetery A burial associations appears to confirm that some of the burials from Cemetery A at SRI-3 date to the Early Holocene. It remains to be determined, however, how many of the 79 interments are related to the Middle Holocene occupation of the site. Fifty-seven of the burials had associated artifacts, though these were not abundant ( $n = 374$ ) and most were concentrated with a few individuals (including Burial 8). Among the 334 shell artifacts were 300 shell beads, including spire-removed ( $n = 189$ ), barrel (82), and rectangular (22) *Olivella* specimens (C. D. King 1981:409). Nineteen bone artifacts included bipoints (5), abalone pry bars (3), awls (3), a wedge, and a shoehorn-shaped object made from a split porpoise jaw (see Orr 1968:127). Eleven ground stone tools were recovered, including four "donut stones" or digging stick weights (Orr 1968:129). Orr also illustrates a well-made pestle from Cemetery A, though it is not described in the text or tables and probably was associated with the overlying midden. The eight chipped stone tools include a large leaf-shaped obsidian knife and at least three smaller leaf-shaped bifaces. Two asphaltum basket impressions also were found (Orr 1968:122).

While some of these artifact classes (i.e., bone bipoints, leaf-shaped bifaces, square and spire-ground *Olivella* beads) appear typical of Early Holocene assemblages of the California coast (Erlandson 1988a:390-392), the association of others (e.g., asphalt-

coated baskets, donut stones) with the early component at SRI-3 remains problematical. A focus of future research on the Tecolote Point materials should be on the differentiation of Early and Middle Holocene elements within Cemetery A.

*SRI-6 (Arlington Canyon).* Exposed in the sea cliff east of Arlington Canyon, SRI-6 reportedly contains four red abalone lenses underlying a surficial midden at depths of approximately 1.8, 3.7, 4.5, and 7.0 m below the surface (Orr 1968:144-146). The site was eroding severely when observed in 1949, but no systematic excavation was conducted because of the remote location of the site (Orr 1968). Red abalone shells collected from the two middle buried middens were dated to  $6820 \pm 160$  (L-257) and  $7440 \pm 200$  (LJ-27) RYBP, respectively (Orr 1968:145), equal to approximately 7470 and 8030 CYBP (Stuiver et al. 1986). Consequently, the lowest midden at SRI-6 must have been deposited over 8,000 years ago. A brief visit in 1989 revealed that eroded remnants of the site still covered a large area, with multiple red abalone midden loci. Unfortunately, no further information on the site is available at this time.

### San Miguel Island

Four archaeological sites on San Miguel Island have been dated to the Early Holocene (fig. 8.3), though only minimal information is available from three of

these. Excavation data are available from only one site, SMI-261 (Rozaire 1978; Walker et al. 1978; Snethkamp 1987). Information for the other three is limited to stratigraphic and contextual data collected during geological (D. L. Johnson 1972, 1980) and archaeological (Greenwood 1978b) surveys.

*SMI-261 (Daisy Cave).* One of the most important archaeological sites on the islands is a rockshelter and cave complex located near Bay Point<sup>1</sup> on the east end of San Miguel Island. Known as Daisy Cave (SMI-261), the site covers an area of approximately 210 m<sup>2</sup> and contains a stratified shell midden up to 2 m deep (Rozaire 1978). The cave is situated approximately 15 m above sea level, but an apron of shell midden in front of the rockshelter spills down-slope some 7 m, where it is being eroded along the sea cliff. The cave is located less than 200 m from the 10-fathom isobath, which approximates the Early Holocene shoreline.

In 1967 and 1968, SMI-261 was the subject of intensive excavations (approximately 272 m<sup>2</sup>) directed by Charles Rozaire of the Los Angeles County Museum of Natural History. Rozaire's excavation focused on Late and Middle Holocene strata inside the rockshelter, however, and the earlier occupation was not recognized at the time (Snethkamp 1987), probably because few diagnostic artifacts were recovered from the Early Holocene levels. Analysis of the chronologically sensitive beads and ornaments

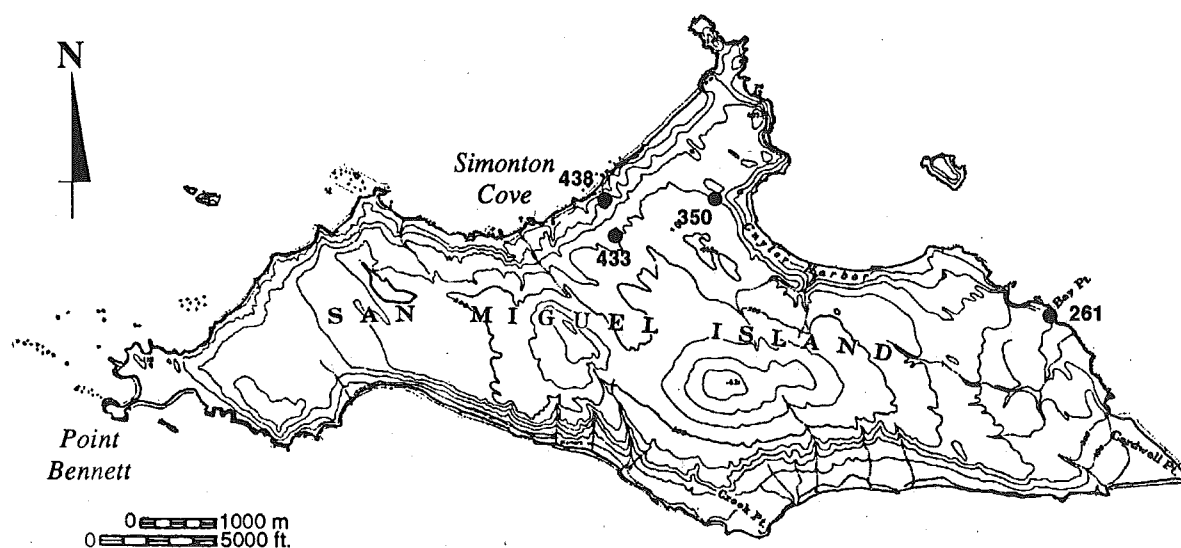


Figure 8.3. Early Holocene sites of San Miguel Island (site numbers omit SMI- prefix for San Miguel Island)

from the site also found no definitive evidence for an early occupation (Walker et al. 1978:120). Unfortunately, the site was excavated in 6-inch horizontal levels, a problem that complicates interpretation of the recovered artifacts and faunal remains. Most excavation levels appear to crosscut the temporally discrete strata that slope downward from west to east and south to north outside the mouth of the cave and rockshelter.

In 1985, a team led by Pandora Snethkamp (UCSB) and Daniel Guthrie (Claremont Colleges) reexamined Rozaire's stratigraphic profiles and excavated two column samples in natural stratigraphic levels. Radiocarbon samples analyzed at this time (table 8.2) first documented the presence of extensive midden deposits dated between approximately 8000 and 8500 RYBP (Snethkamp 1987), or 8600 and 9100 CYBP. Snethkamp (1987) has argued that the initial settlement of Daisy Cave may have occurred as early as  $10,260 \pm 90$  RYBP (Beta-14660), the date produced by a red abalone shell found below the Early Holocene midden. Further dating has yet to confirm a Pleistocene occupation of Daisy Cave, and it is uncertain if the dated abalone shell was of cultural origin. Pleistocene levels below the cultural sequence contain a few marine shells; however, seagull and raven remains have also been found in the cave deposits. Both birds are known to transport shells away from the intertidal zone.

According to Snethkamp and Guthrie (1988), the Early Holocene levels at SMI-261 contain side-scrapers, modified flake tools, and cores of Monterey chert. Also recovered was a single *Olivella* barrel bead, small amounts of eel grass cordage, and bone

bipoints or fish gorges. On a recent visit to the site, I found eel grass cordage and other woven material to be abundant in portions of the Early Holocene midden.

Rozaire (1978:29) collected faunal remains from 1/4-inch mesh, with "spot checking done with a 1/8-inch screen." The faunal remains were the subject of preliminary analysis by Walker et al. (1978), who identified a variety of cetacean, pinniped, fish, bird, land mammal, and human remains. Excavation techniques and published descriptions make it difficult to attribute faunal elements to specific occupational strata, reconstruct the subsistence economy of any specific occupation, or identify subsistence changes through time. The existing data do suggest that portions of the small bird, rodent, and fish remains may be of natural origin, since the cave contains the bones of barn owls, ravens, cormorants, and gulls. The lowest levels of the midden do appear to contain the remains of pinnipeds and fish of cultural origin, along with a dense shell midden deposit. In test units that span the depth of the cave, the density of fish bone decreases significantly in the lower levels (Walker et al. 1978:136), consistent with other Early Holocene sites of the California coast (Erlandson 1988a). The left mandible of a domestic dog (*Canis familiaris*) also appears to have come from the Early Holocene midden.

Analysis of the faunal remains from the Daisy Cave column samples has yet to be completed and quantitative data remain unavailable. According to Snethkamp and Guthrie (1988), the faunal assemblage is dominated by rocky shore shellfish, especially mussels, turban, abalone, and sea urchins. Limited numbers of fish, bird, and sea mammal

Table 8.2. Radiocarbon Dates from SMI-261 (Daisy Cave)

Stratum	Depth (cm)	Lab number	Material dated	Uncorrected C <sup>14</sup> date	Adjusted C <sup>14</sup> age
A <sup>1</sup>	25-40	Beta-15619	<i>Haliotis rufescens</i>	2990 ± 90	3430 ± 90
C	44-49	Beta-15620	<i>Haliotis cracherodii</i>	5940 ± 110	6380 ± 110
E <sup>2</sup>	55-65	Beta-15621	<i>Haliotis cracherodii</i>	8030 ± 100	8460 ± 100
E <sup>3</sup>	75-78	Beta-15622	<i>Haliotis cracherodii</i>	8270 ± 120	8730 ± 120
F <sup>4</sup>	80-87	Beta-15623	<i>Mytilus californianus</i>	8470 ± 120	8900 ± 120
J	108-111	Beta-19871	<i>Mytilus californianus</i>	8290 ± 200	8700 ± 200
G	110-117	Beta-14660	<i>Haliotis rufescens</i>	10,260 ± 90	10,700 ± 90

Note: Adapted from Snethkamp (1987). All samples from profile D-5 except Beta-19871 (profile H-5). Adjusted ages corrected for isotopic fractionation.

bones also are present in the earliest levels. Snethkamp and Guthrie (1988) believe that San Miguel Island may have been occupied on a seasonal basis during the Early Holocene.

*SMI-350 (Harris Point).* Located on a dune ridge at an elevation of 140 m on a terrace west of Cuyler Harbor, SMI-350 is a 10,000 m<sup>2</sup> midden dominated by mussel, red abalone, and other rocky shore shellfish remains. Greenwood (1978b) lists two C<sup>14</sup> dates from this site, one each from the Middle and Early Holocene. The radiocarbon samples were collected and reported by geographer D. L. Johnson (1972). A red abalone shell collected from a depth of 51 cm in the midden was dated to 6030 ± 150 RYBP (I-3717). Charcoal from the same depth, but collected from a soil profile 40 feet west of the abalone shell (D. L. Johnson 1972:83), was dated to 9750 ± 150 (I-4583). It is unclear whether this charcoal came from the midden or from a soil in an interdune swale just south and west of the site. Given the questionable cultural association of the charcoal, the large discrepancy between the two dates, and the antiquity of natural wildfires on San Miguel Island (D. L. Johnson 1980:117), the Early Holocene date attributed to SMI-350 may be unrelated to human occupation.

*SMI-438 (Yardang Canyon).* In Yardang Canyon at Simonton Cove, a buried shell lens is present in the upper portions of a well-developed paleosol, the Simonton Soil, located between two thick dune strata. The upper dune appears to have been deposited circa 7500 RYBP (D. L. Johnson 1972:209) and is capped by a dense, artifact-strewn shell midden, SMI-438 (Greenwood 1978b). Johnson (1972:206-207) also identified a lower shell lens, exposed in the sea cliff and the walls of Yardang Canyon, as archaeological in origin, calling it the "Midden Soil." Fragments of mussel and abalone shell from the upper 50 cm of the paleosol dated to 7940 ± 80, the equivalent of approximately 8550 CYBP (Stuiver et al. 1986). Analysis of scattered charcoal collected from a depth of 75 to 100 cm in the same soil produced an uncorrected date of 9360 ± 200 (UCLA-148A). Johnson suggested no association between the shell date and the charcoal date, the former being "the earliest date for human presence on San Miguel" at that time (Johnson 1972:208). Charcoal from a burned tree stump exposed at the base of the Midden Soil west of SMI-438 was dated to 17,730 ± 300

RYBP (I-4586), indicating up to 10,000 years of soil formation.

In 1989, I carefully examined the Midden Soil, tracing it almost continuously for over 750 m between the Yardang and Range Pole Canyon areas. Interpretation was complicated by the fact that the Simonton Soil has been truncated in places, is obscured by vegetation or recent dune sand in others, and often has more recent midden material cascading onto it from overlying strata. The shell-bearing portions of the soil may extend even farther to the west (where profiles were not examined), but extensive exposures to the east in Charcoal Canyon appear to lack shell completely.

After initial examination of profiles in Yardang Canyon, I believed the midden was identified correctly as an archaeological site. The more I saw, however, the less convinced I became of its cultural origin, even though the shells appear to have been deposited at a time when humans definitely lived on San Miguel Island. The upper 25 to 50 cm of the Simonton Soil contains a low-density scatter of marine shells, mostly whole or large pieces of California mussel, with occasional acorn barnacles (*Balanus* sp.), rare black abalone shells, and isolated instances of gooseneck barnacle (*Pollicipes polymerus*), platform mussel (*Septifer bifurcatus*), and an unidentified limpet. While the shell scatter is laterally extensive, there is no evidence of lenses or spatial concentrations typical of nearby village sites or other Santa Barbara Channel shell middens. The marine shells also show little evidence of the fragmentation or orientation characteristic of shells deposited on living surfaces with relatively firm soil substrates.

Even more important than the structure of the deposit is the dearth of associated cultural debris, despite careful examination of hundreds of meters of soil exposure along the sea cliff and canyon walls. No clearly modified artifacts of stone or bone, no hearths or concentration of fire-cracked rocks, and no other cultural features were found in situ in the shell-bearing soil, though artifacts displaced from overlying middens were abundant on erosional surfaces. Charcoal flecks were scattered throughout the soil, but this is true of soils of all ages on San Miguel Island (D. L. Johnson 1972:264), and no concentrations were noted. Finally, only one bone (an unidentified fish bone) was observed, though animal bones are common constituents of Early Holocene middens elsewhere on the California coast.

*SMI-443 (Range Pole Canyon).* Another of D. L. Johnson's geological localities, SMI-443, is located along Simonton Cove at the mouth of Range Pole Canyon. Greenwood's (1978b) report attributes Johnson's (1972:83) Early Holocene date for this locality to archaeological site SMI-433, located on a high terrace at an elevation of over 100 m above Yardang Canyon. My field examination showed that SMI-433 bears no resemblance to Johnson's (1972: 351) locality, where the Midden Soil is exposed in the canyon walls and sea cliff at the mouth of Range Pole Canyon below as much as 40 m (140 feet) of dune and fluvial sediments. This dune is capped by SMI-443, a huge shell midden adjacent to Range Pole Canyon.<sup>2</sup>

The massive upper midden appears to be associated with Middle or Late Holocene occupations of the upper dune. Radiocarbon dating of mussel and barnacle shell fragments from the upper 10 cm of the buried Midden Soil produced an uncorrected age of  $7580 \pm 140$  RYBP, equal to approximately 8170 CYBP. As was the case at SMI-438, this shell stratum at the top of the Simonton Soil is of uncertain cultural origin. In the stratigraphic exposures available in the walls of Range Pole Canyon, I traced the shell stratum for over 100 m inland from the sea cliff.

Direct evidence for cultural associations with the marine shells is scanty. Between Yardang and Range Pole canyons, I found only two possible artifacts in situ in the Midden Soil. The first was a small siltstone cobble spall, found west of Yardang Canyon, which may have been flaked intentionally. The second was a fire-cracked igneous beach cobble fragment found between Yardang and Range Pole canyons. Whether or not these two stones were culturally modified, they appear to be manuports out of context in the dune soil. They represent an artifact density so low, however, that they could be isolated introductions into a natural shell deposit.

### Santa Cruz Island

Santa Cruz Island is the largest of the northern Channel Islands and probably contains the largest number of archaeological sites. At present, however, only one Early Holocene site has been identified. SCRI-109 is a large and dense shell midden exposed in the sea cliff adjacent to a broad, shallow subtidal shelf at Punta Arena on the south coast. The midden appears

to date largely to the Middle Holocene (ca. 5000 CYBP), though a shell from the basal strata has been dated to circa 7500 CYBP. In 1974, a UCSB team directed by Michael Glassow excavated two column samples from the sea cliff (Glassow 1985a). Other than Berger and Prostch's (1989) carbon isotope study of the Lobo Canyon skeleton from Santa Rosa Island, the faunal remains from the SCRI-109 columns provide the only quantitative data with which to estimate the diet of the early occupants of the northern Channel Islands.

The SCRI-109 columns were screened over 1/8-inch mesh, an effective recovery procedure given the pristine condition of many Santa Cruz Island middens. California mussel dominates the shellfish remains, with only small amounts of bone recovered. Estimates of the protein yield of the recovered faunal remains (Glassow 1985a:8) suggest that the Early Holocene site occupants depended heavily on shellfish (90.8%), supplemented by fish (5.4%), and sea mammals (3.8%). Due to the impoverished terrestrial fauna of Santa Cruz Island, marine resources probably provided nearly 100% of the animal protein consumed by Early Holocene groups. Land plants, either endemic to the island or transported from the mainland, may have been significant carbohydrate and calorie sources throughout Santa Cruz Island prehistory (Glassow 1985a:9). However, the available plant foods are relatively poor protein sources, suggesting that shellfish and other marine resources were essential to the survival of early Santa Cruz Island groups.

### SUMMARY

After more than 30 years of controversial claims, there remains no firm evidence for a Pleistocene association of humans and mammoths on the northern Channel Islands or the adjacent Santa Barbara coast. Extraordinary claims require extraordinary evidence, and claims for such associations have suffered in recent years from an accumulation of data on the periodicity of wildfires in the region, on noncultural processes that discolor sediments and bones, and on the difficulties in interpreting "associations" on both eroded surfaces and in stratified contexts. More and better data are needed on the distribution and antiquity of mammoth bones, isolated shells, and stone tools in Pleistocene sediments

of the Channel Islands. Additional information also is needed on the origin of fire areas versus "ocherous areas" (Cushing et al. 1986). Until such data are forthcoming, most scientists who closely examine the data will remain unconvinced.

The same argument can be made for the "Pleistocene middens" of Santa Rosa Island's "Black Line" and for the Early Holocene "Midden Soil" of San Miguel Island. While these may prove to be true shell middens, questions remain about the age of the Santa Rosa Island localities and the cultural origin of the shell deposits on both islands. Further study needs to be done on what natural processes (if any) might account for the formation of these early shell-bearing soils. Are some of them wind-blown deposits formed as rising postglacial sea levels approached the modern shore? Were shells deposited by birds scavenging shellfish washed up on the beach by storm surf? Or are they true shell middens, possibly of a temporary or specialized nature (i.e., shellfish processing stations) that leave behind few of the artifacts normally associated with human occupation?

Based on the dating of the Arlington Man skeleton from Santa Rosa Island, the earliest evidence for human occupation of the northern Channel Islands may date to circa 10,000 RYBP, an uncorrected age that falls between roughly 10,500 and 11,000 CYBP. This is essentially contemporary with the earliest proposed date for the occupation of SMI-261 on San Miguel Island (Snethkamp and Guthrie 1988), though further research is needed to confirm a cultural association with the Pleistocene levels at Daisy Cave. For now, the earliest unequivocal occupational refuse is found in Daisy Cave's Early Holocene strata, where  $C^{14}$  dates from near the base of the midden indicate occupation as early as 9200 CYBP. By about 8,000 to 8,500 years ago, evidence for human occupation on the islands is somewhat more widespread, though little is known about the technology or adaptations of these groups. It appears likely, however, that they had seaworthy boats and actively exploited a variety of shellfish, fish, sea mammals, and plant foods.

The early settlement of the Channel Islands raises questions about the validity of recent models of the development of coastal adaptations, particularly those that propose that marine foods are less than optimal resources exploited only when terrestrial alternatives have been exhausted (e.g., Osborn 1977). If this characterization is correct, why were the Channel Islands occupied so early? What led people to leave the security and diversity of mainland terrestrial habitats at such an early date? Finally, why have sites of equal antiquity not been found on the adjacent mainland?

## NOTES

1. SMI-261 appears to have been mismapped by Greenwood (1978b), whose survey may have mistook Daisy Cave for the nearby Cave of the Chimneys, which also contains midden deposits (D. Morris, personal communication, 1989).

2. Greenwood's (1978b) correlation of Johnson's Range Pole Canyon locality with SMI-433 may have been a typographical error.

## ACKNOWLEDGMENTS

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## Chapter 9

# Early Holocene Adaptations on Vandenberg Air Force Base, Santa Barbara County

Michael A. Glassow

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**A**rchaeological investigations carried out along the coastal region of south Vandenberg Air Force Base since 1974 have revealed the presence of a diverse record of prehistoric occupation during the Early Holocene. Five sites in this region, spanning the coastline between Jalama Creek and the Santa Ynez River (fig. 9.1), are known to have deposits dating to different times between circa 9000 and 6700 RYBP. Interestingly, the radiocarbon dates for these early deposits constitute a discrete cluster separated in time by roughly 1,500 years from dates for Mid-Holocene sites in the Vandenberg region. While the data are too skimpy to argue that the south Vandenberg vicinity was abandoned after 6700 RYBP, they do allow cultural development during the Early Holocene to be discussed as a discrete analytical topic.

Several research questions concerning Early Holocene cultural development may be addressed with the available data. First, what is the evidence for change in subsistence and settlement during this interval of time? Second, assuming such changes can be discerned, what are their causes? In particular, what are the effects of population growth and environmental change on these changes? Third, why

are there no known sites in the Vandenberg region dating between 6700 RYBP and circa 5000 RYBP? Finally, how are the available data biased by the nature of archaeological research to date and by destruction or invisibility resulting from geomorphic processes? While definitive answers to these questions currently are impossible, I will attempt to address each with the information available.

Virtually all of the data referred to in this chapter were obtained from excavations undertaken in response to the construction of space shuttle facilities on south Vandenberg Air Force Base. Test excavations in 1974 were of relatively limited scope, their purpose being the collection of data relevant to site significance evaluation (Glassow et al. 1976). One to three test units in Early Holocene deposits were excavated at three of the five sites under consideration, and collections were obtained by screening deposits through 1/4-inch mesh. Conversely, a data recovery program undertaken between 1978 and 1980 focused on three sites impacted by the shuttlecraft tow route construction and involved intensive excavation (Glassow et al. 1981), with a large proportion of the excavated deposits water-screened through 1/8-mesh and all screen residues sorted in a field lab. As

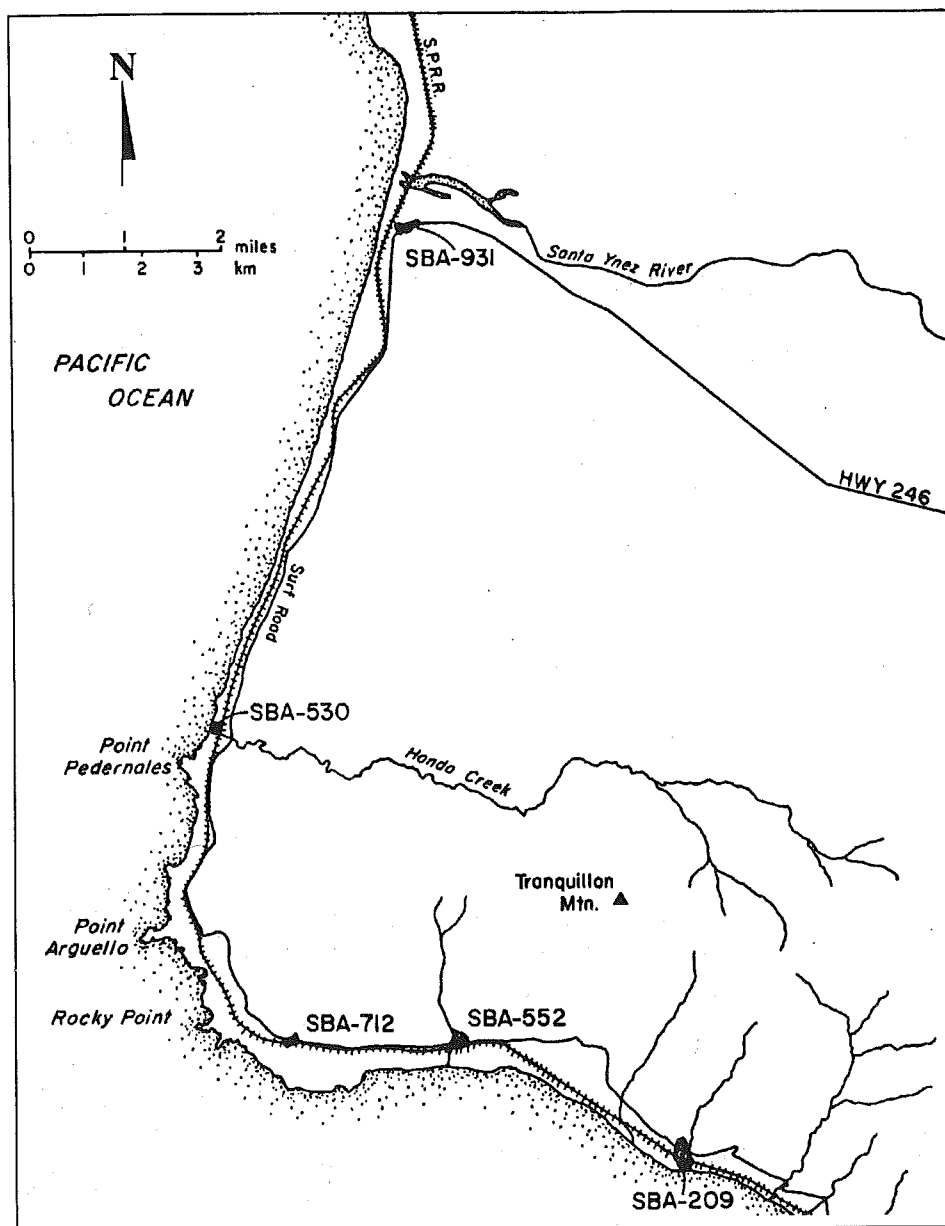


Figure 9.1. South Vandenberg Air Force Base showing the locations of known Early Holocene sites.

a result, the collections obtained in 1974 were not gathered as systematically as those obtained in 1978-1980, and the data from the two projects are not always comparable. Major portions of the 1974 collections and all of the 1978-1980 collections are currently undergoing analysis at UCSB.

#### THE DATA BASE

Of the five sites with deposits dating to the Early Holocene (fig. 9.1), only one contains deposits dat-

ing as early as 9000 RYBP, these comprising the lower cultural stratum at SBA-931, a site with at least two occupational components overlooking the mouth of the Santa Ynez River. The 11 radiocarbon dates from the lower stratum (fig. 9.2) span a period between 7970 and 9150 RYBP, with most dates falling within the interval between 8400 and 8900 RYBP. Approximately 4.2 m<sup>3</sup> of deposits were excavated from this stratum during the 1978-80 data recovery program. Another site, SBA-530, on the coast at the mouth of Honda Canyon, has yielded three dates

spanning the period between 7830 and 8430 RYBP, but aside from the collection of the  $C^{14}$  samples from an extensive erosional exposure bisecting the site, data come only from systematic observations along the length of the midden profile and from a few artifacts collected from this profile.

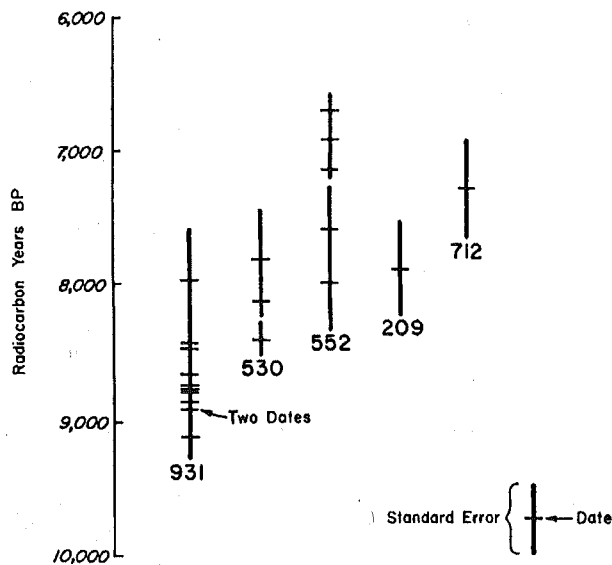


Figure 9.2. Distribution of uncorrected radiocarbon dates from Early Holocene sites on south Vandenberg Air Force Base.

The remaining three sites have dates younger than 8000 RYBP (fig. 9.2). SBA-209, with a date of 7890 RYBP, is represented by a surface collection from a railroad cut bisecting the site. Test excavations at SBA-712 produced relatively limited collections associated with a date of 7300 RYBP from one unit excavated in 1974. In contrast, SBA-552 yielded extensive collections from a 1974 test unit penetrating deposits dating between 6700 and 7990 RYBP. As indicated by five radiocarbon dates, it appears that all unit 9 deposits between 140 and 520 cm below surface date to this time interval. Another site component possibly dating between 7000 and 8000 RYBP is the upper stratum of SBA-931. While excavated collections from this component are substantial, no organics have been recovered for radiocarbon dating. As a result, dating rests on inferences made on the nature of the artifact assemblage.

### SUBSISTENCE AND SETTLEMENT BETWEEN 9000 AND 8000 RYBP

Two areas of SBA-931 contain a basal cultural stratum dating in excess of 8400 RYBP. In area B these deposits consist of sporadic lenses of shell midden no more than a few centimeters thick, while in area A the shell midden stratum is approximately 15 cm thick at its maximum. The upper cultural stratum at this site, presumably dating later in time, consists of 50 to 100 cm of sandy loam containing relatively abundant ground stone and chipped stone artifacts. Interestingly, radiocarbon dates of shellfish remains from the upper cultural stratum indicate that all or nearly all shellfish remains in this deposit were probably brought up by rodents from the lower cultural stratum. This is indicated both by an increase in the density of shellfish remains with depth (below a partially wind-deflated zone within the first 20 cm) until the maximum density is reached in the lower cultural stratum and by the extensive evidence of rodent burrowing in both cultural strata.

The predominant constituent in the lower cultural stratum is shellfish remains, mainly of California mussel (*Mytilus californianus*). The very low densities of other cultural materials such as chipped stone and bone may or may not have been introduced by rodent activity from above. Although an effort was made during excavation to separate intact deposits from those filling rodent burrows in this stratum, this separation was certainly not perfect, making it impossible to be confident that constituents in lower densities actually pertain to the lower stratum. Almost certainly, no ground stone artifacts can be attributed to the lower cultural stratum.

Regardless of this problem, it is certainly apparent that shellfish was a principal dietary component while people occupied SBA-931 as much as 9,000 years ago. The minimal evidence of other subsistence activities implies that SBA-931 was likely a temporary camp used when the focus of subsistence activity was on shellfish collection. It is possible that a variety of plant foods also were harvested if freshwater marshlands existed at the time near the mouth of the Santa Ynez River. The absence of milling equipment implies either that seed grinding was not part of the food processing technology 9,000 years ago or that seed grinding was undertaken elsewhere.

That shellfish remains are present in the lower cultural stratum and apparently absent from the up-

per may imply a shift in the availability of shellfish along the coastline nearest to the site. Today, sandy beaches extend along the coastline from the northern margin of the Santa Ynez Valley mouth to several kilometers south of SBA-931. It is possible that shellfish were obtained by the site's inhabitants 8000 to 9000 RYBP from locations north of the Santa Ynez River, where a rocky shoreline provides a habitat for extensive mussel beds. However, at this time, sea level would have been between roughly 15 to 30 m lower than it is today (Inman 1983), and the coastline would have been located approximately 1.4 to 3.8 km farther west of the present coastline. Bathymetric data for this section of the coastline hint at the possibility that the rocky shoreline extended farther south to include the coast directly west of SBA-931 (Continental Shelf Data Systems 1967). In particular, rocky protrusions are shown at a depth between 22 and 24 m and below current sea level and about 2 km directly off the coast from the mouth of the Santa Ynez River.

Alternatively, the proximity or accessibility of mussel beds may not have been significant in determining the emphasis on shellfish by occupants of SBA-931. If site catchments from which subsistence remains were obtained were larger before 8000 RYBP than they were after, and if shellfish were a relatively regular dietary constituent, then one would expect most sites of this age, including SBA-931, to contain evidence of an emphasis on shellfish collecting.

As mentioned above, SBA-530, located on the north side of the mouth of Honda Canyon, is the only other site with dates earlier than 8000 RYBP. Only a remnant of an apparently once extensive shell midden is left, the rest of the site having been removed by seacliff retreat. Between 8000 and 9000 RYBP this site would have been approximately 2 km from the open coastline. However, the rising sea level probably produced an embayment at the mouth of Honda Canyon, which would have brought relatively protected coastline closer to the site. As the midden overlies a dune surface that pitches downward toward land, most likely the site existed on the lee side of a Pleistocene-aged dune (D. L. Johnson 1987). Interestingly, Middle to Late Holocene dune deposits cap this site, so the meter-thick midden deposits give the appearance of bisecting a large coastal dune.

While no excavated data exist for this site component, the extensive profile of the midden deposits created by seacliff erosion has provided the opportu-

nity to determine the presence of particular classes of artifacts and faunal remains. The very high density of shellfish remains in the midden deposits of this site indicates that shellfish were a significant dietary component. In addition, there are noticeable quantities of bone, large fragments of sea mammal and terrestrial mammal bones being most obvious. Some fish bone also has been recognized. How important mammals and fish were to the diet of the site's occupants will have to await future investigations.

Although rare, manos are present in the SBA-530 midden, as are biface preforms of Monterey chert. Consistent with the presence of the preforms, chert flakes are present as well. The presence of these ground and flaked stone artifacts at SBA-530 is in marked contrast to their absence or extreme rarity in the lower cultural stratum at SBA-931.

Today, rocky coastline exists within 0.5 km north and south of the mouth of Honda Canyon, and highly irregular bathymetric contours imply that the shoreline was relatively rocky in the vicinity when sea level was 15 to 30 m lower than it is today (Continental Shelf Data Systems 1967). Consequently, it is likely that mussel and other intertidal shellfish would have been as accessible between 8000 and 9000 RYBP as they are today, except for the 2 to 3 km walk that the site's inhabitants would have had to make to reach the coastline (assuming that mussels were minimally available in an embayment that probably existed at the mouth of Honda Canyon).

To summarize, the data from these two sites shed only a glimmer of light on subsistence and settlement between 8000 and 9000 RYBP. It is clear, however, that inhabitants of the region lived near the coast at least intermittently and obtained at least some of their subsistence resources from the intertidal zone in the form of shellfish. Undoubtedly other contemporaneous sites have been submerged or destroyed as sea level rose to its modern level, thus eliminating a segment of the archaeological record perhaps associated with significantly more intensive use of maritime resources. Even though SBA-530 clearly has the potential to yield much more information on subsistence during this period, one cannot escape the fact that data will remain very scanty unless other sites used by the regional population at that time can be discovered and investigated.

In assessing the available evidence of subsistence and settlement prior to 8000 RYBP, one must recognize that there are some significant differences

between SBA-530 and -931. The sparse data from the lower cultural stratum at SBA-931 appear to represent a segment of a settlement system in which a local group was highly mobile, perhaps ranging over a territory the size of the entire Vandenberg Air Force Base. The presence in the lower stratum of mussel shells in the absence of other cultural remains implies rather brief occupation for the specific purpose of collecting shellfish. Obviously other subsistence activities took place elsewhere, and these likely emphasized hunting and collecting terrestrial resources rather than marine resources. Conversely, SBA-530, with its diversity of artifacts and subsistence remains, including marine mammals and fish, may represent some sort of residential base that was a focal point of a settlement system. In this regard, this site may have been a node in a settlement system with greater similarity to those persisting after 8000 RYBP than to those characterizing the period around 9000 RYBP when SBA-931 first was occupied. In future studies at SBA-530, it will be important to assess whether there are any stratigraphic differences in the distribution of particular classes of faunal remains and artifacts. It may be, for instance, that the earlier deposits, dating in excess of 8000 RYBP, are more similar to those comprising the lower cultural stratum at SBA-931, while the later deposits are more similar to those post-dating 8000 RYBP. Alternatively, a significant shift in settlement system type may have occurred immediately before the occupation of SBA-530, around 8500 RYBP rather than 8000 RYBP. This possibility will be considered in more detail later.

#### SUBSISTENCE AND SETTLEMENT AFTER 8000 RYBP

A good deal more information is available for the period between 8000 and 6700 RYBP, especially from SBA-552 and -931. While the data from the other two sites dating to this period, SBA-209 and -712, are scanty by comparison, what little is known about these sites conforms to the conclusions reached on the basis of the much richer data base from SBA-552 and -931.

As mentioned, the upper cultural stratum at SBA-931 is thought to date to this period on the basis of the nature of the artifact assemblage, although the presence of several artifacts believed to date to later periods of prehistory leave this temporal assignment

somewhat tenuous. Aside from substantial numbers of manos and metates typical of sites dating prior to circa 7000 RYBP, the artifact assemblage is diagnostic of these early times by the absence or rarity of types distinctive of later periods. Specifically, circular shell fishhooks, which are found regularly in coastal sites dating after circa 5000 RYBP, were not encountered. Similarly, despite the large volume of excavated deposits, only one shell bead (of a type that could date as early as 7500 RYBP), a complete stone mortar, three mortar fragments, two typeable projectile point fragments, and a charmstone were collected. While mortars, projectile point forms, and the charmstone are typical of periods dating to circa 5000 RYBP or later, their rarity implies that they are associated with intermittent occupation after a main occupation dating prior to 7000 RYBP.

The manos and metates from areas A and B of SBA-931 clearly reflect a focus on milling, presumably of a variety of seeds. The kinds of seeds processed cannot be guessed due to the lack of preserved seed remains in the deposits. Further, in all likelihood, the plant communities in the site vicinity were quite different prior to 7000 RYBP. Today, the area in and around the site is covered by Coastal Sage Scrub and Coastal Bluff Scrub communities (as defined by Munz 1959), which are dominated by plant species not known to be productive of seeds popularly collected by California Indians. Patches of grasslands also occur, however, which certainly would have yielded a variety of seeds and underground plant parts of potential interest to the prehistoric collector. Another possibility is that seeds and perhaps other plant parts were collected from marshlands adjacent to the Santa Ynez River just north of the site.

Faunal remains in the upper cultural stratum of SBA-931 are significant in their rather low densities. Earlier, I mentioned that most or all of the shellfish remains in this component appear to be derived from the lower cultural stratum. Shellfish collection, therefore, does not seem to have been an important subsistence pursuit during occupation at the site after 8000 RYBP. As discussed above, this reduced emphasis may have been the result of changing geomorphic characteristics of the coastline. Between 7000 and 8000 RYBP, sea level would have been between 7 and 15 m lower than today, and the coastline would have been between 1 and 2 km farther west. Bathymetric data indicate that the shoreline was probably

sandy, as it is today (Continental Shelf Data Systems 1967), implying that greater distances would have had to be traveled to obtain shellfish.

In addition, bone remains are in very low densities; most are of animals the size of gophers or rabbits, implying that much of the bone is derived from burrowing animals dying in their burrows. In fact, of the bone from all excavations at the site, pocket gopher (*Thomomys bottae*) bones are most abundant, followed by cottontail or brush rabbit (*Sylvilagus* spp.) (see table 9.1).

The bone from the 10 cm levels in one unit associated with the upper occupational stratum is presented in table 9.2. Fish and sea mammal bone certainly are the product of prehistoric subsistence practices, but their weights are significantly less than those derived from various small terrestrial mammal categories, and, as just discussed, most of this bone is undoubtedly the product of several thousand years of rodent burrowing. Although fish remains are scarce at this site, it is significant that the majority are of species in the surfperch family (Embiotocidae). These fish range very near shore and would be one of the most likely species to be acquired with a beach seine. The presence of clupeiform vertebrae is problematical: while these fish could have been caught from shore with nets, along with surfperches, they

also could have entered the site as the stomach contents of sea mammals.

It would appear, then, that subsistence activities taking place at SBA-931 between circa 8000 and 7000 RYBP emphasized seed collecting and processing. Some hunting of sea mammals and some marine fishing also transpired, but their importance in relation to plant resources seems minimal. While SBA-931 may have been some sort of residential base at this time, most likely it was of a relatively specialized sort, others being more important to the site's inhabitants during the course of an annual cycle of movement.

If any site was a principal residential base during this period, SBA-552 is the logical candidate. The lower 3.5 to 4 m of this site appear to date between circa 6700 and 8000 RYBP. No other site along the California coast of such antiquity is known to contain deposits of such thickness. Indeed, few sites of this age contain such abundant faunal remains in an excellent state of preservation, brought about here most likely by a reduction in rodent disturbance resulting from a protective overburden of later midden deposits.

A variety of artifacts in relatively high densities also are present in these deposits, implying that occupation was intense and involved a diverse set of

Table 9.1. Frequency and Weight of Bones Identified to Genus or Family from SBA-931

Taxon	Common name	Count	Weight (g)
<b>Mammals</b>			
<i>Odocoileus hemionus</i>	Mule deer	9	57.3
<i>Lepus californicus</i>	Blacktail jackrabbit	46	20.7
<i>Sylvilagus</i> spp.	Rabbits and cottontails	85	12.2
<i>Thomomys bottae</i>	Pocket gopher	281	51.4
<i>Citellus beecheyi</i>	Ground squirrel	2	0.8
Sciuridae	Squirrels	5	0.3
<i>Neotoma</i> spp.	Woodrat	1	<0.1
<i>Scapanus latimanus</i>	California mole	3	0.7
<b>Fish</b>			
<i>Amphistichus</i> spp.	Surfperches	30	
Clupeidae	Sardines and herrings	11	
<i>Sebastes</i> spp.	Rockfishes	2	
<i>Engraulis mordax</i>	Northern anchovy	2	
<i>Hypsypops rubicundus</i>	Garibaldi	1	
<i>Genyonemus lineatus</i>	White croaker	1	

Note: Bones are from 1/4-inch and 1/8-inch screened samples combined; fish weight not available.

Table 9.2. Weights in Grams of Major Categories of Faunal Remains from the Upper Occupational Stratum of Unit B353X, SBA-931

Faunal category	Level in cm						Total
	0-10	10-20	20-30	30-40	40-50	50-60	
Fish	0.0	<0.1	0.1	<0.1	0.2	0.1	0.4
Small fauna	1.2	1.8	1.4	1.1	2.3	2.0	9.8
Undifferentiated mammal	1.8	0.0	0.0	0.0	0.0	0.0	1.8
Large land mammal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Unidentified bone	3.0	7.2	8.8	6.8	16.1	12.2	54.1
Total bone	6.0	9.0	10.3	7.9	18.6	14.3	66.1
<i>Mytilus californianus</i>	54.4	91.9	36.1	36.4	41.8	46.6	307.2
Other shell	0.2	0.3	0.3	0.5	0.4	0.0	1.7

Note: Unit size: 0.5 x 1 m; complete unit screened through 1/8-inch mesh. Small fauna includes bones of rodents and lagomorphs, undifferentiated mammal includes bones of mammals of unknown size as well as probable sea mammal bones, and large land mammal includes animals the size of deer.

Table 9.3. Bone and California Mussel Remains and Their Protein Values from Three Levels of a Column from Unit 9, SBA-552

Level (cm)	Bone (g)	Protein		Mussel (g)	Protein	
		g	%		g	%
200-220	9.8	23.7	10.3	6,415.7	205.3	89.7
300-320	12.3	29.8	18.5	4,105.8	131.4	81.5
400-420	12.4	30.0	15.6	5,075.0	162.4	84.4
Totals	34.5	83.5	14.3	15,596.5	499.1	85.7

Note: Column is 20 x 20 cm in area and was screened through 1/8-inch mesh. Nutritional conversions follow Glassow and Wilcoxon 1988. Ratio for sea mammal was used for bone conversion; if most bone is of land mammal, protein values may be somewhat higher.

activities. The 15 manos recovered from levels between 220 and 440 cm below surface of unit 9 (none occurring at higher levels) are indicative of the importance of seeds to the site's occupants. In this regard, the pre-6700 RYBP strata at this site are similar to other sites dating to this time period in the Vandenberg region and elsewhere.

Weights of shellfish and bone remains in three levels of a column sample from unit 9 are presented in table 9.3. Shellfish is relatively abundant in the pre-6700 RYBP strata at this site, but significant quantities of bone also are present. As at SBA-931, the bulk of the bone appears to be that of small mammals, and there is reason to believe that most of this is derived from rodents and rabbits dying in their

burrows or dens. Bones of fish, large terrestrial mammals, and sea mammals occur in considerably lower quantities. The protein values represented by the shellfish remains relative to the bone remains is informative (see table 9.3). Even if one assumes that all of the small fauna bone is a product of subsistence activities, the protein value of all four bone categories combined for a given level is no more than 23% of the protein represented by the shellfish remains in the same level. The estimates of bone densities in the deposits from the column sample probably are too low, however, considering that the unit excavation encountered a number of relatively large and dispersed bone fragments. Nonetheless, considering that a significant proportion of the small fauna cat-

egory must be noncultural, the evidence still points to shellfish being a more important source of protein than mammals.

The weights of bone by broad taxonomic category collected from the 1/4-inch screens during excavation is presented in figure 9.3. Because this bone was not collected by laboratory sorting of washed screening residues, the fish and small fauna categories certainly are underrepresented. Furthermore, since sea mammal bone tends to fragment more readily than most terrestrial mammal bone of comparable size, sea mammal bone probably is underrepresented slightly as well. The three mammal bone categories exhibit rather irregular distributions through the levels, which is likely the result of collection procedures and the relatively large size of individual bones. The comparison between land and sea mammal categories is informative: even compensating for the probable underrepresentation of sea mammal bone, land mammal bone is relatively more abundant in most levels. Conversions from bone weight to calorie or protein weight indicate that land mammal hunting probably contributed more to subsistence than sea mammal hunting.

Although species identifications have not been made, essentially all of the terrestrial mammal bone is derived from large ungulates, probably deer. In fact, much of the unidentifiable mammal bone probably is from large ungulates as well. Significantly, four elk bones have been identified in the collections from the pre-6700 RYBP levels. Elk bones also occur in higher levels of unit 9 and in the later deposits at the neighboring site of SBA-210. So far as is known, elk (possibly the Tule elk, *Cervus nannodes*) was extinct in southern coastal California in historic times. The sample is large enough from sites of the Vandenberg region to indicate that it was locally available perhaps as recently as 2000 RYBP (Spanne 1973).

Bird bone from the 1/4-inch screened sample reveals that at least 34 species of birds were hunted, trapped, or snared (Guthrie n.d.), although their collective contribution to the diet was minimal. Included are a variety of both marine and terrestrial species, including 18 bones of *Chendytes lawi*, an extinct flightless marine duck (Guthrie n.d.). Since bones of this species also occur in later deposits at the adjacent site of SBA-210, it did not become extinct

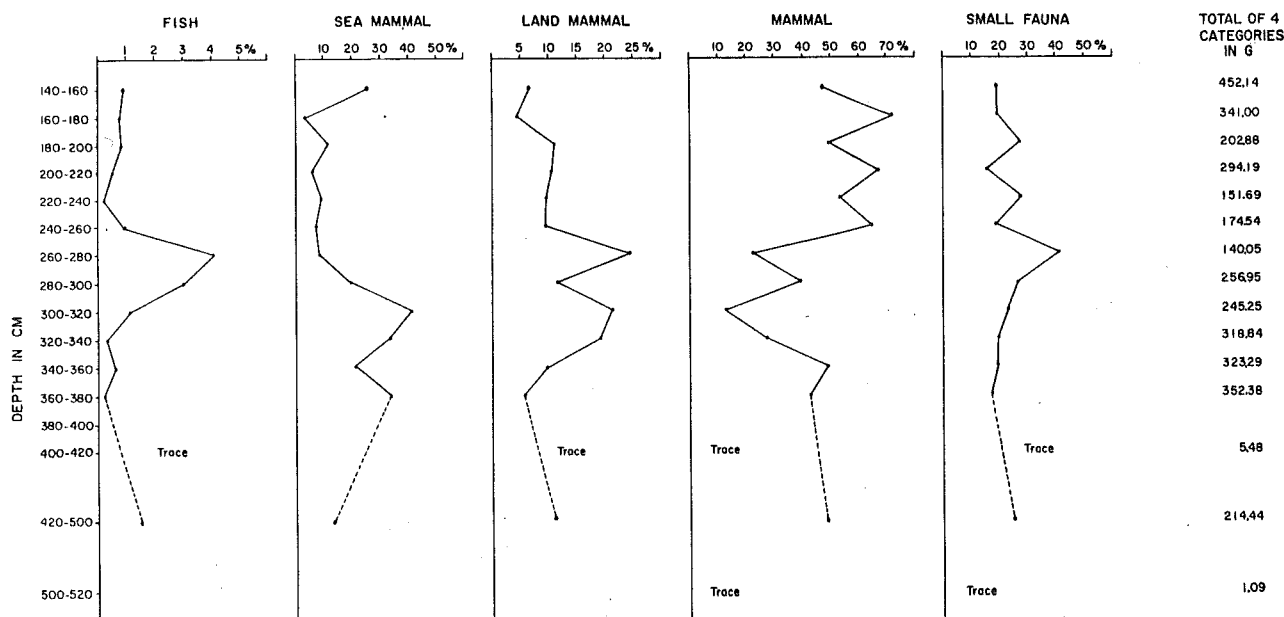


Figure 9.3. Bone weight percentages by faunal category for levels below 140 cm of unit 9, SBA-552. Bone from the 380 to 400 cm level and from the four levels between 420 and 500 cm was mistakenly lumped. The total bone weight for these levels was divided by five for comparison with other levels.



until perhaps 4000 RYBP. Indeed, *Chendytes* bones have been found in archaeological deposits on San Miguel Island dating perhaps as late as 2000 BP (Guthrie 1980).

Between 7000 and 8000 RYBP, the coastline immediately south of SBA-552 would have been between 0.5 and 1 km beyond the modern coastline. The bathymetry for this section of coast (Continental Shelf Data Systems 1967) indicates that the shoreline would probably have been just as rocky as it is today throughout this 1,000-year period. As a result, the site's inhabitants probably did not venture far to acquire the shellfish represented in the pre-6700 RYBP deposits.

Interestingly, the density of chert flakes in the pre-6700 RYBP levels at SBA-552 is especially low when compared to the upper levels or to many other sites in the Vandenberg region dating later in time. As seen in table 9.4, flakes decrease from quantities well over 100 in levels above 120 cm to quantities

substantially less than 100 below 120 cm. Similarly, all the preforms recovered from unit 9 occur above 120 cm (table 9.5). It would appear that the biface manufacturing evident in the chipped stone assemblages at many sites in the Vandenberg region was not taking place prior to 6700 RYBP, at least it was not at SBA-552. This fact hints at the possibility that the upper occupational stratum at SBA-931, which contains clear evidence of a biface manufacturing industry, may date to a time after 6700 RYBP or, alternatively, before 8000 RYBP and contemporary with occupation at SBA-530.

The depth of the pre-6700 RYBP deposits at SBA-552 and the density of faunal remains contained within them imply that this site served as a major locus of settlement for at least major intervals of time over a period of about 1,200 years. In fact, SBA-552 may have served as the principal residential base for a social group also using perhaps all other sites of comparable age in the south Vandenberg region. Three major environmental factors seem important in attracting this intensity of settlement to SBA-552. First, the creek that runs along the western border of the site is perennial and appears to have a reliable flow from one year to the next. Second, the site looks out over a south-facing shoreline that is largely protected from the heavy surf typical of the west-facing shoreline of the Vandenberg region. Not only does the rocky intertidal zone of this protected section of the coast provide access to prolific intertidal shellfish, but the relatively quiet nearshore waters make shore fishing easier than it would be elsewhere in the region. Third, the hills north of the site deflect much of the wind and fog that prevail along the exposed west-facing coastline, making the site more hospitable than other nearby localities to the north and west.

SBA-712, having a radiocarbon date of circa 7300 RYBP, is located 2.8 km west of SBA-552 in a similar environmental setting, the principal difference being that a perennial stream does not run past the site. However, archaeological deposits at this site are only 1 m deep, and the stratification of these deposits indicates two distinct periods of occupation that have been mixed by extensive faunalurbation. Deposits between 60 and 100 cm appear to pertain to the 7300 RYBP date, and they have yielded manos and metates. Density of shellfish remains is only 10 to 12% by weight of that in the pre-6700 RYBP levels at SBA-552, and bone is in trace quantities in

Table 9.4. Quantity and Weight of Chert Flakes per Column Sample Level of Unit 9, SBA-552

Level (cm)	Count	Weight (g)
0-20	243	85.1
100-120	167	24.5
200-220	26	8.2
300-320	63	8.6
400-420	38	6.0
500-520	6	0.2

Note: Column sample is 20 x 20 cm in size.

Table 9.5. Frequency of Biface Preforms per Level from Unit 9, SBA-552

Level (cm)	Count
0-20	5
20-40	5
40-60	6
60-80	3
80-100	4
100-120	2
120-520	0

Note: Unit size is 1.5 x 1.5 m.

the column sample. On the basis of the little information available, SBA-712 appears to have been used much less intensively than SBA-552, although it may have been a residential base if one assumes that the presence of ground stone artifacts indicates occupation for more than a few days or weeks at a time.

In evaluating the data on subsistence and settlement between roughly 7000 and 8000 RYBP, two conclusions are immediately apparent. First, although evidence for occupation during this time interval is certainly far more substantial than for the period prior to 8000 RYBP, it is still relatively meager in comparison to that for later periods of time, especially after circa 4500 RYBP. Consequently, our ability to discuss subsistence and settlement on a regional scale remains relatively limited. Second, the diversity of data from the four sites indicates that settlement varied substantially in intensity, with SBA-552 containing evidence of far more intense occupation in comparison to the other sites.

The notion of intensity of settlement covers up considerable behavioral variability since it is only a convenient way of referring to density and diversity of cultural remains. Intensity may take the form of more frequent returns to a site over the course of decades or centuries, longer durations of occupation during an annual cycle, or a greater emphasis on debris-causing activities (e.g., discard of shellfish remains) regardless of frequency or length of occupation. All of these factors may play some part in causing the variability in intensity of occupation, but available data do not allow the relative role of each to be discerned.

Almost certainly, many other sites in the region that are far less visible than the four dated sites may have been used between 7000 and 8000 RYBP. If such other sites were hunting camps, for instance, they probably would lack ground stone artifacts so diagnostic of this period of time, and they also might lack organic remains necessary for radiocarbon dating. Furthermore, many sites that were next to the coast during this period may have been destroyed by sea level rise and concomitant coastline erosion. While SBA-552 contains a wealth of data pertaining to this time period, it is undoubtedly only one of many sites used during the course of an annual cycle of movement, and certain subsistence pursuits may have been given considerably more emphasis at other sites than they were at SBA-552.

## CONCLUSIONS

Any interpretations of cultural developments between 9000 and 7000 RYBP in the Vandenberg region must recognize the severe limitations of the available data. Too few sites are known to date within this time interval, and too few data from excavations currently exist for definitive conclusions to be reached. Still, the information that can be gleaned from the available data does allow some tentative statements about the course of cultural development that may serve as hypotheses for guiding future research.

First, population density appears to have been significantly greater in the post-8000 RYBP period, if the number of dated sites per time period in the Vandenberg region is any indication. In fact, the sharp increase in the number of dated sites in the southern California coastal region as a whole (see Erlandson 1988a:383) may imply that population density increased in a marked spurt for the first time in prehistory. The date of  $7990 \pm 350$  RYBP from the basal deposits at SBA-552 supports this conclusion in that this major residential base appears to have been occupied initially at the onset of this period of hypothesized population growth.

Second, seed collecting and milling in the Vandenberg region apparently began sometime around 8500 RYBP if the data from SBA-530 are a valid indication. Again, data from the surrounding region tend to support this conclusion. At Diablo Canyon, SLO-585, metates and manos appear to be associated with a stratum radiocarbon dated to  $8410 \pm 190$  RYBP (Greenwood 1972:61-62, 86). Furthermore, Erlandson's (1988a:390) recent survey of data from Early Holocene sites throughout southern coastal California revealed that milling equipment dates no earlier than circa 8500 RYBP. If this pattern holds, it may indicate that the introduction of seed collection, storage, and milling arose in southern coastal California at a time when populations were undergoing a good deal of subsistence stress favoring the development of this new technology. Relatively fine-scale paleoenvironmental data obviously would be needed to assess this possibility.

Third, the data from the Vandenberg region are probably sufficient to conclude that shellfish were an important source of dietary protein throughout the period between 9000 and 7000 RYBP, although its place in the annual cycle of subsistence activities likely changed quite radically. In addition, the other

two major categories of marine food resources, fish and sea mammals, were part of the diet by circa 8500 RYBP, implying that the maritime orientation of subsistence, so prevalent in later prehistoric times, was already relatively well developed by this time. Still, the data from SBA-552, and possibly also from SBA-530, imply that terrestrial hunting, specifically of large ungulates, was more important than marine mammal hunting or fishing. Such a focus on terrestrial hunting may extend back to the period prior to 8500 RYBP if populations then did not spend as much time at the coast as they did later.

Taken together, the data from the Vandenberg region imply a shift in subsistence-settlement systems from a relatively wide-ranging foraging type prior to 8500 RYBP, in which mobility was high and food storage apparently was of minor importance, to a type involving lower mobility, collection, storage, and milling of seeds, and use of principal residential bases at or near the coast. In other words, the date of circa 8500 RYBP may mark the inception of a collecting subsistence-settlement system as defined by Binford (1980), which replaced a foraging type more akin in structure, at least, to those of Paleoindians. Still, one must keep in mind that direct evidence of food storage from any of the Vandenberg sites dating between circa 8500 and 7000 RYBP is absent. While the presence of tools for milling seeds implies food storage, it may otherwise imply only an expansion of the subsistence base to include seeds.

This proposed shift around 8500 RYBP from a foraging to a collecting subsistence-settlement system also may be reflected in the data from SLO-2 and SLO-585 (Greenwood 1972), two sites located on the San Luis Obispo County coast 70 km north of the Vandenberg sites. The deposits at and below 290 cm below surface at SLO-2, from which radiocarbon dates circa 9000 RYBP were obtained, do not contain milling implements. As mentioned above, however, SLO-585 does contain milling implements in apparent association with a radiocarbon date of circa 8500 RYBP. Taken together, the data from these two sites appear to reflect the same kind of shift in subsistence and settlement proposed for the Vandenberg region.

Moratto (1984:104-109) has placed certain manifestations in southern coastal California dating prior to circa 8000 RYBP into a tentatively defined Paleo-Coastal tradition. He includes within this tradition those site components dating between circa 8000 and 8500 RYBP that contain manos and metates,

and therefore he does not place as much significance as I do on the inception of seed collecting and milling. I have argued that the use of these artifacts reflects much more than just the expansion of the diet to include seeds. Assuming that food storage went along with seed collecting and milling, and that certain sites became principal residential bases at this time as well, the whole structure of the subsistence-settlement system would have shifted from a foraging type to a collecting type.

If, indeed, a collecting subsistence-settlement system involving seeds as a significant dietary component came into existence circa 8500 RYBP in the Vandenberg region and surrounding regions, significant change in subsistence and settlement may not have occurred circa 8000 RYBP, when population began to increase significantly. Instead, the period following 8000 RYBP may have witnessed the expansion of populations practicing a subsistence-settlement system proven to be successful during the previous 500 years.

The faunal remains from SBA-552 imply that a wider variety of animal species was available between circa 8000 and 6700 RYBP than has been recorded historically. In particular, elk hunting appears to have been relatively important, and the flightless duck *Chendytes* was quite significant among the birds exploited. Although these fauna apparently did not become locally extinct until sometime during the Mid-Holocene, they nonetheless point to the existence of a natural environment with some important differences in comparison with the modern or historic environment. Of more importance in indicating environmental conditions during the Early Holocene are the fossil pollen data from a core sample taken from the bottom of the Santa Barbara Channel (Heusser 1978; see also Glassow et al. 1988). The pollen percentages indicate that vestiges of the cooler and wetter habitat typical of the terminal Pleistocene apparently were still prevalent until circa 7000 RYBP.

What happened after 7000 RYBP, or more precisely after 6700 RYBP, is currently unknown. No deposits in the Vandenberg region dating between 6700 and circa 5000 RYBP have been discovered yet. As my colleagues and I have pointed out in a recent paper (Glassow et al. 1988), this gap in radiocarbon dates correlates with a depression in the frequency of radiocarbon dates centering in the 6000s RYBP all over southern coastal California. We have argued that population density may have decreased

during this time interval in response to environmental degradation brought about by warm, arid climatic conditions. Future research at SBA-552 and its neighboring site, SBA-210, may provide some insight into events during this interval.

The increasing evidence of occupation as early as 9000 RYBP north of Point Conception—as opposed to east of the point along the Santa Barbara Channel<sup>1</sup>—is intriguing (see Erlandson 1988a:284-321, 353-374 for an overview of the Early Holocene prehistoric chronology). Two possible explanations for this pattern may be proposed. First, sites of such antiquity along the Santa Barbara Channel simply may have been missed by investigators because shellfish remains, so visible in sites north of the point dating in excess of 8000 RYBP, may be scarce or absent in sites along the channel. Today, mussels are not readily available along the majestic sandy beaches of the Santa Barbara Channel, and this condition surely existed during the Early Holocene as well. Even though Erlandson (1988a) reports that estuarine species of shellfish were widely available along the channel coast during the Early Holocene, their abundance apparently never equaled that of mussels north of Point Conception. If shellfish collection along the channel coast as early as 9000 RYBP was relatively sporadic and not associated with the use of residential bases, very little would be left behind for the archaeologist to recognize. This possibility gains some support from the growing prospect that sites on the Channel Islands, specifically San Miguel Island, may date as early as 9000 RYBP (Snethkamp 1987). Like sites north of Point Conception, those on the Channel Islands frequently contain very high densities of shellfish remains, predominantly of mussel, which is as abundant in the intertidal zones around the islands as it is north of Point Conception.

The alternative hypothesis, that occupation actually was not as dense along the Santa Barbara Channel prior to circa 8000 RYBP, also takes into consideration the differential abundances of intertidal shellfish. If the adaptation of people prior to 8000 RYBP emphasized shellfish collection as an important subsistence resource for supplying protein to the diet, at

least while they were occupying localities near the coast, then the Santa Barbara Channel mainland coast may not have been as attractive and therefore did not witness the extent of occupation seen north of Point Conception. The presence of pre-8000 RYBP sites on the Channel Islands can be accommodated by this hypothesis if it can be assumed that once populations began to live on the Channel Islands they were able to live in relatively higher densities than on the mainland coast. Indeed, if the subsistence of mainland populations prior to 8000 RYBP was much more terrestrially oriented, one might expect populations on the Channel Islands to be in higher densities due to an inevitable focus on shellfish and other marine fauna. An elaborate maritime subsistence orientation in fact may have had its origins on the Channel Islands rather than on the mainland.

In conclusion, the data from sites of the Vandenberg region have yielded significant, although still scant, information pertaining to the 2,000-year period beginning circa 9000 RYBP. Although the picture is still hazy, one thing is certain: cultural development of a very fundamental sort occurred during this vast span of time. While the interpretations presented in this chapter are tentative—even speculative to some extent—they do serve as viable hypotheses to be considered as more research is undertaken in the Vandenberg region and neighboring areas. Fortunately, the archaeological record of the Vandenberg region still has much to offer those who wish to evaluate these hypotheses as well as others not yet proposed.

#### NOTE

1. Erlandson et al. (1987) report that a fragment of a Clovis point was found at a site on the coastal plain of Hollister Ranch, east of Point Conception. While this point fragment may indicate use of the Santa Barbara Channel coast between circa 11,000 and 11,500 RYBP, there is no evidence of continuity of occupation from this time until circa 8000 RYBP, the time of the earliest radiocarbon date so far obtained from site deposits (Erlandson 1988a).

## Chapter 10

### Early Holocene Occupation of the Central California Coast

Gary S. Breschini and Trudy Haversat

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**T**his chapter discusses the problem of Early Holocene occupation along the central coast of California, defined herein as the area approximately between San Francisco on the north and Point Conception on the south (fig. 10.1). The Vandenberg area of northern Santa Barbara County is discussed elsewhere (chap. 9, this vol.) and is omitted here. The focus here will be the changing coastal environments during and since the Early Holocene in the coastal areas of San Luis Obispo, Monterey, Santa Cruz, San Mateo, and San Francisco counties.

At least 552 radiocarbon dates have been obtained within these five counties (Breschini et al. 1988, 1990). Of these, only 37 dates (from nine sites) are attributable to the Early Holocene (between 7000 and 10,000 RYBP). All of these samples are from coastal or near-coastal sites (see fig. 10.1; table 10.1).

The two Early Holocene radiocarbon dates from MNT-229 are described as erroneous. The reservoir effect, in conjunction with a major submarine canyon, appears to have reduced the reliability of *Protothaca* samples at this site and possibly the bone sample as well (see Dietz et al. 1988:121-126). Elimination of these two samples reduces the num-

ber of Early Holocene dates on the central California coast to 35 and the number of sites to eight. One of these eight sites is in Santa Cruz County, while the other seven are in San Luis Obispo County. We are not aware of any reliable Early Holocene radiocarbon dates from coastal San Francisco, San Mateo, or Monterey counties.

#### SITE LOCATIONS DURING THE EARLY HOLOCENE

In discussing the Early Holocene period, and what has been called the Paleo-Coastal tradition, Moratto (1984:104) notes that "coastal sites tend to be located on estuary and bay shores—a parallel to the lakeshore and marshside settings of the interior sites."

The estuary and bay shore adaptation of the Early Holocene, however, may have led directly to the destruction of a large percentage of these sites. Situated along the coast, they would have been subject to both coastal erosion and sea level fluctuations. Even 8,000 years ago, following most of the changes in sea level which occurred at the end of the glacial period, sea levels would have been some 15 to 20 m lower than at present (Erlandson 1985:107; Bickel 1978:7).

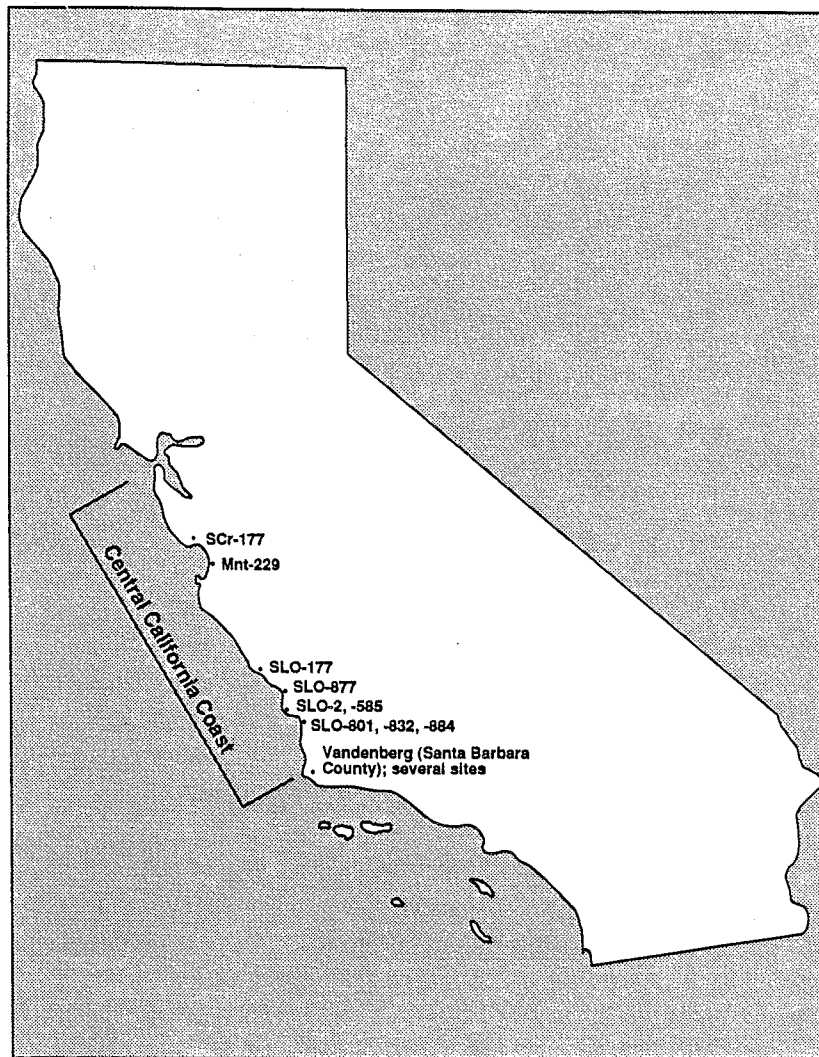


Figure 10.1. Archaeological sites on the central California coast with Early Holocene radiocarbon dates.

Coastal erosion rates of between 15 and 25 cm per year have been suggested for the Santa Barbara Channel, and of 70 feet per century (equivalent to about 21 cm per year) for some portions of the San Luis Obispo coast. Given the magnitude of these changes, many sites older than 7,000 years probably lie inundated beneath 15 to 20 m of water or, more likely, have been destroyed by coastal erosion. Moratto (1984:108) estimates that 10,000 years ago the shoreline may have been as much as 10 km farther west along many stretches of the southern coast. This can be expected for portions of the central coast as well.

The Early Holocene sites that are now being found most likely were originally situated some distance from the coast or along steep cliffs more resistant to coastal erosion and sea level fluctuations.

This introduces a bias of unknown magnitude into the data set.

Of the eight Early Holocene sites known along the central California coast, at least four (SCR-177, SLO-177, -832, and -877) appear to have been situated inland, probably along a marshy creek. The other four (SLO-2, -585, -801, and -884) appear to have been situated adjacent to embayments, with steep rocky cliffs which would have been less subject to sea level fluctuations and coastal erosion.

No Early Holocene sites are known from along Monterey Bay. Perhaps the reason for this can be seen in figure 10.2, which shows the possible Early Holocene shoreline in relation to known sites. Of the 11 sites on this map, radiocarbon dates are available from 3; the oldest dates at each of these sites are:

Site no.	Oldest date
MNT-17	3900 RYBP
MNT-170	5330 RYBP
MNT-834	4740 RYBP

sites are probably along the 10-fathom (60-foot) line, which, in many areas, lies approximately 1 km offshore.

As Bickel (1978) notes, the sea level rose rapidly until about 7,000 years ago, when the rate slowed. Since that time the change has been on the order of 1 to 2 m per 1,000 years. Many of the Early Holocene

All of these factors, along with the smaller population sizes of the Early Holocene, have combined to leave us with very few sites from this time period along the central California coast. Of the few sites we do have, most have been subjected to only limited research.

Table 10.1. Uncorrected Early Holocene Radiocarbon Dates from the Central California Coast

Site no.	Age in RYBP	Lab no.	Material	Provenience	
				Unit	Level (cm)
MNT-229	7020 ± 170	WSU-3314	Bone-Elk tibia	12	100-120
	7700 ± 90	WSU-3298	Shell- <i>Protothaca</i>	32	40-60
SCR-177	7050 ± 110	Beta-7714	Charcoal	29	60-80
	7100 ± 180	Beta-24203	—	AA138	100-110
	7180 ± 290	RL-1374	Charcoal	2	140-190
	7310 ± 220	Beta-19711	—	101	140-150
	7470 ± 140	Beta-24409	—	CC139	60-80
	8500 ± 250	Beta-22328	—	BB135	50-60
	8500 ± 450	Beta-22332	—	BB135	110-130
	8720 ± 740	Beta-19712	—	101	150-160
	9070 ± 340	Beta-22330	—	BB135	80-90
	9200 ± 230	Beta-22331	—	BB135	90-100
	9470 ± 300	Beta-24206	—	BB142	71-78
	9580 ± 260	Beta-22329	—	BB135	70-80
	10080 ± 460	RL-1373	Charcoal	5	100-110
	10090 ± 420	Beta-21926	—	BB140	53-64
	10120 ± 320	Beta-24207	—	BB142	88-90
	10650 ± 180	Beta-21293	—	AA120-121	100-110
	10790 ± 340	Beta-24208	—	BB142	120-130
	12390 ± 610	Beta-19713	—	101	160-180
	12520 ± 740	Beta-21925	—	BB140	80-94
SLO-2	8960 ± 190	GAK-02044	Shell- <i>Haliotis rufescens</i>	N1/W5	290
	9320 ± 140	UCLA-1686A	Bone	S4/W9	320-330
SLO-177	8290 ± 100	Beta-07035	Shell- <i>Mytilus</i>	—	—
	8430 ± 200	UCR-0789	Shell- <i>Mytilus</i>	60S/60W	122-145
SLO-585	7370 ± 150	GAK-02042	Shell- <i>Haliotis rufescens</i>	N14-W7	160-170
	7520 ± 170	GAK-02043	Shell- <i>Haliotis rufescens</i>	N14-W7	120-130
	8410 ± 190	GAK-02040	Shell- <i>Haliotis rufescens</i>	N12-W6	200
SLO-801	7210 ± 220	UCR-1336	Shell- <i>Tivela stultorum</i>	Trench 1	20-40
	7565 ± 125	UCR-1337	Shell- <i>Tivela stultorum</i>	Trench 1	100-120
	8540 ± 140	UCR-1339	Shell- <i>Tivela stultorum</i>	Trench 1	200-220
	8660 ± 150	UCR-1338	Shell- <i>Tivela stultorum</i>	Trench 1	180-200
SLO-832	8140 ± 250	UCR-1343	Shell- <i>Protothaca</i>	Auger M-1	190-230
	8520 ± 140	UCR-1342	Shell- <i>Macoma</i>	Auger M-1	130-150
SLO-877	8080 ± 100	WSU-2620	Shell-mixed	Col. B	50-60
SLO-884	7250 ± 100	WSU-3873	—	—	0-10
	8010 ± 100	WSU-3874	—	—	15-30

Source: Breschini et al. (1988, 1990).

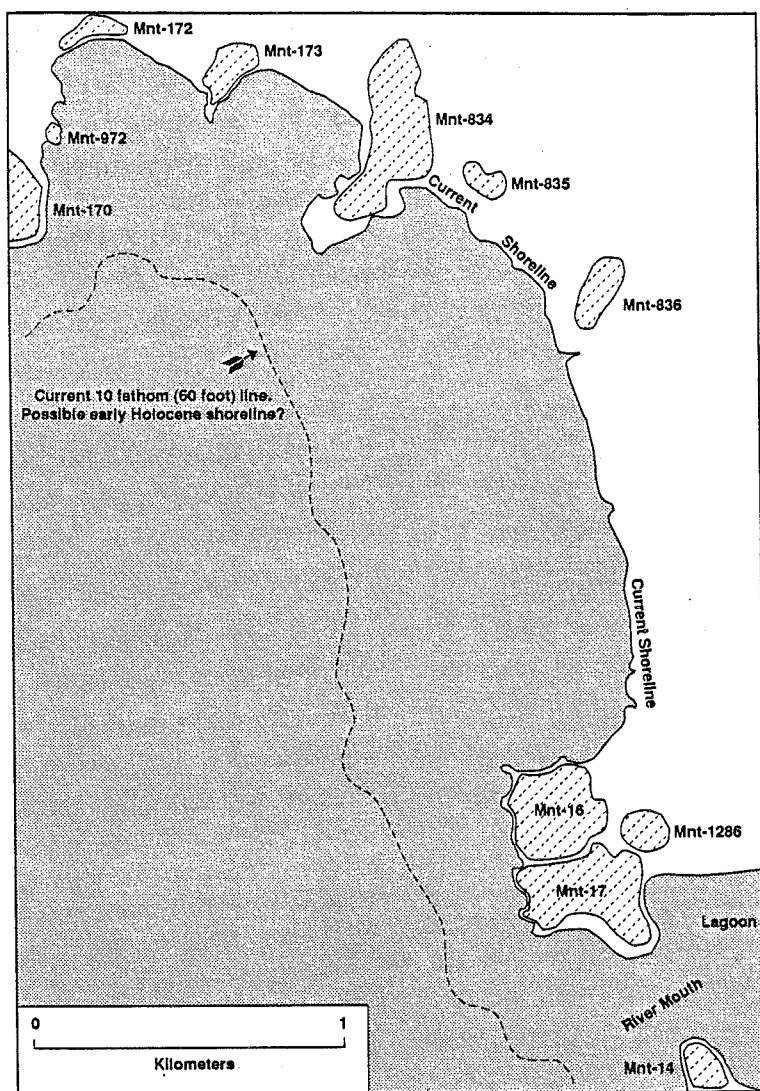


Figure 10.2. Current shoreline and possible Early Holocene shoreline at the 10-fathom line.

### Research at Early Holocene Sites

Relatively little research has taken place at seven of the eight known Early Holocene sites along the central California coast. The following section presents a brief discussion of each site, as well as references to the available data. (Additional discussions of the Early Holocene are found in Erlandson 1988a.)

**SCR-177.** SCR-177 is located approximately 10 km from the modern coast, at an elevation of about 550 to 600 feet. It is situated adjacent to a marshy creek, which may have been more extensive during the Early Holocene.

Unlike most Early Holocene sites, SCR-177 has undergone several phases of excavation, including two "mass exposures" encompassing hundreds of cubic meters of soil, and extensive dating. This large sample was critical to the research because the deposit has a very low density of cultural materials.

There are currently 37 radiocarbon dates from SCR-177; 25 of these are 6000 RYBP or older, and 19 are Early Holocene. Eleven radiocarbon dates were obtained from unit 101 (table 10.2), which has a continuous span of nearly 12,000 radiocarbon years. The Napa obsidian recovered from SCR-177 supports an age of nearly 10,000 years (using the formula given by Dietz et al. 1988:136) (see fig. 10.3).



Table 10.2. Radiocarbon Dates from Unit 101 at SCR-177

Level	Date
0-10	-
10-20	-
20-30	-
30-40	-
40-50	580 $\pm$ 130
50-60	1680 $\pm$ 230
60-70	-
70-80	2230 $\pm$ 160
80-90	3490 $\pm$ 320
90-100	4960 $\pm$ 160
100-110	4960 $\pm$ 140
110-120	5100 $\pm$ 120
120-130	5970 $\pm$ 200
130-140	6540 $\pm$ 140
140-150	7310 $\pm$ 220
150-160	8720 $\pm$ 740
160-170	-
170-180	12,390 $\pm$ 610

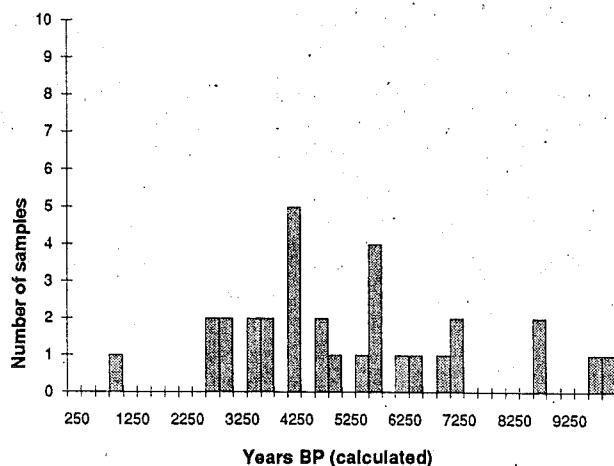


Figure 10.3. Napa obsidian dates from SCR-177 (based on formulae provided by Dietz et al. 1988:136).

SCR-177 contains virtually no shell or bone. The primary materials at the site are lithics (including numerous bifaces and an eccentric crescent) and ground or pecked stone, along with extensive rock features. As such, there is little information on the nature of human subsistence or coastal paleogeography during the Early Holocene.

Preliminary information on this site has been presented by Cartier (1984, 1985, 1988a, 1988b), and a detailed monograph is anticipated.

**SLO-832.** SLO-832 is situated on a gradual slope above a marshy creek area approximately 0.7 km inland from the ocean. Its elevation ranges from 25 to about 180 feet.

The early portion of SLO-832 was identified by Bob Gibson (personal communication, 1983). Radiocarbon dates of 6530  $\pm$  130, 8140  $\pm$  250, and 8520  $\pm$  140 RYBP were obtained from shell samples recovered from one portion of the deposit during auger testing. These dates were sufficient to obtain some protection for portions of the site, but, given the limited nature of the project, no detailed analyses were conducted; other than these radiocarbon dates, no other information is available from the Early Holocene component.

There is also a later component at SLO-832; this has been radiocarbon dated to 5190  $\pm$  370. Additional research on this upper component, based on excavations by the authors, is now in progress. Still other portions of the site may represent the ethnographic village of *Pismu* (Greenwood 1978a:520).

**SLO-801 and SLO-884.** SLO-801 is situated on the sloping coastal terrace at an elevation of 60 to about 160 feet. The coastal edge of the site is less than 0.2 km from the ocean. This site lies about 1.6 km northwest of SLO-884, in essentially the same environmental setting.

Bob Gibson obtained radiocarbon dates of 7210  $\pm$  220, 7565  $\pm$  125, 8540  $\pm$  140, and 8660  $\pm$  150 RYBP from SLO-801 (personal communication, 1983). Unfortunately the samples were collected during monitoring of construction trenching and grading, and virtually no scientific data were recovered. Additional research has also revealed a more recent component at the site (Westec Services 1984).

SLO-884 is situated on the sloping coastal terrace at an elevation of about 60 to 80 feet. The edge of the site is less than 0.2 km from the ocean.

W. B. Sawyer obtained two Early Holocene radiocarbon dates from this site (personal communication, 1989) (see table 10.1). Unfortunately, the only information we have on the site is the depth of the samples, 0 to 15 cm and 15 to 30 cm.

**SLO-2 and SLO-585.** In the spring of 1968, Greenwood (1972) tested two multicomponent sites at Diablo Canyon, west of San Luis Obispo. SLO-2 and SLO-585 are situated on the coastal terrace about 4 km apart. SLO-2 has an elevation between 20 and 160 feet and is located within a few meters of the coast. SLO-585 is located at an elevation of 120 to 200 feet and is about 0.3 km inland from the ocean. The coast in this area is generally characterized by steep rocky cliffs, ranging from 20 to 60 feet in height.

Greenwood obtained radiocarbon dates of  $930 \pm 50$ ,  $8,960 \pm 190$ , and  $9,320 \pm 140$  RYBP from SLO-2, and dates of  $5100 \pm 110$ ,  $7370 \pm 150$ ,  $7520 \pm 170$ , and  $8410 \pm 190$  RYBP from SLO-585.

In spite of a "rigorous statistical search," Greenwood (1972:87) could not identify any significant shifts in food pattern or dramatic trends in population size from top to bottom of SLO-2. It is possible, however, that some changes did occur through time. The earliest component at SLO-2 (dated to ca.  $8960 \pm 190$  and  $9320 \pm 140$  RYBP) did not contain milling tools, although later components, and the basal component at SLO-585 (dated to ca.  $8410 \pm 190$  RYBP), did contain such tools (Moratto 1984:107).

Unlike at SLO-877, the relative proportions of shellfish remain almost constant at SLO-2. *Mytilus* is the dominant shellfish throughout the deposit, averaging around 85% by weight (fig. 10.4). This suggests there was little change in the effective coastal environment, probably because the site is adjacent to an embayment with high, steep, rocky cliffs. The effects of sea level fluctuations and coastal erosion

would thus have been minimized. The earliest portion of SLO-2 contained a tremendous diversity of resources, including 13 fish species, 71 molluscan genera, and 20 species of game animals and birds.

**SLO-877.** SLO-877, near Cayucos, is situated on the coastal terrace immediately adjacent to the ocean along what was probably a marshy creek. The elevation of the site is currently about 15 to 20 feet, and coastal erosion is gradually consuming the deposit.

Excavations by the authors identified a small Early Holocene component buried beneath an extensive Middle Holocene deposit. Radiocarbon dates from the early component were  $6865 \pm 120$  and  $8080 \pm 100$  RYBP, while three radiocarbon assays from the upper component ranged between 5150 and 5420 RYBP.

One of the notable differences between the upper and lower components is the shellfish distribution. *Mytilus* predominates during the Early Holocene, *Tivela* during the Middle Holocene (fig. 10.5), a change that may reflect changing coastal environments or changing exploitation patterns. However, the low coastal bluff, comprised of sediments rather than rock, is highly subject to erosion and probably retreated by one or more kilometers during the Early Holocene. Changes in the shellfish species brought to the site thus may also have reflected changes in the distance to the coast.

As at Diablo Canyon, the Early Holocene component exhibits a mixed resource strategy involving both land and marine resources.

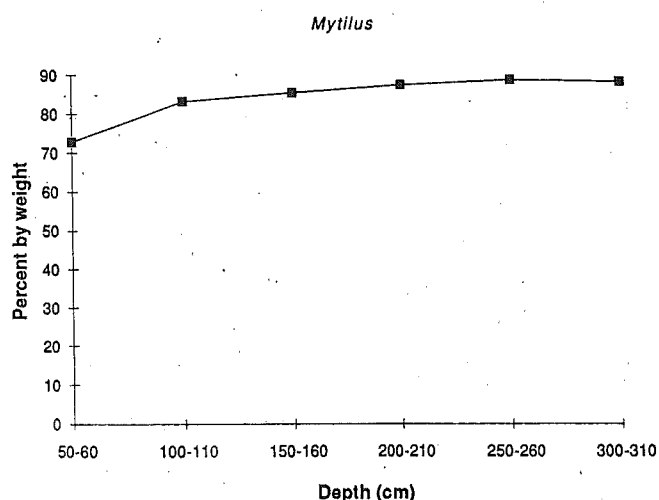


Figure 10.4. Distribution of *Mytilus* at SLO-2.

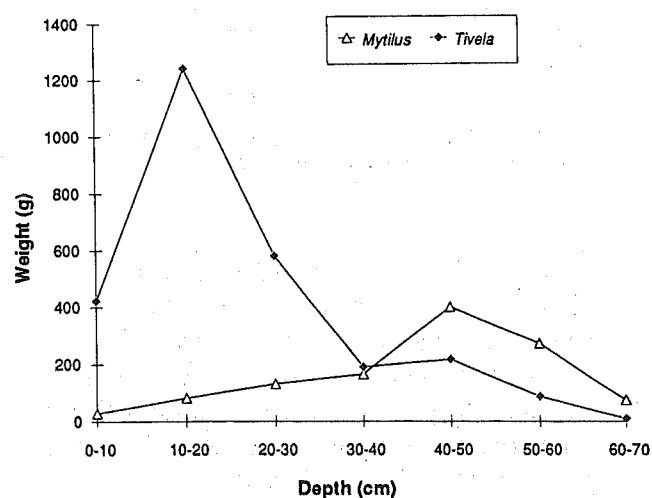


Figure 10.5. *Tivela* and *Mytilus* distribution from unit 3 at SLO-877.

**SLO-177.** Unlike the other Early Holocene sites along the San Luis Obispo County coast, SLO-177 is located on the top of a hill, at an elevation of about 250 feet and a distance of 0.7 km from the ocean. The site most likely was associated with a nearby marshy creek, although it is possible a spring was once located nearby.

At least two test excavations have been undertaken at this site. The first, a major excavation in the center of the site, was conducted in 1976 under the direction of Bert A. Gerow and Ezra Zubrow. The collection from this site was the subject of a master's thesis by A. M. Pierce (1979). The second test, a relatively small excavation closer to the periphery of the site (T. P. Rudolph 1983a, 1983b), was conducted perhaps 100 m away from where Gerow worked. Each project obtained a single radiocarbon date; the assays were  $8430 \pm 200$  and  $8290 \pm 100$  RYBP, respectively.

The shellfish distribution obtained by T. P. Rudolph (1983a) appears similar to that from SLO-2, with *Mytilus* dominant throughout (approximately 78%) (see fig. 10.6). However, there are no dates from the upper portions of the site, and consequently we do not know what temporal periods are represented. T. P. Rudolph believed that the portion of the deposit she tested represented a single component. (See J. L. Rudolph 1985 for additional data on changing shellfish exploitation at SLO-177.)

The collection described by Pierce (1979), however, appears to contain materials from a wide temporal

range, possibly most of the Holocene. Included are milling tools (Pierce 1979:28-30), a number of large side-notched points similar to those from the Middle Holocene component at SLO-877, and small triangular points associated with the Chumash period.

## CONCLUSIONS

There are few Early Holocene sites currently known on the central California coast. It is likely that most sites which were once situated along the coast during the Early Holocene have been destroyed by coastal erosion associated with sea level changes.

Of the known sites, three are situated far enough inland to avoid coastal erosion, and four of the others are protected by steep rocky coastal bluffs, which sheltered them from erosion. Only one, SLO-877, is located adjacent to the ocean without such protection. All of the known sites are either situated adjacent to a marshy creek or are within 0.3 km of the ocean.

The majority of the Early Holocene sites on the central California coast are in San Luis Obispo County (or the adjacent section of northern Santa Barbara County; see chaps. 7 and 9, this vol.). The absence of Early Holocene sites along the coasts of Monterey, Santa Cruz, San Mateo, and San Francisco counties may be attributed, at least in part, to the environmental and physiographic setting. The coast of Monterey County is generally very steep, with few suitable site locations, while the Salinas Valley to the interior probably supplied an abundance of marshy terrain. As such, the rugged coast was probably avoided in favor of the more habitable terrain. The Monterey Bay is characterized in many areas by low rocky or low sandy bluffs, which would be more subject to coastal erosion and flooding by sea level changes. The north coast, between the northern Monterey Bay and San Francisco, has steeper rocky bluffs, but may have been bypassed in much the same way as the Monterey County coast. Further, this area has been subject to less archaeological testing, so sites could easily have been missed.

While there were changes in the environment during the Holocene, some sites do not appear to have reflected those changes as much as others. SLO-2, for example, contains nearly constant quantities of various faunal remains throughout a nearly 9,000-year time span. Other sites (e.g., SLO-877) reveal changes in some constituents through time.

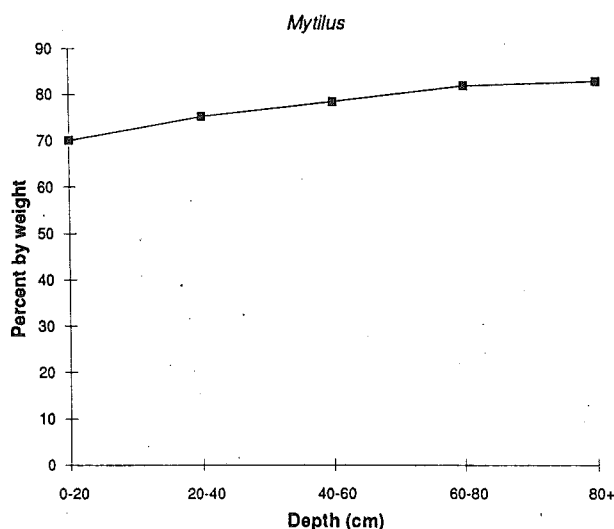


Figure 10.6. Distribution of *Mytilus* at SLO-177.

Virtually all of the Early Holocene sites have one or more later components. As such, more thorough and systematic radiocarbon dating of the lower strata of recent sites may reveal additional Early Holocene components.

Finally, our oldest and most critical sites are being poorly managed. Six of these critical sites have been subjected to at least moderate damage, and archaeological studies have generally been conducted on limited budgets, with no overall research goals and with only limited (or no) concern by the lead agencies. For example:

At SCR-177, excavations came about because the City of Scotts Valley bulldozed portions of the site. Settlement of a lawsuit brought by the Santa Cruz Archaeological Society and the Society for California Archaeology mandated data recovery and partial preservation of the site.

In Pismo Beach, where three of the Early Holocene sites are situated, cultural resource management has been limited. SLO-832 has been poorly managed, in part because of its size; it extends over dozens of parcels which are undergoing development or redevelopment at different rates. Because of this piecemeal approach, and the lack of concern on the

part of the City of Pismo Beach, considerable scientific data have been lost. SLO-801 and -884 have produced only very limited data for similar reasons.

SLO-877, in Cayucos, was identified as Early Holocene only after it had been almost entirely destroyed by construction. A major sample has been obtained from the site, but most material was recovered from a spoils pile, rather than from an in situ context. (A portion of the site remains intact under one structure.)

SLO-177, in Cambria, is being managed in a piecemeal fashion because it is situated beneath a street and extends onto perhaps 12 to 15 small building lots. Indeed, the lead agency, the County of San Luis Obispo, does not even require archaeological surveys for some portions of the site. A water shortage has slowed development in the area and is fortunately helping to slow the rate of destruction at this site.

The other two Early Holocene sites, SLO-2 and SLO-585, are being managed with more success because they are located adjacent to the Diablo Canyon Power Plant where access and development are limited and where management requirements imposed by the lead agencies have been more consistent.

## Chapter 11

### Perspectives on Early Hunter-Gatherers of the California Coast

Roger H. Colten and Jon M. Erlandson

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**I**n chapter 1, we summarized some of the issues we believe are central to a more thorough understanding of the early cultures of the California coast. The studies presented in this volume should make it clear that adaptations of the Early Holocene, though sharing fundamental similarities throughout much of the southern and central California coast, were characterized by both spatial and temporal diversity. Carbone in chapter 2 and other contributors also emphasize the dynamic and varied nature of early coastal environments to which California's hunter-gatherers adapted, variability that is a major source of adaptational diversity within the region.

In this chapter, we discuss some of the implications of research detailed in this volume for studies of early hunter-gatherers of the California coast, focusing on the origin of the earliest coastal groups, revisions to previous conceptions of California's culture history, variability in early ecological adaptations, and some suggested directions for future research. For large portions of the California coast, little archaeological information is available, a fact that limits the resolution with which the origins, evolution, and ecology of early coastal groups can be

examined. Moreover, attempts to place early maritime cultures of the California coast into the broader context of Pacific Rim prehistory are limited by the scarcity or absence of data from early sites on the adjoining coasts of Baja California, northern California, Oregon, and Washington. Early coastal cultures roughly as old as California's are known from the Aleutians (Laughlin 1975), southeast Alaska (e.g., Ackerman et al. 1979, 1985; Davis, ed. 1988), British Columbia (Fladmark 1986), Peru (Moseley 1975; Keatinge 1988), and Chile (e.g., Lagostera 1979), but specific comparative data from early sites of these areas are sparse as well. The large gaps in the record preclude anything but speculative assessments of the broader relationships of these diverse coastal cultures.

#### THE ORIGIN OF CALIFORNIA'S EARLY COASTAL CULTURES

Despite serious interpretive problems caused by coastal inundation and erosion, considerable data are available to examine the questions of when and from where the earliest human groups arrived on the Cali-

formia coast. The large number of early coastal sites probably results from the combined effects of two factors: the generally steep offshore bathymetry and numerous deep submarine canyons (both limiting lateral shoreline displacements caused by sea level rise) and the tendency for early groups to settle on elevated landforms around coastal embayments at some distance from the open coast, locations least subject to coastal inundation and erosion. Despite these mitigating factors, many early coastal sites undoubtedly have been destroyed by erosion, inundated by sea level rise, or covered by sediments, processes that continue to bias the coastal archaeological record and our interpretations of it. Furthermore, because the effects of these geological and eustatic processes are cumulative, the earliest coastal sites are those most likely to have been submerged, obscured, or destroyed.

Erlandson (1988a:392-397) assessed the available evidence for the origins of the earliest known coastal groups, concluding that no firm evidence existed for an occupation predating 9500 to 10,000 CYBP, that no apparent technological precursors are known in the North Pacific, and that similarities of California's early coastal and interior assemblages support a common origin. More recently, Meighan (1989) reversed a similar opinion (Meighan 1978:236), suggesting that similarities between the earliest maritime assemblages of the California islands and early bifacial traditions of the Northwest coast may have a common origin. Both coastal and interior traditions (including Clovis) of western North America at the Pleistocene-Holocene transition appear to be related to a common bifacial tradition, whose movement can be traced around the North Pacific at the end of the Pleistocene. The similarities among interior and coastal assemblages complicate the identification of distinctive migration routes, especially given the limited number and size of the assemblages available and the large spatial gaps that remain.

This volume will not resolve the controversy about alternative migration routes into the Americas or even the antiquity and origin of California's earliest coastal cultures. Salls (chap. 5), Erlandson (chap. 8), Glassow (chap. 9), and Breschini and Haversat (chap. 10) do present new data on some of the earliest coastal or peri-coastal sites of the California coast.

In addition, Gallegos (chap. 3) presents new data to support the notion that early groups of the San Diego coast migrated from the interior after abandoning drying pluvial lakes that once contained aquatic habitats (e.g., marshes) and resources (shellfish, fish) similar to those of the coast. Gallegos emphasizes the relative ease with which interior populations may have adapted to coastal environments.

With the data presently available, logical cases can be made for both coastal and interior migration theories. Eventually, the archaeological evidence may indicate that both migrations took place. At present, however, the archaeological evidence for potential precursors for both coastal and interior regions is woefully inadequate. It now seems likely that Clovis-like Paleoindian groups occupied both the coast and interior by around 11,000 years ago. Although their economies often are assumed to have focused on big game hunting, there is little or no direct evidence for such an adaptation in California, where knowledge of their subsistence and settlement patterns remains almost nonexistent (Jones 1989). What happened to these groups between 11,000 and 10,000 years ago is virtually unknown as well, though this is commonly thought to be a period of diversification and adaptation to changing environmental conditions. Did Paleoindian groups in California exploit aquatic resources? Was there a substantial human presence on the coast at this time? If interior groups moved to the coast at the close of the Pleistocene, did they encounter maritime groups already occupying the area after migrating south along the North Pacific coast?

If the proposed terminal Pleistocene occupations of the California islands (i.e., Orr's Santa Rosa Island localities, Daisy Cave [SMI-261], and Eel Point [SCLI-43B]) are confirmed, or if even earlier coastal sites are documented, the case for a coastal migration route will be strengthened (Chartkoff and Chartkoff 1984:33). At present, however, at least a 1,000 to 2,000 year gap remains between the earliest unequivocal evidence for the occupation of California's coast and the presumed 11,000 to 11,500 span of interior prehistory. This seems an adequate amount of time to account for the adaptation required for interior hunter-gatherers to develop a simple maritime technology, including boats to settle the offshore islands.

### IMPLICATIONS FOR CALIFORNIA CULTURE HISTORY

William Wallace (1955) presented the first synthetic cultural chronology for the larger southern California region, building on the work of pioneers like David Banks Rogers and Malcolm Rogers. Although Wallace's chronology and culture history have been refined (e.g., Warren 1968; Moratto 1984), the broad outlines of his scheme are still in use. This volume adds considerable detail to the picture, largely due to an increased data base, more rigorous recovery and analytical methods, and many more radiocarbon dates. In 1955, Wallace's "Early Man Horizon" was largely a hypothetical construct, with few sites of clear archaeological association and even fewer reliable  $C^{14}$  dates. In 1991, Moratto's (1984) Paleo-Coastal tradition is only slightly better defined, despite recent fluted point finds (Simons et al. 1986; Erlandson et al. 1987), several apparent "pre-Millingstone" components (SLO-1, SBA-931, ORA-64, SDI-149, SDI-210), and early maritime sites on the southern and northern Channel Islands. At this time, there appears to be little question that a pre-Millingstone horizon existed on the California coast, that these groups practiced an adaptation that was at least partly maritime in character, and that they occupied much of the coast by at least 9,500 years ago and possibly a millennium or more earlier. Meighan (1989) has suggested that maritime "California Island Dwellers" may have been contemporaneous with the "big game hunters" of the Paleoindian tradition and could indicate more diversity in the earliest occupations of the New World.

This volume and other recent research (see Erlandson 1988a, with references) suggest that Millingstone horizon groups, marked by the incorporation of manos and metates into their subsistence technology, appear along much of the California coast circa 9000 CYBP. Contemporary sites of the Channel Islands generally lack milling tools, probably due to the limited diversity and productivity of seed producing plants. A common denominator for many of these Early Millingstone horizon sites is the relative abundance of shellfish remains, though there are many apparently early sites that lack faunal remains altogether. Some of these "lithic" sites may result from occupations focused on terrestrial resources (e.g., the Pauma complex of San Diego

County), especially on plant foods that preserve relatively poorly. Other lithic sites may be coastal camps or villages where acidic soils have destroyed the evidence for the exploitation of marine (and terrestrial) resources. More data from such sites are needed to assess their antiquity and functional variability.

Another important issue in California's culture history is the relationship between two groups of early hunter-gatherers of the San Diego region. Warren (1964, 1968), based mostly on data from the multicomponent Harris site (SDI-149), contended that the earlier San Dieguito complex was distinct from later La Jolla groups who occupied the San Diego coast. In recent years, traits once thought to be unique to one culture or the other have been found together in a number of early sites (e.g., Norwood and Walker 1980; Kaldenberg 1982), including manos and metates going back as far as 8600 CYBP. This has led to the notion of a San Dieguito-La Jolla transition period (Moriarty 1967), though there has been no consensus among San Diego archaeologists about the nature of the transition (see Gallegos 1987). In this volume, Gallegos (chap. 3) and Koerper, Langenwalter, and Schroth (chap. 4) argue convincingly for cultural continuity from San Dieguito (pre-Millingstone) to La Jolla (Millingstone), during a transitional period between roughly 9,500 and 8,500 years ago.

As chapters by Colten (chap. 6) and Erlandson (chap. 8) have shown, some of the best known Early Holocene sites of the California coast remain to be adequately dated. The Glen Annie site (SBA-142) has long been considered the type site for the Oak Grove variant of the Millingstone horizon (Owen 1964, 1967:238), yet recent  $C^{14}$  dating of shells recovered in the 1960s showed that many of the attributes thought to predate 7000 RYBP probably are associated with a Middle period occupation dating to approximately 1500 RYBP (Erlandson et al. 1988; chap. 6, this vol.). At SRI-3 (Tecolote Point) on Santa Rosa Island, intrusive elements also have been identified in a cemetery once thought to date entirely to the Early Holocene (chap. 8, this vol.). Other key early sites like SDI-149 (the Harris site), SDI-210 (Agua Hedionda), LAN-138 (Malaga Cove), and SLO-2 (Diablo Cove) have yet to be adequately dated, and significant revisions in our notions of Early Holocene adaptations can be expected when these and other sites are redated.

## THE CULTURAL ECOLOGY OF EARLY COASTAL CULTURES OF CALIFORNIA

### Social Organization and Cultural Complexity

Most hunter-gatherers have comparatively simple social and political organization, though the relatively populous late prehistoric and ethnographic groups of the California coast are exceptions. The development of social and political complexity among hunter-gatherers has become an important focus of archaeological research (e.g., Price and Brown 1985), and California is an excellent laboratory for such studies. Although the early hunter-gatherer societies of the California coast appear to have been much less complex than the late prehistoric occupants of the region, the roots of this cultural complexity may lie in the Early Holocene. As several authors have noted in this volume, the evidence for long-distance trade appears in some of the earliest sites of the California coast, and trade is often an important aspect of emergent complexity.

A primary source of information on prehistoric social organization is the analysis of mortuary data, including studies of artifact distributions and skeletal analyses focused on the relative status or health of individuals within a population. Unfortunately, there are relatively few skeletal remains dating to the Early Holocene. Existing collections generally are limited to the remains of a few individuals from any given site, and these usually are relatively incomplete and poorly preserved. The largest single skeletal population thought to date to the Early Holocene is the 79 individuals from SRI-3 (Orr 1968:115-129), a cemetery now known to contain intrusive elements.

In general, Early Holocene ornaments, burial associations, works of art, and artifacts used in ritual contexts are relatively rare and unelaborated. C. D. King (1981) argues that many of these objects were used prehistorically to maintain socio-political hierarchies of the California coast. The dearth of such artifacts in early sites suggests a relatively egalitarian social and political structure (C. D. King 1981:158). Evidence for craft specialization and trade also is limited during this period, though small amounts of obsidian from the eastern Sierras suggest that some long-distance trade took place. The presence of spire-lopped *Olivella* beads in probable Early Holocene contexts of some Great Basin and Columbia Plateau sites (Bennyhoff and Hughes

1987:160) also provides evidence for early trade and suggests that obsidian may have been traded to coastal groups in exchange for shell beads.

Given the current political climate on repatriation and reburial of skeletal remains in California, it is imperative that analyses of existing skeletal collections be conducted in the near future and in a manner sensitive to the concerns of living Native Americans. Recent advances in isotope and trace element studies of human bone can yield valuable data on early diet and health, as well as their evolution through time. Coupled with studies of the differential distributions of artifacts with burials within mortuary populations, these data have tremendous potential for explaining the development of social organization and cultural complexity among Native Californians. Erlandson (chap. 7, this vol.) has suggested that knowledge about the structure of early subsistence economies may provide clues to the nature of social organization in Early Holocene populations. Presently, evidence for significant social stratification during the Early Holocene may be relatively tenuous, but we can examine the archaeological record in a more sophisticated manner to fully exploit the potential of various types of data.

### Early Settlement

Our understanding of regional settlement patterns along the California coast generally is limited by the focus on large artifact-rich sites, with less attention paid to smaller or low-density locations (Glassow 1985b). Recent discussions of mobility among hunter-gatherers (Binford 1980) and horticulturalists (Eder 1984) provide useful models for prehistoric settlement studies. Eder's work suggests that horticulturalists with relatively permanent settlements may still be relatively mobile, using what Binford calls logistical mobility for special tasks. The study of small archaeological sites is clearly important for such research. Historically, small and low-density coastal sites have been undervalued by most California archaeologists. Many early sites of the region are smaller and of lower density (e.g., SBA-2057, -2061; see chap. 7) than later sites and, with a relatively high proportion of nondescript or nondiagnostic tools, may have gone unrecognized or unexplored by many archaeologists. Clearly, the antiquity and contents of small and low-density sites must be established before their full significance can be appre-



ciated. We hope the development of regional research designs will guide future CRM studies in the coastal zone and help to more systematically extract useful data from small sites, providing a more complete data base for settlement studies.

Few areas of the California coast contain enough investigated Early Holocene sites to effectively examine early settlement patterns. It has long been assumed, however, that by the Millingstone horizon settlements were at least semisedentary, with residential base camps occupied for a significant portion of the annual round (Curtis 1965). Though there have been dissenting opinions (e.g., Owen 1964), the size of early sites, the density and diversity of their contents, and the common occurrence of burials argue for some degree of sedentism. By and large, the studies in this volume support this view of relatively sedentary settlement. Data from a series of early sites on Vandenberg Air Force Base have led Glassow (chap. 9) to propose that a fundamental shift from a foraging to a collecting strategy may have occurred in this area circa 8500 RYBP, however, resulting in the initial appearance of residential bases and the inception of the Millingstone horizon. In chapter 7, Erlandson compares the location, structure, and contents of three roughly contemporary Millingstone horizon middens and suggests that the sites may indicate a settlement strategy similar to the semisedentary pattern of the ethnographic Chumash, where a large and semipermanent residential base is used in concert with a variety of smaller seasonal or special-purpose camps.

### Subsistence Strategies and Faunal Analyses

The subsistence of Early Holocene groups undoubtedly varied through time and space, depending on temporal shifts in regional and local environments, spatial variation in the availability and productivity of food resources, changes in population densities, the effects of human exploitation on local resource productivity (chap. 5, this vol.), technological developments, and other factors. A considerable volume of data now exists on the diversity of animal resources exploited by early coastal populations, but there are few quantitative studies of Early Holocene dietary patterns that integrate the whole spectrum of fauna exploited. Furthermore, variation in the recovery and analytical methods used by various researchers, sometimes even by different faunal analysts (i.e.,

shell versus fish bone, bird bone versus mammal bone) working on a single project, limit our ability to study spatial and temporal variability in coastal subsistence. Even without variation in recovery and analytical techniques, California middens pose formidable problems for those interested in quantitative dietary reconstructions based on faunal analyses (Erlandson 1988a:80-83; 1989). We must solve these problems if our knowledge of the evolution of subsistence on the California coast is to improve substantially.

The studies in this volume generally support traditional views of early subsistence patterns on the California coast, especially for mainland sites of the Millingstone horizon, for which the vast majority of subsistence data is available:

... the collecting of seeds was nearly as important to the economy as shellfish collecting, and perhaps more so. The numerous milling stones and shell middens are prime indicators of these activities at these sites. Fishing and the hunting of land or sea mammals all appear relatively unimportant to the economy, if the few quantitative analyses of middens and the field observations recorded can be considered valid. These observations seem to be substantiated by the relatively rare occurrences of hunting and fishing equipment in Milling Stone horizon sites. [Warren 1967b:235]

Integrated dietary reconstructions from 10 Early Holocene middens from San Diego County (SDI-4405, -4630), Los Angeles County (LAN-267), Santa Cruz Island (SCRI-109), the western Santa Barbara coast (SBA-1807, -2057, -2061), Vandenberg Air Force Base (SBA-530, -552), and San Luis Obispo County (SLO-877) all support this notion of a meat diet dominated by shellfish (Erlandson 1988a:387). Nonetheless, the data also indicate a diversified pattern of faunal exploitation and considerable spatial variability in the importance of various classes of faunal resources. Koerper, Langenwaller, and Schroth's contribution (chap. 4) and other research in Orange County (see Koerper 1981; Drover et al. 1983) emphasize the diversity of early subsistence and suggest that shellfish may have been secondary resources at some sites. Given the amount of variation in resource availability and productivity in

California's diverse coastal habitats, this pattern is not unexpected. It seems likely that future research on early sites of the California coast will document even greater diversity in the range of human subsistence patterns discernible in the archaeological record.

### The Role of Plants in Prehistoric Economies

The study of prehistoric hunter-gatherers often focuses on faunal remains and human subsistence, emphasizing adaptation to the natural environment, and this volume is no exception. Comparatively speaking, Early Holocene groups are typified by relatively simple technology and social organization, and studies of ecological adaptation are a natural focus in hunter-gatherer research. In early sites of the California coast, the bulk of the archaeological record consists of food remains and artifacts related to food gathering and processing. Most previous research has emphasized animal remains as the primary constituents of the prehistoric diet. Researchers do not ignore the dietary role of plants, but plant remains rarely are recovered, identified, or quantified. Instead, the use and importance of plant foods is inferred from the presence or relative frequency of certain artifact types. Scholars often equate the appearance of millingstones with the inception or increasing importance of hard seed exploitation, for instance, and the appearance of mortars and pestles with the first systematic exploitation of acorns or other soft plant foods (e.g., Glassow et al. 1988).

Ethnographic data from California and most other parts of the world show that plant foods are the major source of calories in most hunter-gatherer societies, and we have no reason to believe that prehistoric Californians differed in the overall composition of their diet. Landberg (1965:77-81) notes that the Chumash consumed seeds, bulbs, roots, tubers, fruits, and nuts, for instance, and that the remains of manzanita, pigweed, chia, acorns, red maids, and pine nuts had been recovered from Chumash area archaeological sites as of 1965. Timbrook (1984) lists 155 plant taxa that the Chumash used for food, medicine, ritual, and raw materials. Plant materials preserve poorly in most sites of the California coast, so they are underrepresented in the archaeological record and difficult to incorporate into traditional dietary reconstructions. Furthermore, most plant foods are consumed and leave little refuse in archaeological sites, though there are significant ex-

ceptions (acorn husks, pine nut shells, etc.) that may preserve if carbonized. Finally, with the prevalence of wildfires and bioturbation along the California coast, it is difficult to differentiate naturally and culturally derived plant remains in many sites. Because of such problems, California archaeologists rarely try to recover or identify plant remains systematically, even from intact features. Yet floral data from archaeological sites are critical to addressing both archaeological and paleoecological issues, such as Erlandson's (1988a:388) recent suggestion that calorie-rich pine nuts may have been a staple before circa 9000 CYBP, with the introduction of millingstones marking a switch to small seeds as the productivity of coniferous forests declined.

To fully appreciate the complexity of the ecological adaptations of California's prehistoric hunter-gatherers, we need a greater emphasis on recovering and identifying plant remains from archaeological sites. Recent advances and wider publication of paleoethnobotanical techniques (Pearsall 1989; Hastorf and Popper 1989) indicate that flotation and other relatively routine recovery methods may provide valuable information on prehistoric plant uses. Food residues also have been identified on prehistoric ceramics from the midwestern U.S. (Lovis 1990a, 1990b), and similar studies may prove fruitful on California's prehistoric stone tools. Along the California coast, recent reports of plant remains recovered from archaeological sites (e.g., chap. 3, this vol.), including the identification of carbonized seeds from the surfaces of ground stone tools (B. Bowser, personal communication, 1988), are encouraging. The appropriate recovery methods and analytical techniques need to be applied more widely by California archaeologists, however, if a more complete picture of prehistoric adaptations is to emerge. Though the amount of information recovered on specific plant uses may often be small, general statements should be possible about the plant communities present and exploited, along with the relative ranking of various plant taxa in prehistoric economies. Quantifying the relative importance of plant and animal foods is a challenging problem, but advances in isotope and trace element analyses of human bone are providing encouraging avenues for future research. When combined with the recovery of carbonized plant remains, the identification of microscopic traces of plant uses, relative abundance of plant gathering and processing implements, and

studies of dental caries (e.g., Walker and Erlandson 1986), such bone chemistry studies will provide important insights on adaptative variation along the California coast.

### The Use of Existing Museum Collections

In chapter 1, we suggested several avenues that archaeologists might pursue to gather new data on the prehistory of the California coast. One of the most important sources of data is housed in museum collections scattered across the state and around the world. Some museums contain substantial collections of archaeological materials that have never been processed, analyzed, or published completely. The fact that many unstudied or incompletely studied collections have been stored in museums for decades provides a compelling political argument in favor of repatriation of collections to Native American groups. Moreover, given the finite and non-renewable nature of the archaeological record and the relatively ephemeral nature of many of California's earliest sites, archaeologists must use existing collections to their fullest potential. This will require greater cooperation between museum personnel and others conducting archaeological research as well as the enlargement of the many museums filled to capacity by the explosive growth in CRM-generated collections. Just as importantly, much of this research will depend on the commitment of California archaeologists to voluntarily analyze collections, to guide students toward the study of existing collections rather than toward new excavations,

to write grants for collections analysis, and to incorporate such studies into CRM budgets for related projects.

### CONCLUSIONS

Ultimately, a broader understanding of Early Holocene adaptations on the California coast will rely on more and better archaeological and paleoecological data. Especially important are data from early sites uncontaminated by later components because the mixing of multicomponent sites by bioturbation and other processes has led to considerable confusion about the nature of early tool assemblages and subsistence strategies. Ultimately, archaeologists must more carefully assess the integrity of the sites they investigate, the veracity of earlier interpretations, and the accuracy of their own reconstructions. We hope this volume helps to stimulate more thought and research on the nature of early adaptations along the California coast. For sheer numbers of early coastal sites, the diversity of faunal and artifactual materials preserved within them, the volume of data already available, and the range of institutional and legislative support available for their preservation and investigation, California's coastal archaeological record is virtually unparalleled around the world. Future research can contribute valuable insight into many of the local, regional, and general archaeological issues raised by various contributions to this volume, as well as important methodological developments in the study of hunter-gatherer adaptations.



## References

- 
- Ackerman, R. E., T. D. Hamilton, and R. Stuckenrath  
 1979 Early cultural complexes of the northern Northwest coast. *Canadian Journal of Archaeology* 3:195-209.
- Ackerman, R. E., K. C. Reid, J. D. Gallison, and M. E. Roe  
 1985 *Archaeology of Heceta Island: A Survey of 16 Timber Harvest Units in the Tongass National Forest, Southeastern Alaska*. Pullman: Center for Northwest Anthropology, Washington State University.
- Adam, D. P.  
 1967 Late Pleistocene and recent palynology in the central Sierra Nevada, California. In *Quaternary Paleocology*, edited by E. J. Cushing and H. E. Wright, Jr., 275-301. New Haven: Yale University Press.
- Allen, L. G.  
 1985 A habitat analysis of the nearshore marine fishes for southern California. *Bulletin of the Southern California Academy of Sciences* 84 (3):133-155.
- Ames, J. A.  
 1972 California sheephead. Ms. on file, California Marine Technical Information Center, Long Beach, California.
- Anderson, P. M., C. W. Barnosky, P. J. Bartlein, P. J. Behling, L. Brubaker, E. J. Cushing, J. Dodson, B. Doworetsky, P. J. Guetter, P. S. Harrison, B. Huntley, J. E. Kutzbach, V. Margraf, R. Marvel, M. S. McGlone, A. Mix, N. T. Moar, J. Moreley, R. A. Perrott, G. M. Peterson, W. L. Prell, I. C. Prentice, J. C. Ritchie, N. Roberts, W. F. Ruddiman, M. J. Salanger, W. G. Spaulding, F. A. Street-Perrott, R. S. Thompson, P. K. Wang, T. Webb III, M. G. Winkler, and H. E. Wright, Jr.  
 1988 Climatic changes in the last 18,000 years: observations and model simulations. *Science* 241:1043-1052.
- Anikouchine, W. A., and R. W. Sternberg  
 1973 *The World Ocean: An Introduction to Oceanography*. Englewood Cliffs, New Jersey: Prentice Hall.
- Antevs, E.  
 1948 Climatic changes and pre-white man. In *The Great Basin, with Emphasis on Glacial Times and Postglacial Times*. *Bulletin of the University of Utah, Biological Series* 10 (7):168-191.
- 1953 On division of the last 20,000 years. *University of California Archaeological Survey Reports* 22:5-8. Berkeley.
- 1955 Geologic-climatic dating in the west. *American Antiquity* 20 (4):317-335.

# REFERENCES

- Aschmann, H.  
1958 Great Basin climates in relation to human occupance. *University of California Archaeological Survey Reports* 42:23-40. Berkeley.
- Ault, J. S.  
1985 Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest)—black, green, and red abalones. *U.S. Fish and Wildlife Service Biological Report* 82 (11.32). U.S. Army Corps of Engineers, TR EL-82-4:1-19.
- Axelrod, D. L.  
1967 Geologic history of the Californian insular flora. In *Proceedings of the Symposium on the Biology of the California Islands*, edited by R. N. Philbrick, 267-315. Santa Barbara: Santa Barbara Botanic Garden.  
1978 The origin of coastal sage vegetation of Alta and Baja California. *American Journal of Botany* 65:1117-1131.  
1981 Holocene climate changes in relation to vegetation disjunction and speciation. *American Naturalist* 117 (6):847-870.
- Axford, M.  
1981 Current archaeological investigations on San Clemente Island, California. Paper presented at the 46th Annual Meeting of the Society for American Archaeology, San Diego.
- Aycock, R. D.  
1983 An early Channel Island site: excavations at Eel Point, San Clemente Island. Ms. on file, Department of Anthropology, University of California, Los Angeles.
- Bada, J. L.  
1985 Aspartic acid racemization ages of California paleoindian skeletons. *American Antiquity* 50: 645-647.
- Bada, J. L., R. A. Schroeder, and G. F. Carter  
1974 New evidence for the antiquity of man in North America deduced from aspartic acid racemization. *Science* 184:791-793.
- Bailey, H. P.  
1954 Climate, vegetation and land use in Southern California. *California Division of Mines Bulletin* 170, chap. I:31-44.
- Beardsley, R., P. Holder, A. D. Krieger, B. J. Meggers, J. B. Rinaldo, and P. K. Kutsche  
1955 Functional and evolutionary implications of community patterning. In *Seminars in Archaeology, 1955. Memoirs of the Society for American Archaeology* 11 [1956]:131-151.
- Bennyhoff, J. A., and R. E. Hughes  
1987 Shell bead and ornament exchange networks between California and the western Great Basin. *Anthropological Papers of the American Museum of Natural History* 64 (2). New York.
- Berger, R.  
1980 Early man on Santa Rosa Island. In *The California Islands: Proceedings of a Multidisciplinary Symposium*, edited by D. M. Power, 73-78. Santa Barbara: Santa Barbara Museum of Natural History.  
1982 The Woolley Mammoth site, Santa Rosa Island, California. In *Peopling of the New World*, edited by J. E. Ericson, R. E. Taylor, and R. Berger, 163-170. Ballena Press Anthropological Papers 23.
- Berger, R., and P. C. Orr  
1966 The fire areas on Santa Rosa Island, California, II. *Proceedings of the National Academy of Sciences* 56:1678-1682.
- Berger, R., and R. Protsch  
1989 UCLA radiocarbon dates XI. *Radiocarbon* 31:55-67.
- Berger, R., R. Protsch, R. Reynolds, C. Rozaire, and J. R. Sackett  
1971 New radiocarbon dates based on bone collagen of California paleoindians. *Contributions of the University of California Archaeological Research Facility* 12:43-49. Berkeley.
- Berger, W. H., and L. D. Labeyrie, eds.  
1987 Abrupt climate change. In *Abrupt Climate Change*, 3-22. Dordrecht, Holland: D. Reidel.
- Bickel, P. McW.  
1978 Changing sea levels along the California coast: anthropological implications. *Journal of California Anthropology* 5:6-20.

# REFERENCES

- Binford, L. R.  
1980 Willow smoke and dogs' tails: hunter-gatherer settlement systems and archaeological site formation. *American Antiquity* 45:4-20.
- Bingham, J. C.  
1978 *Archaeological Test Excavations within Border Field State Park, San Diego County*. California Archaeological Reports 16. Sacramento: California Department of Parks and Recreation.
- Birkeland, P. W.  
1972 Late Quaternary eustatic sea-level changes along the Malibu coast, Los Angeles County, California. *Journal of Geology* 80:432-448.
- Blong, R. J., and R. Gillespie  
1978 Fluvially transported charcoal gives erroneous <sup>14</sup>C ages for recent deposits. *Nature* 271:739-741.
- Booth, W.  
1988 The otter-urchin-kelp scenario. *Science* 241: 157.
- Bouey, P.  
1984 Obsidian studies and their implications for prehistory. *Pacific Coast Archaeological Society Quarterly* 20 (1):55-60.
- Bowers, A., and C. Savage  
1962 Primitive man in Brown Bench, Idaho. *Information Circular* 14:16-17. Moscow, Idaho: Bureau of Mines and Geology.
- Bowers, S.  
1878 History and antiquities of Santa Rosa Island. *Smithsonian Institution Annual Report for 1877*, 316-320. Washington, D.C.
- Bowser, B.  
1984 Fish remains. In *Archaeological Investigations at CA-SBA-1203: Results of Mitigation Excavations*, edited by Jerry D. Moore. Office of Public Archaeology, Social Process Research Institute, University of California, Santa Barbara. Ms. on file, Anthropology Department, University of California, Santa Barbara.
- Bradley, R. S.  
1985 *Quaternary Paleoclimatology: Methods of Paleoclimatic Reconstruction*. Boston: Allen and Unwin.
- Brassell, S. C.  
1986 Isoprenoid thiophenes: novel products of sediment diagenesis. *Nature* 320:160-162.
- Breschini, G. S., T. Haversat, and J. M. Erlandson  
1988 *California Radiocarbon Dates*. 5th ed. Salinas: Coyote Press.  
1990 *California Radiocarbon Dates*. 6th ed. Salinas: Coyote Press.
- Brown, A.  
1967 *The Aboriginal Population of the Santa Barbara Channel*. University of California Archaeological Survey Reports 69. Berkeley.
- Brown, J. H., and A. C. Gibson  
1983 *Biogeography*. St. Louis: C. V. Mosby Company.
- Buchner, A. P.  
1980 *Cultural Responses to Altithermal Climate Along the Eastern Margins of North American Grassland 5500 to 3000 B.C.* National Museum of Man Mercury Series 97. Ottawa.
- Bull, C.  
1987 A new proposal: some suggestions for San Diego prehistory. In *San Dieguito-La Jolla: Chronology and Controversy*, edited by D. Gallegos, 35-42. San Diego County Archaeological Society Research Paper 1. San Diego.
- Burma, B. H.  
1950 Erosion and sedimentation in the Great Plains: a criticism of Dr. Antev's conference papers. *University of Utah Anthropological Papers* 11:52-55. Salt Lake City.
- Butler, B. R.  
1970 A surface collection from Coyote Flat, southwestern Oregon. *Tebiwa* 13 (1):34-35.
- Butzer, K. W.  
1978 Changing Holocene environments at the Koster site: a geo-archaeological perspective. *American Antiquity* 43 (3):408-413.
- Campbell, E. W. C., W. H. Campbell, E. Antevs, C. E. Amsden, T. A. Barbieri, and F. D. Bode  
1937 *The Archaeology of Pleistocene Lake Mohave*. Southwest Museum Papers 11. Los Angeles.

# REFERENCES

- Carbone, L. A.
  - 1984 Environmental change and cultural transition in the early prehistory of south-coastal California. Master's thesis, Department of Archaeology, Simon Fraser University, Burnaby, British Columbia, Canada.
- Carter, G. F.
  - 1957 *Pleistocene Man at San Diego*. Baltimore: Johns Hopkins Press.
  - 1980 *Earlier Than You Think*. College Station: Texas A & M University Press.
- Cartier, R.
  - 1984 The Scotts Valley site (CA-SCR-177). Paper presented at the annual meeting of the Society for California Archaeology, Salinas.
  - 1985 Chronology at Scotts Valley (CA-SCR-177). Paper presented at the annual meeting of the Society for California Archaeology, San Diego.
  - 1988a Scotts Valley chronology and temporal stratigraphy. *Proceedings of the Society for California Archaeology* 2:81-111. San Diego.
  - 1988b The completion of fieldwork at the Scotts Valley site (CA-SCR-177). Paper presented at the annual meeting of the Society for California Archaeology, Redding.
- Casteel, R. W., D. P. Adam, and J. Sims
  - 1977 Late Pleistocene and Holocene remains of *Hysteroecarpus traski* (tule perch) from Clear Lake, California, and inferred Holocene temperature fluctuations. *Quaternary Research* 7 (1):133-143.
- Cessac, L. de
  - 1882 Observations sur des fetiches de pierre sculptes en forme d'animaux decouverts a l'Ile de San Nicolas (Californie). *Revue d'Ethnographie* 1:30-40.
- Chartkoff, J. L., and K. K. Chartkoff
  - 1984 *The Archaeology of California*. Stanford: Stanford University Press.
- Christenson, A. L.
  - 1980 Change in the human food niche in response to population growth. In *Modeling Change in Prehistoric Subsistence Economies*, edited by T. K. Earle and A. L. Christenson, 31-72. New York: Academic Press.
- Christenson, L. E.
  - 1981 Mammalian faunal butchering practices at an inland La Jolla site, San Diego County, California. Master's thesis, Department of Anthropology, San Diego State University.
- Cogswell, H. L.
  - 1977 *Water Birds of California*. California Natural History Guides 40. Berkeley: University of California Press.
- Cohen, M. N.
  - 1977 *The Food Crisis in Prehistory: Overpopulation and the Origin of Agriculture*. New Haven: Yale University Press.
- COHMAP (Cooperative Holocene Mapping Project)
  - 1988 Climatic changes in the last 18,000 years: observations and model simulations. *Science* 241:1043-1052.
- Colten, R.
  - 1987 *Intrasite Variability in Early and Middle Period Subsistence Remains from CA-SBA-143, Goleta, Santa Barbara County, California*. Archives of California Prehistory 13. Salinas: Coyote Press.
  - 1989 Prehistoric shellfish exploitation around the Goleta Lagoon. *Journal of California and Great Basin Anthropology* 11 (2):203-214.
- Continental Shelf Data Systems
  - 1967 Bathymetric map, southern California, Point Sal-Point Arguello (121-40-4). Scale 1:48,000. On file at the Map and Imagery Library, University of California, Santa Barbara.
- Cook, S. F.
  - 1946 A reconsideration of shell mounds with respect to population and nutrition. *American Antiquity* 12:50-53.
- Corum, J.
  - 1977 An examination of intersite variability during the Millingstone horizon of southern California. Master's thesis, Department of Anthropology, California State University, Northridge.



# REFERENCES

- Courtemanche, M., and V. Legendre  
1985 *Os de Poissons: Nomenclature Codifiée, Noms Français et Anglais*. Gouvernement du Québec, Ministère du Loisir de la Chasse de la Pêche. Direction Régional de Montréal.
- Cowan, R.  
1981 The role of sheephead in structuring subtidal communities. In *Biennial Mugu Lagoon/San Nicholas Island Ecological Research Symposium, October 28-29, 1981*, 221-232. Point Mugu, California: Pacific Missile Test Center.
- Crabtree, R. H., C. N. Warren, and D. L. True  
1963 Archaeological investigations at Batiquitos Lagoon, San Diego County, California. *University of California Archaeological Survey Annual Reports* 5:319-349. Los Angeles.
- Crane, H. R., and J. B. Griffin  
1962 University of Michigan radiocarbon dates VII. *Radiocarbon* 4:183-203.
- Cressman, L. S.  
1936 Archaeological survey of the Guano Valley region of southwestern Oregon. *University of Oregon Monographs, Studies in Anthropology* 1:1-48. Eugene.
- Cronin, T. M.  
1982 Rapid sea level and climatic change: evidence from continental and island margins. *Quaternary Science Reviews* 1 (3):177-214.
- Curtis, F.  
1965 The Glen Annie site (SBA-142): a case for sedentary village life. *University of California Archaeological Survey Annual Reports* 7:1-18. Los Angeles.
- Cushing, J., A. M. Wenner, E. Noble, and M. Daily  
1986 A groundwater hypothesis for the origin of "fire areas" on the northern Channel Islands. *Quaternary Research* 26:207-217.
- Daniel, G.  
1976 *150 Years of Archaeology*. Cambridge: Harvard University Press.
- Daugherty, R. D.  
1956 Archaeology of the Lind Coulee site, Washington. *Proceedings of the American Philosophical Society* 100 (3):223-278. Philadelphia.
- David, O. K., R. S. Anderson, P. L. Fall, M. K. O'Rourke, and R. S. Thompson  
1985 Palynological evidence for Early Holocene aridity in the southern Sierra Nevada, California. *Quaternary Research* 24 (3):322-332.
- Davis, E. L.  
1975 The "exposed archaeology" of China Lake, California. *American Antiquity* 40 (1):39-53.
- Davis, E. L., and C. Panlaqui  
1978 Stone tools, the action units. In *The Ancient Californians: Rancholabrean Hunters of the Mohave Lakes Country*, edited by E. Davis, 30-75. Natural History Museum of Los Angeles County Science Series 29. Los Angeles.
- Davis, E. L., C. W. Brott, and D. L. Weide  
1969 *The Western Lithic Co-Tradition*. San Diego Museum Papers 6. San Diego Museum of Man.
- Davis, S. D., ed.  
1988 *The Hidden Falls Site, Baranof Island, Alaska*. Aurora: Alaska Anthropological Association Monograph 5. Anchorage.
- Deevy, E. S., and R. F. Flint  
1957 Postglacial Hypsithermal interval. *Science* 125 (3240):182-184.
- Desgrandchamp, C. S.  
1976 Estuary exploitation in aboriginal California. Master's thesis, Department of Anthropology, San Francisco State University.
- Dietz, S. A., W. Hildebrandt, and T. Jones  
1988 *Archaeological Investigations at Elkhorn Slough: CA-MNT-229, A Middle Period Site on the Central California Coast*. Papers in Northern California Anthropology 3. Berkeley: Northern California Anthropological Group.
- Drover, C. E., H. C. Koerper, and P. E. Langenwaller II  
1983 Early Holocene human adaptation on the southern California coast: a summary report of investigations at the Irvine Site (CA-Ora-64), Newport Bay, Orange County, California. *Pacific Coast Archaeological Society Quarterly* 19 (3/4):1-84.
- Drover, C. E., R. E. Taylor, T. Cairns, and J. E. Ericson  
1979 Thermoluminescence determinations on early

# REFERENCES

- ceramic materials from coastal southern California. *American Antiquity* 44 (2):285-295.
- Dunbar, R. B.
  - 1981 Sedimentation and the history of upwelling and climate in high fertility areas of the north-eastern Pacific Ocean. Ph.D. dissertation, University of California, San Diego.
- Earle, T. K.
  - 1980 A model of subsistence change. In *Modeling Change in Prehistoric Subsistence Economies*, edited by T. K. Earle and A. L. Christenson, 1-29. New York: Academic Press.
- Eder, J.
  - 1984 The impact of subsistence change on mobility and settlement pattern in a tropical forest foraging economy: some implications for archaeology. *American Anthropologist* 86:837-853.
- Edwards, R. L., and K. O. Emery
  - 1977 Man on the continental shelf. In *Amerinds and Their Paleoenvironments in Eastern North America*, edited by W. S. Newman and B. Salwen, 353-359. Annals of the New York Academy of Sciences 288.
- Eisen, G.
  - 1905 An account of the Indians of the Santa Barbara Islands in California. *Sitzungsberichte der Königlichen Böhmischen Gesellschaft der Wissenschaften*, Jahrg 1904, 1-30. Prague.
- Emery, K.
  - 1954 General geology of the offshore area, southern California, edited by R. H. Jahns. *Divisions of Mines Bulletin* 170:107-111. California Department of Natural Resources.
  - 1967 Estuaries and lagoons in relation to continental shelves. In *Estuaries*, edited by G. H. Lauff, 9-14. American Association for the Advancement of Science 83. Washington, D.C.
- Erlandson, J. M.
  - 1985 Early Holocene settlement and subsistence in relation to coastal paleogeography: evidence from CA-SBA-1807. *Journal of California and Great Basin Anthropology* 7:103-109.
  - 1988a Of millingstones and molluscs: the cultural ecology of Early Holocene hunter-gatherers of the California coast. Ph.D. dissertation, Department of Anthropology, University of California, Santa Barbara.
  - 1988b The role of shellfish in prehistoric economies: a protein perspective. *American Antiquity* 52:102-109.
  - 1988c Cultural evolution and paleogeography on the Santa Barbara coast: a 9600 year <sup>14</sup>C record from Southern California. *Radiocarbon* 30:25-39.
  - 1988d *Cultural Ecology on the Southern California Coast at 5500 BP: A Comparative Analysis of CA-SBA-75*. Archives of California Prehistory 17. Salinas: Coyote Press.
  - 1988e An annotated bibliography for radiocarbon and stable carbon analyses. In *California Radiocarbon Dates*, 5th ed., edited by G. S. Breschini, T. Haversat, and J. Erlandson, 109-119. Salinas: Coyote Press.
  - 1989 On reconstructing diets from California shell middens. Paper presented at the meeting of the Society for American Archaeology, Atlanta.
- Erlandson, J. M., and T. K. Rockwell
  - 1987 Radiocarbon reversals and stratigraphic discontinuities: natural formation processes in coastal California archaeological sites. In *Natural Formation Processes and the Archaeological Record*, edited by D. Nash and M. Petraglia, 51-73. Oxford: BAR International Series 352.
- Erlandson, J. M., R. H. Colten, and M. A. Glassow
  - 1988 Reassessing the chronology of the Glen Annie Canyon site (CA-SBA-142). *Journal of California and Great Basin Anthropology* 10:237-245.
- Erlandson, J. M., T. Cooley, and R. Carrico
  - 1987 A fluted projectile point fragment from the southern California coast: chronology and context at CA-SBA-1951. *Journal of California and Great Basin Anthropology* 9:120-128.
- Eschmeyer, W., E. Herald, and H. Hammann
  - 1983 *A Field Guide to Pacific Coast Fishes of North America*. Boston: Houghton Mifflin Company.

# REFERENCES

- Estes, J. H., and J. F. Palmisano  
1974 Sea otters: their role in structuring nearshore communities. *Science* 185:1058-1060.
- Ezell, P. H.  
1977 New information on San Dieguito III technology. *Journal of California Anthropology* 4 (2):306-308.  
1983 A new look at the San Dieguito culture. *Casual Papers* 1 (3):103-109. San Diego: Cultural Resource Management Center, San Diego State University.  
1987 The Harris site—an atypical San Dieguito site, or am I beating a dead horse? In *San Dieguito-La Jolla, Chronology and Controversy*, edited by D. Gallegos, 15-22. San Diego County Archaeological Society Research Paper 1. San Diego.
- Fagan, B. M.  
1987 *The Great Journey: The Peopling of Ancient America*. London: Thames and Hudson.
- Feder, H. M., C. H. Turner, and C. Limbaugh  
1974 Observations on fishes associated with kelp beds in Southern California. *Fish Bulletin* 160. California Department of Fish and Game.
- Fenenga, G. L.  
1987 A typological analysis of the temporal and geographic distribution of the eccentric crescent in western North America. *Contributions of the University of California Archaeological Research Facility* 48. Berkeley.
- Figgins, J.  
1927 The antiquity of man in America. *Natural History* 27 (3):229-239.
- Fitch, J. E.  
1969 Fish remains, primarily otoliths, from a Ventura, California Chumash village site (VEN-3). *Memoirs of the Southern California Academy of Sciences* 8:56-70.
- Fitch, J., and R. Lavenberg  
1971 *California Marine Food and Game Fishes*. Berkeley: University of California Press.
- Fladmark, K. R.  
1979 Routes: alternate migration corridors for early man in North America. *American Antiquity* 44: 55-69.
- 1986 *British Columbia Prehistory*. Ottawa: Archaeological Survey of Canada, National Museum of Man.
- Fredrickson, D. A.  
1973 Early cultures of the north coast ranges, California. Ph.D. dissertation, Department of Anthropology, University of California, Davis.
- Gallegos, D.  
1985 Batiquitos Lagoon revisited. In *Casual Papers*, edited by C. White, 2 (1):1-13. San Diego: Cultural Resource Management Center, San Diego State University.  
1987 A review and synthesis of environmental and cultural material for the Batiquitos Lagoon region. In *San Dieguito-La Jolla: Chronology and Controversy*, edited by D. Gallegos, 23-34. San Diego County Archaeological Society Research Paper 1. San Diego.
- Gallegos, D., ed.  
1987 *San Dieguito-La Jolla: Chronology and Controversy*. San Diego County Archaeological Society Research Paper 1. San Diego.
- Gallegos, D. R., and R. Carrico  
1984 Windsong Shores Data Recovery Program for Site W-131, Carlsbad, California. Ms. on file at ERCE (WESTEC), San Diego, California.
- Garth, J. S., and D. P. Abbott  
1980 Brachyura: the true crabs. In *Intertidal Invertebrates of California*, edited by R. H. Morris, D. P. Abbott, and E. C. Baderlie, 594-630. Stanford: Stanford University Press.
- Garth, J. S., and W. Stephenson  
1966 *Brachyura of the Pacific Coast of America. Brachyrhyncha: Portunidae*. Allan Hancock Monographs in Marine Biology 1. Los Angeles: University of Southern California.
- Gerstle, A., and J. Serena  
1982 Archaeological investigations at SBa-56. Office of Public Archaeology, Social Process Research Institute, University of California, Santa Barbara. Ms. on file, Department of Anthropology, University of California, Santa Barbara.

# REFERENCES

- Ghiradelli, F.  
1984 A chronological-cultural development sequence for the Eel Point site, San Clemente Island, California. Master's thesis, Interdepartmental Archaeology Program, University of California, Los Angeles.
- Gifford, D. P.  
1980 Ethnoarchaeological contributions to the taphonomy of human sites. In *Fossils in the Making: Vertebrate Taphonomy and Paleocology*, edited by A. K. Behrensmeyer and A. A. Hill, 94-106. Chicago: University of Chicago Press.
- Gilliland, L. E.  
1985 Proximate analysis and mineral composition of traditional California Native American foods. Master's thesis, Department of Nutrition Science, University of California, Davis.
- Glassow, M. A.  
1975 Considerations in the evaluation of the archaeological significance of sites of the Santa Barbara Channel mainland. Paper presented at the Society for California Archaeology Fall Data Sharing Meeting, California State University, Northridge, October 18, 1975.  
1980 Recent developments in the archaeology of the Channel Islands. In *The California Islands: Proceedings of a Multidisciplinary Symposium*, edited by D. Power, 79-99. Santa Barbara: Santa Barbara Museum of Natural History.  
1985a Changes in subsistence on marine resources through 7000 years of prehistory on Santa Cruz Island, California. Paper presented at the annual meeting of the Society for American Archaeology, Denver.  
1985b The significance of small sites to California archaeology. *Journal of California and Great Basin Anthropology* 7:58-66.  
1987 The red abalone middens of the northern Channel Islands: a preliminary report on their chronology and implications for environmental change. Paper presented at the Third California Island Symposium, Santa Barbara.
- Glassow, M. A., and L. Wilcoxon  
1988 Coastal adaptations near Point Conception, California, with particular regard to shellfish exploitation. *American Antiquity* 53:36-51.
- Glassow, M. A., L. W. Spanne, and J. Quilter  
1976 Evaluation of archaeological sites on Vandenberg Air Force Base, Santa Barbara County, California. Ms. on file, Department of Anthropology, University of California, Santa Barbara.
- Glassow, M. A., L. Wilcoxon, and J. M. Erlandson  
1988 Cultural and environmental change during the early period of Santa Barbara Channel prehistory. In *The Archaeology of Prehistoric Coastlines*, edited by G. N. Bailey and J. E. Parkington, 64-77. Cambridge: Cambridge University Press.
- Glassow, M. A., J. E. Arnold, G. A. Batchelder, A. G. Bixler, D. T. Fitzgerald, J. L. Hudson, K. R. Lawson, D. F. Stone, and P. L. Walker  
1981 Archaeological data recovery program in relation to space shuttle development, Vandenberg Air Force Base, California. Office of Public Archaeology, Social Process Research Institute, University of California, Santa Barbara. Ms. on file, Department of Anthropology, University of California, Santa Barbara.
- Goldberg, C., and M. Titus  
1986 Site chronology on San Clemente Island. Ms. on file, Department of Anthropology, University of California, Los Angeles.
- Goodman, J.  
1981 *American Genesis: The American Indian and the Origins of Modern Man*. New York: Summit Books.
- Gorsline, D. S., and P. W. Barnes  
1972 Carbonate variations as climatic indicators in contemporary California flysch basins. *International Geological Congress, 24th session*, 270-277. Montreal.
- Gorsline, D. S., and S. E. Prenskey  
1975 Paleoclimatic inferences for the late Pleistocene and Holocene from California borderland basin sediments. In *Quaternary Studies IX Inqua Congress*, edited by R. P. Suggate and M. M. Cresswell, 147-154. Wellington, New Zealand.

# REFERENCES

- Grayson, D.
  - 1976 The Nightfire Island avifauna and the Alti-thermal. In *Holocene Environmental Change in the Great Basin*, edited by R. Elston, 74-103. Nevada Archaeological Survey Research Paper 6. Reno.
  - 1984 *Quantitative Zooarchaeology: Topics in the Analysis of Archaeological Faunas*. New York: Academic Press.
- Greengo, R. F.
  - 1951 *Molluscan Species in California Shell Middens*. Reports of the University of California Archaeological Survey 13. Berkeley.
- Greenwood, R. S.
  - 1969 *The Browne Site: Early Milling Horizon in Southern California*. Memoirs of the Society for American Archaeology 23. Washington, D.C.
  - 1972 *9000 Years of Prehistory at Diablo Canyon*. San Luis Obispo County Archaeological Society Occasional Papers 7.
  - 1978a Obispeño and Purisimeño Chumash. In *California*, edited by R. F. Heizer, 520-523. Handbook of North American Indians, vol. 8, W. G. Sturtevant, general editor. Washington, D.C.: Smithsonian Institution.
  - 1978b Archaeological survey and investigation: Channel Islands National Monument, California, vols. I and II. Ms. on file, Department of Anthropology, University of California, Santa Barbara.
- Grotefend, G. F.
  - 1837 *Neue Beiträge zur Erläuterung der Persepolitischen Keilschrift*. Hahn: Hannover, Germany.
- Guthrie, D. A.
  - 1980 Analysis of avifaunal and bat remains from midden sites on San Miguel Island. In *The California Islands: Proceedings of a Multidisciplinary Symposium*, edited by D. M. Power, 689-702. Santa Barbara: Santa Barbara Museum of Natural History.
  - n.d. Analysis of avian remains from archaeological sites, Vandenberg Air Force Base, Santa Barbara County, California. Ms. in possession of M. Glassow, Department of Anthropology, University of California, Santa Barbara.
- Harrington, M. R.
  - 1948 *An Ancient Site at Borax Lake, California*. Southwest Museum Papers 16. Los Angeles.
- Harrold, C., and D. Reed
  - 1981 Foraging patterns, reproductive capacity, and microhabitat distribution of red sea urchins in kelp and urchin-dominated subtidal habitats at San Nicolas Island. In *Biennial Mugu Lagoon/San Nicolas Island Ecological Research Symposium, October 28-29, 1981*, 233-259. Point Mugu, California: Pacific Missile Test Center.
- Hastorf, C., and V. Popper
  - 1989 *Current Palaeoethnobotany*. Chicago: University of Chicago Press.
- Hayden, B.
  - 1981 Research and development in the Stone Age: technological transitions among hunter-gatherers. *Current Anthropology* 22:519-531.
- Hayden, J. D.
  - 1987 Notes on the apparent course of San Dieguito development. In *San Dieguito-La Jolla: Chronology and Controversy*, edited by D. Gallegos, 43-47. San Diego County Archaeological Society Research Paper 1. San Diego.
- Haynes, C. V., D. C. Grey, D. E. Daman, and R. Bennett
  - 1967 Arizona radiocarbon dates VII. *Radiocarbon* 9:1-14.
- Hertlein, L. G., and U. S. Grant
  - 1954 Geology of the Oceanside-San Diego coastal area, southern California. In *Geology of Southern California*. Chap. II: *Geology of the Natural Provinces*, edited by R. H. Jahns, 53-64. Division of Mines Bulletin 170. San Francisco.
- Hester, T. R., and R. F. Heizer
  - 1972 Problems in the functional interpretation of artifacts: scraper planes from Mitla and Yagul, Oaxaca. *Contributions of the University of California Archaeological Research Facility* 14:107-123. Berkeley.

# REFERENCES

- Hester, T. R., E. Wuertele, and R. F. Heizer  
1976 Unifacial cobble tools from the northwest California coast: experimental and wear pattern notes. *Contributions of the University of California Archaeological Research Facility* 33:25-43. Berkeley.
- Heusser, L. E.  
1978 Pollen in Santa Barbara Basin, California: a 12,000 year record. *Geological Society of America Bulletin* 89:673-678.
- Hicks, S. D.  
1981 Long-period sea level variations for the United States through 1978. *Shore and Beach* 49:26-29.
- Hill, J.  
1985 Cultural evolution in the Archaic-Mesolithic: a research design for the Los Angeles Basin. Submitted to the U.S. Army Corps of Engineers, Los Angeles District.
- Howorth, P. C.  
1978 *The Abalone Book*. Happy Camp, California: Naturegraph Publishers.
- Hubbs, C. L.  
1960 Quaternary paleoclimatology of the Pacific coast of North America. *California Oceanic Fisheries Investigations* 7:105-112.
- Hubbs, C. L., G. S. Bien, and H. Suess  
1962 La Jolla natural radiocarbon measurements II. *Radiocarbon* 4:928.
- 1965 La Jolla natural radiocarbon measurements IV. *Radiocarbon* 7:106-111.
- Huddleston, R. W.  
1981 Fish remains from an archaeological site (Ora-193) at Newport Bay, Orange County, California. *Pacific Coast Archaeological Society Quarterly* 17 (2/3):127-137.
- Hudson, D. T.  
1977 *Marine Archaeology along the Southern California Coast*. San Diego Museum Papers 9. San Diego: San Diego Museum of Man.
- Inman, D.  
1983 Application of coastal dynamics to the reconstruction of paleocoastlines in the vicinity of La Jolla, California. In *Quaternary Coastlines and Marine Archaeology*, edited by P. M. Masters and N. C. Flemming, 1-49. New York: Academic Press.
- Jackson, J. B.  
1977 Plane sense: a technological and functional analysis of a stone tool category. Master's thesis, Department of Anthropology, Washington State University.
- Jahns, R. H.  
1954 Geology of the Peninsular Range Province, southern California and Baja California. In *Geology of Southern California*. Chap. II: *Geology of the Natural Provinces*, edited by R. H. Jahns, 29-52. Division of Mines Bulletin 170. San Francisco.
- Jennings, J. D.  
1957 *Danger Cave*. University of Utah Anthropological Papers 27. Salt Lake City.
- 1978 *Prehistory of Utah and the eastern Great Basin*. University of Utah Anthropological Papers 98. Salt Lake City.
- Jertberg, P. M.  
1978 A qualitative and quantitative analysis of relationships of the eccentric crescent and its value as an indicator of culture change. Master's thesis, California State University, Fullerton.
- Johnson, D. L.  
1972 Landscape evolution on San Miguel Island, California. Ph.D. thesis, University of Kansas. Ann Arbor: University Microfilms International.
- 1977 Late Quaternary climate of coastal California: evidence for the Ice Age refugium. *Quaternary Research* 8 (2):154-179.
- 1980 Episodic vegetation stripping, soil erosion, and landscape modification in prehistoric and recent historic time, San Miguel Island, California. In *The California Islands: Proceedings of a Multidisciplinary Symposium*, edited by D. M. Power, 103-121. Santa Barbara: Santa Barbara Museum of Natural History.
- 1981 More comments on the northern Channel Islands mammoths. *Quaternary Research* 15: 105-106.

# REFERENCES

- 1987 Soil geomorphological analysis, pedogenetic interpretation, and paleoenvironmental reconstruction of selected coastal archaeological sites between the Santa Ynez River and Pedernales Point, Vandenberg Air Force Base, California. Ms. in possession of M. Glassow, Department of Anthropology, University of California, Santa Barbara.
- Johnson, J.
  - 1980 Reconstructing the prehistoric fishery of the Goleta Lagoon. Ms. on file, Department of Anthropology, University of California, Santa Barbara.
- Jones, T.
  - 1989 Marine resource value and the priority of coastal settlement among hunter-gatherers: a California perspective. Master's thesis, Department of Anthropology, University of California, Davis.
- Kahn, M. I., T. Oba, and T. L. Ku
  - 1981 Paleotemperatures and the glacially induced changes in the oxygen isotope composition of sea water during Late Pleistocene and Holocene times in Tanner Basin, California. *Geology* 9 (9):485-490.
- Kaldenberg, R. L.
  - 1982 *Rancho Park North: A San Dieguito-La Jolla Shellfish Processing Site in Coastal Southern California*. Imperial Valley College Museum Society Occasional Papers 6. El Centro, California.
- Kaldenberg, R. L., and P. H. Ezell
  - 1974 Results of the archaeological mitigation of Great Western sites A and C, located on the proposed Rancho Park North development near Olivenhain, California. Ms. on file, Cultural Resource Management Center, San Diego State University.
- Kaldenberg, R. L., and R. V. May
  - 1975 Possible environmental stress factors which may have induced cultural horizon change in San Diego County, California. *Archaeological Fellowship of San Diego State University* 3 (2):3-6. San Diego.
- Keatinge, R. W.
  - 1988 *Peruvian Prehistory*. New York: Cambridge University Press.
- Kennett, J. P.
  - 1976 Phenotypic variation in some recent and Late Cenozoic planktonic foraminifera. In *Foraminifera*, vol. 2, edited by R. H. Hedley and C. G. Adams, 1-60. New York: Academic Press.
- Kerr, R.
  - 1988 The weather in the wake of El Niño. *Science* 240:883.
- Kheradpir, A.
  - 1970 Foraminiferal trends in the Quaternary of Tanner Basin, California. *Micropaleontology* 16 (1):102-116.
- King, C. D.
  - 1967 The Sweetwater Mesa site (LAn-267) and its place in southern California prehistory. *University of California Archaeological Survey Annual Reports* 9:29-73. Los Angeles.
  - 1981 The evolution of Chumash society. Ph.D. dissertation, Department of Anthropology, University of California, Davis. Ann Arbor: University Microfilms.
- King, F. B., and R. Graham
  - 1981 Effects of ecological and paleoecological patterns of subsistence and paleoenvironmental reconstructions. *American Antiquity* 46 (1): 128-142.
- King, T. J.
  - 1976 *Archaeological Implications of the Paleobotanical Record from Lucerne Valley Area of the Mojave Desert*. San Bernardino County Museum Association Quarterly 23 (4).
- Koerper, H. C.
  - 1981 Prehistoric subsistence and settlement in the Newport Bay area and environs, Orange County, California. Ph.D. dissertation, Department of Anthropology, University of California, Riverside. Ann Arbor: University Microfilms.
  - 1983 Chronology building for coastal Orange County: the case from CA-Ora-119-A. *Pacific Coast Archaeological Society Quarterly* 19:1-34.
  - 1986 The Agua Hedionda Project: archaeological investigations at CA-SDi-5353 and CA-SDi-9649. Prepared for Elfend and Associates, Inc.

# REFERENCES

- Ms. on file, Cultural Resource Management Center, San Diego State University.
- in the north of Chile. *American Antiquity* 44: 309-324.
- Koerper, H. C., and M. F. Farmer  
1987 A bear shaped crescentic from northern San Diego county. *Journal of California and Great Basin Anthropology* 9:282-288.
- LaMarche, V. C., Jr.  
1973 Holocene climate variations influenced from treeline fluctuations in the White Mountains, California. *Quaternary Research* 3(4):632-660.
- Koerper, H. C., J. S. Killingley, and R. E. Taylor  
1986 The little Ice Age and coastal southern California human economy. *Journal of California and Great Basin Anthropology* 7 (1):99-103.
- Lamb, H. H.  
1988 *Weather, Climate and Human Affairs*. London: Routledge.
- Koerper, H. C., J. E. Ericson, C. E. Drover, and P. E. Langenwaller II  
1986 Obsidian exchange in prehistoric Orange County. *Pacific Coast Archaeological Society Quarterly* 22 (1):33-69.
- Landberg, L.  
1965 *The Chumash Indians of Southern California*. Southwest Museum Papers 19. Los Angeles.
- Koloseike, A.  
1968 The logic of midden analysis with respect to shell. *University of California Archaeological Survey Annual Reports* 10:371-382. Los Angeles.
- Laughlin, W. S.  
1975 Aleuts: ecosystem, Holocene history, and Siberian origin. *Science* 189 (4202):507-515.
- 1969 On calculating the prehistoric food resource value of molluscs. *University of California Archaeological Survey Annual Reports* 11:143-162. Los Angeles.
- Leakey, L. S. B., R. D. Simpson, T. Clements, R. Berger, J. Withoft, and participants of the Calico Conference  
1972 *Pleistocene Man at Calico: A Report on the International Conference on the Calico Mountains Excavations, San Bernardino County, California*. Redlands: San Bernardino County Museum.
- Kowta, M.  
1969 The Sayles complex: a late milling stone assemblage from Cajon Pass and the ecological implications of its scraper planes. *University of California Publications in Anthropology* 6:1-101. Berkeley.
- Lerman, M.  
1986 *Marine Biology: Environment, Diversity, Ecology*. Menlo Park, California: Benjamin Cummings Publishing Company, Inc.
- Kraft, J. C., D. F. Belknap, and I. Kayan  
1983 Potentials of discovery of human occupation sites on the continental shelves and nearshore coastal zone. In *Quaternary Coastlines and Marine Archaeology*, edited by P. M. Masters and N. C. Flemming, 87-120. New York: Academic Press.
- Libby, L. M.  
1983 *Past Climates: Thermometers, Commodities, and People*. Austin: University of Texas Press.
- Kuhn, G. G., and F. P. Shepard  
1984 *Sea Cliffs, Beaches, and Coastal Valleys of San Diego County: Some Amazing Histories and Some Horrifying Implications*. Berkeley: University of California Press.
- Lohmar, J., K. MacDonald, and S. James  
1980 Late Pleistocene-Holocene infilling and faunal change in a southern California coastal lagoon. In *Quaternary Depositional Environments of the Pacific Coast*, 231-240. Fourth Pacific Coast Paleogeography Symposium, Bakersfield, California.
- Lagostera, M. A.  
1979 9700 years of maritime subsistence on the Pacific: an analysis by means of bioindicators
- Lovis, W.  
1990a Accelerator dating the ceramic assemblage from the Fletcher site: implications of a pilot study for interpretation of the Wayne period. *Midcontinental Journal of Archaeology* 15 (1): 37-50.
- 1990b Curatorial considerations for systematic research collections: AMS dating a curated ce-



# REFERENCES

- ramic assemblage. *American Antiquity* 55 (2): 382-387.
- Mackey, J. C., and S. J. Holbrook  
1978 Environmental reconstruction and the abandonment of the Largo-Gallina area, New Mexico. *Journal of Field Archaeology* 5:29-49.
- Marcus, L. F., and W. S. Newman  
1983 Hominid migrations and the eustatic sea level paradigm: a critique. In *Quaternary Coastlines and Marine Archaeology*, edited by P. M. Masters and N. C. Flemming, 64-85. New York: Academic Press.
- Martin, P. S.  
1967 Prehistoric overkill. In *Pleistocene Extinctions: The Search for a Cause*, edited by P. S. Martin and H. E. Wright, Jr., 75-120. New Haven: Yale University Press.  
1984 Prehistoric overkill: the global model. In *Quaternary Extinctions: A Prehistoric Revolution*, edited by P. S. Martin and R. G. Klein, 354-403. Tucson: University of Arizona Press.
- Masters, P. M.  
1983 Detection and assessment of prehistoric artifact sites off the coast of southern California. In *Quaternary Coastlines and Marine Archaeology*, edited by P. M. Masters and N. C. Flemming, 189-213. New York: Academic Press.
- McCormick, H. W., T. Allen, and W. E. Young  
1963 *Shadows in the Sea*. New York: Chilton Books.
- McKusick, M. B., and C. N. Warren  
1959 Introduction to San Clemente archaeology. *University of California Archaeological Survey Annual Reports* 1:107-183. Los Angeles.
- McMillan, R. B., and W. E. Klippel  
1981 Post-glacial environmental change and hunting-gathering societies of the southern Prairie peninsula. *Journal of Archaeological Science* 8 (3):215-245.
- Mehring, P. J., Jr.  
1967 Pollen analysis and the alluvial chronology. *Kiva* 32:96-101.
- 1977 Great Basin late Quaternary environments. In *Models and Great Basin Prehistory: A Symposium*, edited by D. O. Fowler, 113-169. Desert Research Institute Publications in the Social Sciences 12. Las Vegas.
- 1986 Prehistoric environments. In *Great Basin*, edited by W. L. D'Azevedo, 31-50. Handbook of the North American Indians, vol. 11, W. G. Sturtevant, general editor. Washington D.C.: Smithsonian Institution.
- Meighan, C. W.  
1965 Pacific Coast archaeology. In *The Quaternary of the United States*, edited by H. E. Wright and D. C. Frey, 709-720. Princeton: Princeton University Press.  
1978 California. In *Chronologies in New World Archaeology*, edited by R. E. Taylor and C. W. Meighan, 223-240. New York: Academic Press.  
1984 Studies of San Clemente Island archaeology. Ms. on file, Department of Anthropology, University of California, Los Angeles.  
1986 UCLA archaeological research on San Clemente Island. Submitted to the Natural Resources Office, Naval Air Station, North Island, San Diego, California.  
1989 The earliest shell-mound dwellers of southern California. Paper presented at the Circumpacific Prehistory Conference, Seattle.
- Menzies, A.  
1924 California journal of the Vancouver expedition 1790-1794. *California Historical Quarterly* 2:265-340.
- Merifield, P. M., D. L. Lamar, and M. L. Stout  
1971 Geology of central San Clemente Island. *Geological Society of America* 82:1989-1991.
- Miller, J.  
1966 The present and past molluscan faunas and environments of four southern California coastal lagoons. Master's thesis, University of California, San Diego.
- Milliman, J. and K. Emery  
1968 Sea levels during the last 35,000 years. *Science* 162:1121-1123.

# REFERENCES

- Moore, J. D.  
1985 Shells, seeds, and sites. Paper presented at the annual meeting of the Society for California Archaeology, San Diego.
- Moratto, M. J.  
1984 *California Archaeology*. New York: Academic Press.
- Moratto, M. J., T. F. King, and W. B. Woolfenden  
1978 Archaeology and California's climate. *The Journal of California Anthropology* 5 (2):147-161.
- Morejohn, G. V.  
1976 Evidence of the survival to recent times of the extinct flightless duck *Chendytes lawi*. *Smithsonian Contributions to Paleobiology* 27: 207-211. Washington, D. C.
- Moriarty, J. R.  
1966 Culture phase divisions suggested by typological change coordinated with stratigraphically controlled radiocarbon dating at San Diego. *Anthropological Journal of Canada* 4 (4):20-30.  
1967 Transitional pre-desert phase in San Diego County, California. *Science* 155:553-556.  
1969 The San Dieguito complex: suggested environmental and cultural relationships. *Anthropological Journal of Canada* 7 (3):2-18.  
1987 A separate origins theory for two early man cultures in California. In *San Dieguito-La Jolla: Chronology and Controversy*, edited by D. Gallegos, 49-60. San Diego County Archaeological Society Research Paper 1. San Diego.
- Morris, D. P.  
1987 Early human skeletal material from Santa Rosa Island. Paper presented at the Channel Islands Symposium, Santa Barbara Museum of Natural History.
- Morrison, I. A.  
1976 Comparative stratigraphy and radiocarbon chronology of Holocene marine changes on the western seaboard of Europe. In *Geoarchaeology*, edited by D. A. Davidson and M. L. Shackley, 159-174. Boulder, Colorado: Westview Press.
- Moseley, M. E.  
1975 *The Maritime Foundations of Andean Civilization*. Menlo Park: Cummings Publishing.
- Munz, P. A.  
1959 *A California Flora*. Berkeley: University of California Press.
- Neck, R. W.  
1987 Changing Holocene snail faunas and environments along the eastern Caprock escarpment of Texas. *Quaternary Research* 27 (3):312-322.
- North, W.  
1983 The sea urchin problem. In *The Effects of Waste Disposal on Kelp Communities*, edited by W. Bascom, L. Harris, and G. Sibley, 147-162. Papers from a symposium presented by the Southern California Coastal Water Research Project and the Institute of Marine Resources of the University of California, Scripps Institution of Oceanography, La Jolla, California, January 24-25, 1983.
- Norwood, R.  
1980 The cultural resources of Fairbanks Ranch, Rancho Santa Fe, California. Report prepared by and on file with Regional Environmental Consultants (RECON), San Diego.
- Norwood, R., and C. Walker  
1980 The cultural resources of San Dieguito Estates. Report prepared by and on file with RECON, San Diego, California.
- Oakley, K. P.  
1963 Relative dating of Arlington Springs Man. *Science* 141:1172.
- Odum, E. P.  
1959 *Fundamentals of Ecology*. Philadelphia: W. B. Saunders.  
1969 The strategy of ecosystem development. *Science* 164:262-270.
- Ore, Thomas H., and C. N. Warren  
1971 Late Pleistocene-Early Holocene geomorphic history of Lake Mojave, California. *Geologic Society of America Bulletin* 82:2553-2562.
- Orr, P. C.  
1949 Third Santa Rosa Island expedition (1949) field notes, locality 131.3, containing cemeteries A

# REFERENCES

- and B. Ms. on file, Santa Barbara Museum of Natural History (Ms. #NA-CA-131.3-1).
- 1960 Observations on the Black Line. Unpublished notes of July 3, field notes, 131.173 Arlington Springs (1959/1960). Ms. on file, Santa Barbara Museum of Natural History (Ms. #NA-CA-131.173-1).
- 1967 Geochronology of Santa Rosa Island, California. In *Proceedings of the Symposium on the Biology of the California Islands*, edited by R. N. Philbrick, 317-325. Santa Barbara: Santa Barbara Botanic Garden.
- 1968 *Prehistory of Santa Rosa Island*. Santa Barbara: Santa Barbara Museum of Natural History.
- Orr, P. C., and R. Berger  
1966 The fire areas on Santa Rosa Island, California. *Proceedings of the National Academy of Sciences* 56:1409-1416.
- Osborn, A. J.  
1977 Strandloopers, mermaids, and other fairy tales: ecological determinants of marine resource utilization—the Peruvian case. In *For Theory Building in Archaeology*, edited by L. R. Binford, 157-205. New York: Academic Press.
- Owen, R. C.  
1964 Early Millingstone Horizon (Oak Grove), Santa Barbara County, California: radiocarbon dates. *American Antiquity* 30:210-213.
- 1967 Assertions, assumptions, and Early horizon (Oak Grove) settlement patterns in southern California: a rejoinder. *American Antiquity* 32:236-240.
- Owen, R. C., F. Curtis, and D. S. Miller  
1964 The Glen Annie Canyon site, SBa-142, an Early horizon coastal site of Santa Barbara County. *University of California Archaeological Survey Annual Reports* 6:431-520. Los Angeles.
- Paine, R. T.  
1966 Food web complexity and species diversity. *American Naturalist* 100:65-75.
- 1974 Intertidal community structure: experimental studies on the relationship between a dominant competitor and its principal predator. *Oecologia* 15:93-120.
- Paine, R. T., and R. L. Vadas  
1969 The effects of grazing by sea urchins, *Strongylocentrotus* spp., on benthic algal populations. *Limnology Oceanography* 14: 710-719.
- Pearsall, D.  
1988 *Paleoethnobotany*. New York: Academic Press.
- Pearse, J. S., and A. H. Hines  
1976 Kelp forest ecology of the central California coast. In *University of California Sea Grant College Program Annual Report 1975-1976*. Sea Grant Publications 57. La Jolla.
- 1979 Expansion of a central California kelp forest following the mass mortality of sea urchins. *Marine Biology* 51:85-91.
- Pearson, R.  
1978 *Climate and Evolution*. London: Academic Press.
- Peck, S. L.  
1955 *An Archaeological Report on the Excavation of a Prehistoric Site at Zuma Creek, Los Angeles County, California*. Archaeological Survey Association of Southern California 2. Los Angeles.
- Pierce, A. M.  
1979 Archaeological investigations at SLO-177 and vicinity, Cambria, California. Master's thesis, Department of Anthropology, Stanford University.
- Pierson, L. J., G. I. Shiller, and R. A. Slater  
1987 Archaeological resource study: Morro Bay to Mexican border. Los Angeles: U.S. Department of the Interior, Minerals Management Service.
- Pisias, N. G.  
1978 Paleooceanography of the Santa Barbara Basin during the last 8,000 years. *Quaternary Research* 10:366-384.
- 1979 Model for palaeoceanographic reconstructions of the California current during the last 8,000 years. *Quaternary Research* 11 (3):373-386.

- Price, T.D., and J. A. Brown  
1985 *Prehistoric Hunter-Gatherers: The Emergence of Cultural Complexity*. New York: Academic Press.
- Putnam, W. C.  
1964 *Geology*. New York: Oxford University Press.
- Raab, L. M.  
1989 Eaten out of house and home. Ms. on file at the Center for Public Archaeology, California State University, Northridge.
- Reinman, F. M.  
1964 Maritime adaptation on San Nicolas Island, California: a preliminary and speculative evaluation. *University of California Archaeological Survey Annual Reports* 6:51-75. Los Angeles.
- Renfrew, C.  
1972 *The Emergence of Civilization: The Cyclades and the Aegean in the Third Millennium B.C.* London: Methuen.
- Rogers, D. B.  
1929 *Prehistoric Man of the Santa Barbara Coast*. Santa Barbara: Santa Barbara Museum of Natural History.
- Rogers, M. J.  
n.d. Site record notes on W-131. On file at the San Diego Museum of Man, San Diego.  
1929 The stone art of the San Dieguito plateau. *American Anthropologist* 31:454-467.  
1939 *Early Lithic Industries of the Lower Basin of the Colorado River and Adjacent Desert Areas*. San Diego Museum of Man Papers 3.  
1966 Ancient hunters of the far west. *Union Tribune*, San Diego.
- Rosen, M. D.  
1978 Archaeological investigations at Ven-294, an inland Chumash village site. In *The Archaeology of Oak Park, Ventura County, California*, edited by C. W. Clewlow, Jr., H. Wells, and A. Pastron. Monograph V. Los Angeles: UCLA Institute of Archaeology
- Island, California. Los Angeles: Los Angeles County Museum of Natural History.
- Rudolph, J. L.  
1985 Changing shellfish exploitation in San Luis Obispo County, California. *Journal of California and Great Basin Anthropology* 7 (1):126-132.
- Rudolph, T. P.  
1983a Archaeological testing at SLO-177, Cambria, California. Ms. on file (E-421 SLO), Regional Information Center of the California Archaeological Inventory, University of California, Santa Barbara.  
1983b Horizontal and vertical distributions of artifacts on the Condon property: a supplemental report to archaeological testing at SLO-177, Cambria, California. Ms. on file (E-457 SLO), Regional Information Center of the California Archaeological Inventory, University of California, Santa Barbara.
- Russell, R. J.  
1967 Origins of estuaries. In *Estuaries*, edited by G. H. Lauff, 93-99. American Association for the Advancement of Science 83. Washington, D.C.
- Salls, R. A.  
1985 The scraper plane: a functional interpretation. *Journal of Field Archaeology* 12:99-106.  
1986a The La Brea atlatl foreshafts: inferences for the Millingstone Horizon. *Pacific Coast Archaeological Society Quarterly* 22 (2):21-30.  
1986b Subsistence change and the concept of alternate stable-state communities in prehistoric marine adaptations. Paper presented at the annual meeting of the Society for American Archaeology, New Orleans.  
1988a Prehistoric fisheries of the California Bight. Ph.D. dissertation, Archaeology Program, University of California, Los Angeles.  
1988b The fisheries of Mission Nuestra Señora de la Soledad, Monterey County, California. *Research in Economic Anthropology* 11:251-284.
- Schoener, T. W., and D. A. Spiller  
1987 Effects of lizards on spider populations: ma-
- Rozaire, C.  
1978 *Archaeological Investigations on San Miguel*

# REFERENCES

- nipulative reconstructions of a natural experiment. *Science* 236:949-952.
- Schumacher, P.
  - 1875 Ancient graves and shell heaps of California. *Smithsonian Institution Annual Report for 1874*, 335-350. Washington, D.C.: Smithsonian Institution.
- Schwaderer, R., J. Ferneau, and E. B. Parkman
  - 1990 Coyote's Rock: preliminary investigations at SON-348/H, the Duncan's Point Cave site, Sonoma coast. Paper presented at the annual meeting of the Society for California Archaeology, Foster City.
- Shepard, F. P.
  - 1964 Sea level changes in the past 6,000 years: Possible archaeological significance. *Science* 143:574-576.
- Shumway, G., C. L. Hubbs, and J. R. Moriarty
  - 1961 Scripps Estate site, San Diego, California, a La Jolla site dated 5460-7370 years before present. *Annals of the New York Academy of Sciences* 93 (3):37-172.
- Sidwell, V. D.
  - 1981 Chemical and nutritional composition of fin-fishes, whales, crustaceans, mollusks, and their products. NOAA Technical Memorandum NMFS F/SEC-11. U.S. Department of Commerce.
- Simenstad, C. A., J. A. Estes, and K. W. Kenyon
  - 1978 Aleuts, sea otters, and alternate stable-state communities. *Science* 200:403-411.
- Simons, D. D., T. N. Layton, and R. Knudson
  - 1985 A fluted point from the Mendocino County coast, California. *Journal of California and Great Basin Anthropology* 7:260-269.
- Smith, B. F.
  - 1987 A reinterpretation of the Transitional phase. In *San Dieguito-La Jolla: Chronology and Controversy*, edited by D. Gallegos, 61-71. San Diego County Archaeological Society Research Paper 1. San Diego.
- Smith, E. A.
  - 1983 Anthropological applications of optimal foraging theory: a critical review. *Current Anthropology* 24:625-651.
- Snethkamp, P. E.
  - 1986 The early occupation at Daisy Cave 6000 to 10000 BP. Paper presented at the Society for California Archaeology Data Sharing Meeting, Los Angeles.
  - 1987 Prehistoric subsistence variability on San Miguel Island. Paper presented at the Third California Islands Symposium, March 2-6, 1987, Santa Barbara Museum of Natural History.
- Snethkamp, P. E., and D. Guthrie
  - 1988 The early Holocene occupations of Daisy Cave, San Miguel Island, California. Paper presented at the annual meeting of the Society for California Archaeology, Redding.
- Spanne, L. W.
  - 1973 Excavations at the Barka Slough Site, SBa-1010, Vandenberg Air Force Base, California. Ms. on file, Department of Anthropology, University of California, Santa Barbara.
- Spencer, R. W., and J. R. Christy
  - 1990 Precise monitoring of global temperature trends from satellites. *Science* 247:1558-1562.
- Squire, J. L., and S. Smith
  - 1977 *Anglers Guide to the United States Pacific Coast*. Seattle: National Oceanic and Atmospheric Administration, National Marine Fisheries Service.
- Stafford, T. W., Jr., A. J. T. Hull, K. Brendel, R. C. Duhamel, and D. Donahue
  - 1987 Study of bone radiocarbon dating accuracy at the University of Arizona Accelerator Facility for Radioisotope Analysis. *Radiocarbon* 29:24-44.
- Stephenson, W., and R. B. Searless
  - 1960 Experimental studies on the ecology of intertidal environments at Heron Island, I: Exclusion of fish from beach rock. *Australian Journal of Marine and Freshwater Research* 11:241-267.
- Stock, C.
  - 1972 *Rancho La Brea: A Record of Pleistocene Life in California*. 6th ed. Los Angeles County Museum of Natural History Science Series 20, Paleontology 11. Los Angeles.

# REFERENCES

- Stuiver, M.  
1982 A high precision calibration of the AD radiocarbon time scale. *Radiocarbon* 24:1-26.
- Stuiver, M., G. W. Pearson, and T. Braziunas  
1986 Radiocarbon age calibration of marine samples back to 9000 CAL YR BP. *Radiocarbon* 28: 980-1021.
- Suess, H. E.  
1979 A calibration table for conventional radiocarbon dates. In *Radiocarbon Dating*, edited by R. Berger and H. E. Suess, 777-784. Los Angeles: University of California Press.
- Sutherland, J. P.  
1974 Multiple stable points in natural communities. *American Naturalist* 108:859-873.
- Tadlock, W. L.  
1966 Certain crescentic stone objects as a time marker in the western United States. *American Antiquity* 31:622-675.
- Tartaglia, L. J.  
1976 Prehistoric maritime adaptations in southern California. Ph.D. dissertation, Department of Anthropology, University of California, Los Angeles. Ann Arbor: University Microfilms.
- Taylor, R. E., L. A. Payen, C. A. Prior, P. J. Slota, Jr., R. Gillespie, J. A. J. Gowlett, and R. E. M. Hedges, A. J. T. Jull, T. H. Zabel, D. J. Donahue, and R. Berger  
1985 Major revisions in the Pleistocene age assignments for North American human skeletons by C-14 Accelerator Mass Spectrometry: none older than 11,000 C-14 years B.P. *American Antiquity* 50:136-140.
- Thomas, D. H.  
1969 Great Basin hunting patterns: a quantitative method for treating faunal remains. *American Antiquity* 34:392-401.
- Timbrook, J.  
1984 Chumash ethnobotany: a preliminary report. *Journal of Ethnobiology* 4:141-169.
- Treganza, A. E., and C. G. Malamud  
1950 The Topanga culture: first season's excavation of the Tank site, 1947. *University of California Anthropological Records* 12 (4):129-157. Berkeley.
- Troxel, B. W.  
1954 Geologic guide number 3, Los Angeles Basin. In *Geology of Southern California*, edited by R. H. Jahns, 1-46. California Department of Natural Resources, Division of Mines Bulletin 170. San Francisco.
- True, D. L.  
1958 An early complex in San Diego County, California. *American Antiquity* 23 (3):255-263.  
1983 Casual artifacts in northern San Diego County, California: the hammergrinder. *Journal of California and Great Basin Anthropology* 5: 208-223.
- True, D. L., and M. E. Basgall  
1987 Archaeological investigations in Crowder Canyon: interior Milling Stone adaptations in southern California. Paper presented at the annual meeting of the Society for California Archaeology, Fresno.
- Ultrasonics, Inc.  
1983 Supplemental environmental studies: Kelly Ranch. Ms. on file at the Cultural Resource Management Center, San Diego State University.
- Van Devender, T. R., and W. G. Spaulding  
1979 Development of vegetation and climate in the southwestern United States. *Science* 204 (4394):701-710.
- Vaughn, S. J.  
1982 A replicative systems analysis of the San Dieguito component at the C. W. Harris site. Master's thesis, Department of Anthropology, University of Nevada, Las Vegas.
- Walker, E. F.  
1952 *Five Prehistoric Archeological Sites in Los Angeles County, California*. Publications of the Frederick Webb Hodge Anniversary Publication Fund 6. Los Angeles: Southwest Museum.
- Walker, I. R., and R. W. Mathewes  
1987 Chironomids, lake trophic status and climate. *Quaternary Research* 28 (3):431-437.
- Walker, P. L., and J. M. Erlandson  
1986 Dental evidence for prehistoric dietary changes

# REFERENCES

- on the northern Channel Islands, California. *American Antiquity* 51:375-383.
- Walker, P. L., S. Craig, D. Guthrie, and R. Moore  
1978 An ethnozoological analysis of faunal remains from four Santa Barbara Channel Island archaeological sites. Ms. on file, Department of Anthropology, University of California, Santa Barbara.
- Wallace, W. J.  
1954 The Little Sycamore site and the early Milling Stone cultures of Southern California. *American Antiquity* 20:112-123.  
1955 A suggested chronology for southern California coastal archaeology. *Southwest Journal of Anthropology* 11:214-230.  
1978 Post-Pleistocene archeology, 9000 to 2000 B.C. In *California*, edited by R. F. Heizer, 26-36. Handbook of North American Indians, vol. 8, W. G. Sturtevant, general editor. Washington: Smithsonian Institution.  
1985 A last look at Malaga Cove. In *Woman, Poet, Scientist: Essays in New World Anthropology Honoring Dr. Emma Louise Davis*, edited and compiled by the Great Basin Foundation, 135-144. Ballena Press Anthropological Papers 29. Los Altos, California.
- Wallace, W. J., E. S. Taylor, R. J. Desautals, H. R. Hammond, H. Gonzales, J. Bogart, and J. P. Redwine  
1956 *The Little Sycamore Shellmound, Ventura County*. Contributions to California Archaeology 2. Los Angeles: Archaeological Research Associates.
- Warren, C. N.  
1964 Cultural change and continuity on the San Diego Coast. Ph.D. dissertation, University of California, Los Angeles. Ann Arbor: University Microfilms.  
1967a The San Dieguito complex: a review and hypothesis. *American Antiquity* 32:168-185.  
1967b The southern California Milling Stone horizon: some comments. *American Antiquity* 32: 233-236.
- 1968 Cultural tradition and ecological adaptation on the southern California coast. *Eastern New Mexico University Contributions to Anthropology* 1 (3):1-14. Portales.  
1987 San Dieguito and La Jolla: some comments. In *San Dieguito-La Jolla: Chronology and Controversy*, edited by D. Gallegos, 75-85. San Diego County Archaeological Society Research Paper 1. San Diego.
- Warren, C. N., ed.  
1966 The San Dieguito type site: M. J. Rogers' 1938 excavation on the San Dieguito River. *San Diego Museum Papers* 5:1-39. San Diego Museum of Man.
- Warren, C. N., and M. G. Pavesic  
1963 Shell midden analysis of site SDi-603 and ecological implications for cultural development of Batiquitos Lagoon, San Diego County. *University of California Archaeological Survey Annual Reports* 4:407-438. Los Angeles.
- Warren, C. N., and D. L. True  
1961 The San Dieguito complex and its place in California prehistory. *University of California Archaeological Survey Annual Reports* 3:246-338. Los Angeles.
- Warren, C. N., D. L. True, and A. Eudey  
1961 Early gathering complexes of western San Diego County. *University of California Archaeological Survey Annual Reports* 3:1-106. Los Angeles.
- Watt, B. K., and A. L. Merrill  
1975 *Composition of Foods*. Agriculture Handbook 8. Washington, D.C: United States Department of Agriculture.
- Weide, D. L.  
1976 The Altithermal as an archaeological "non-problem" in the Great Basin. In *Holocene Environmental Change in the Great Basin*, edited by R. Elston, 174-185. Nevada Archaeological Survey Research Paper 6. Reno.
- Wendorf, M.  
1982 Early man on Santa Rosa Island: a reassessment. *Anthroquest: The L. S. B. Leakey Foundation News* 22:9. Pasadena.

## REFERENCES

- Westec Services, Inc.  
 1984 Results of archaeological testing program at CA-SLO-801, San Luis Obispo County, California. Ms. on file, Regional Information Center of the California Archaeological Inventory, University of California, Santa Barbara.
- Wheeler, T.  
 1984 Appendix C: experimental yucca processing. In *Data Recovery of a Portion of Bow Willow Wash North, Fort Irwin, San Bernardino County, California*, by E. J. Skinner. Fort Irwin Archaeological Project Research Report 11. Salinas: Coyote Press.
- White, T. E.  
 1953 A method of calculating the dietary percentages of various food animals utilized by aboriginal peoples. *American Antiquity* 18:396-398.
- Willey, G. R., and J. A. Sabloff  
 1980 *A History of American Archaeology*. San Francisco: Freeman.
- Wilson, K., and R. McPeak  
 1983 Kelp restoration. In *The Effects of Waste Disposal on Kelp Communities*, edited by W. Bascom, L. Harris, and G. Sibley, 99-216. Papers from a symposium presented by the Southern California Coastal Water Research Project and the Institute of Marine Resources of the University of California, Scripps Institute of Oceanography, La Jolla, California, January 24-25, 1983.
- Wright, H. W., Jr.  
 1976 The dynamic nature of Holocene vegetation: a problem of paleoclimatology, biogeography and stratigraphic nomenclature. *Quaternary Research* 6 (4):581-596.
- Yesner, D. R.  
 1980 Maritime hunter-gatherers: ecology and prehistory. *Current Anthropology* 21:727-735.



