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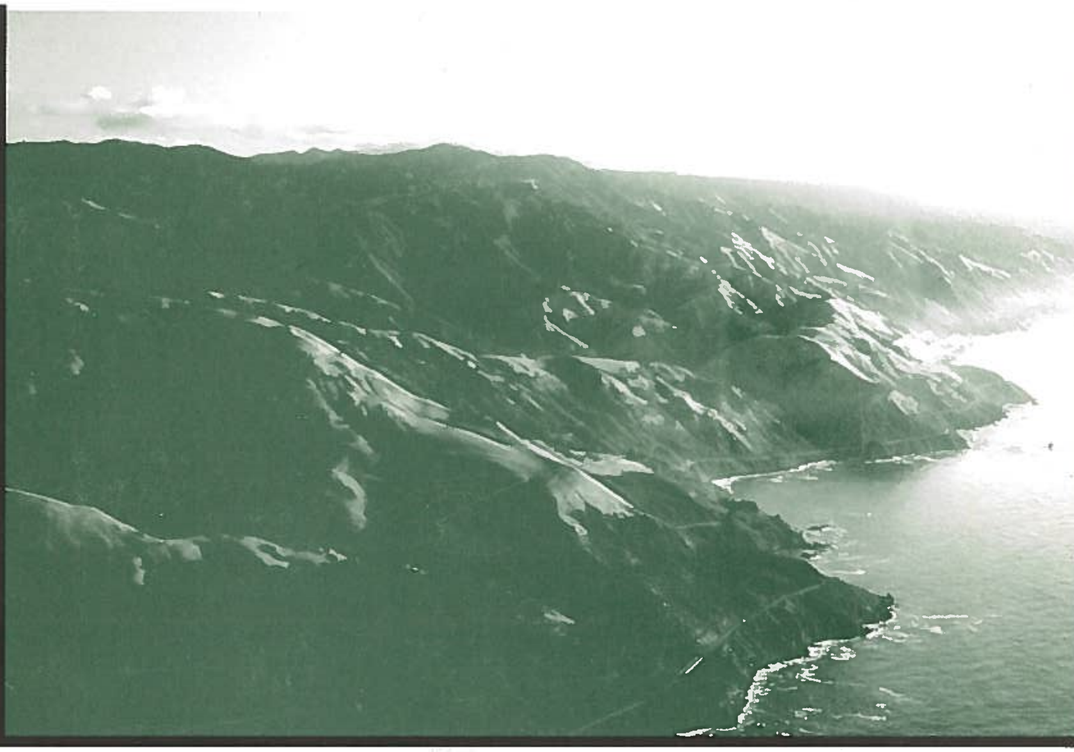
PREHISTORIC HUMAN ECOLOGY OF THE BIG SUR COAST, CALIFORNIA



TERRY L. JONES

With Contributions by
Douglas J. Kennett and Steven A. Moffitt

NUMBER 61
CONTRIBUTIONS OF THE UNIVERSITY OF CALIFORNIA
ARCHAEOLOGICAL RESEARCH FACILITY
BERKELEY

Author Terry L. Jones in the field at MNT-1223 in August 1986 with coworkers.

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PREFACE AND ACKNOWLEDGEMENTS

This volume is the result of eight seasons of field work completed over a 17-year period between 1983 and 2000. The research was initiated at Landels-Hill Big Creek Reserve, a 7100-acre teaching and research facility situated on the Big Sur coast, about 40 miles south of Carmel in Monterey County. In 1983, Big Creek Reserve was a newly established facility, and seminal studies of its natural and cultural history were just being completed. Because California archaeologists tended to overlook Big Sur and its rugged terrain, little was known about its prehistory, so, as a supplement to this early research, an archaeological surface inventory was undertaken in 1983 and 1984. To the surprise of many, including myself, this surface reconnaissance yielded a great deal more evidence for prehistoric occupation than expected. Midden deposits with abundant surface artifacts and molluscan remains were found in a wide variety of elevational settings, including locations above 2000 feet, several miles inland. With such a rich and puzzling record, it was clear that more research was warranted, and the two-year surface study evolved into a dissertation project focused on regional culture history, settlement practices, and dietary trends through time. As the study expanded in scope, areas outside Landels-Hill Big Creek Reserve were investigated. When the dissertation project was completed at U.C. Davis in 1995, findings from Andrew Molera and Julia Pfeifffer Burns State Parks and the Los Padres National Forest were included.

The coastal archaeological sites all showed abundant signs of regular contact with the interior. Nearly all of the flaked stone tools found at Landels-Hill Big Creek Reserve, for example, were made from Monterey chert that was obtained from inland sources. To understand regional settlement practices, it was clear that some knowledge of the interior archaeology was necessary, and in 1995 an opportunity to investigate sites in the Nacimiento and San Antonio river valleys presented itself in the form of contract projects from Fort Hunter Liggett Military Reservation. Between 1995 and 2000, fifteen sites were excavated as part of the installation's compliance with federal historic preservation laws and policies. During this period, I was also fortunate to obtain additional coastal data from a midden deposit on the northern San Luis Obispo coast slightly south of the Sur coast. The additional information resulted from of a large data recovery investigation sponsored by Caltrans. This monograph presents findings from the most significant subsurface investigations completed between 1983 and 2000 on the coast between Point Sur and Point Piedras Blancas and in the interior within Fort Hunter Liggett Military Reservation.

ACKNOWLEDGEMENTS

The labor of field research was provided by field school students from two universities (U.C. Santa Cruz and U.C. Davis), volunteers from San Jose State University, the Sacramento Archaeological Society, California Polytechnic State University, and employees from the California Department of Transportation, Sonoma State University, Biosystems Inc., Garcia and Associates, and Albion Environmental. With so many different organizations involved, it should come as no surprise that a tremendous number of individuals assisted in planning, permitting, logistical support, field work, post field analysis, initial reporting, and preparation of the final monograph. For the field alone, over 100 different individuals helped in the completion of ca.

10,000 acres of survey and excavations at 30 sites. Suffice it to say, that I greatly appreciated the work of all of these people over the years, and I apologize for not being able at this juncture to thank everyone individually for their efforts. I hope you all realize that I could not have completed this project without you.

Some individuals who played ongoing and/or particularly significant roles deserve special recognition. First I would like to thank Larry Ford and John Smiley for facilitating the archaeological field schools at Landels-Hill Big Creek Reserve. John and Kim Smiley were especially gracious and helpful during the large field project of 1990. Funding for that work was provided by the Giles Mead Foundation, the Nature Conservancy, the University of California Natural Reserve, and contracts between Fort Hunter Liggett Military Reservation and Biosystems Inc., Garcia and Associates, and Albion Environmental. People who were instrumental in obtaining and managing those funds were Dan Cheatham, Suki Molina, Dave Fredrickson, Susan Alvarez, and Clinton Blount. Thank you.

People who were instrumental in permitting and logistical support for the project included Don Usner, Alisa Fineman, Feiner Arias, Evan Goldblatt, Jeff Kennedy, Glen Farris, Peter Schulz, Herb Dallas, Robert Orlins, Steven Horne, Andrea Maliarik, John Johnson, Diane Gifford-Gonzalez, Adrian and Mary Praetzellis, Susan Alvarez, Martha Proctor, Jack Hunter, and Wendy Waldron. Thank you all.

People who played key supervisory roles in the field were: Sarah Anderson, Karen Hildebrand, Betty Rivers, Andrew York, Michael Baldrica, Jeff Haney, Pete Johnson, Dave Fredrickson, Terry Joslin, Bill Stillman, Jerry Doty, John Edwards, Jim Nelson, Rick Fitzgerald, Seana Gause, Chris Corey, and Dana Tinsley. The Big Sur coast is not an easy place to do field work, and completion of the field research in many cases required herculean efforts on the part of the supervisory staff. I can't thank you all enough for your efforts. Cartography was completed by Nelson Thompson who deserves special recognition for the consistent quality of his work over the years.

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A great number of specialists were involved in the analyses of materials recovered from the field. Obsidian studies were completed by Richard Hughes, Tom Origer, Paul Bouey, and Craig Skinner. Bird and mammal bone identifications were completed by Patricia Lambert, Carol Cope, Jeffrey Hall, Judy Porcasi, and Krislyn Taite. All fish bone was identified by Ken Gobalet. Rob Jackson, Bill Bloomer, and Jeff Haney assisted with lithic analysis. Ground stone artifact analyses were completed by Jennifer Ferneau, Jeff Haney, Rick Fitzgerald, and Susan Baldry. Bead identifications were completed by the late Dr. James A. Bennyhoff assisted by Steven Grantham and Jeff Haney. Randy Milliken also consulted on bead identifications from CA-MNT-879.

All of the illustrations in this volume were done by Rusty van Rossman, and I thank him for the fine quality of his work.

Several individuals provided editorial assistance during various stages of the project. Foremost among them were Martha Brown, Betty Rivers, and Kathryn Crabtree. I'm also thankful to Rosemary LeBlanc and especially Leroy Laurie for his dedicated efforts in helping compile the final manuscript. I'd also like to thank Eric Wolgemuth for his willingness to share the data from CA-MNT-1942.

I am also indebted to the members of my dissertation committee, Robert Bettinger, William Davis, Phillip Walker, and the late Delbert True for their guidance in the successful completion of that project. The present document is basically an enlarged version of that treatise.

I would like to add an additional word of thanks to people who provided miscellaneous support of one form of the other for this endeavor: John Smiley and the staff of Landels-Hill Big Creek Reserve and the Natural Reserve System, Dave Fredrickson, Betty Rivers, Clinton Blount, Jeff Haney, Susan Alvarez and the cultural staff at Fort Hunter Liggett.

I would also like to acknowledge Kent Lightfoot and several anonymous reviewers from the Archaeological Research Facility at U.C. Berkeley for constructive comments provided on earlier drafts of the manuscript. Series editor, Tanya Smith, was also most helpful in providing guidance and assistance in preparation of the final document.

Finally I wish to thank my life partner, Debbie Jones, for her love, support, assistance, and unending patience with this long project. Thank you all.

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CHAPTER 1: INTRODUCTION

Long assumed a prehistoric backwater, the Big Sur coast of central California was routinely passed over by archaeologists for decades. Between Point Sur and Point Piedras Blancas (Figure 1), Big Sur's Santa Lucia Range encompasses some of the steepest coastal terrain in western North America with an exceptionally diverse terrestrial biome that interfaces with a high-energy, exposed, rocky shore. Systematic archaeological surveys, initiated in the 1970s and 80s, revealed shell middens of widely varying size in settings ranging from shoreline terraces to small benches, 4-5 km inland at elevations in excess of 850 m. Middens with high shell content are also found in the interior valleys of the South Coast Range, 20-30 km inland. With chronological controls provided by excavation, artifact and faunal assemblages from a sample of these deposits illuminate systems of subsistence, settlement, and exchange employed over the last 6400 years by resident hunter-gatherers. Marine resources were used throughout this sequence, but diachronic variability in the importance and intensity of the marine resource exploitation was greatest across two periods of transition: one ca. 3500 B.C. and the second ca. A.D. 1000-1300. Marked changes in diet and settlement suggest that population growth was a significant agent of cultural change at these junctures, but population-induced stress was also exacerbated by high intensity, rapidly-transpiring environmental flux ca. A.D. 1000-1300. Systems of social organization may have changed at these times, in response to varied labor requirements associated with alternative resources and the subsistence capabilities of different members of the hunting and gathering groups. Explanation of these transitions requires a full-scale ecological perspective in which human interaction with the environment is not limited to simple adaptation and includes the possibility of natural resource shortages, human overexploitation, and demographic imbalances wrought by both human economic proclivities and unfavorable environmental circumstances.

Ecological archaeology has recently come under attack by post-modernists (e.g., Arnold et al. 1997; Brumfiel 1992; Bender 1985) who envision diachronic cultural patterns as reflections of highly individualistic histories of power, social conflict, elite conspiracies, and gender inequities, minimally influenced by environmental context. These authors make little distinction between ecology and adaptation, but their criticisms are more suitably directed at the latter. Models of hunter-gatherer adaptation often envision only limited relationships between humans and their environment, emphasizing simple cultural adjustments and relative demographic balance. Conceptualizations of this type emerged in California in the 1960s and 70s, incorporating long-held historical perceptions of the California natural environment as rich and stable, and California Indians as generally in sync with their natural surroundings. This image was initially forged by A. L. Kroeber, who hypothesized a complacent environmental past largely in the absence of substantial paleoenvironmental information:

> ...the food resources of California were bountiful in their variety rather than in their overwhelming abundance...If one supply failed, there were hundreds of others to fall back upon. If a drought withered the corn shoots, if the buffalo unaccountably shifted, or if the salmon failed to run, the very existence of peoples in other regions was shaken to its foundations. But the manifold

> distribution of available foods in California and the working out of corresponding means of reclaiming them prevented a failure of the acorn crop from producing similar effects. It might produce short rations and racking hunger, but scarcely starvation. (Kroeber 1925:524)

In 1976, in a series of papers edited by Lowell John Bean and Thomas Blackburn, entitled "Native Californians: A Theoretical Retrospective," the richness of the California natural environment was wed to Native resource management strategies and conservation. Most of the views expressed in this volume emphasized the ecological sophistication of hunting and gathering adaptations in Native California. The most strident of these was posed by Bean and Lawton who argued that California Indians were not really hunter-gatherers at all, but rather "semi-agriculturalists," who enhanced the natural productivity of their environment with such skill (largely through the application of controlled burning [see Lewis 1973]) and sophistication that they had achieved a hunting and gathering equivalent of agriculture. California Indians were envisioned as managers of a rich, stable environment, that they manipulated only in ways that benefited both themselves and natural ecosystems.

Supplanting these neo-functionalist perspectives are more recent Neo-Darwinian theories which rely on concepts of optimal foraging and economic intensification --linked with population growth -- to explain diachronic variability in settlement and subsistence often without reference to environmental change. Intensification concepts have provided good explanations for diachronic variability in subsistence among hunter-gatherers in the North Coast Range (Basgall 1987; Bouey 1987), the Mojave Desert (Basgall and Hall 1992), and the coasts of California and Oregon (Beaton 1991; Broughton 1994, 1999; Hildebrandt and Jones 1992). Despite this success, these models also consider only limited directions for change in the prehistoric past, as the apices of subsistence intensity, social complexity, and exchange are usually seen as occurring immediately prior to historic contact.

The wholesale rejection of environment as an agent of change in optimal foraging and intensification models is bound ultimately to lead to unsuccessful, inaccurate characterizations of the past. Environmental change was probably not the primary cause underlying most cultural transitions in western North America, but some types of environmental events provoke changes that simply cannot be ignored. Especially critical were those that might have impacted the quality and abundance of basic subsistence resources. Most obvious are high intensity, rapidly transpiring environmental oscillations associated with natural disasters (e.g., floods, hurricanes, earthquakes, or tornadoes) and short-term ecological catastrophes (see Oliver-Smith 1996). Such events are sometimes invisible in the archaeological record, particularly in the distant past, but intervals of sustained and/or repeated ecological/demographic problems are potentially detectable.

Many extant treatments of California prehistory deal with environment, population growth, and culture change in one of these limited ways. Models emphasizing population growth and/or cultural evolution posit unilinear or incremental explanations. Simple optimization and intensification, while positing different causal mechanisms, often resemble the unilinear configurations of cultural evolution (Fredrickson 1994:100). Cultural ecological models posit more varied trajectories in response to the vagaries of environmental fluctuation. These are countered by suggestions that human influence over their environment (i.e., overexploitation) may have been more significant than the affects of climate. Models positing prehistoric resource overexploitation are, in turn, opposed by those in which prehistoric resource stewardship and conservation are emphasized.

In this study, four alternative explanations for regional diachronic variability in diet, mobility, and exchange are considered. Evaluation of the relative effectiveness of different perspectives is based on their explanation of transitions at 3500 B.C. and A.D. 1300, since the value of a particular theory is readily exposed in its treatment of the direction and character of cultural change. Extant theories used elsewhere in California, discussed below, include the gradualist/cultural evolutionary model, a sea temperature/cultural ecology model, resource stewardship, and simple intensification. Ultimately it will be argued that none of these constructs alone provide fully effective explanations for the Big Sur coast, largely because the archaeological record reveals a sequence of multi-directional change. Much of the diachronic variability can be directly attributed to intensification and transcendence of environmental change, but rapidly transpiring environmental problems ca. A.D. 1000-1300 had a marked affect on population and culture. The high intensity climate change at this juncture may have been a significant cause of cultural shifts, reflecting the distinction between low intensity/long duration environmental change and rapidly transpiring environmental degradation. Hunter-gatherers are capable of wea-

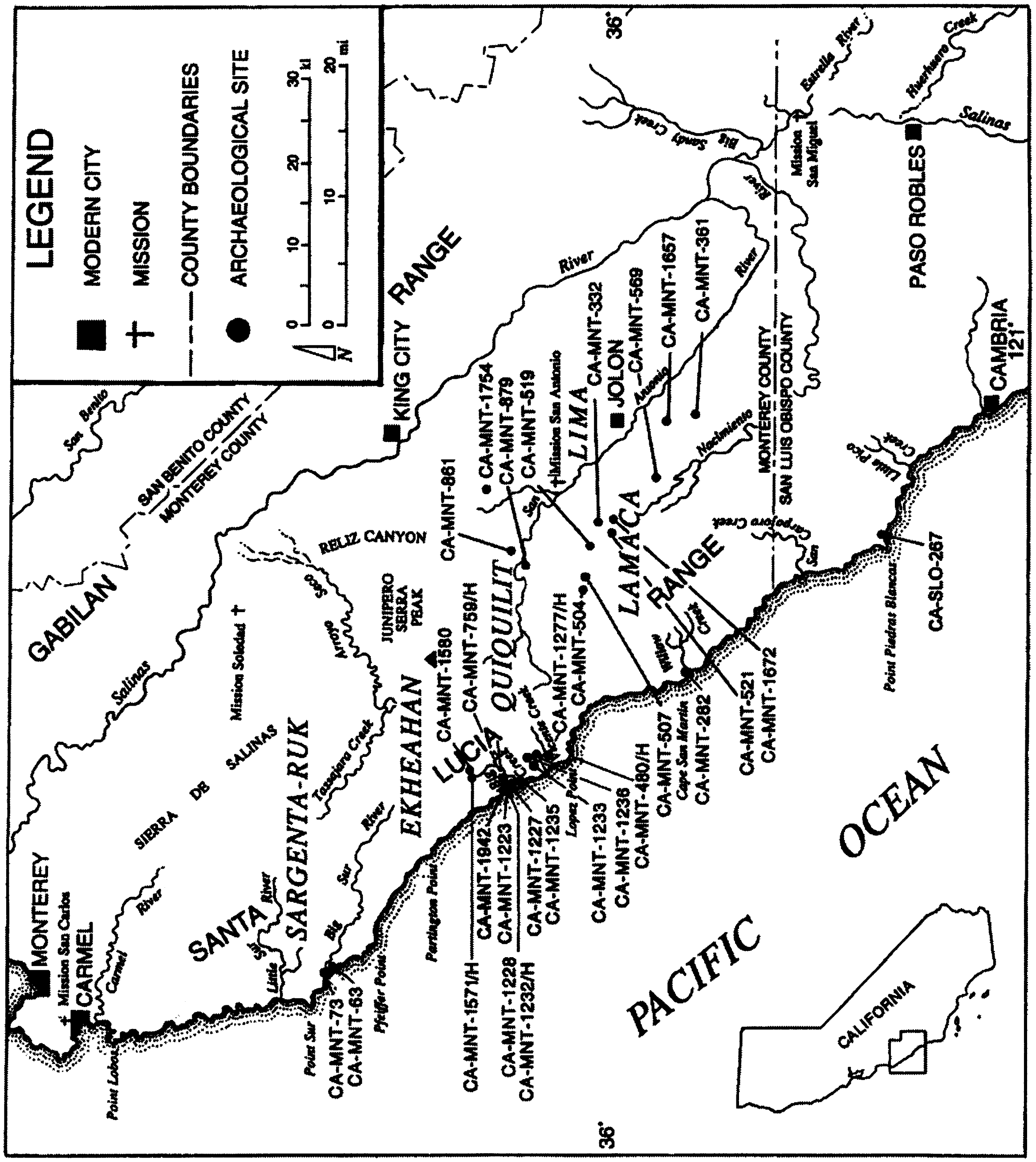


Figure 1 Study Sites and approximate Locations of Ethnographic Tribelets of the Big Sur Coast

thering low intensity/long duration environmental flux, but growing populations are susceptible to rapid environmental oscillation. Effective explanations must account for behavioral trends that are not simply unidirectional or gradualist, and consider environmental change of varied intensity, population growth, demographic imbalance, human impact on subsistence resources, and social organization.

GRADUALISM AND CULTURAL EVOLUTION

Many maritime prehistories, particularly those concerned with population growth, can be classified as gradualist or unidirectional. As populations gradually increased, cultures slowly evolved, adapted, and changed. Although the era of its theoretical domination has long passed, cultural evolutionary concepts contribute to many models of prehistoric marine resource exploitation in California. The key attribute of cultural evolutionary sequences is their inevitable postulation of transitions from simple to more complex and from worse to better, generally as a consequence of the discovery of new, improved technologies. Chartkoff and Chartkoff (1984:40), for example, suggest that Paleoindians in California "lacked the knowledge" to exploit shellfish, acorns, and fish, further stating that only "much later would the rich potential of ocean resources be realized more fully" (Chartkoff and Chartkoff 1984:108). Fitch (1972:115) attributes an increase in fish remains during the Middle Period at Diablo Canyon on the San Luis Obispo coast to the discovery of shell fishhooks. Fredrickson (1974, 1994) endorsed a cultural evolutionary framework for the northern California coast, in which a highly mobile Paleoindian economy gradually progresses to semi-sedentism during his Lower Archaic Period (6000-3000 B.C.), and later to full sedentism. Fredrickson (1974:49) was also explicit in positing a unilineal progression in inter-regional exchange: from *ad hoc* during the Paleoindian Period, to systems in which goods were "moving farther and farther" immediately prior to historic contact. Chartkoff (1989:167) hypothesizes a similarly linear progression of increasingly regularized inter-regional trade that reached its zenith immediately prior to historic contact. The archaeological expectations from these theories are relatively straight-forward: Exotic materials should become more abundant in sites over time, Late Period economies should be sedentary, and expressions of socio-political complexity should increase through regional sequences. Changes of varied direction (e.g., a decrease in exchange through time) are not readily accommodated within this theoretical framework.

SEA TEMPERATURES AND CULTURAL ECOLOGY

Changing sea temperatures have been emphasized in a series of publications by archaeologists from the University of California, Santa Barbara (Glassow 1992; Glassow et al. 1988; Davenport et al. 1993; Walker and Lambert 1989). Proponents suggest that Holocene changes in ocean water temperatures strongly influenced marine productivity, subsistence vitality, and cultural change among maritime hunter-gatherers in California. Glassow et al. (1988), for example, suggest that seal and sea lion pursuit was strongly encouraged, if not initiated in the Santa Barbara Channel by a decline in water temperatures ca. 3400 B.C., as nearshore productivity was enhanced by colder ocean waters which encouraged an increase in sea mammals, rendering them more available to human populations. Concurrent adoption of the mortar and pestle, a possible reflection of acorn use, was attributed to a loss of habitat for seed-bearing plants, associated with the earlier milling technology, as a consequence of early Holocene sea level rise. In contrast, an apparent deterioration of environmental conditions ca. A.D. 500, coincident with a rise in sea water temperatures (Pisias 1978) caused resource stress (Walker et al. 1989) and in-migration of southern ichthyofauna (Davenport et al. 1993). When considered separately, the Glassow et al. (1988) explanation for mid-Holocene cultural change and the Walker and Lambert (1989) characterization of the Middle/Late transition are reasonable and relatively consistent with the empirical record; when considered together, they are somewhat deterministic in their portrayal of human/environment relationships, as human population trends are inversely correlated with sea temperatures. Arnold (1992a; 1992b) and Colten (1993) focused on an apparent 100-year period of particularly high water temperatures ca. A.D. 1150-1250 which they claim was a time of serious deterioration of marine habitats, inspiring the rise of complex social organization and craft specialization.

Akin to other theoretical constructs in which large-scale climatic change is seen as a prime mover in the development of prehistoric subsistence strategies and culture (e.g., Baumhoff and Heizer 1965; Moratto et al. 1978), sea temperature models have clear, time-specific implications for the coastal archaeological record: cultural changes should parallel the sea temperature record, exploitation of marine mammals should increase ca. 3400 B.C. when seas off California apparently got colder, while signs of cultural stress should begin to appear ca. A.D. 300, when seas began to warm (Pisias 1978).

RESOURCE STEWARDSHIP

At the time of historic contact, the California natural environment was universally described as rich, verdant, and filled with food (Margolin 1989; Priestley 1972). There is a growing consensus that this luxuriant landscape was the end-product of a long history of sophisticated resource stewardship by Native peoples (Blackburn and Anderson 1993), echoing common opinions about hunter-gatherer societies in general (Hunn and Williams 1982:1). Indeed, there can be little question that California Indians effectively manipulated their environment, particularly with fire, to enhance its productivity (Lewis 1973). Blackburn and Anderson (1993) argued that the California environment at the time of historic contact was best considered a cultural landscape enhanced by thousands of years of human intervention. The productivity of many biological habitats can be improved by low level exploitation (Hockey and Bosman 1986), but the prehistoric human condition in Native California may not always have been one in which resource exploitation was restricted to low level disturbance. Environmentally or culturally-induced resource stress could place optimal collection and resource management at odds, and in such situations, management would become a secondary priority to basic survival.

SIMPLE OPTIMIZATION

Optimization concepts have been used effectively in coastal settings (e.g., Perlman 1980; Glassow and Wilcoxon 1988; Erlandson 1991) to characterize one element in the subsistence ecology equation. Human foragers can maximize reproductive success through efficient acquisition of food, meeting dietary requirements and providing ample time for other fitness-enhancing pursuits. In its simplest form, optimization looks very similar to cultural evolution (Fredrickson 1994:100): as populations grow, diets simply broaden over time in a linear fashion. Efficient subsistence can have consequences, however, which foster constraints on optimization, so that diets do not simply broaden through the course of a region's prehistory. Commonly, a shift toward sub-optimal subsistence is characterized in terms of economic intensification (Price and Brown 1985), in which more labor-intensive foods are exploited more heavily (Basgall 1987; Bouey 1987). In much of California, increasing evidence of acorn use over time is attributed to this process (Basgall 1987). Intensified, often sedentary, hunter-gatherer economies are generally correlated with high population density, and population growth is commonly linked to increasing reliance on high-cost foods over time. Effective as these concepts are, they do not deal well, or tend to ignore, diachronic variability that is not gradual and linear. Furthermore, many intensification models, even the most elegant (e.g., Basgall 1987; Bouey 1987), do not incorporate diachronic environmental variability into their explanations for cultural change.

Intimately related to economic intensification, are debates over sedentism, which have a long history along the California coast. Based on the presence of deep deposits, from which long, continuous occupations were inferred, Wallace (1955) argued that sedentism was achieved in the early Holocene by Millingstone peoples. Owen (1964), in turn, suggested these same people were highly mobile, similar to many contemporary hunters and gatherers. Most recently Binford's (1980) forager/collector scheme has been the subject of ongoing, sometimes contentious debate (see D. Jones 1992) concerning varying levels of coastal mobility. Recent portraits of California mobility share a general, but poorly substantiated, consensus that high residential mobility preceded logistical mobility, albeit with marked disagreement on the chronology of the transition from one to the other. Koerper et al. (1991) and Glassow (1990, 1991, 1995) argue that Millingstone peoples were largely sedentary, based, according to Koerper et al., on the use of bone awls and presumed manufacture of storage-related basketry, and according to Glassow, on a reliance upon stored seeds. In the Monterey Bay area, logistical mobility is argued to have replaced residential mobility ca. 500 B.C. (Breschini and Haversat 1980; Dietz and Jackson 1981; Moratto 1984), or A.D. 1000 (Dietz et al. 1988). On the northern coast, a similarly late date is posited (Hildebrant 1984). In many instances, particularly along the central California coast, this putative transition conflicts with historic accounts which clearly suggest residential mobility at the time of historic contact. Stored commodities (e.g., acorns and dried fish) were relied upon, but group movements were also undertaken. Binford (1980) originally based the distinction between foragers and collectors on environment; collecting was pursued in seasonally heterogeneous northern environments, while foraging was a product of resource homogeneity in lower latitudes. His model never proposed any clear prediction as to how such strategies should progress over time in intermediate latitudes where the central California coast is situated. Binford's model provides a highly useful settlement typology, but over-reliance on the construct has probably fostered some misinterpretations of mobility. Certainly, there remains a need to investigate mobility more carefully making full use of the ethnohistoric record.

TOWARD A PREHISTORIC HUMAN ECOLOGY

While optimal foraging and economic intensification are useful for explaining many progressions in diet and mobility among California hunter-gatherers, to explain the multi-directional sequence apparent in Big Sur and to avoid the pitfalls associated with some conceptualizations (e.g., environmental determinism or assumed cultural progression), it is important to consider intensification within a framework of human ecology. This framework would also take into account long-term and short-term environmental variability and its influence on resource distribution and quality, population dynamics (including the possibilities of both growth and decline), and the influence of human activities on natural systems, particularly impacts from resource overexploitation. Human social organization also needs to be considered as a mediating factor influencing the procurement and distribution of resources.

Certainly any realistic human prehistory must also recognize historical and cultural contingencies including such processes as migration, diffusion, population replacements, and the accomplishments of individuals aspiring to obtain and manipulate power. During the era of chronological archaeology, most of these processes were relied upon heavily if not exclusively by cultural historians to explain culture change. The New Archaeology of the 60s, in seeking to counter the earlier paradigm and develop new explanatory frameworks, abandoned many of these principles in favor of "in situ" adaptation. In California, models of in-place adaptation are complicated, if not doomed to fail, by a linguistic map that can only be explained as at least a partial result of migrations, population movements, and replacements (see Kroeber 1925, 1955a). There is simply no other reasonable explanation for the existence of many highly distinctive language groups in such close proximity. While early linguistic models posited overly simplistic relationships between language groups and archaeological phenomena (e.g., Kroeber 1955a; Baumhoff and Olmsted 1963), more recent studies have considered these relationships more seriously (e.g., True 1966), resulting in a variety of attempts to integrate adaptive adjustment with historical contingency (e.g., Basgall 1982, 1987; Bettinger and Baumhoff 1982; Moratto 1984; Warren 1964; Whistler 1988). In one instance, Hughes (1992) criticized attempts at correlating linguistic and archaeological classes, suggesting that the effort might be all but hopeless due to the infinitely complex relationships between language and material culture. Such criticisms notwithstanding, any ecological conceptualization of a regional prehistory must consider historical contingencies--both those wrought by cultural processes of migration and diffusion, and those imposed by localized and/or temporally abrupt environmental changes.

Population Dynamics and Stress

While population growth seems to provide a good explanation for gradual increases in diet breadth, growth cannot explain culture change all by itself (Cowgill 1975), particularly major cultural transitions. Intervals of significant change can be strongly influenced by population variables, however. Incremental population growth occurred when human movements and activities began to be influenced by the presence of groups in adjoining areas. In North America, an historical threshold of population circumscription (Price and Brown 1985) would have logically manifested itself following initial colonization. With access to some resources blocked, groups would have been forced to focus their subsistence efforts inward, decreasing diet breadth. A marked subsistence shift along the Big Sur coast ca. 3500 B.C. seems to reflect a threshold of population circumscription. Elsewhere (Jones 1991) I've argued that initial settlement of California was probably characterized by high mobility, as frequent movements were undertaken to insure continuing high resource yields. As an inevitable outcome of efficient foraging, population growth could initially be accommodated through annexation of previously-bypassed, lower-ranked resource habitats, like those of Big Sur. Frequent movement within an expanded range of habitats would continue to fuel population increase, and ultimately, a shift to more labor-intensive lifeways ca. 3500 B.C.

Population increase can also contribute to precarious demographic situations, which place human populations at risk from natural downturns in resource productivity. Shnirelman (1992:28) suggests that hunter-gatherers could experience crises as a result of environmental changes, shifts in population size density or structure, technological inadequacies, or a combination of these factors, and describes many ethnographic and historic accounts of hunter-gatherer crises. Among historic hunter-gatherers living adjacent to agriculturalists or pastoralists, crises often spawned shifts in subsistence. Some !Kung San, for example, engaged in farming during periods of abundant precipitation, but mostly foraged during drought years (Shnirelman (1992:34). In aboriginal economies unexposed to agriculture, economic orientation did not change in the face of periodic resource shortfalls, but death rates sharply increased (Shnirelman 1992:30).

Shnirelman (1992:34) cautions that hunter-gatherers can shift to food production in the face of demographic pressure only where conditions allow farming and when the ecological transition is gradual enough to provide people enough time to transform their subsistence practices and value systems. Without these factors, a demographic crisis could result in disintegration of the economy, inter-regional aggression, violence, and extinction of some groups.

Testart (1988) made a strong case that storage-dependent hunter-gatherers, like those of the central California coast, were more at risk from long-term shortfalls than were non-storing foragers. While storage is a mechanism for countering seasonal shortfalls, storage-reliant hunter-gatherers are inevitably dependent on a few important staples because commonly there is only a limited number of species that occur in large quantities and are amenable to storage. Failure of one of these species (e.g., a failed salmon run or poor acorn crop) could cause significant problems (Testart 1988:173). In intensive economies, storage was a necessity that did not necessarily provide insurance against shortfalls of more than a few seasons. As a consequence, Testart (1988:173) suggested that the level of susceptibility of storage-reliant hunter-gatherers to food shortages and catastrophic famine was probably comparable to that of agriculturalists. It is worth mentioning as well, Cohen's (1977) likening of the demographic stresses that precipitated the advent/acceptance of agriculture by hunter-gatherers to a crisis-like situation caused strictly by human population growth. If such stresses underlay agricultural and intensive hunting and gathering economies in western North America under complacent environmental circumstances, rapid environmental deterioration would have the potential to cause even more serious problems.

Long-term and Short-term Environmental Variability

While high-intensity/short duration environmental flux could combine with growing populations to cause significant demographic problems, much of the climatic change of the Holocene was long in duration and low intensity so that it would not have demanded immediate or strenuous response from resident hunter-gatherers and would be unlikely to promote rapid cultural change. The early-middle Holocene, for example, is commonly associated with climatic amelioration, when warm dry climatic conditions of the era alternatively classified as the Altithermal (Antevs 1948), Xerithermic, or Hypsithermal (Porter and Denton 1967) gave way to a more favorable climate. Along the California coast, where ocean waters mitigate the extremes of climate (Johnson 1977), low intensity/broad scale environmental change, be it atmospheric or marine, generally cannot be assumed severe enough to promote major cultural shifts by itself. Attempts to argue such a relationship underestimate human ability to transcend low intensity climatic variability through technological innovation or the implementation of back-up strategies (cf. Flannery 1972; Kelly 1983). The remarkable biotic diversity of the Big Sur coast, in particular, provides a hedge against serious resource stress in the face of low intensity/long duration climatic change.

Environmental variability cannot be totally dismissed in explaining changes in mobility and diet, however. Many of the Holocene climatic changes were of such low intensity and long duration, that they provided sufficient opportunity for technological adjustment. Rapid and severe environmental deterioration, on the other hand, demands immediate response. Arnold (1991, 1992a, 1992b) and Stine (1994) have directed the attention of the California archaeological community to a period of high intensity/brief duration environmental oscillation dating ca. A.D. 800-1350. Referred to by climatologists as the Secondary Climatic Optimum, Little Optimum (Sulman 1982), or the Medieval Warm Epoch (Ingram et al. 1981), this interval is associated with extreme drought and warm temperatures in many parts of the world (Stine 1994), although precise dating varies from region to region, (Ingram et al. 1981:16). In California this phenomenon was recently identified in tree rings in the Sierra Nevada, dating ca. A.D. 1100 to 1375 (Graumlich 1993), and lowered water levels in Mono Lake, east of the central Sierra (Stine 1994). It is represented in the White Mountains tree ring sequence as well (LaMarche 1974), and has been linked to harvest failures, famine, disease, and depopulation in Europe (Sulman 1982:6). In contrast with the slow, low intensity climatic change of most of the Holocene, the abrupt, intense fluctuations between A.D. 800 and 1350 may have contributed to significant resource stress among many California hunter-gatherers, including those of the Big Sur coast.

Intensification and Resource Overexploitation

One anticipated consequence of population circumscription and economic intensification would be resource overexploitation. The possibility that Native inhabitants of prehistoric California in some instances overexploited their environment was suggested as early as 1916 by Gifford, who argued that the impacts of human collection were responsible for changes in molluscan fauna in San Francisco Bay shell mounds. That explanation was subsequently dismissed, as changes in San Francisco Bay shellfish assemblages were subsequently recognized as reflections of the Bay's paleoenvironmental history (Bickel 1978). Due to the prevalence of the neo-functionalist environmental paradigm in California in the 1960s and 70s, overexploitation was not raised again as a possible influence on prehistoric California fauna until 1980 when Botkin suggested that diminution in shells over time in a south coast shell midden was the result of overly intensive harvest. Botkin, however, did not further explore the causes or consequences of human overexploitation nor did he place his finding into chronological or ecological perspective. Salls (1988; 1992) discussed the possibility that fish were heavily overexploited at San Clemente Island, but supported his case with very meager data. Fish were probably the one resource that was most difficult to overexploit in Native California. Raab and Yatsko (1992) have since discussed the likelihood that insular populations were most likely to engage in overexploitation due to a demographic situation that would almost inevitably result in resource stress. The possibility of overexploitation of extinct megafauna has, of course, been championed by Martin (1967) for nearly three decades. Human predation has also been most recently implicated as an influence in the population histories of elk (Kay 1990, 1994) and bison (Truett 1996).

More recently Hildebrandt and Jones (1992) and Jones and Hildebrandt (1995) argued that exploitation of California marine mammal populations approximated a prehistoric *tragedy of the commons* in which these animals were overexploited during thousands of years of pursuit by humans. Initially available in large numbers in hypothetical mainland rookeries, these animals were pursued along the entire length of the California and Oregon coasts. Through time, optimal exploitation of the easily accessible breeding sites caused a decline in populations, a disappearance of mainland rookeries, and an increased reliance on smaller more elusive taxa (e.g., harbor seals and sea otter). Pursuit technology gradually increased in sophistication as human hunters were forced to pursue their prey in less accessible offshore contexts. Marine mammals are susceptible to overexploitation because they are k-strategists, with large body size, long lifespans, small populations, and long reproductive cycles. Optimal foraging theory suggests, however, that these animals should not have been hunted into extinction, as the costs associated with pursuit of dwindling populations become inordinately high (Smith 1983). A species need not be harvested to extinction, however, to be overexploited, but rather can be collected to the point that population renewal is impacted and subsequent harvests are diminished. Shellfish, which are typical r-strategists with small body sizes, short lifespans, and rapid reproductive cycles, are even less likely to be exploited into extinction (Claassen 1986:130), but can indeed suffer from overharvest. Zooarchaeological findings supporting a model of marine mammal overhunting along California shores have subsequently been reported by Burton (2000), Porcasi et al. (2000), and Walker et al. (2000), although Colten and Arnold (1998) argue against such a scenario on Santa Cruz Island. Broughton (1999) presented one of the most comprehensive models of resource intensification and depression based on findings from the Emeryville shellmound in the San Francisco Bay area..

It is not unreasonable to expect that over-exploitation would be a byproduct of circumscription and decreased mobility. Many researchers attribute sedentism to a richness and diversity of coastal resources (Sauer 1962; Perlman 1980). Perlman (1980:292-294), in particular, equates coastal productivity and optimization with sedentism and cultural complexity. Being sedentary, of course, requires a year-round food source, either natural or stored (Binford 1980; Kelly 1992:53). In Native California, at the time of historic contact, populations with a stable year-round food supply engaged in any number of decidedly labor-intensive subsistence activities, including acorn exploitation (Basgall 1987; Bettinger 1991:100), pelagic fishing, and offshore pursuit of marine mammals (Hildebrandt 1981, 1984). Some coastal inhabitants, including those of Big Sur, were only minimally involved in marine resource acquisition. Optimal resource use could only be accomplished in situations where a level of selectivity could be maintained and resource overexploitation avoided. Groups moving regularly among a wide range of territories could maintain such selectivity, but population circumscription would constrain mobility, and encourage exploitation of narrower foraging radii, thereby promoting resource overuse.

Social Organization and Gender

A final variable to be considered in foraging economies is social organization and the manner in which it influences division of labor, particularly along gender lines. Social organization is treated extensively in several intensification sequences in California (e.g., Arnold 1992a; Bouey 1987; L. King 1982; C. King 1990; Martz 1992). In nearly all cases these efforts have concentrated on the rise of so-called complex or non-egalitarian social organization. Most involve the Chumash of the Santa Barbara Channel and attempt to document social stratification and the timing and causes of its emergence from simple egalitarian precursors. These arguments articulate with an increasing interest in complex hunter-gatherer societies, and a growing recognition that inequality is related to mobility and specific ecological conditions (Gould 1982; Kelly 1991). More importantly, for the purposes of this study, it has also been recognized that there is a range of variability among so-called complex hunter-gatherer societies (Kelly 1991:153). Whether or not a class society has actually been documented among the Chumash, Native groups of the Big Sur coast - speakers of Salinan, Costanoan, and Esselen languages - were organized politically into tribelets and socially into patrilineages (Bean 1978:673). There is no reason to assume that these structures existed throughout the prehistoric occupation of this area, and it is important to identify possible signs of their development in the archaeological record. It is also germane to consider the possible influence of these structures on resource access, mobility, and exchange.

Goldschmidt (1948) suggested that lineal descent was associated with high population in California, and Baumhoff (1962:228) demonstrated a correlation between tribes with highly developed unilineal organization and population density. It follows, therefore that lower population densities of the early Holocene may have been associated with non-lineal descent, and that subsequent population events (e.g., mid-Holocene circumscription) may have influenced the development of patrilineal organization. The abrupt cultural changes of the Medieval Climatic Anomaly may also have influenced the socio-political sphere, but in keeping with the premise that this was a period of serious environmental problems, changes in social organization may reflect crisis, as resource competition encouraged solidification of territorial boundaries, and the tribelet system of political organization emerged. Lineal descent reckoning was still practiced, but the wide-ranging structural integrity of the lineage system was disrupted.

Intimately related to concepts of social organization and inequality among hunter-gatherers is variability in gender-based roles, particularly those of women. Kelly (1991:153) and Hayden et al. (1986:157) have observed that male/female relationships are commonly unequal even among societies that are otherwise characterized as non-complex. Certain generalities about the division of labor according to gender have long been recognized among hunter-gatherers. Men are more mobile and more commonly hunt, while women, owing to the constraints imposed by pregnancy and child-rearing, are generally less mobile (Jochim 1988; Zihlman 1981:110) and more frequently gather and process. There are strong differences of opinion as to the chronology of division of labor by gender (see McGrew 1981; Zihlman 1981), but there is some consensus that that it must have emerged as part of the biological evolution of modern humans because it is so pervasive among hunter-gatherers. Certainly it was well established before colonization of the New World. Not surprisingly, California groups conformed with this division at the time of contact (Willoughby 1963; E. Wallace 1978:683). Men, however, are perfectly capable of gathering, and California ethnography describes their participation in the collection of any number of vegetable commodities (McGuire and Hildebrandt 1994). Women are also capable of hunting, and ethnographic accounts describe their pursuit of game of among hunter-gatherers in other parts of the world (Estioko-Griffin and Griffin 1981), but in Native California hunting and fishing were male-dominated activities (E. Wallace 1978:683). What is important is the range of relative participation of men and women in the various tasks associated with subsistence. A typical gender division of labor characterized Native California at contact, but world hunter-gatherer ethnography suggests a potential for variation in the past.

In a review of hunter-gatherer ethnography, Hayden et al. (1986) identified a strong correlation between certain ecological/technological situations and the status of women. Low status appears to be highly correlated with resource stress, participation in warfare, and the importance of hunting in overall subsistence. Such correlations have significant implications for alternative conceptualizations of mobility and diet, particularly those emphasizing population growth, intensification, and resource stress, be it achieved gradually or catastrophically. Intensification is contingent upon the availability of processing labor, which affects foraging decisions and influences a group's ability to behave in an optimal fashion (Bettinger 1991:101). Kelly (1991, 1992:58) has outlined possible gender outcomes of intensification and reduced mobility, suggesting that reliance on a reduced foraging radius encourages the development of social alliances through inter-lineage marriage. In such circumstances women are at risk of being manipulated by men as exchange objects in the establishment of alliances and the concomitant need for increased processing labor, akin to the manner in which Service (1962) portrayed the exchange of women in the development of lineal descent systems. Among patrilineal agriculturalists, exchange often takes the form of bridewealth, which represents the net benefit that female labor provides to a group (Bell and Song 1994; Goody and Tambiah 1973). As inter-lineage alliances grow, exchange increases, the need for processing labor increases, the status of women paradoxically decreases as they become objects of manipulation by men (Kelly 1991:146). Women's status among hunter-gathers dependent upon storage is commonly lower than among their non-storing counterparts (Kelly 1991:146).

Women in Native California, operating within systems of lineal descent, were strongly associated with foodstuffs marking intensified subsistence (i.e., acorns and fish) (E. Wallace 1978; Willoughby 1963). If it can be assumed that more optimal circumstances of lower population density and higher mobility preceded intensified subsistence, women's roles and, indeed the division of labor along gender lines, may have been different in the past. Hill et al. (1987) have demonstrated that among contemporary foraging populations, men, by participating in hunting, provide far fewer calories to a group than they could by gathering, as gathering produces mean net caloric yields twice as high as those associated with hunting. Hill et al. suggest that the reason for male hunting is the occasional acquisition of a major bonanza which would reward males with greater sexual access to females. The relative importance of hunting versus gathering, however, and the participation of group members according to gender may be more related to diachronic variation in the availability of prey and the relative importance of labor-intensive resources through time.

European Contact and Colonialism

Complicating any attempt to reconstruct prehistory in central California was the virtual elimination of traditional cultures over 200 years of historic contact and acculturation. European seafarerers, who communicated with some Native Californians as early as 1542, never landed along the rugged and inaccessible Big Sur coast. Spanish explorers finally made their way through the area by foot in 1769, establishing Mission San Antonio de Padua two years later in the interior along the San Antonio River (Figure 1). Under influence of the missionaries and impacted by newly introduced diseases, Native populations declined precipitously and the traditional hunting and gathering lifestyle eventually disappeared. An emphasis on cattle ranching introduced by the Spanish and perpetuated under the regimes of Mexico (1822-1847) and the United States (post-1847), precipitated a conversion of local inhabitants from foragers to small-scale subsistence ranchers, and/or ranch laborers. The global events that placed California under control of this succession of large nation states fostered continually changing rules about the control/ownership of land that pushed the remaining Native inhabitants into more remote, undesirable areas (Plate 1) where they eked out somewhat precarious livings. When the first serious attempt at anthropological ethnography was undertaken early in the 20th century (e.g., Mason 1912, 1918; Harrington 1942), Native inhabitants were residing in small scattered adobe dwellings (Plate 2), subsisting largely on a combination of ranching, farming, and sale of their labor. Salinan-speaking peoples, who were the group that occupied most of the Big Sur coast, were concentrated in settlements at the head of the San Antonio River, among other places. These people spoke Spanish, English, and Salinan, and their familiarity with and apparent use of hundreds of Native plants and animals indicate they were still pursuing some gathering and hunting, albeit with new technology and as an apparent supplement to the other forms of subsistence. Despite this remarkable continuity, the tremendous changes that accompanied successive rule by Spain, Mexico, and the United States, which included extensive inter-marriage between Salinan and Euro-Americans, renders the ethnohistoric data from the early 20th century of somewhat limited value in attempting to reconstruct pre-contact foraging lifeways. In some instances, pre-contact settlements marked by archaeological sites have been associated with named villages or encampments. Such cases provide an opportunity for archaeological findings to enhance the limited ethnohistoric record, but the gap between pre-contact lifeways and the ethnohistoric record of the 20th century cannot be overlooked.

PREVIOUS RESEARCH

Archaeological research began in the South Coast Ranges in the 1940s when Arnold Pilling from U.C. Berkeley began surveys along the coast of Monterey County. Pilling recorded hundreds of midden deposits including several of the sites investigated for the current project. Seminal excavations were completed soon thereafter at Willow Creek (Pohorecky 1964, 1976) on the coast (CA-MNT-281 and -282) and in the interior at Isabella Meadows Cave (CA-MNT-250) (Meighan 1955). The important but largely descriptive findings from these two investigations stood as the only substantive excavation data from this region until the 1980s. An avocational archaeologist, Don Howard, investigated scores of sites in the 1970s, but the reporting from these investigations varied in completeness and research value. Professional work from the 1960s through the 1980s focused more on reconnaissance and site survey including large projects in the interior by Edwards (1975) and

Plate 1 Overview of former Santa Lucia Peak (today Junipero Serra Peak) and area where Tito Encinales, one of J. P. Harrington's primary Salinan consultants, was living in 1931. (Photograph taken by J. P. Harrington, courtesy of the Santa Barbara Museum of Natural History)

Swernoff (1982) and on the southern Big Sur coast by Baldwin (1971). Swernoff's research also included modest testing at four sites in the interior (CA-MNT-323, -567, -571, and -1130). In the early 1990s Fort Hunter-Liggett stepped up its compliance with section 106 of the National Historic Preservation act, and over 40 sites were investigated between 1990 and 2000, the most important of which are included in the present study. CRM investigations of the last decade or so have also included modest testing projects at CA-MNT-1215 (Breschini et al. 1984), CA-MNT-515, CA-MNT-540, and CA-MNT-862 (Wickstrom and Jackson 1994), CA-MNT-1455 (Cartier 1995), CA-MNT-1592 (Hildebrandt and Jones 1998), CA-MNT-798, -799, and -800 (Edwards et al. 2000). More detailed summaries of the history of research are available in Breschini et al. (1983), Eidsness and Jackson (1994), Jones et al. (1989), and Jones (2000).

THE PRESENT STUDY

The purpose of my study was to define a local cultural sequence, isolate periods of transition, and evaluate the relative effectiveness of alternative theories for explaining cultural changes and their relationship to the environment. My objective was to demonstrate that a broad framework of human ecology, not limited to adaptationism or neo-functional ideals about Native American conservation but that also takes into account population dynamics, overexploitation, and different types and severity of environmental change, can provide a coherent explanation for patterns in the prehistoric past. To accomplish this objective, the ethnohistoric and archaeological records were used to reconstruct systems of diet, settlement, and exchange employed immediately prior to historic contact. The develop-

Plate 2 Maria Jesusa Encinales (right) and Maria de Los Angeles (center), two of Harrington's primary Salinan consultants with another unidentified individual in front of adobe dwelling. (Photograph courtesy of the Smithsonian Institute and the Santa Barbara Museum of Natural History)

mental history of these systems was then traced back in the archaeological record, and periods of significant transition were established. These in turn were placed in context by reviewing available paleoenvironmental information, and conducting some limited original research. Transitions were then evaluated relative to alternative expectations derived from cultural evolution, cultural ecology, resource management, and simple intensification.

In a state marked by environmental diversity, the Big Sur coast, because of its central latitude and range in elevation, exhibits remarkable ecological heterogeneity (see Chapter 2). The diverse resource base presents many scheduling conflicts, and there is no clear seasonal/spatial pattern in resource availability. Environmental conditions preceding those of the present were assessed through a review of paleoenvironmental studies completed in the surrounding area, and a preliminary investigation of paleo-ocean temperatures reflected in oxygen isotope readings obtained from archaeological mussel shells (Appendix I). This sequence covers only the last two millennia, or roughly the latter third of the cultural history. Research completed in adjacent regions includes oceanographic studies from the Santa Barbara Channel, palynological investigations from the Monterey and San Francisco Bay areas, and tree ring and other studies from the Sierra Nevada.

The ethnohistoric review (Chapter 3) includes pertinent secondary and historical sources, emphasizing analyses of mission records (Milliken 1990; Gibson 1983, 1985), early historic accounts, and original research on the recently published field notes of John Peabody Harrington (1985), who conducted fieldwork in the South Coast Ranges during the early part of this century. Accounts written by the first Spanish explorers of central California also provide a seasonal transect across the Santa

Lucia Range in 1769 which suggests that coastal inhabitants at that time congregated in villages, away from the shoreline, during parts of the year, and dispersed into smaller residential camps during others. Harrington's notes and maps identify two villages inhabited by Salinan-speaking peoples and one upland shell midden, associated with hunting. The archaeological record confirms these three sites.

Data from 30 archaeological sites are presented as the main thrust of the project. For the most part, the Big Sur coast was unexplored prior to this study, but limited excavation data from three sites reported previously (Pohorecky 1976; Howard 1973) have been incorporated. Twenty-six of the remaining sites were investigated over a ten-year period between 1986 and 1996 for a variety of research and CRM undertakings. Seventeen of these were coastal sites, situated between Point Sur and Point Piedras Blancas (Figure 1), mostly within Landels-Hill Big Creek Reserve and Andrew Molera State Park. The Piedras Blancas site (CA-SLO-267) at the southern edge of the study area is situated on land held by the California Department of Transportation (Caltrans) and a private owner. It was investigated for Caltrans in 1996. The twelve inland sites are all within the Fort Hunter-Liggett military installation in southern Monterey County and were investigated between 1995 and 2000. Findings from two sites, CA-MNT-1571/H and –1580, are limited to surface observations. Investigations at all other sites included subsurface findings. While this monograph was in preparation, Caltrans conducted a major excavation at CA-MNT-1942 at the mouth of Big Creek on the Big Sur coast. Findings from that investigation (Wolgemuth et al. 2002) have been incorporated into the present study. Detailed descriptions of excavation results from all of the sites are available in technical reports (Table 1), most of which are on file at offices of the California Historical Resources Inventory at Sonoma State University and the University of California, Santa Barbara. Summaries of the technical findings are reported here (Chapter 5).

The investigated sites included shell middens, flaked stone scatters, and bedrock mortar outcrops, ranging in location from the shoreline to 30.5 km inland (Table 1). Most deposits were middens with concentrations of invertebrate remains, flaked stone debitage, mammal and fish bone. Most also yielded human remains, ground stone implements, bone tools, and shell beads, although there was significant variability in the density and relative diversity of constituents. The sites also varied considerably in size and elevation: CA-MNT-569, a multi-component site covered an area of ca. 63,744 m^2, while a midden at CA-MNT-759/H had a surface area of only 250 m^2; CA-MNT-63 and CA-MNT-73 occur at the shoreline, while CA-MNT-1236 was situated at an elevation of 713 m. It was anticipated that the differences in location, size, and constituents reflected temporally discrete systems of settlement and diet that could be isolated with chronological controls achieved through excavation. Field recovery involved a mixed excavation strategy, employing 1 x 2 m units to recover samples of artifacts and mammal remains, and 20 x 20 cm columns to obtain invertebrate and fish remains (Chapter 4). The archaeological investigations undertaken specifically for my study were multi-faceted and were not limited to a single class or type of site constituent. All of the micro- and macro-constituents recovered during excavation were considered relative to questions of diet, site function, and exchange.

This study essentially presents a regional prehistory for a long overlooked and unusual if not dramatic portion of the California coast. It employs a variety of principles to attempt to define the most effective explanations for diachronic patterns in the regional record. During the era of processual archaeology, many studies, regional and otherwise, were constructed to highlight or demonstrate single theoretical principles -- usually those closely related to basic adaptation. Despite the unquestionable importance of such contributions, the intent of the present monograph is to demonstrate that regional prehistories employing only a single ecological or social principle will ultimately achieve only limited success in explaining the past. This is largely due to the fact that human beings are complicated creatures driven by both cultural and biological forces. They also function within highly complex environmental systems. Honest recognition of the failure of individual principles at particular junctures leads to prehistories that are highly particularistic--even when when emphazing human ecology. Perhaps, however, they are more accurate.

Table 1 Characteristics of Study Sites

Trinomial	Name	Elevation (m)	Area (m^2)	Inland (km)	Primary reference
		COASTAL SITES			
CA-MNT-63	Molera	12	2500	0.0	Jones (1994, 1995)
CA-MNT-73	Big Sur River Mouth	3	2700	0.0	Jones (1994, 1995)
CA-MNT-281	Willow Creek II	5	-	0.0	Pohorecky (1976)
CA-MNT-282	Willow Creek I	3	-	0.0	Pohorecky (1976)
CA-MNT-480***	Gamboa/*Ts'alák'ak'a*	595	18,000	1.6	Howard (1973)
CA-MNT-759/H	Arbuez Boronda	350	250	2.4	Jones and Haney (1992) Jones (1995)
CA-MNT-1223	Dolan I	370	1365	0.8	Jones (1995)
CA-MNT-1227	Harlan Spring	305	4135	0.6	Jones and Haney (1992) Jones (1995)
CA-MNT-1228	Redwood Terrace	245	548	1.2	Jones and Haney (1992) Jones (1995)
CA-MNT-1232/H	Interpretive Trail	245	3756	1.1	Jones and Haney (1992) Jones (1995)
CA-MNT-1233	Highland Camp	550	2413	1.6	Jones and Haney (1992) Jones (1995)
CA-MNT-1235	Cliff Hanger	125	452	0.4	Jones and Haney (1992) Jones (1995)
CA-MNT-1236	Shakemaker	713	981	3.3	Jones and Haney (1992) Jones (1995)
CA-MNT-1277/H*	Santos Boronda/*Matalcé*	565	18,870	2.0	Jones and Haney (1992 Jones (1995)
CA-MNT-1571/H**	*Tr'aktén*	866	2300	4.2	Huddleson and Jones (1992)
CA-MNT-1580**	-	872	800	4.3	Huddleson and Jones (1992)
CA-MNT-1942	Big Creek Bridge	1	1500***	0.0	Wolgemuth et al. (2002)
CA-SLO-267	Piedras Blancas	2	37200	0.0	Bouey and Basgall (1991) Jones and Ferneau (2002)
		INLAND SITES			
CA-MNT-332	-	440	8679	21.0	Haney and Jones (1997)
CA-MNT-361	-	374	2120	21.5	Wickstrom (1995), Haney and Jones (1997)
CA-MNT-504	-	459	942	15.0	Haney and Jones (1997)
CA-MNT-507	-	445	5105	22.0	Haney and Jones (1997)
CA-MNT-519	-	387	19550	16.0	Jones (2000)
CA-MNT-521	-	373	30,500	19.0	Jones and Haney (1997a)
CA-MNT-569	-	380	63,774	20.0	Jones and Haney (1997b)
CA-MNT-861	-	376	6048	24.0	Haney and Jones (1997)
CA-MNT-879	-	354	5860	22.0	Haney et al. (2002)
CA-MNT-1657	-	453	2356	22.0	Haney and Jones (1997)
CA-MNT-1672	-	433	4847	20.0	Haney and Jones (1997)
CA-MNT-1754	-	531	5183	30.5	Haney and Jones (1997)

*Midden only; overall site area including historical materials is larger.
** Surface data only
***Approximate

CHAPTER 2: ENVIRONMENTAL CONTEXT

For hunter-gatherers, characteristics of the local environment, particularly the types, distribution and seasonality of available resources are major contributors to the overall human ecology. Dietary practices, settlement patterns, and divisions of labor are at least partially conditioned by the structure of local resource assemblages, and attempts to explain changes through time in these practices and patterns require knowledge of the local environment. The following is a description of features of the Big Sur coast and adjacent interior valleys, both past and present, that would most influence its aboriginal resource potential. This description culminates with reconstruction of paleo sea temperatures for the late Holocene based on a study of oxygen isotope readings obtained from archaeological mussel shells.

CONTEMPORARY SETTING

Coastal Zone

The coastline between Point Sur and Point Piedras Blancas - the area generally known as the Big Sur - is the most rugged stretch of shoreline in California (Plate 3) and one of the most environmentally diverse. Marked by a near absence of coastal terraces, the Santa Lucia Mountains (part of the South Coast Ranges) rise directly and precipitously from the Pacific Ocean. Peaks in excess of 1500 m (5000 ft) occur within less than 5 km (3 miles) from the shoreline, creating one of the steepest coastal gradients in the continental United States (Henson and Usner 1993:12). This steep coastal flank encompasses a varied topography that promotes a wide array of micro-habitats. Seven distinct plant communities have been identified in Big Sur, each with a variety of subtypes (Henson and Usner 1993:85-230). These range from cool, moist redwood forest, commonly found in drainages influenced by coastal fog, to steep, dry, rocky slopes supporting various types of chaparral.

Also contributing to the lack of homogeneity in the Big Sur landscape is latitude. Big Sur is located midway between northern mesic environs, and more xeric southern environments. Both flora (Bickford and Rich 1984:7) and intertidal fauna (Ferguson 1984:5) reflect this mid-latitude position; topographic and microhabitat diversity result in a strange co-existence of both northern species and southern species found nowhere else. Big Sur also retains a number of endemic taxa, so that the composite environment, a mix of northern, southern, and endemic species, exhibits astounding taxonomic diversity that has attracted the attention of botanists since the nineteenth century (Henson and Usner 1993:85).

The geology of Big Sur is dominated by deep sea sedimentary rocks of the Franciscan Formation along with intrusive and metamorphic rocks of the Coast Ridge Belt. The Franciscan assemblage underlies most of the coastal topography at the mouths of the Big Sur River and Big Creek. A small outcrop of the Monterey Formation occurs at Point Piedras Blancas, providing an important source of siliceous stone. Metamorphic rocks also occur 4-5 km inland at Big Creek and the Big Sur River.

The Mediterranean climate of the Big Sur coast brings cool, wet winters and warm dry summers with frequent fog. Average temperatures are 12.8°C (55°F), although inland areas experience a more extreme temperature range. The moderating influence of fog is not felt above ca. 610 m (2000 ft);

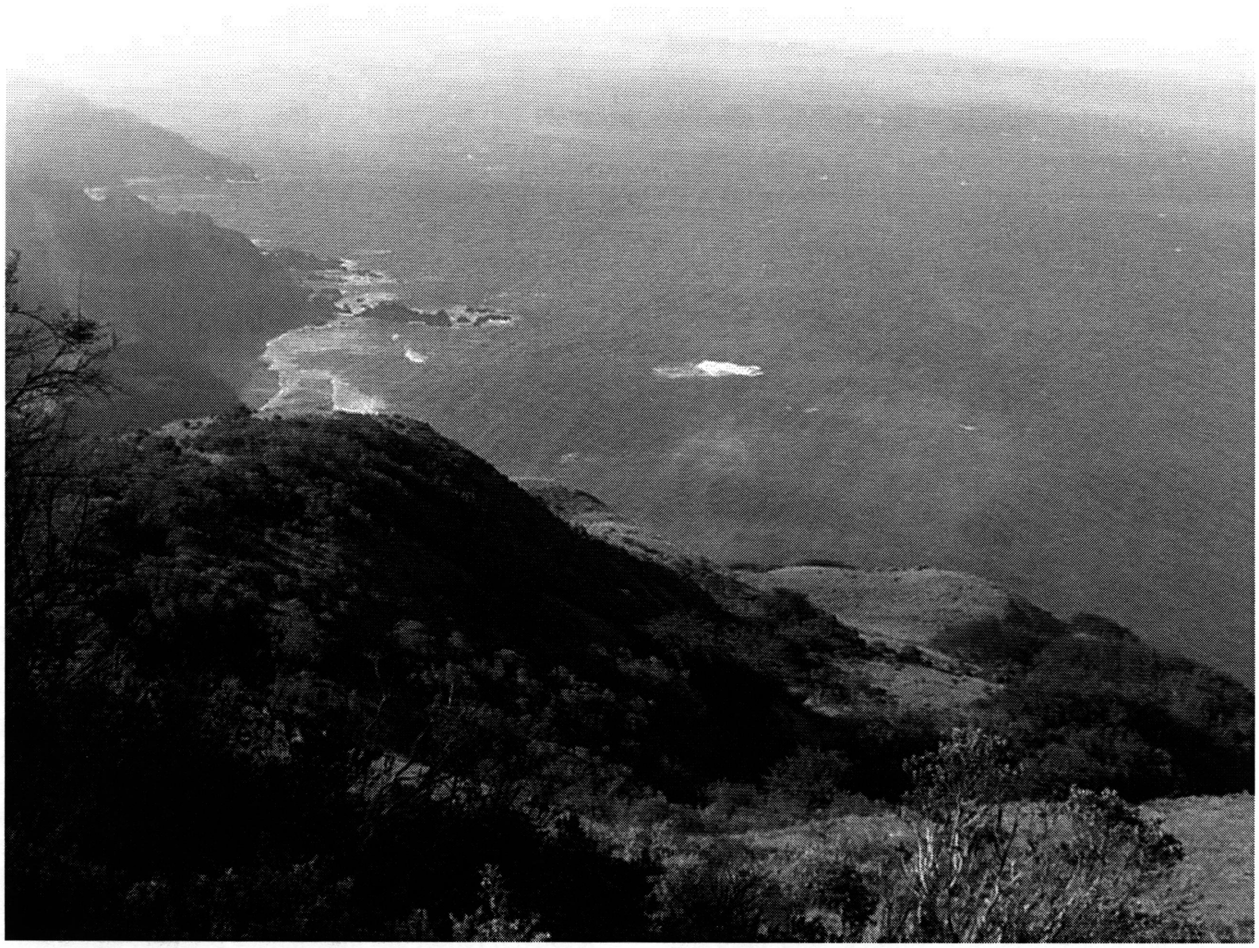


Plate 3 Big Sur coastline near Big Creek looking south (Photograph by John Smiley)

the higher elevations regularly receive snow in the winter and reach temperatures above 32°C (90°F) in summer (Engles 1984). Overall, Big Sur lands are characterized by a highly variable climate; temperature, humidity, precipitation, and fog cover change dramatically according to elevation and exposure.

The coastal flank of the Santa Lucia Range is bisected by a series of small, steep creeks and rivers, that drain directly into the Pacific Ocean. Among the largest of these are the Big Sur River and Big Creek, along which most of the archaeological sites investigated for this study are situated. The Big Sur River and Big Creek have enough year-round flow to support small steelhead (*Oncorhynchus mykiss*) fisheries.

The vegetation pattern on the coast is a dense mosaic in which virtually all of the plant communities that occur within the greater province of central California, including coniferous species more common in the interior ranges, are found. With respect to resource potential, the most significant associations are those of grassland, oak woodland, chaparral, and mixed evergreen forest, which generally occupy the uplands beyond the influence of summer fog. Dense stands of resource-poor chamise chaparral occur on the dry slopes of the highest reaches of the Santa Lucias (Henson and Usner 1993:118).

Coastal sites investigated for this study, indeed most sites on the Sur coast, cluster in three different environmental zones. Shoreline sites are common, particularly on small terraces at the mouths of major drainages. Associated with coastal scrub, this setting is represented by sites at the mouth of the Big Sur River, CA-MNT-63 and CA-MNT-73, as well as CA-SLO-267 at Piedras Blancas. Sites are also common at moderate elevations (250-600 m) on ridge tops and small benches near stands of grassland/oak woodland (Plate 4), particularly in the Big Creek area. Less abundant are sites in the rugged upland of the Santa Lucias, over 2 km inland, at elevations in excess of 600 m. These occur near pockets of grassland,

Plate 4 Looking north from Solstice Peak on the central Big Sur coast showing the coastal vegetative mosaic of oak woodland, grassland, and scrub (Photograph by John Smiley)

chaparral, mixed evergreen forest, and the upper limit of the redwoods.

Terrestrial mammals that frequent these habitats include black-tailed deer (*Odocoileus hemionus*), bobcat (*Lynx rufus*), coyote (*Canis latrans*), gray fox (*Urocyon cinereoargenteus*), cottontail rabbit (*Sylvilagus auduboni*), and mountain lion (*Felis concolor*). Pronghorn antelope (*Antilocapra americana*) were frequently observed by Spanish explorers in the interior valleys. Tule elk (*Cervus elaphus*) were present in the interior as well but did not frequent the rugged coastal zone. Of the terrestrial taxa, deer were probably the most significant. California coastal deer do not engage in major seasonal migrations but reside most of their lives in the same small territory (Taber and Dasmann 1958).

The coastal zone typifies exposed, high energy outer coasts of California. Much of the shoreline is marked by steep cliffs flanked by isolated narrow beaches. Potential resources occurring in the littoral zone and offshore waters include: shellfish, fish, sea mammals, and marine algae (kelp). Shellfish in the mid- to high littoral zone include mussel (*Mytilus californianus*), barnacle (*Balanus* spp.), limpet (*Collisella* spp.), and one species of chiton (*Nuttalina californica*). Taxa most commonly encountered in the mid - low intertidal zone include three other species of chiton (*Ischnochiton regularis, Mopalia* spp., and *Cryptochiton stelleri*), black abalone (*Haliotis cracherodii*), and black turban snail (*Tegula funebralis*). The red abalone (*Haliotis rufescens*) are found exclusively in the low intertidal zone (Ferguson 1984:58). Other common intertidal invertebrates, not generally restricted to a particular zone, are the sea anemone (*Anthopleura xanthogrammica*), sea urchin (*Strongylocentrotus purpuratus*), and purple olive (*Olivella biplicata*) (Ferguson 1984).

Marine fish include those common to the open rocky coast of central California, particularly rockfish that frequent near-shore kelp forests. Most abundant are cabezon (*Scorpaenichthys marmoratus*), surf perch (Embiotocid), rockfish (*Sebastes* spp.), and lingcod (*Ophiodon elongatus*). Smaller taxa include the northern anchovy (*Engraulis mordax*), herring, and sardines (Clupeidae).

Marine mammals include year-round residents, the sea otter (*Enhydra lutris*) and harbor seal (*Phoca vitulina*), and seasonal migrants including the California sea lion (*Zalophus californianus*), Stellar sea lion (*Eumetopias jubatus*), northern fur seal (*Callorhinus ursinus*), and southern fur seal (*Arctocephalus townsendi*). In the 1990s, elephant seals (*Mirounga angustirostris*) established major mainland rookeries near Gorda and at Point Piedras Blancas.

Inland Valleys

The inland investigations were undertaken at sites within Fort Hunter Liggett, a 164,762-acre military facility in southern Monterey County on the eastern flank of the Santa Lucia Range. Located midway between the Pacific Ocean and the Salinas Valley, the facility encompasses two major drainages --the Nacimiento and San Antonio rivers— that parallel one another, and flow north to south into the Salinas River. Both are associated with expansive inland valleys. Heavily dissected rolling hills separate the two valleys. Within this intervening area are smaller tributaries of the Nacimiento River.

Elevations are highest along the western installation boundary, which follows the main ridge system of the Santa Lucia Range and rises to a maximum of 1150 m (3744 ft.) at Alder Peak. Drainages west of this crest flow directly into the Pacific Ocean. Elevations in the valley floors range from 240 m (ca. 800 ft.) along the lower San Antonio River to roughly 370 m (ca. 1200 ft.) in Milpitas. A wide variety of soil types reflect the diversity of the installation's topography, although loamy types are most common. Soils in the installation were described and mapped in 1978 (Soil Conservation Service 1978).

The inland study area is underlain by a variety of geologic formations derived from marine sediments and volcanic intrusives dating from the Pre-Cretaceous to the Plio-Pleistocene. Of particular relevance are the marine sediment-derived sandstone outcrops which occur primarily in the Nacimiento River drainage. These sandstone outcrops were particularly attractive to prehistoric people, as locations for bedrock mortars and for rock art, and as habitation areas which offered some protection from the elements. Also of importance is the locally available Monterey chert, used for manufacture of flaked stone tools.

The climate is typical Mediterranean with cool, wet winters and warm dry summers. Because it is cut off from the tempering effects of the Pacific Ocean by the Santa Lucia Range, the installation experiences greater extremes in temperature and precipitation than does the coast. Daytime temperatures in the summer commonly rise above 100°F and often drop below 32°F in the winter. Records kept between 1960 and 1997 show that lowest temperatures occur in December and highest in July. The range during this period was between 7 and 115 degrees. Mean annual temperature is 58.2°F . Mean rainfall is 19.22 inches (48.8 cm), with a recorded maximum of 36.76 inches ((93.3 cm) and a minimum of 7.15 inches (18.2 cm). The higher elevations regularly receive snow in the winter. Overall, the inland valleys are characterized by a highly variable climate in which temperature, humidity, and precipitation change dramatically according to elevation and exposure.

The inland biota is nearly as diverse as that of the coast. Eighteen distinct plant communities have been described and mapped within Fort Hunter Liggett (Osborne 1997), including some modern communities (e.g., ponds), and others with very limited (albeit important) distributions (e.g., wet meadows, vernal swales). The immediate banks of the Nacimiento and San Antonio rivers are associated with riparian communities (sycamore riparian, mixed riparian, willow riparian, valley oak riparian, and cottonwood willow riparian). The flatter, lowest portions of the valleys are associated with grassland and two savanna communities: valley oak savanna and blue oak savanna (Plate 5). The grasslands today are dominated by non-native annuals such as soft-chess brome (*Bromus hordaceous*), wild oat (*Avena* spp.), and wild barley (*Hordeum murinum*). Native bunch grasses such as *Nasella* spp. and *Melica imperfecta* were abundant prior to historic grazing (Osborne 1997:18). Grasslands also seem to have increased at the expense of woodland communities during the last 200 years due to agricultural activities (Osborne 1997:18). The grasslands often intergrade with valley oak savanna, which is the more widespread of the two savanna communities. Valley oaks (*Quecus lobata*) prefer deep alluvial valley soils and tend to form open savanna in those settings (Osborne 1997:19). On the fringes and interspersed between the valleys in rolling hills are two variants of what Barbour and Major (1988) defined as blue oak/digger pine forest: blue oak woodlands and foothill woodlands. Of these, foothill woodland, marked by an association of blue oak and gray pine (*Pinus sabiniana*) (formerly digger pine) with occasional shrubs (e.g., *Ceanothus* spp., *Rhamnus* spp.), is the most widespread. The higher elevations and more rugged terrain of the Santa Lucia Range are associated with mixed chaparral and chamise

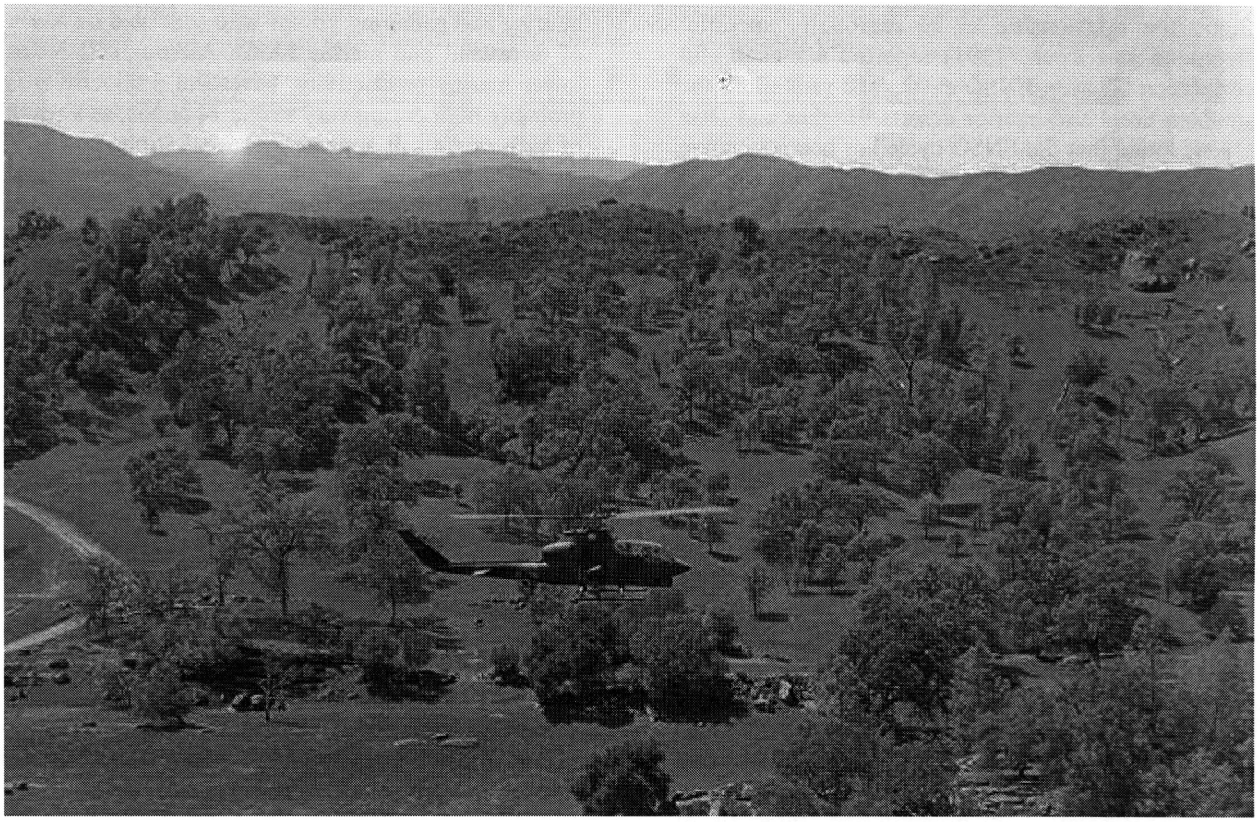


Plate 5 Aerial view of the Gabilan Creek area (Photograph courtesy of Susan Alvarez, Fort Hunter-Liggett)

chaparral. From the standpoint of aboriginal land use, the grassland, savanna, and woodland communities held the most potentially important floral resources. The chaparral communities provide habitat for game animals.

Terrestrial mammals that frequent these habitats include black-tailed deer (*Odocoileus hemionus*), bobcat (*Lynx rufus*), coyote (*Canis latrans*), gray fox (*Urocyon cinereoargenteus*), cottontail rabbit (*Sylvilagus auduboni*), and mountain lion (*Felis concolor*). Pronghorn antelope (*Antilocapra americana*) were observed by Spanish explorers in central California but have not yet been identified in Fort Hunter-Liggett archaeofauna. The species was represented at CA-MNT-229 in the Monterey Bay area, however (Dietz et al. 1988:340). Tule elk (*Cervus elaphus*) were also present in the interior valleys, and a single bone from CA-MNT-332 (Haney and Jones 1997) represents their presence prehistorically. Of the terrestrial taxa, deer were probably the most significant game animal.

SHORT TERM CLIMATIC CHANGE

Climatic variability can be measured on many temporal scales along the central California coast. First, much interannual variability in marine and terrestrial climate is related to El Niño and its parent, the El Niño Southern Oscillation (ENSO), although the impact of El Niño on water temperatures and marine productivity is more direct than its influence on terrestrial biomes. Elevated sea-surface temperatures associated with the ENSO of 1982-1983, for example, had widespread effects on the California coastal environment, including reduced upwelling, physical disturbances to kelp beds (Dayton and Tegner 1990:433; Tegner and Dayton 1987, 1991), and reduction in northern anchovy populations due to reproductive failures (Fiedler 1984). Many studies of California precipitation patterns based on historic records, show correlations between ENSO events and rainfall peaks (Michaelsen and Daily 1983; Yarnal and Diaz 1986).

One study by Schonher and Nicholson (1989) found the relationship to be regionally specific. Redmond and Koch (1991) reported a meaningful correlation between ENSO events and rainfall on the southern coast and interior deserts. Hughes and Diaz (1994) found that the ENSO cycle has been operative in the northern Pacific for at least the last millennium. In a longer study based on a 600-year tree ring record, Haston and Michaelsen (1994) concluded that the ENSO/rainfall relationship may be more equivocal than reflected historically, but that wet years associated with ENSO events tend to be exceptionally wet.

Historic records of rainfall and sea temperatures from Monterey (dating back to 1919) and Big Sur (dating back to 1972) generally show a positive correlation between precipitation and sea temperature (Figure 2), and a strong relationship between ENSO events and rainfall. Based on determinations made by Quinn et al. (1987), there were 16 ENSO events between 1927 and 1987, with intensities varying between moderate (N=9), strong (N=4), and very strong (N=3) (Figure 2). Historic rainfall and sea temperature data show a clear correlation between very strong ENSO events (1941, 1958, and 1982/83) and inordinately high rainfall. Among nine years associated with strong or very strong events, seven show inordinately high precipitation. Intervals of non-El Niño (e.g., 1932-1938, 1945-1950, 1960-1964) show moderate sea temperatures, and during 34 years with no ENSO event, 22 (64.7%) show rainfall below the yearly mean. The overall pattern is consistent with ENSO events in Peru, where El Niño was originally linked with "years of abundance," when heavy rains come to the coastal deserts (Philander 1990:1).

Moderate ENSO events show marked variability in rainfall and sea temperatures and some tendency toward lower than average rainfall. The moderate El Niño of 1976/77, for example, was associated with exceptionally low rainfall. Among 15 years during which moderate ENSO events occurred, ten are associated with lower than average rainfall. The two lowest rainfall years of the century (1931 and 1977) both occurred during moderate ENSO events.

Rainfall records from the southern Sierra Nevada where Graumlich (1993) detected Medieval droughts also show correlation between ENSO events and precipitation. Very strong ENSOs are marked by high rainfall, while non-ENSO years are drier. Moderate El Niños show even greater variability than on the coast, with both extreme highs and lows. The lowest rainfall of the century was again associated with the moderate ENSO of 1977.

On an interannual scale the relationship between rainfall, sea-surface temperatures, and upwelling intensity has important implications for coastal hunting and gathering groups who subsisted on a mix of terrestrial and marine foods. Although El Niños lower marine productivity, terrestrial productivity is probably high during very strong El Niños, as a result of high rainfall. It appears then, that strong and very strong El Niños would lower marine resource potential for hunter-gatherers, but the impact of these events would commonly be offset by enhanced terrestrial productivity, thereby preventing simultaneous deterioration of the marine and terrestrial resource base.

El Niño events are very short-lived phenomena, during which high sea temperatures persist for no more than two or three years. This renders them effectively invisible in the archaeological record of mainland California, where midden deposits generally reflect occupations of several centuries, if not millennia, and where faunalturbation compromises vertical stratigraphy in middens. Lack of precision in marine-shell derived radiocarbon dates, based on varied correction for upwelling (Kennett et al. 1997), further lessens chronological resolution so that individual El Niño events simply cannot be identified. Nonetheless, it is important to recognize the relationship between ENSO events and climatic variability, as one study (Anderson 1994) suggests that warmer, drier conditions of the Medieval Period may be the result of the low frequency and intensity of El Niños.

SEA-LEVEL RISE

Rise in sea-level following the last glacial maximum (ca. 18,000 years ago) was a significant influence on shoreline environments of California. At the peak of the last glacial, seas were approximately 120 m below their present level (Bloom 1983; Fairbanks 1989). This low-stand was followed by fairly rapid transgression (Flandrian) until approximately 7,000-6,000 years B.P., when sea levels stabilized--with very slow rise up to the present. Along low-lying shores of California, rising seas affected major changes in the size and character of estuaries (Bickel 1978), transforming them from deeply incised channels to broad embayments. Drainages of the Big Sur coast, however, are generally very small, and no major estuarine habitats were created--at least none are visible today. Bathymetric contours show that the land lost to sea-level rise along much of the Big Sur coast amounts to only a very narrow strip- in some locations only 1.0 km wide based on 120 m bathymetric contour. This strip was wider (up to 10 km) in the vicinity of Point Sur and Piedras Blancas. At 10,000 years B.P., sea level was 20-40 m below its present level, and the

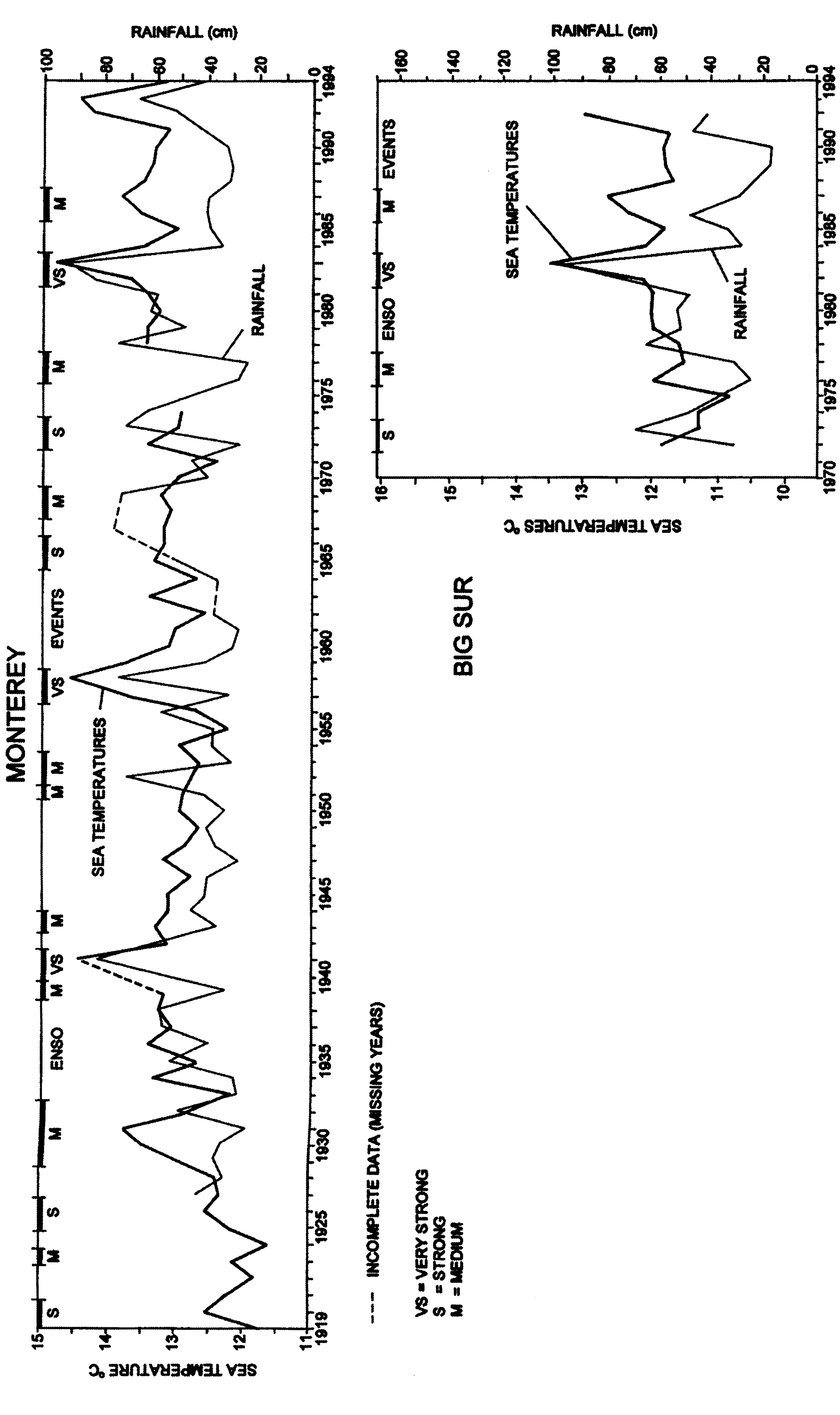


Figure 2 ENSO Events (from Quinn et al. 1987), Mean Monthly Sea Temperatures and Rainfall (cm) for Monterey (1919-1994) and the Big Sur Coast (1972-1994), Monterey County, California

shoreline was generally within 0.5 km of its present location. Because so little land has been lost to sea-level rise, Big Sur may be a good location to identify very early coastal occupations.

PALEOENVIRONMENTAL VARIABILITY

The degree to which ambient conditions along the Big Sur coast remained constant over the last 6400 years is a subject of considerable relevance to the reconstruction of past human lifeways. That the North American continent experienced a series of large-scale low-intensity environmental fluctuations during the Holocene Epoch has been known since the work of Antevs (1948, 1952). The degree to which these changes significantly altered the composition of human environments along the California coast, however, is open to discussion. An opinion offered by Johnson (1977) is of paramount importance and is certainly accurate to some degree: because of the tempering effect of ocean waters, the severity of impact in the coastal zone was less than in inland contexts.

Paleoenvironmental data obtained from the Big Sur coast are limited to a study of oxygen isotopes reported in more detail below. This preliminary study compliments detailed research completed to the north in the Monterey and San Francisco Bay areas, to the east in the Sierra Nevada, and to the south in the Santa Barbara Channel. Synthesis of data from these surrounding regions provides an adequate proxy for reconstruction of the actual local conditions. Holocene paleoenvironmental data are available from terrestrial and marine sources.

The Record From the Land

The first coastal pollen sequence available for California was actually recovered from a marine core in the Santa Barbara Channel, but it depicts changes in terrestrial vegetation (Heusser 1978). This sequence shows vegetation and inferred climatic changes that are generally concordant with Antevs' western North American climate sequence (Heusser 1978) and more recent global climatic sequences (Shackleton and Opdyke 1973; Currey and James 1982). The early Holocene was characterized by a cool wet climate, with a higher incidence of pine and fern (Antevs' Anathermal dating 7000-5000 B.C., or the Late Glacial). Pollen from terminal Pleistocene layers at Daisy Cave in the Santa Barbara Channel also suggest more widespread pine forests until about 9000 B.C. Mid-Holocene (5800-2400 B.C.) was a warm/dry period, as xeric taxa (oak, sagebrush, and sunflower) became more prominent in vegetation around the Channel. Peak warming (Antevs' Altithermal, or the Postglacial Substage [5500-3000 B.C.]) was represented by a maximal stance of oak and sunflower pollen, dating ca. 3400-2400 B.C. The climate became cooler and moister after 2400 B.C. (Antevs' Medithermal dating post 2000 B.C., or the Neoglacial Substage [3000 B.C.-present]), although modern conditions of temperature, rainfall, and vegetation were not established until after ca. 300 B.C.

Pollen cores reported from the central coast raise questions about the severity of the impact of climatic fluctuations on the biotic environment. Adam et al. (1981) found that pollen from the terminal Pleistocene (ca. 10,000 B.P.) in the Santa Cruz Mountains indicated the presence of a pine-dominated coniferous forest, much like that which now is found 800 km (500 miles) to the north, as a result of mean annual temperatures 2-3 degrees below those of today. As the Pleistocene epoch ended, there appears to have been a coastward and northward progression of warmer drier climates (Axelrod 1981), and pine-dominated forests retreated northward from their former extension to well south of Big Sur. The disjunct stands of Ponderosa pine occurring in the Santa Lucia and Santa Cruz mountains are probably vestiges of this earlier vegetation pattern.

Another pollen core reported from Elkhorn Slough 90 km north of the Big Sur River (West 1988) indicates that wholesale vegetation replacements did not transpire during the last 6400 years on the central coast. Pine, redwood, oak, and grass pollen are all present in moderate frequencies in the lowermost levels of the 6.9 m core, but a shift of some significance is evident between 400 and 356 cm, where pine reaches its lowest frequency, and oak declines. Concomitantly, grasses, high-spine composites, and redwood all appear in elevated proportions. Dating ca. 3200 B.C., this pattern conforms with the decrease in pine and increase in redwood associated with mid-Holocene in the San Francisco Bay area (Adam et al. 1981), and further correlates with Heusser's (1978) dating of peak warming in the Santa Barbara Channel. Adam et al. (1981) have pointed out, however, that the continued high frequency of redwood pollen at mid-Holocene argues against persistent drought during this period on the coast.

More recently, on the basis of a pollen core from Arroyo San Augustin, West (1987) suggested that chaparral and sage were important constituents throughout the Holocene, with a continuity in species common in the coastal sage scrub community (Munz with Keck 1968). Rypins et al. (1989:84) have also emphasized the apparent complacency of Holocene vegetation profiles on the central California coast.

Even Heusser (1978:677) commented that the magnitude of vegetation change over the last 6,000 years in the Santa Barbara Channel was not great.

Findings from the Sierra Nevada east of Big Sur indicate that while the coastal zone may exhibit a uniform Holocene climatic history, inter-regional variability is also apparent (Davis and Moratto 1988). In the southern Sierra Nevada a high frequency of sage pollen in Early Holocene sediments in a location today covered with typical Sierran montane forest speaks to serious aridity in that location between ca. 8000 and 5000 B.C.

A pollen sequence reported by Morgan et al. (1991) from the Santa Ynez River area in northern Santa Barbara County supports the general trends outlined by Heusser (1978), albeit with slightly different dating. Cores from Santa Lucia and Oak canyons suggested that Early Holocene climatic warming culminated with a peak warm/dry interval between 5600 and 2800 B.C.; a trend toward cooler conditions began after 2000 B.C. (Morgan et al. 1991:93). As the pollen reported in this study were recovered from somewhat suspect alluvial contexts, the alternative dating for peak warm/dry conditions proposed is questionable.

The Oak Canyon core reported by Morgan et al. also showed an increase in coastal scrub pollen between ca. A.D. 400 and 1400, suggesting an interval of warm and dry conditions. Other evidence for significant climatic variability after ca. 1000 B.C. comes from inland locations, which also suggest that California was influenced by the period of global drought dating A.D. 800-1350 known alternately as the Little Climatic Optimum, Medieval Warm Epoch, or Medieval Climatic Anomaly. California coastal habitats were probably also affected by the ensuing Little Ice Age, A.D. 1500-1800 (Koerper et al. 1985). Tree rings from the southern Sierra Nevada, east of Big Sur, reflect drought between A.D. 1100 and 1375 (Graumlich 1993), while low stands of Mono Lake in the eastern Sierra dating A.D. 705-1270 (Stine 1990) have been linked with global climate change (Stine 1994). More recent, refined dating of the Mono Lake low stands shows two intervals of drought, the first between A.D. 890 and A.D. 1110, and the second from A.D. 1210-1350 (Stine 1994:549). Stine further suggests that this dry interval was caused by a climatic anomaly with no analog in the contemporary weather cycle of California. This interval corresponds with a brief interglacial in the Sierra Nevada (Curry 1969) and the White Mountains (LaMarche 1974), which are followed by glacial advances of the Little Ice Age (see also Fagan 2000).

The Record from the Sea

A rapidly growing oceanographic data base holds promise for reconciling conflicts in terrestrial sequences and providing more fine-grained dating, although better understanding of the complex relationships between ocean water temperature and terrestrial climate must ultimately be developed. A Holocene ocean temperature sequence from the Santa Barbara Channel based on radiolarian fossils (Pisias 1978, 1979), has been relied upon heavily by local archaeologists (e.g., Glassow et al. 1988; Arnold 1992a). Two aspects of this sequence are significant. First, there is a strong suggestion that the mid-Holocene period of warm terrestrial conditions was punctuated by a period of cold water between 3400 and 1800 B.C. Second, periods of very warm ocean temperatures were identified ca. 1800-1600 B.C. and A.D. 200-1200.

The cold water interval beginning ca. 3400 B.C. corresponds closely with a glacial advance detected in the White Mountain Bristlecone pine sequence (LaMarche 1974), suggesting it is linked with terrestrial cooling. In the Santa Barbara Channel, however, the mid-Holocene decline in water temperatures corresponds with a period of terrestrial warming in the pollen sequence (Heusser 1978). As discussed above, ocean cooling is historically associated with reduced rainfall on the central coast. There are two alternative interpretations of mid-Holocene terrestrial/marine climatic relationshps. Pisias (1978: 381) argues that the correspondence between cool seas and dry terrestrial conditions reflects the historical inverse relationship between sea surface temperature and terrestrial climate. Glassow et al. (1988), however, suggest the interval of cool water temperatures, beginning ca. 3400 B.C., coincided with a cool wet terrestrial climate.

Glassow et al. (1994) reported supporting evidence for an interval of reduced ocean temperatures beginning ca. 3400 B.C. in the form of oxygen isotope profiles from an archaeological mussel shell from Santa Cruz Island. These data support earlier assertions about the antiquity of red abalone middens, which in the Channel Islands mark cold ocean periods (Glassow et al. 1988). Glassow et al. (1994) date this interval ca. 3900-2500 B.C. Another recent study by van Geen et al. (1992) reports greater upwelling off the mouth of San Francisco Bay ca. 2000 B.C., consistent with lower surface sea temperatures.

The Pisias (1978) sequence posits a short-lived return of warm water conditions between ca. 1800 and 1600 B.C., which corresponds with an interval of reduced runoff into San Francisco Bay between 1700 and 1450 B.C. (Ingram and DePaolo 1993). After this interval, cool waters returned, and most local paleoenvironmental sequences throughout California depict the termination of mid-Holocene warming at this juncture (Moratto 1984:548)

The period of warm water conditions dating A.D. 200-1200 in the Pisias sequence overlaps with the Medieval Warm Period of A.D. 1000-1400. Occurrence of a warm ocean during this interval is further indicated by studies of archaeological black abalone shells from the Channel Islands, which between A.D. 1150 and 1250, show patterns of growth consistent with a warm habitat (Arnold and Tissot 1993). Arnold (1992b:132) and Arnold and Tissot (1993:391) likened this interval to an extended El Niño-Southern Oscillation (ENSO), suspecting it was caused by changes in oceanic currents.

The Little Ice Age has been detected in the oceanographic record of southern California, where oxygen isotope profiles taken from archaeological mussel shells suggest water temperatures 3.0° C colder than present (Koerper 1985:101). Dated ca. A.D. 1400-1800 this interval may have been associated with increased upwelling and cooler climate. This correlation provides some support for the Glassow et al. (1988) interpretation of mid-Holocene conditions in the Santa Barbara Channel, in that it supports a positive relationship between sea and terrestrial temperatures and aridity. In keeping with such an interpretation, Koerper et al. (1985) concluded that Little Ice Age climate had no detrimental effect on southern California hunter-gatherers. Indeed, productivity of the south coast terrestrial biome may have increased.

The late Holocene paleoenvironmental record for south-central California has recently been enhanced by a series of studies reported by Kennett (1998) and Kennett and Kennett (2000). This work combines oxygen isotope findings from archaeological mussel shells with isotope data from cores taken from the Santa Barbara Channel. This study, more fine-grained than the Pisias sequence, shows results that are strongly at odds with the earlier research. Seas off the Santa Barbara coast appear to have been relatively cool between A.D. 450 and 1300, and there is no evidence for unusually warm seas or reduced marine productivity during this time. Rather, intervals of unusually low sea temperature correlate fairly well with intervals of low precipitation, including Stine's (1994) droughts of the Medieval Climatic Anomaly. Findings for the Little Ice Age also conflict with previous characterizations, suggesting warm seas and low precipitation, with a particularly dry interval between A.D. 1650 and 1750.

Summary and Sythesis of Previous Research

A fine-grained, fully concordant Holocene paleoenvironmental sequence, incorporating surface sea temperature, terrestrial climate, and vegetation is not available for the central California coast, and there are contradictions with the existing oceanographic and terrestrial data. Nonetheless, some patterns are suggested. The end of the Pleistocene was apparently associated with cooler and/or wetter climate that slowly ameliorated with the end of glacial conditions. Pollen from the Santa Barbara Channel shows higher frequencies of pine (Erlandson et al. 1996; Heusser 1978) than today, as a reflection of terminal Pleistocene climate. Warming associated with the close of the Pleistocene seems to have culminated in an interval of warm and/or dry climate at early-mid Holocene. Originally referred to by Antevs (1948) as the Altithermal and today known as the mid-Holocene warm period or Holocene maximum, this period is reflected in most California paleoenvironmental sequences (e.g., Woolfenden 1996) as it is many other places in the world (Roberts 1998). The chronology, duration, severity, and actual conditions (warm or dry or both) of this interval are somewhat unclear, however, as regional sequences are not concordant. This is especially true for the central California coast, where the empirical record is very limited. Nonetheless, the basic vegetative communities present today were probably in place in Big Sur 6400 years ago, when the earliest site investigated for this study was occupied, and ocean water temperatures and terrestrial climate were in the midst of early-mid Holocene warming. A transition toward cooler sea temperatures ca. 3400 B.C. apparent in the Santa Barbara Channel (Pisias 1978; Glassow et al. 1994) corresponds with an increase in redwoods and grasses in the Elkhorn Slough pollen column within Monterey Bay, as well as the maximal occurrence of sunflower pollen in the Channel. Alternatively these signals indicate a cool/wet (Glassow et al. 1988), warm/dry (Heusser 1978), cool/dry, or warm/wet climate, but the persistence of redwoods suggests this was not a period of extended drought.

A more substantial paleoenvironmental record is available for the late Holocene, although still comprised largely of data from adjoining regions. A variety of records from the interior (Graumlich 1993; LaMarche 1974; Stine 1994) and Transverse (Larson and Michaelson 1989) ranges shows evidence for prolonged droughts between A.D. 800 and 1350. The most recent sea temperature reconstructions suggest cool, productive seas during the and some hints of contemporaneous elevated sea surface temperatures.

These broad-scale trends in climate and sea temperatures are very different from the variability associated with the ENSO cycle. During very strong El Niño events, warm seas reflect decreased upwelling and low marine productivity. Precipitation tends to be high. On a latitudinal basis, California climate generally shows a correlation between warm seas, warm temperatures and low rainfall (in the south), with cooler ocean temperatures, more rainfall, and cooler climate in the north. If broad-scale changes in climate reflect latitudinal shifting of weather patterns, then declining seas temperatures should reflect cooler/wetter conditions on land. Kennett and Kennett's (2000) findings from the Santa Barbara Channel, however, show an association between cool seas and drought-like conditions during the late Holocene which could reflect changes in global weather patterns more complex than simple latitudinal shifts. In either case, the co-occurrence of warm seas and high rainfall that marks very strong El Niño events differs from the longer duration/lower intensity climatic phenomena. In contrast with short-term increases in sea temperature caused by ENSO events, a long-term, gradual change in sea surface temperatures would not necessarily alter overall marine productivity, but rather would promote gradual latitudinal shifting of habitats and movement of species (Barry et al. 1995; Davenport et al. 1993). This would alter the mix of species available to hunter-gatherers but would not cause major problems in the availability of food.

Late Holocene Sea Temperatures off the Big Sur Coast Inferred from Oxygen Isotope

To obtain a direct measure of sea conditions off the Big Sur coast during the late Holocene, a pilot study was conducted by Douglas J. Kennett to reconstruct sea temperatures via oxygen isotope readings obtained from archaeological mussel shells. Results of this study incorporating additional data from other investigations on the central coast were reported by Jones and Kennett (1999). Oxygen isotope readings were also used to evaluate the seasonality of shellfish collection. Details of these studies are presented in Appendix I. For the purpose of paleoenvironmental reconstruction, 169 oxygen isotopic measurements were obtained from 12 archaeological *Mytilus californianus* shells. Once isotope samples were taken the shells were radiocarbon dated. When placed in temporal order, results from the shells show fairly strong patterning (Figure 3). Comparison of historic sea- surface temperatures with those inferred from oxygen isotopic profiles of prehistoric shells indicates variation in oceanographic conditions during the late Holocene. Oxygen isotope results from shells dating A.D. 1-1300 suggested fairly stable conditions, with seas slightly cooler than present. Between A.D. 1300 and 1500, the transition from the Medieval Climatic Period to the Little Ice Age, temperatures reached peaks higher than present and also show an unusually wide seasonal range. Mussel shells dating from A.D. 1500 to 1700 (the Little Ice Age) showed colder, less variable sea-surface temperatures, consistent with previous isotopic studies (Dunbar1983; Koerper et al. 1985). Compared with historic sea-temperature records, the oxygen isotopic profiles from the late Medieval Period are unusual in their suggestion of large-scale seasonal fluctuations in water temperature, with a range greater than any recorded historically. Single specimens from this interval, representing one to two years of temperature cycles each, showed seasonal flux of 8-9 °C, while the modern range represented in a 20-year-period spans only 5.95 °C. Although sea-surface temperatures during the A.D. 1500-1700 period were, on average, lower than modern conditions, the seasonal range was similar to the present, fluctuating 4-5 °C. The seasonal range in temperatures between A.D. 1300 and 1500 is inconsistent with very strong El Niños, which show warm temperatures throughout the seasonal cycle. As in Peru, very strong ENSO events off California are commonly "years of abundance"

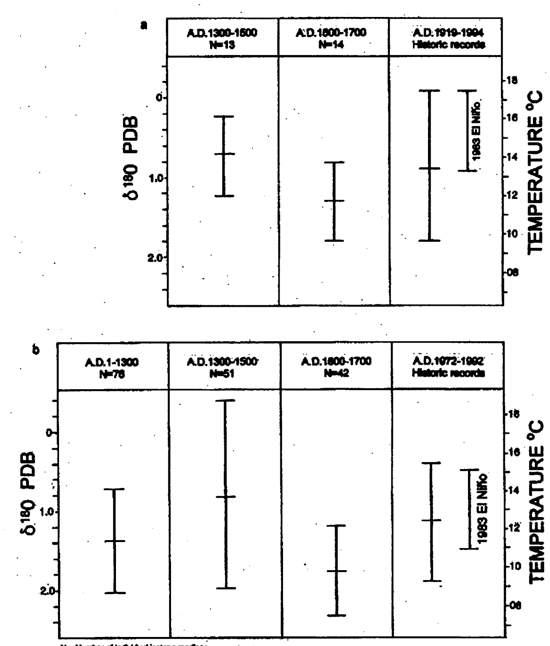


Figure 3 Range and Midpoint of ^{18}O Values and Inferred Temperatures for 12 Archaeological Specimens of *Mytilus californianus* Compared with Historic Ranges and Midpoints for the Big Sur Coast.

in the terrestrial environment due to high rainfall. The period between A.D. 1300 and 1500 off the Big Sur coast was a time of warm seas, but it was also one of prolonged drought in central California, as indicated by tree rings (Graumlich 1993) and drowned stumps (Stine 1994) in the interior. Low incidence and low intensity of El Niños may partially explain the extended warm, dry conditions in central California (Anderson 1994), but the range of variation in sea temperatures between A.D. 1300 and 1500 suggests conditions not wholly accounted for by the ENSO cycle, and which may contribute to Stine's (1994) characterization of the Medieval Period as somewhat anomalous relative to the rest of the Holocene. It is important to acknowledge that the central coast findings are not concordant with the Santa Barbara Channel study reported by Kennett and Kennett (2000). This discrepancy may be related to differences in chronological resolution between the two studies and possibly the division of readings into different temporal periods, but it may also reflect more significant variation. Kennett and Kennett (2000:384-385) characterize the Little Ice Age as a period of warm and stable sea temperatures in the Santa Barbara Channel, which conflicts directly with the Big Sur record that suggests seas colder than present (Figure 4). The Little Ice Age is commonly interpreted as a period of cold terrestrial climate and wetter conditions which precipitated the brief advance of glaciers in the Sierra Nevada (Moratto 1984:548). While the formation of glaciers would certainly require high preciptation which is suggested in the Santa Barbara Channel, it would also require cool temperatures. On a north-south gradient in California, cool seas are correlated with cool temperatures on land, and it is not unreasonable to envision the Little Ice Age as a period when climatic regimes moved slightly southward, bringing cold seas, greater rainfall, and cooler land temperatures to central California. It is distinctly possible that the climatic reconstructions generated from the Santa Barbara Channel, particularly the islands, have limited applicability to the mainland. The islands are heavily influenced by the northward-flowing California counter current which does not affect lands north of Point Conception. The islands seem to experience much greater swings in sea temperature, and are generally more climatically variable than the mainland. Both regions, however, show evidence for significant climatic change focused at A.D. 1300, during the latter of Stine's (1994) two Medieval droughts.

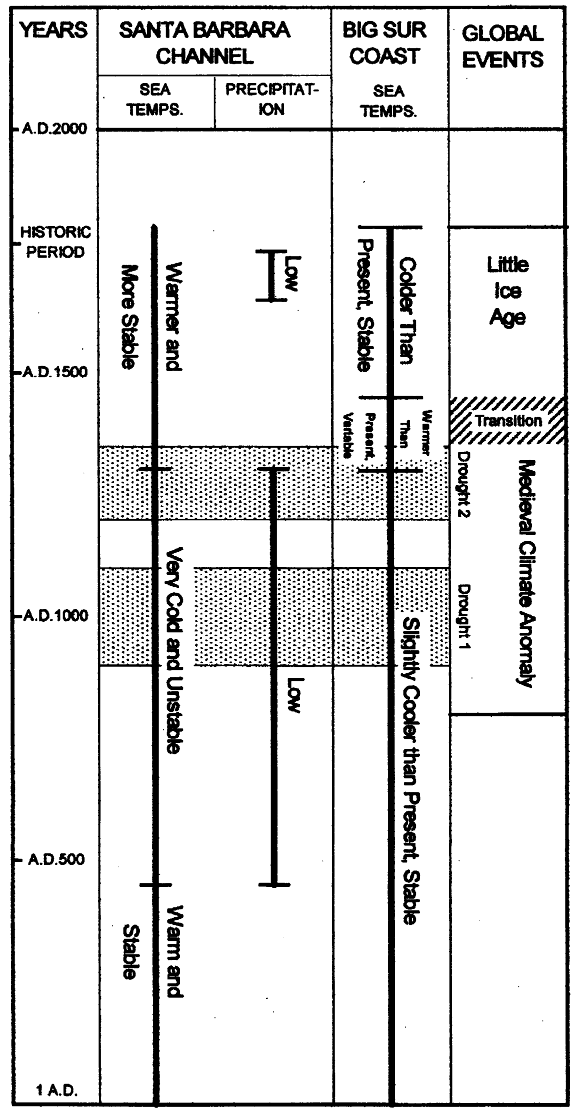


Figure 4 Comparison between Paleoclimatic Findings from the Santa Barbara Channel (Kennett and Kennett 2000) and the Big Sur Coast (Jones and Kennett 1999)

DISCUSSION

The Big Sur coast is best considered relatively complacent in its response to low intensity/long duration climatic change. As reflected by present-day flora, microtopographic diversity ensures the perpetuation of a complex mosaic of vegetation. Absolute frequencies have no doubt varied, and some change in the expanse and elevation of certain communities probably took place, but wholesale vegetation replacements are not evident for the last 7,000-8,000 years. Given the radii in which hunter-gatherers forage in a day (ca. 10 km), vegetation changes over the last 6400 years were probably of little consequence due to the unchanging concentration of multiple habitats. While this environment should not be considered stagnant--it is anything but--diachronic variability during the Holocene was probably on a scale that would not have demanded major response by resident human populations.

In contrast, short-term fluctuations in water temperature during very strong ENSO events cause a decline in marine productivity, but coincident high rainfall stimulates terrestrial habitats. Drought between ENSOs (La Niña) reduces the vitality of terrestrial habitats. Neither of these situations would have been catastrophic for prehistoric hunter-gatherers, but a more extended drought or deterioration of marine habitats could have had significant impacts. There is growing evidence for environmental oscillations focusing on A.D. 1300 that included changing sea temperatures and drought. These certainly could have been of sufficient magnitude and duration to cause resource stress and invoke human cultural responses.

CHAPTER 3: ETHNOHISTORIC INVESTIGATION

Ethnohistoric investigations were undertaken to try to reconstruct systems of settlement, mobility, diet, social organization, and exchange at the time of contact with the Spanish in 1769--using ethnographic information that was collected over 100 years later. The difficulties and potential shortcomings of such effort are not insubstantial (see Wilmsen 1989) in that the ethnographic record consists mostly of the recorded memories of individuals who were several generations removed from the pre-contact era. While inhabitants of the Santa Lucia Range were still speaking Native Salinan (in addition to Spanish and English) when ethnographic research was initiated, they were no longer pursuing a traditional hunting and gathering lifeway. They provided the early ethnographers with precious few insights into the mechanics of local settlement and subsistence. In light of this, the ethnohistoric research was particularly focused on ethnogeography with the idea that place names identified by Native speakers and listed in Mission records could be correlated with archaeological deposits. Investigation of these deposits could in turn illuminate patterns of contact and pre-contact culture. That is, a direct archaeological approach was to be used to enhance the limited ethnohistoric record.

Study of Native culture in this region is reliant on a host of primary and secondary sources which vary widely in their precision and applicability to the contact-era. The portrait of Big Sur ethnohistory presented below combines fine-grained ethnogeographic data collected by the late John Peabody Harrington in the early 20th century with early historic accounts, and generalized observations about central California aboriginal culture developed by early California anthropologists.

Immediately prior to European contact, the central California coast seems to have been occupied by a substantial number of relatively small, autonomous, native communities, each associated with a clearly defined territory. Recent research suggests that the coast between Point Sur and San Carpoforo Creek was occupied by four such communities (Milliken 1990): *Sargenta-Ruc* in the north including the mouth of the Big Sur River, *Ekheahan*, in the vicinity of Partington Point, *Quiquilit*, in the vicinity of Big Creek and Lopez Point, and *Lamaca* in the area of Willow Creek (Figure 1). The area south of San Carpoforo Creek was apparently occupied by Chumash speakers (Gibson 1983), although more recent, ongoing studies may push this boundary further south (Randall Milliken, personal communication 2002).

Contact between the inhabitants of the Big Sur districts and Spanish explorers in 1769 was soon followed by the establishment of Mission San Carlos de Borromeo in 1770, Mission San Antonio de Padua in 1771, Mission Nuestra Senora de la Soledad in 1791, and finally Mission San Miguel Arcangel in 1797 (Figure 1). Knowledge of contact-era lifeways comes from three major sources. The first are observations made by European expeditions prior to the establishment of the missions. Unfortunately, only the expedition of Gaspar de Portolá passed through the territory of a coastal tribelet. Explorers after Portolá took inland routes to avoid the rugged terrain of Big Sur. As a consequence, there are no first-hand accounts of the *Sargenta-Ruc*, *Ekheahan*, or *Quiquilit* tribelets for the contact period. Indeed, the names and locations of these communities have only been established through detailed analysis of mission records (Cook 1974; Gibson 1983, 1985; Milliken 1990), which constitute the second body of information on contact-era culture. These are valuable for their ethnogeographic insights, but are woefully lacking in accounts of non-mission settlement and subsistence. In some instances, particularly in the Monterey and Carmel area, mission records can be supplemented with descriptions recorded by early travelers, such as the account published by the French scientific expedition of 1787. Finally, there are accounts written by ethnographers who conducted interviews among surviving descendants during the early 20th century, recording language, placenames, and memories of past lifeways. A. L. Kroeber and C. Hart Merriam interviewed Costanoan-speaking peoples in the Carmel Valley; Merriam and Harrington recorded some Esselen vocabulary (Beeler 1978); and Merriam, J. A. Mason (1912, 1918), and J. P. Harrington worked with Salinan speaking peoples in the San Antonio Valley between 1902 and 1935. Merriam's research is only partially published (Merriam 1955, 1968), while Kroeber (1904) and Mason gathered important linguistic information, but precious little else of substance. Harrington's ethnographic interviews among the Salinan, while never synthesized, have been recently made available in their original format on microfilm (Harrington 1985). Like Kroeber, Merriam, and Mason, Harrington was dealing with people who had been divorced from pre-European lifeways for several generations, but his information is valuable because he spent more time in the field with his consultants and recorded more accurate and extensive ethnogeographic and ethnobotanical data. The general accuracy of these accounts is testified to by their correlation with the archaeological record (Rivers and Jones 1993; Jones et al. 2000).

Accounts by the first Spanish expedition through the Santa Lucia Range are an unparalleled source of information on contact-era culture. The ethnohistoric summary developed below begins with a review of these accounts and settlement inferences that can be drawn from them. This information was supplemented with early historic descriptions, data from Harrington's ethnographic field notes, and the results of mission record studies. Most of these data emphasize speakers of Salinan languages, specifically the *Quiquilit* community. The majority of investigated archaeological sites are in this district.

THE PORTOLA EXPEDITION OF 1769

Members of the 1769 expedition of Gaspar de Portolá--including Juan Crespi, Miguel Costanso, and Pedro Fages--were the first Europeans known to have made contact with the Native inhabitants of the Santa Lucias. Traveling by mount northward from San Diego to Monterey, this entourage reached the southern portion of the Big Sur coast on September 16, when they turned inland from what had until then been a coastal route. The group eventually reached their destination later that year, and passed through the Santa Lucias again during the return trip to the south in December. The translated diaries of the expedition include brief descriptions of encounters with native inhabitants. The available documents include translations of the Crespi (Piette 1947), Costanso (Teggart 1911), and Portolá (Boneu y Companys 1983) diaries, as well as a previously untranslated version of Crespi recently translated from the original and made available by Alan Brown (personal communication 1991). Also important is the transcript of the official report of the expedition completed by Fages in 1775 (Priestley 1972).

The Portolá expedition was probably near the southwestern edge of the district of *Lamaca* when they decided to turn inland on September 16th. The route and the location of the expedition's camping places have been reconstructed by Bolton (1927), Gibson (1983), and most recently by Brown (personal communication 1991), who traced the route on foot and correlated diary entries with on-the-ground locations. Initial passage inland was up San Carpoforo Creek (Figure 5). From the 17th to the 20th the entourage laid over at a location they called "*La Hoya de la Sierra de Santa Lucia*," which Brown correlates with the upper end of Dutra Creek Flat (Figure 7). It was at this point that the first reference to Indians was made:

> We have a village of very good, poor heathens (there must be some eighty of them)

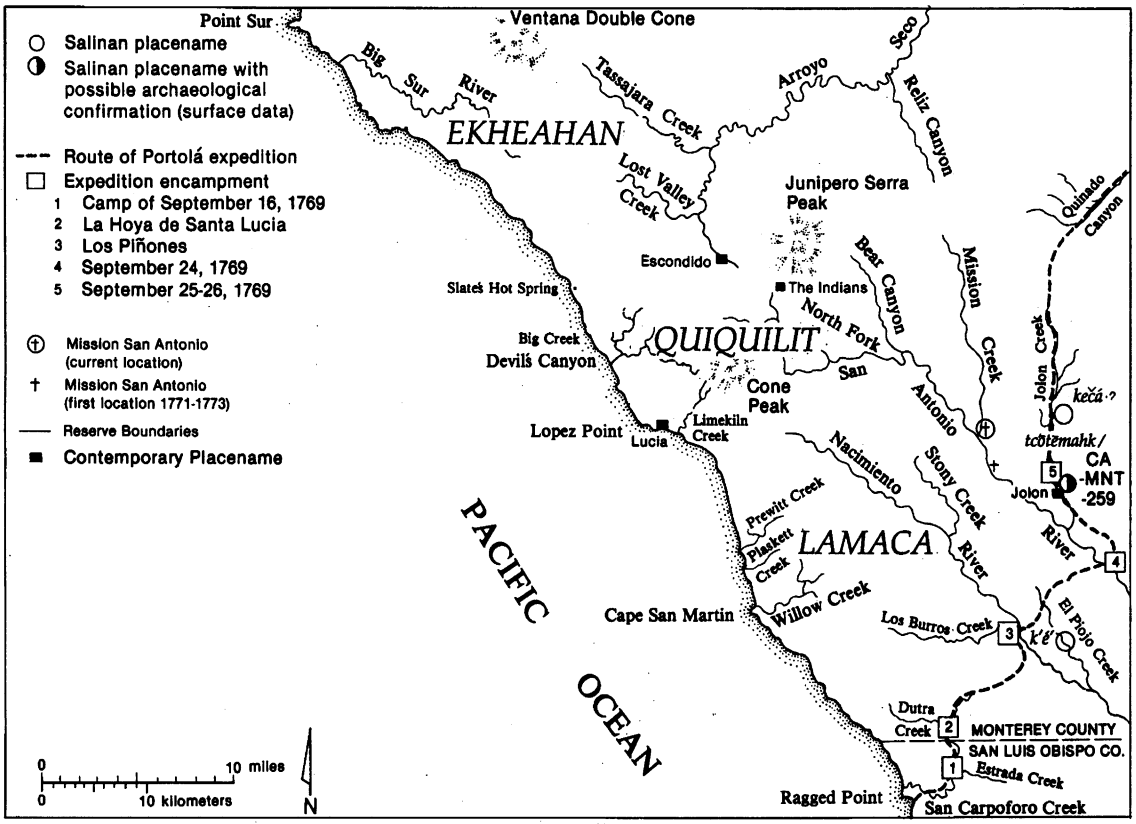


Figure 5 Approximate Locations of Tribelets on the Big Sur Coast after Milliken (1990), with Route of the Portolá Expedition of 1769 after Bolton (1927) and Smith (1932)

> who, though not settled here but belonging a bit further away, came over as soon as they saw our scouts and that we were on the way to stopping here, and brought all of their gear and women and children, in order to make the march with us when we start toward their village, which they say lies along the way we are to take. (Crespi translated by Brown 1991).

Bolton's (1927:192) translation of the diary also stated that... *a village of heathen who numbered perhaps sixty souls, but without a single house. They are very gentle and friendly.* (Juan Crespi translated by Bolton, 1927:192).

On the 20th of September the party left this camp and traveled in a northerly direction for approximately two leagues (5.2 miles) to a small, narrow valley they named Camp of Piñones, after gifts of pine nuts brought to them by natives:

> Six or seven big villages with their chiefs resorted to this spot, all of them so they said belonging to this vicinity, all very well behaved and friendly and bearing no weapons; at least six hundred souls of all descriptions must have gathered here. They presented us with a great many pine nuts like those in Spain, and good well flavored gruels. (Crespi translated by Brown 1991)

Bolton's (1927:193) translation stated: "We found there three villages of heathen, who were harvesting pine nuts. They had their houses not far from camp, from what they said." The Fages description of this location adds some details:

> There were in the vicinity three bands of Indians, wanderers like those of the preceding group, without house or home. They were at this time engaged in harvesting pine nuts, of which there is an abundance throughout the entire range. The camp was called Real de los Piñones. (Priestley 1972:54)

While there are clear inconsistencies in these accounts, it is apparent that a large number of people, comprising 3-6 groups, were present in this vicinity harvesting pine nuts. They were not all inhabitants of local villages, however. Bolton (1927:194) locates the Pine Nuts Camp near Los Burros Creek, west of the Nacimiento River (Figure 5). From here the party headed north traveling one league (2.6 miles) to a large arroyo where they camped until the 24th. According to Crespi, here they were visited by natives from several nearby settlements:

> One or two villages are close to this spot; and shortly after our reaching here some heathens belonging to them came to the camp, presenting us with bowls of gruel and pine nuts. (Brown 1991)

Gibson (1983:203) places this encampment along the Nacimiento River (Figure 5). Upon starting out again on the 24th, the party apparently traversed the divide between the Nacimiento and San Antonio rivers, then followed the latter northward. On the edge of the stream they encountered a group of natives and Crespi commented:

> All the trees were loaded with acorns, as yet unripe, and the crop would be so large that many herds of swine could be maintained. The Indians use them in making their atole - of which we have partaken in various places - and they also roast them and eat them as bread. On the margin of this stream there was a village of very poor, wandering Indians, but they showed themselves friendly and obsequious. (Bolton 1927:196)

On the following day the party moved on to what Bolton (1927:197) believes was the upper Jolon Valley. The group then departed the Santa Lucias and descended into the Salinas River Valley. On September 26th they encountered yet another village. Crespi noted that:

> At the foot of the declivity we found a village of wandering Indians numbering more than two hundred souls, who were camped beneath a fallen live oak. They gave us a quantity of seeds and pine nuts, to which we responded with some beads. (Bolton 1927:197)

Passing this village, the entourage camped along the river near the present day community of King City; the river was named San Elizario, and the camping place, "*El Real del Chocolate.*" From this location, the party continued north to San Francisco Bay, and after a sequence of unplanned exploring caused by their inability to find the port of Monterey, eventually returned south, again reaching the *Real del Chocolate* on December 15th. Leaving the Salinas Valley they again encountered the village of *Palo Caido* (fallen stick or tree), the same one noted on September 26th. By December 18th, they made their way back to the place referred to as *Los Piñones*. Crespi's commentary at this location is significant:

> We halted at this spot, not having seen a single heathen out of the great many who gathered at this place on the way coming and presented us with a great many pine nuts (it being a place that has them). (Brown 1991)

On the following day the party continued to retrace their steps, returning to the location named *La Hoya de Santa Lucia*. Here, Crespi noted that:

> We made camp at the same spot as on the way coming, which was close to a good sized village that was here, and there were some heathens at it now as well. (Brown 1991)

By the 20th of December the party reached the vicinity of the mouth of San Carpoforo Creek, where they commented on what Gibson (1983:200) believes was a Chumash village, indicated by a passage describing: "a good sized village of heathens who were already here on the way coming up." (Brown 1991).

A return trip was made the following spring along the same route. Reaching the foot of the Santa Lucias on May 16, 1770, the entourage headed up San Carpoforo Creek on the 17th, arriving once more at *La Hoya de Santa Lucia*, where Crespi commented :

> We saw, on coming down to this spot, two houses belonging to the village of very fine folk that exist throughout these mountains; we did not see a single heathen, because, it must be, they are gathering their seeds. (Brown 1991)

On May 18th the party passed through, for the third time, the spot of the pine nuts, Los Piñones, where their comments are virtually the same as those made in December:

> ....villages who gathered at this spot during the first voyage and at that time presented us with a great amount of pine nuts, very fine well behaved folk all of them; but we have not as yet seen a single heathen since we have been here this time. (Brown 1991)

No further observations of natives were made during the ensuing days. Passage through the Santa Lucias was completed by May 20, 1770 when the lack of sightings was noted. The supplemental report by Fages in 1775 confirms and summarizes the diary accounts. Describing the area of Mission San Antonio he stated:

> It is said that within a radius of seven leagues there must be 20 villages, without counting those in the direction of the presidio of Monterey, some of them right on the road. (Priestley 1972:57)

Settlement Inferences

Passages through the Santa Lucia Range at different times of year by the Portolá team represent a seasonal and geographical transect of the native settlement system, from which several inferences can be drawn. A significant amount of seasonal movement is evident, based on the repeated description of these peoples as "wandering" and from the presence of large numbers of people engaged in pine nut collection in September who were absent from that location in the winter and spring. A non-permanent settlement/subsistence system is further suggested by a description of Indians in the vicinity of Mission San Carlos by Pedro Fages: "They do not have fixed places for their villages, but wander here and there wherever they can find provisions at hand. Their houses are badly constructed, consisting solely of a few boughs placed in a circular arrangement" (Priestley 1972:67).

Since Spanish passage through the region in the fall was in advance of the ripening of acorns, it can be inferred that use of task-specific pine-nut collection sites preceded the acorn harvest. Since acorn exploitation generally requires storage, most likely at a residential base, the absence of natives along the Portola route during the winter and spring probably reflects movement to winter villages soon after the initial departure of the Spanish. Throughout central California, acorns were harvested near the village sites, and put into storage in the fall and early winter, and subsistence through the spring included use of these stored commodities. The repeated sightings of natives near the location named *La Hoya de Santa Lucia* during all three passes along this route, as well as the mention of houses at this site, suggests strongly this was the location of a residential base or village, occupied for most of the year. It can be further surmised that the population of this village was between 60 and 80 individuals. When acorn stores were exhausted during the spring, movement to exploit other types of resources, including pine nuts, was probably initiated.

MISSION REGISTER CONTRIBUTIONS TO LOCAL ETHNOGEOGRAPHY

As recently as the 1970s, anthropological reports on the ethnogeography of the central California coast consisted largely of vague, if not incorrect, generalizations. Beginning with Milliken's (1981) report on records from Mission San Carlos in Carmel, an increasingly fine-grained portrait of regional ethnogeography has emerged, one in which tribelets names are identified, and their constituent villages located. In 1981, Milliken defined tentative boundaries for the Costanoan-speaking community of *Sargenta-Ruc* on the northern Big Sur coast. In 1990, working with records from Mission San Carlos, Mission San Antonio, and Mission Nuestra de Soledad he plotted the location of the Esselen-speaking community of *Ekheahan*. Precise location of the actual boundaries between these two tribelets remains speculative, however. *Sargenta-Ruc* included the mouth of the Big Sur River, and the village of *Jojopan* was apparently situated somewhere along the lower course of the river. Another village, *pichi* or *pis* was situated to the north of *Jojopan.* The *Ekheahan* community, while clearly situated south of *Sargenta-Ruc* and north of *Quiquilit*, is more poorly known. Milliken (1990) ascribes a series of villages to this community, including *Ekheahan*, *Etsmal* or *Zmaal*, *Gessine*, *Chipicatan*, and *Majjanichul*. Location of these settlements is known only as in the mountains adjacent the beach. Milliken (1990) further speculated that the Salinan-speaking communities of *Quiquilit* and *Lamaca* were located on the coast south of *Ekheahan* and that *Lima* was in the interior.

Gibson (1983; 1985), working with records from Mission San Antonio, established names and locations for over 100 villages in Salinan territory, although his village locations are highly approximate. He did define patterns of marriage relationships between coastal and inland villages in the northern Salinan area. Milliken (1990) developed a complete map of Big Sur tribelets. As a result of these studies, five tribelets can be ascribed to the area covered by this study: the Costanoan-speaking community of *Sargenta-Ruc* on the northern Big Sur coast, the Esselen-speaking community of *Ekheahan,* the Salinan-speaking communities of *Quiquilit* and *Lamaca,* on the southern Big Sur coast, and the Salinan community of *Lima* in the interior (Figure 1).

HARRINGTON'S SALINAN ETHNOGRAPHY

Under the aegis of the Smithsonian Institute, John Peabody Harrington made a series of field trips to the San Antonio Valley between 1922 and 1932 to conduct ethnographic interviews with elderly Salinan speakers. The field notes and maps compiled by Harrington, available on microfilm (Mills 1985), have been used to identify places in the Santa Lucia Range and the interior of the South Coast Range that were significant to Salinan-speaking peoples (Rivers and Jones 1993; Jones et al. 2000). Harrington's primary consultants were five elderly Salinan speakers: Dave Mora, Maria de Los Angeles Baylon Ocarpia Encinales, Maria Jesusa Encinales, Felipe Encinales, and Tito Encinales (Plate 6). Brief biographies of these individuals were presented by Rivers and Jones (1993). Six locations identified by Rivers and Jones (1993) are particularly relevant to reconstructions of settlement. In the vicinity of the Spanish encampment of *Los Piñones*, the Salinan place name *K'e'*, meaning pine, was identified. Harrington's informants associated this place with El Piojo Creek. A profusion of bedrock mortars occur in this drainage, and it is not unreasonable to conclude that the mortars

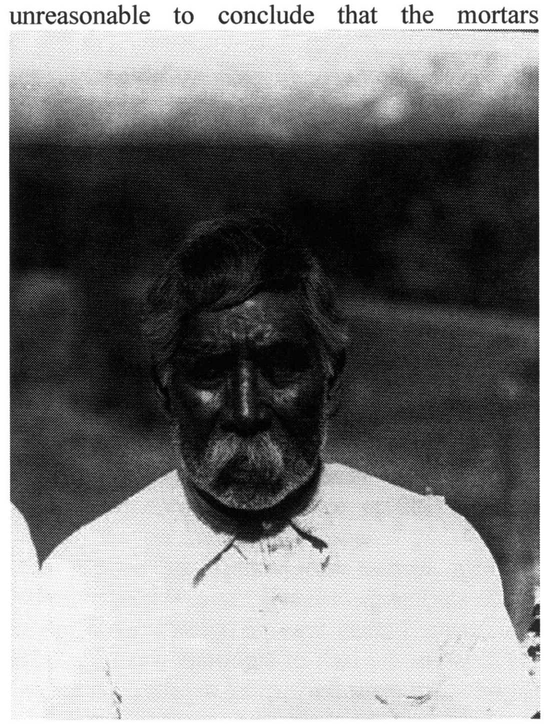


Plate 6 Tito Encinales in 1931 (Photograph by J. P. Harrington, courtesy of the Santa Barbara Museum of Natural History)

were associated with the large pine nut harvest observed by the Spanish. If this gathering indeed included as many as 600 people, multiple lineages were probably involved, from several communities. Furthermore, these mortars may have been used primarily, if not exclusively, for this one seasonal activity. It is impossible to determine whether the pine nuts were intended for immediate consumption or whether they were stored for winter, but presentation to the Spanish explorers of bowls of gruel and nuts suggests at least some immediate consumption. In terms of overall subsistence, the bedrock mortars at *K'e'* reflect seasonal, task-specific resource exploitation, not by small task groups, but rather by large social aggregations drawn from a wide area focused on one seasonally concentrated resource. The specific intent of the gathering observed by the Spanish at *K'e'* seems to have been a seasonal feast

At least five Salinan villages were identified by Harrington's informants. One, *Tc'ótémahk*, near the present-day town of Jolon (Figure 5), was in the vicinity of the Spanish encampment of September 23-24, 1769. A large midden with house depressions (CA-MNT-249) is present in that vicinity. The other four, *Hollóm*, *Sk'éyem*, *Matalcé*, and *Ts'alák'ak'a'* are within the *Quiquilit* district. The first two are situated inland and the others are on the coast (Figure 6). Both *Ts'alák'ak'a'* and *Matalcé* are represented by archaeological sites that have been investigated, *Ts'alák'ak'a'* (CA-MNT-480/H) by Howard (1973) and *Matalcé* (CA-MNT-1277/H) for the present study. The settings of these two sites are similar. CA-MNT-1277/H, a large midden, occurs at an elevation of 566 m, 2 km inland. CA-MNT-480/H was found at 595 m, 1.6 km inland. Both village names appear in the records of Mission San Antonio (Merriam 1968:78, 79; Gibson 1983:115).

Several middens were recorded in the vicinity of *La Hoya de Santa Lucia*, and one or more of these must surely correlate with the village described by the Spanish. Unfortunately, Harrington's consultants were unfamiliar with that area.

Two other types of settlements were located by Harrington's informants. *Tr'aktén*, identified as a hunting camp, was marked by a small shell midden with an associated outcrop of bedrock mortars. Found with the help of Harrington's maps, this site was recorded as CA-MNT-1571/H at an elevation of 845 m, 4.2 km inland *Ts'ápale'kwél'* was identified as a place where deer were killed and their meat dried. This place could not be linked to an on-the-ground location.

SOCIAL AND POLITICAL ORGANIZATION

Kroeber (1955b) defined two types of socio-political organizations in central California: maximal patrilineages and tribelets. Unlike the lineage group, which was organized along kinship lines, the tribelet was "a sovereign though miniature political unit, which was land-owning and maintained its frontiers against unauthorized trespass" (Kroeber 1955b:307). Kroeber (1962:33) further stated that a tribelet consisted of:

> ... several settlements -- there might be three or four or five of them --sometimes more or less the same size, but more often one was dominant or permanent, the other more like suburbs of it. They might be situated some miles away. The smaller settlements were likely to be inhabited seasonally, or by certain families only perhaps for a stretch of years, after which their population might drift back to the main settlement (Kroeber 1962:33).

Tribelets could contain more than one lineage, and Kroeber (1955b:308) felt that in rich environments, like the Santa Barbara Channel, multiple lineages coalesced into permanent villages.

Kroeber (1955b:311) specifically stated that the type of land ownership and social organization employed by speakers of Salinan and Costanoan languages was either of the lineage or tribelet type, but that no definitive determination could be made. The same uncertainty, of course, holds for Esselen speakers, as all aspects of their culture are poorly known.

More information on central coast social and political structure comes from Harrington's (1942) contribution to Kroeber's Culture Element Distribution project, in which cultural traits of Salinan, Costanoan, and Chumash speaking peoples were summarized. While data are far from complete, particularly for the Costanoan speakers, they suggest these people were

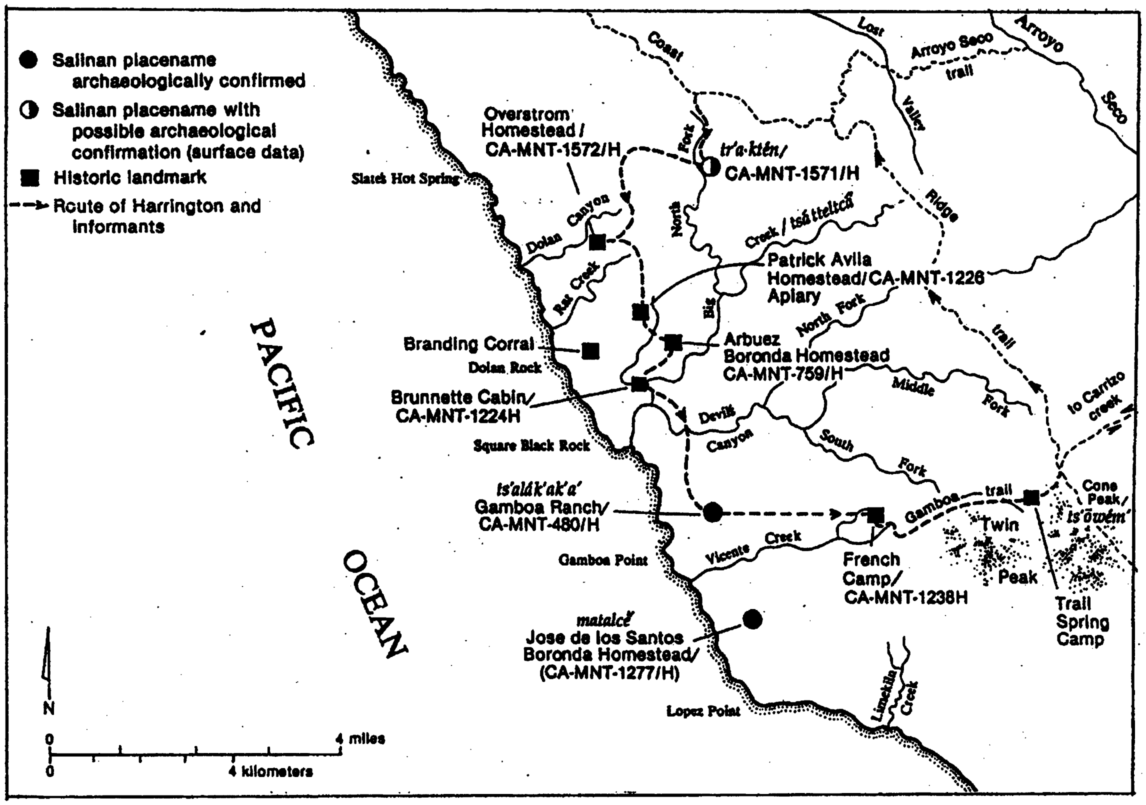


Figure 6 Coastal Segment of *Quiquilit* Showing the Approximate Route of J. P. Harrington with Salinan Consultants in 1932, Archaeological Sites correlated with Salinan Place Names, and Historic Landmarks noted by Harrington

organized into patrilocal lineages, and that multiple lineages were aggregated into tribelets, which were the largest political group (Harrington 1942:32) conforming with Kroeber's definition of a tribelet. Harrington (1942:32) also suggested that many villages contained only a single lineage, although multiple-lineage villages also existed. Each village had a single chief, whose authority was hereditary and was most commonly passed to the first son. Customs of marriage are not well documented. Bride price was not formally negotiated, but presents were exchanged for brides (Harrington 1942:30).

The character of contact-era inter-group relationships is suggested by early historic accounts. Fages stated that the natives were "continually at war with their neighbors" (Priestley 1972:58). Accounts from the Mission San Antonio area suggest this characterization was accurate for that area, and that relations were no better among Salinan-speakers than between Salinan-speakers and others. Fages noted:

> They are governed by independent captains, both those near the mission and those who are more remote within the territory mentioned. They are warlike, as are the Indians everywhere else. (Priestley 1972:66, 67)

Intergroup hostilities were again noted by La Perouse, of the French scientific expedition, who observed in the Monterey/Carmel area in 1787 that "the independent savages are frequently at war, but fear of the Spaniards causes them to respect the missions" (Margolin 1989:93). At Mission San Carlos, Father Juan Amoros in 1814 summarized prominent traits of the native speakers of Esselen and Costanoan:

> the captains or kings. There is one for each tribe. They command obedience and respect during their lifetime. This office is hereditary, or in default of an heir by direct descent, it goes to the closest

relative..(Engelhardt 1972:121, 131)

SUBSISTENCE

Kroeber (1925:547) described Salinan-speaking peoples as "completely omnivorous," and all available data support this observation. Members of the Portolá expedition make explicit reference to seed, pine nut, and acorn exploitation, hunting, and fishing by inhabitants of the Santa Lucia Range. Ethnobotanical data recorded by Harrington for the Salinan peoples are long and detailed, indicating use of hundreds of plant foods for a myriad of purposes.

While diet cannot be quantified from the historical record, it seems that, while the inhabitants of Big Sur resided along the Pacific shore and exploited all of the available marine resources, they were not highly marine-focused. Nut processing and hunting are more frequently mentioned in the historic accounts, although most of the direct observations were made in interior settings where an emphasis on marine foods would seem unlikely.

DIVISION OF LABOR

Division of labor for the pre-contact study area can only be approximated from the meager ethnohistoric record based on generalizations made for the broader province of central California. Native populations of this region seem to have conformed with worldwide patterns of gender-specific task appropriation (Lee and Devore 1968:7): men hunted, fished, and manufactured fishing paraphernalia, while women gathered, processed, and manufactured carrying and storage implements (Kroeber and Barrett 1960:95; Willoughby 1963). One important gathered commodity, shellfish, was collected by both men and women (Greengo 1948:20) but was more commonly gathered by females (Willoughby 1963:21).

Fishing is also intriguing with respect to division of labor along gender lines. As Willoughby, Wallace, and Kroeber and Barrett documented, fishing was predominantly men's work in Native California, but fish processing was done by women. Fishing equipment was made by men including the weaving of nets, which was an exception to the general participation of women in weaving tasks.

SUMMARY

Combining descriptions by the earliest Spanish explorers with ethnogeographic insights provided by Harrington's consultants, and the surface archaeological record makes it possible to develop a preliminary portrait of mobility, diet, exchange, political, and social organization for the Big Sur area. Based on Harrington's (1942) conclusions, the small autonomous communities of the Santa Lucia Range (tribelets) were organized into patrilineages. Each tribelet contained multiple lineages, and there is some evidence for the existence of multiple lineages within single villages. Each village had a headman, whose position was inherited. These communities were often at odds with one another, and as Milliken (1990) noted, there is no evidence that territorial friction was restricted to boundaries between different language groups. Rather, there were probably shifting alliances among tribelets and communities.

Descriptions recorded by the Spanish during their passages through the Santa Lucias in 1769 and 1770 indicate that the Salinan-speaking inhabitants of this area employed a settlement/subsistence system that involved periodic movement within bounded territories. At a minimum, migrations were made between between major residential bases, occupied during the fall through spring, and smaller residential sites. Movement away from villages probably took place in the spring and summer when acorn reserves would be exhausted. The location referred to by the Spanish as Los Piñones seems to reflect a temporary residential encampment, focused on the intensive exploitation of one resource by a large number of people for a feast. A profusion of bedrock mortars in this location apparently marks the temporary encampment. These mortars were probably used to process some pine nuts and other vegetable foods during the brief use of this location. Bedrock mortars, in the absence of other cultural deposits, are often regarded as task-specific/logistical sites, reflecting a "collector" (Binford 1980) type of settlement strategy. In this instance, mortars may have been used for a limited array of tasks, but they reflect a large temporary residential association of people, taking advantage of a seasonally restricted resource.

The shell midden associated with the site of *Tr'aktén*, identified as a hunting camp by Harrington's informants, suggests another type of residential base. The location referred to as *Tsapalekwel*, where meat was cut and dried for transport elsewhere, suggests the possibility of yet another type of site.

The surface archaeological record provides additional insights into this system. Individual tribelets apparently contained semi-permanent villages in both inland and coastal settings, although neither of the two coastal villages, *Ts'alák'ak'a'* (CA-MNT-480/H) or *Matalcé* (CA-MNT-1277/H) is situated on the shoreline. Instead, they are situated in oak-woodland settings, ca. 1.8 km inland at elevations ca. 580 m. Both sites are fairly large and are marked by shell middens. The midden at CA-MNT-1277/H was particularly large (63,000 m^2). The identified hunting camp of *Tr'aktén* is marked by a small shell midden with an associated outcrop of bedrock mortars (CA-MNT-1580) at an elevation of 866 m. As bedrock mortars were most commonly used and controlled by women in Native California (Jackson 1991), the occurrence of this feature along with the shell deposit suggests use not by all-male hunting parties, but instead by men and women, perhaps members of a family group or two. The small size of the deposit (2300 m^2) and the absence of much level habitable ground at the site indicate the group had few members. The mortars and shells further indicate use for tasks other than hunting. What can probably be inferred from the archaeological features and ethnohistoric accounts is that in the spring, and possibly other times of the year, villages broke up into smaller kin groups to exploit the rugged uplands of the Santa Lucia Range and the interior. While hunting of upland game may have been a primary focus at these high elevation encampments, a full spectrum of subsistence tasks was pursued. The description of *Ts'ápale'kwél'* as a place where deer were killed and their meat dried suggests that task-specific encampments may have been used to prepare and transport hunted commodities back to the villages. This site was not identified on-the-ground, however, and may reflect an activity that took place only after historic contact.

LINGUISTIC AFFILIATIONS

A Salinan language was apparently spoken by the inhabitants of the *Quiquilit* and *Lamaca* tribelets, while *Ekheahan* was occupied by speakers of an Esselen language. The language spoken by the residents of *Sargenta-Ruc* is a matter of question, but Milliken (1990), who completed the most thorough study of the issue, concluded that *Sargenta-Ruc* was occupied by speakers of Costanoan (Milliken 1990:62; cf. Breschini and Haversat 1993:7; Cook 1974). Costanoan languages were spoken from the Big Sur River north into the San Francisco Bay area, and together with Miwok, constitute the Utian family. Formerly, Utian was considered part of the Penutian stock, defined by Dixon and Kroeber (1913), which also included the Yokut and Maidu languages. It has long been assumed that speakers of Costanoan intruded into the Big Sur coast from the north (Kroeber 1925; Breschini 1983; Moratto 1984). The Esselen language, while poorly known, is most commonly affiliated with the Hokan stock (Beeler 1978:36), although J. P. Harrington suggested a Penutian affiliation (Beeler 1978:8).

Classification of the Salinan and Chumash languages has changed through time. Early linguists alternatively classified Salinan and Chumash as genetically related in a provisional Iskoman stock (Dixon and Kroeber 1913:652) or as isolates within the Hokan stock (Powell 1891; Sapir 1921). Salinan today is still considered a Hokan language, but recent analysis by Turner (1987) found little evidence for a genetic relationship between Salinan and either of its Hokan neighbors: the Esselen to the north or the Chumash to the south (Turner 1987:3). Turner (1987:194) further identified more similarities between Salinan and the unrelated Uto-Aztecan stock, with whom the Salinan shared no common boundaries at the time of historic contact, than with any other language group. Interestingly, Kroeber (1917:379, 380) felt the system of kinship reckoning employed by Salinan speakers was most similar to that employed by Uto-Aztecan speakers of the Great Basin. Turner also found evidence for long and extended contact with Chumash speakers, contact with the Takic and Numic, and evidence for continuous and long-term occupation of the area inhabited at the time of historic contact.

For Chumash languages, Klar (1977:156) concluded that Chumash is best considered an isolate family not closely aligned with any other family or stock. At some level, Chumash might be related to the Hokan languages, the relationship was not a simple one, and probably occurred at an ancient time depth (Klar 1977:156).

LINKING THE ETHNOHISTORIC AND ARCHAEOLOGICAL RECORDS

The ethnohistoric literature provides a partial portrait of settlement, diet, exchange, and social organization along the Big Sur coast for the contact and early historic periods. The archaeological record also has the potential to flesh out these descriptions and, moreover, to illuminate their developmental history. Two of the Native place names linked with archaeological deposits, CA-MNT-1277/H (the village of *Matilcé*) and CA-MNT-1571/H/1580 (the hunting camp of *Tr'aktén*) were investigated for this study. Another site, CA-MNT-480/H (the village of *Ts'alák'ak'a'*), was investigated by Howard (1973). The archaeological data obtained from these sites have been combined with the ethnohistoric information to develop a model of diet, mobility, exchange, and social organization for the contact era and period immediately preceding it (Chapter 8). The ethnohistoric sites also provide general analogs for the interpretation of other deposits.

CHAPTER 4: ARCHAEOLOGICAL METHODS

Data from 30 sites were used in this study. Four were investigated by other researchers (CA-MNT-281, -282, -480/H, and -1942), and findings from two others (CA-MNT-1571/H and -1580) were limited to surface observations. The remaining 24 sites were investigated within a 14-year-period between 1986 and 2000. Twenty-two sites were middens; of which the 18 located near the coast showed high concentrations of marine shell. Not surprising, the five middens in the interior had very low shell content. One site (CA-MNT-1580) was a bedrock mortar outcrop; another (CA-MNT-361) was a bedrock mortar with an associated subsurface hearth feature and scatter of ground stone; two sites (CA-MNT-504 and –507) were bedrock mortar outcrops with flaked stone scatters; two sites (CA-MNT-861 and –1672) were scatters of flaked and ground stone; and two others (CA-MNT-1657 and –1754) were scatters of flaked stone only. The deposits varied in depth and stratigraphic complexity, but most were shallow with little meaningful vertical stratigraphy. The coastal middens all contained large quantities of sea mussel (*Mytilus californianus*) shells -- mostly broken -- within matrices of anthropogenic black soil, and fire-altered rock. Sea mussel shells also dominated the invertebrate fauna from the interior middens. Most of the sites had been spared the serious impacts common to more heavily populated areas of California, but they were all heavily affected by ground burrowing rodents and erosion. Sites in the interior within Fort Hunter Liggett had all been impacted to some degree by military activities although in most cases these were limited to relatively minor surface disturbances. On the coast, many sites in the Big Creek drainage were impacted by wildfires, and disturbances caused by fire suppression activities. Most recently, a fire in 1985 consumed most of the Big Creek drainage, accelerating the erosion.

FIELD SAMPLING

Due to the ubiquity of shell fragments and exorbitant amount of time that can be spent sorting these constituents, sampling shell-rich deposits effectively is a challenge. Use of different mesh apertures can also cause significant disparities in the characterizations of such sites. Historically, shell deposits have been two approached in two ways in California. First, during the early part of this century, shells themselves were generally not collected at all. This strategy was used at the famous investigations of San Francisco Bay middens like the Emeryville Shell Mound (Uhle 1907; Schenck 1926), and Ellis Landing (Nelson 1910). Unburdened by the labor required to collect and sort shell, investigators employing this strategy excavated large volumes, and recovered substantial artifact collections with which they defined types and assemblages and developed cultural chronologies. Later in this century as questions of ecology came into vogue, low volume, high-resolution sampling strategies were developed, focusing heavily on the recovery of microconstiuents (shell and fish bone), often at the expense of wide cross-sections of sites and acquisition of large and statistically meaningful samples of formal artifacts.

My excavation strategy was essentially a hybrid of these two approaches, with an emphasis on holding methods constant. Attempts were made to develop meaningful samples of both macro- and micro-constituents through use of a mixed excavation strategy, involving moderate-sized excavation samples and column samples. In most instances, the ultimate size of the sample recovered from any given site was dictated by the regulatory context of the investigation. To generate samples of artifacts and identifiable mammal remains, 1 x 2 m and 2 x 2 m units were excavated at each site. Most of the coastal excavations involved salvage from eroding sites (see Jones 1988, 1994; Jones and Haney 1992), and unit location and sample size were dictated by the need to focus on the most badly eroding portions of deposits. Salvage recovery volumes, dictated by severity of erosion and available funding, ranged from 2.4 m^3 at CA-MNT-1235 to 20.9 m^3 at CA-MNT-73 (Table 2). Excavations at CA-MNT-759/H, and CA-MNT-1236 were not erosion-related, but were intended as preliminary evaluations. Samples obtained from these locations were small.

The context of work completed in the interior was different in that it was undertaken as part of compliance with Section 106 of the National Historic Preservation Act within Fort Hunter-Liggett Military Reservation. Work at eight sites (CA-MNT-332, -361, -504, -507, -861, -1657, -1672, and -1754) was limited to small-scale testing, with recovery volumes between 2.1 and 7.3 m^3 (Table 2). To accomplish these tests, an additional type of excavation unit was used in sampling flaked and ground stone scatters. Shallow 1 x 2 m units were excavated along horizontal transects (surface transect units or STUs) to define concentrations of materials that could subsequently be sampled with more traditional vertical units. Shovel tests (25 x 25 cm test probes) were also used at interior sites for the same purposes. Larger recovery volumes were obtained as part of large-scale testing at CA-MNT-521 and data recovery at CA-MNT-569. Additional details of investigations completed at the interior sites can be found in the original site reports (see Table 1). One coastal site was also investigated in compliance with Section 106. A large data recovery was completed at CA-SLO-267 in 1996 in anticipation of a widening of Highway 1.

Soils from units were dry-screened through 3 mm (1/8") mesh or 6-mm (1/4") mesh. Some use of larger mesh (6 mm) allows for more rapid soil processing, which, in turn, can increase excavation volumes and enlarge samples of formal artifacts. In cases where 6-mm screen was employed, samples obtained from 3-mm mesh were also collected as controls, particularly for the consideration of fish bone and debitage profiles. All units were excavated in 10-cm increments. Wall profiles were drawn for all sites. Features, including burials, were exposed and drawn. Fire-altered rock was weighed and discarded. The objective in the use of different screen sizes was to efficiently sample artifact and faunal constituents without incurring excessive processing time.

Shellfish remains were sampled by two methods. First, 20 x 20 cm column samples were excavated in 10-cm levels into the sidewalls of completed units. Once retrieved from the field, these samples were water-processed through nested 6-mm (1/4"), 3-mm (1/8") mesh, and 1.5-mm (1/16") mesh. In most instances, two columns were excavated at each site. Shell residues obtained from column samples were used to evaluate relative species abundance and to reconstruct diet. Second, whole and nearly-whole (30% or more) shells were saved from all excavation units for use as dating samples and to evaluate the mean size/age of exploited shellfish, as an index of harvest intensity and possible overexploitation.

Evaluation of shellfish from columns was based on residues processed through 6-mm and 3-mm mesh only. Because some fish (e.g., anchovies and herring) are so small that their bones are not retained with 3 mm or larger mesh, some column samples were processed with 1.5 mm mesh to recover fish bone. Sorting 1.5 mm samples is extremely time-consuming, and as a result, subsamples of various sizes were used. In one case, the large excavation at CA-SLO-267, residues from an entire 1 x 1 m unit were processed with 1.5 mm mesh and fully sorted. In most other cases, the volume processed with 1.5 mm mesh was very small. Total recovery from the 23 investigated sites was 296.8 m^3, with 204.6 m^3 (68.9%) processed through 6-mm mesh, 90.8 m^3 (30.6%) through 3-mm mesh, and 1.414 m^3 (0.5%) processed through 1.5 mm mesh (Table 2).

LABORATORY PROCESSING

Cultural materials recovered from the field were placed in labeled bags and transferred daily to a field laboratory. Upon arrival, materials were washed, sorted into analytical classes and cataloged. Cataloging prefixes were provided by the California Department of Parks and Recreation for sites CA-MNT-63, CA-MNT-376, and CA-MNT-73, by U.C. Santa Cruz for CA-MNT-759/H, -1223, -1227, -1228, 1232/H, 1233, -1235, -1236, and -1277/H, and U. C. Santa Barbara for CA-SLO-267. The remaining sites were cataloged according to specifications of the Fort Hunter Liggett Military Reservation.

ANALYTICAL TECHNIQUES

Once materials were recovered, washed, and cataloged, they were divided into discrete analytical classes. Each set of items was then subjected to specific analyses discussed below.

Table 2 Summary of Subsurface Investigations

Site	Total excavation volume (m^3)	Volume (m^3) screened through 6 mm (1/4 in) mesh	Volume (m^3) screened through 3 mm (1/8 in) mesh	Volume (m^3) screened through 1.5 mm (1/16 in) mesh
		COASTAL SITES		
CA-MNT-63	4.6	1.4	3.2	0.0040
CA-MNT-73	20.9	0.0	20.9	0.0480
CA-MNT-759/H	2.9	0.0	2.9	0.0023
CA-MNT-1223	13.4	0.0	13.4	0.0120
CA-MNT-1227	9.0	5.2	3.8	0.0061
CA-MNT-1228	14.7	13.1	1.6	0.0027
CA-MNT-1232/H Stratum II	5.4	2.8	2.6	0.0035
CA-MNT-1232/H Stratum I	9.1	7.2	1.9	0.0018
CA-MNT-1233	10.0	6.6	3.4	0.0187
CA-MNT-1235	2.4	0.0	2.4	0.0000
CA-MNT-1236	2.0	0.0	2.0	0.0000
CA-MNT-1277/H	8.5	3.5	5.0	0.0067
CA-SLO-267	70.3	61.0	8.4	0.8600
Sub total	173.2	100.8	71.5	0.9658
		INLAND SITES		
CA-MNT-332	6.5	5.8	0.7	0.0000
CA-MNT-361	2.1	2.1	0.0	0.0000
CA-MNT-504	3.9	3.9	0.0	0.0000
CA-MNT-507	6.2	6.2	0.0	0.0000
CA-MNT-519	10.5	9.0	1.3	0.2250
CA-MNT-521	24.9	21.6	3.2	0.0760
CA-MNT-569 Midden A	30.1*	28.2	1.9	0.0300
CA-MNT-569 Midden B	2.9	0.8	2.1	0.0280
CA-MNT-861	5.1	5.1	0.0	0.0000
CA-MNT-879	14.7	5.1	9.5	0.0960
CA-MNT-1657	4.4	4.4	0.0	0.0000
CA-MNT-1672	7.3	6.7	0.6	0.0000
CA-MNT-1754	4.9	4.9	0.0	0.0000
Sub total	123.5	103.8	19.3	0.4550
Grand total	296.8	204.6	90.8	1.4140

*Additional 8.24 m^3 recovered from CA-MNT-1942 (7.9 m^3 3 mm mesh and 0.3386 m^3 1.5 mm mesh) (Wolgemuth et al. 2002)

Chronology

Dating was accomplished with ^{14}C, obsidian hydration and source analysis, and typological analysis of temporally sensitive shell beads. In addition to the simple, yet critical, objective of defining the temporal parameters of habitation, chronometric analyses were directed toward distinguishing temporally discrete components within overall spans of occupation. Specifics of these analyses are presented below.

Radiocarbon

A total of 131 radiocarbon dates was available from the investigated sites. Seventy-four of these were obtained as part of this study, and 57 were secured by other researchers. Most of the dates in the study came from samples of marine shells that were collected from multiple site proveniences. Because fires occur naturally in this region, charcoal not associated with features was generally avoided for dating samples although 17 charcoal dates were obtained from CA-MNT-1942 by Wolgemuth et al. (2002). All but one of the shell samples (from CA-MNT-1236) that I submitted consisted of single pieces of shell. Three samples obtained by earlier researchers from CA-SLO-267 were made up of multiple fragments. Because all deposits in the study area show signs of bioturbation, samples composed of multiple fragments are likely to contain pieces from different time periods and were therefore considered potentially misleading.

Two dates obtained from CA-MNT-63 were used to establish a marine upwelling correction factor for the Big Sur coast. Recovery context is discussed in more detail in Chapter 5, but the dates were obtained from a historic feature dated, based on associated glass and shell beads, to A.D. 1800-1816. Radiocarbon analysis of an abalone shell taken from this feature yielded an uncorrected date of 440±80 years B.P. (WSU-4053). Charcoal, taken from inside the abalone shell, yielded an essentially modern date of 105.6±0.70 years B.P. (WSU-4054). Sample-specific isotope fractionation analysis was not completed for the shell sample, but the figure of +410 years reported by Stuiver and Polach (1977) was used as a reliable substitute, yielding a date of 850±80 years. The Stuiver and Reimer (1993) computer program, which incorporates a general marine/terrestrial carbon correction that must be supplemented with a regional upwelling correction, was used to convert this value into a calendric age. The local upwelling value developed by Stuiver et al. (1986) of 225±35 years, however, did not bring this date into line with its known age. Rather, an upwelling value of 325±35 was needed to correct the date to the historic age indicated by the associated glass beads. Based on this finding, all shell-derived radiocarbon dates were corrected using the Stuiver and Reimer computer program with an upwelling correction factor of 325±35 years. This value is very similar to a correction factor of 290±35 years developed independently by Ingram and Southon (1996).

Obsidian Hydration and Source Analyses

Obsidian hydration is used as a dating method in many parts of California particularly in areas where organic preservation is poor and radiocarbon samples are hard to come by. Obsidian does not occur naturally in the South Coast Ranges, and it appears in Big Sur as a trade commodity that was imported from distant sources in the North Coast Range and the eastern Sierra Nevada. A total of 295 pieces of obsidian was recovered from the excavated sites. All of these were first submitted for XRF analysis to determine source, and then hydration measurements were made. Source determinations for the coastal sites were made by Dr. Paul Bouey while specimens from the interior sites were analyzed by Biosystems Analysis and Northwest Obsidian Laboratories. Hydration measurements were made by Thomas Origer, Biosystems, and Northwest Obsidian Laboratories. Many pieces were too small for XRF analyses, while others produced either diffuse or no hydration. The total number of specimens for which both hydration and source were secured was 236.

The challenge in using obsidian as a dating tool is to determine the correlation between hydration rim thicknesses and absolute time. Prior to the current study, no obsidian data were available from the Big Sur coast, but some comparison between hydration band thickness and radiocarbon profiles had been reported from areas to the north and south. Findings from CA-MNT-229 (Dietz et al. 1988; Jones and Jones 1992), where a well-delineated Middle Period component was identified were particularly important because of a large hydration sample and coherent radiocarbon results (Figure 7). Another site investigated for the current project, CA-MNT-73, produced cohesive radiocarbon results and a large hydration sample from an Early Period component (Figure 8). Radiocarbon and hydration results from these two sites facilitated development of a relative time scale for the two most abundant obsidians: Casa Diablo and Napa obsidian. Data from CA-MNT-229 suggested that readings of 2.0-4.3 microns on Napa obsidian and 2.0-4.6 microns on Casa Diablo obsidian date to the Middle Period (1000 B.C.-A.D. 1250). Data from CA-MNT-73 demonstrate that readings of 3.8-5.1 microns on Napa obsidian and 3.5-5.2 on Casa Diablo obsidian date to part of the Early Period (1500-2500 B.C.). Because the Napa readings were considerably fewer than those for Casa Diablo, it was assumed that a larger sample would bring Napa into alignment with Casa Diablo. Readings from the two sites also show significant overlap which seems to reflect the general imprecision of hydration dating. An idealized hydration time scale, incorporating significant overlap, was developed based on these findings (Table 3).

During the course of the investigations, my opinion on the value of obsidian hydration dating changed. At the onset of the project it was envisioned that obsidian could provide an important source of chronological information. After working with the hydration data for a decade, however, it became apparent to me that obsidian is a very imprecise dating tool and that there is little reason to rely on it in the face of abundant, and more precise radiocarbon results. Because obsidian is important as an index of inter-regional trade relationships, however, there is some reason to attempt to control its temporal dimension, but it was not to be relied upon as a primary chronometric datum in this study.

Table 3 Obsidian Hydration Time Scale for the Big Sur Coast

Period	Dating	Napa, Casa Diablo, uncorrected hydration readings (microns)
Late-Protohistoric	A.D. 1250-1769	0.9-2.4
Middle-Middle/Late Transition	1000 B.C.-A.D. 1250	2.0-4.6
Early	3500 -1000 B.C.	4.2-6.2
Millingstone	Pre 3500 B.C.	Pre - 5.6

Beads and Temporally Sensitive Ornaments

While the shell bead types found in the Big Sur area had never been documented before this study, there was little reason to suspect that types would fall outside of the established typologies for the greater provinces of California and the Great Basin. Accordingly, shell beads were classified with reference to the Bennyhoff and Hughes (1987) typology, with some use of Bennyhoff and Fredrickson (1967) and C. King (1982, 1990). Dating suggested in Bennyhoff and Hughes (scheme B1) and King (1990) was compared with the contexts of the Big Sur finds to define the dating most applicable to the local situation. Glass beads, found at only two sites, were classified according to the Kidd and Kidd (1970) typology.

Flaked Stone Analysis

Flaked stone residues, whether indicative of settlement strategies and mobility or not (Bamforth 1991), are inevitably influenced by technology, and type and distribution of raw materials. Accordingly, analysis of the Big Sur flaked stone assemblages included attempts to identify sources of raw material and understand local stone tool technologies through experimental replication.

Sources of Raw Material

Other than obsidian that was traded to Big Sur in the form of complete bifaces, the most common tool stones in this area are Franciscan and Monterey cherts which occur as products of discrete geological formations. The Franciscan Formation, a melange of volcanics, metavolcanics, sandstone, shales, shists, and occasional chert, occurs along the western flank of the Santa Lucia Range, at Big Creek, and the mouth of the Big Sur River, where it extends from shoreline to 2-3 km inland (Figure 9). Cherts commonly associated with this formation are green, red, orange, yellow, brown, and tan, with frequent mottling of multiple colors. Franciscan chert occurs in cobble form in many coastal drainages. Two sites investigated for this study (CA-MNT-63 and -73) were associated with a source of cobbles in the Big Sur River. An abundance of flaked stone at the mouth of Kirk Creek (Gibson et al. 1976), south of Big Creek, suggests that Franciscan chert cobbles may occur at that location.

The Monterey Formation was named in 1914 for extensive beds of siliceous shales near the town of Monterey (Parsons 1990:28). The formation is found in the coast ranges of central and southern California between San Diego Bay in the south and Point Arena in the north. It generally occurs in a band 20-50 km wide, although in the center of its range, there are two parallel bands with the interior one 80-90 km wide (Parsons 1990:39). Dating to the middle Miocene, this formation contains sandstone, shales, and other sedimentary rocks, with occasional cherts

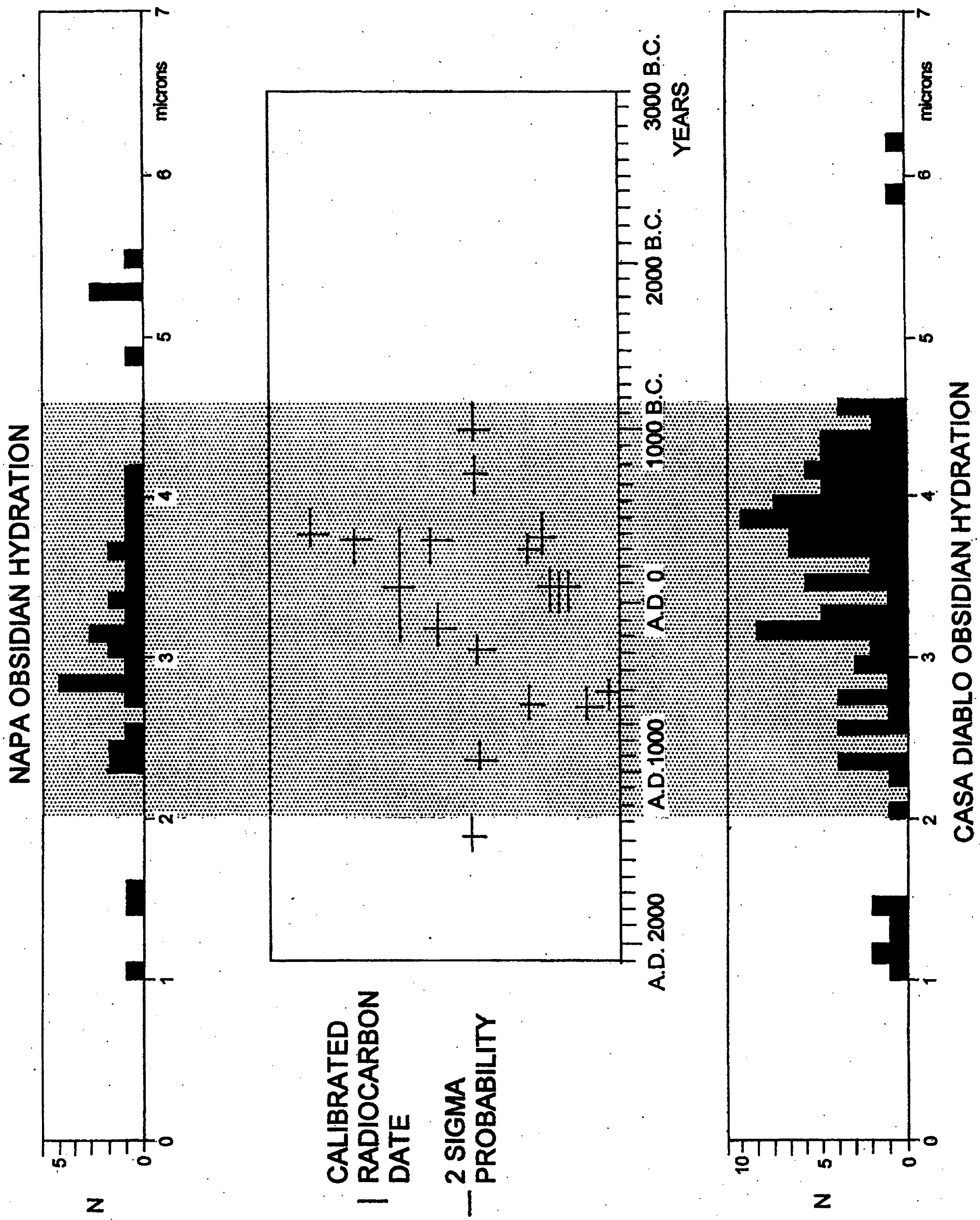


Figure 7 Obsidian Hydration and Radiocarbon Results from CA-MNT-229

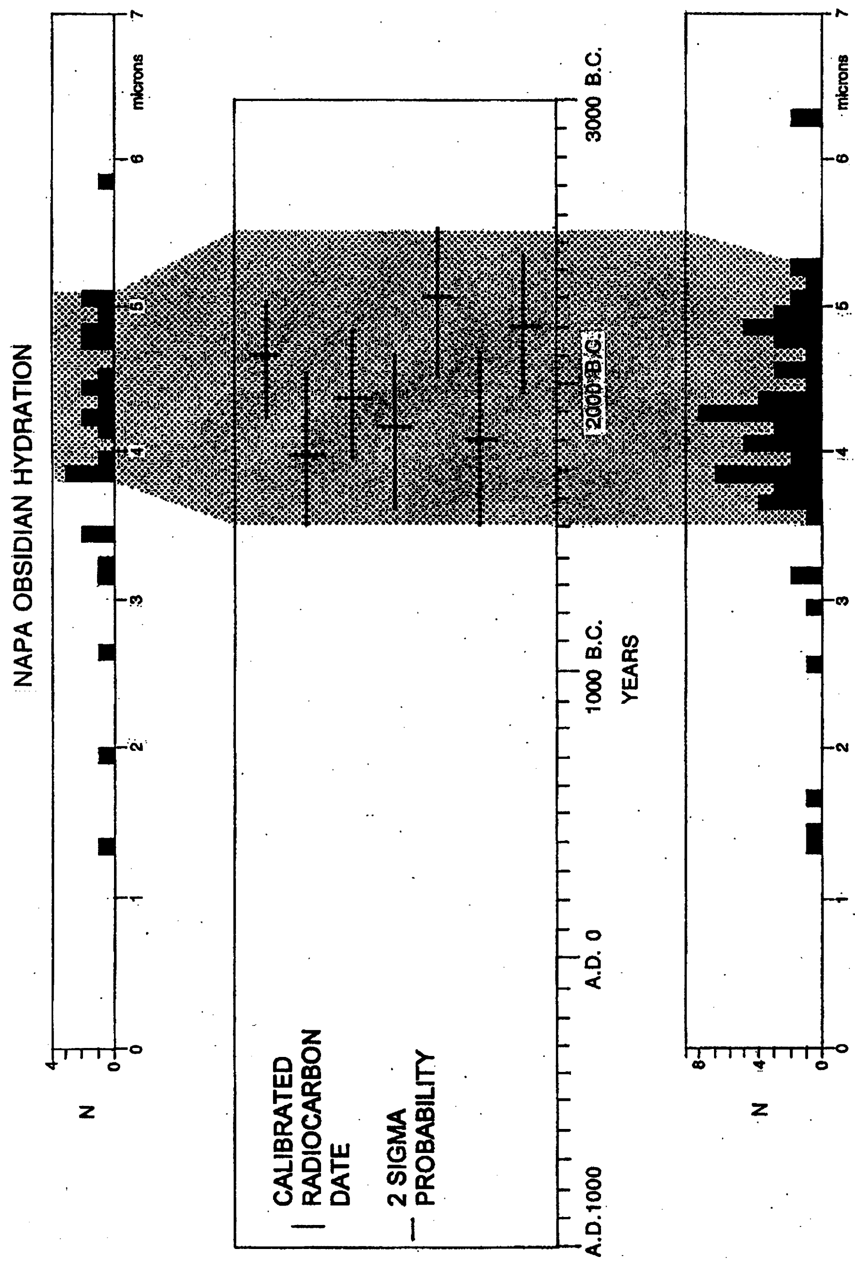


Figure 8 Obsidian Hydration and Radiocarbon Results from CA-MNT-73 on the Big Sur Coast

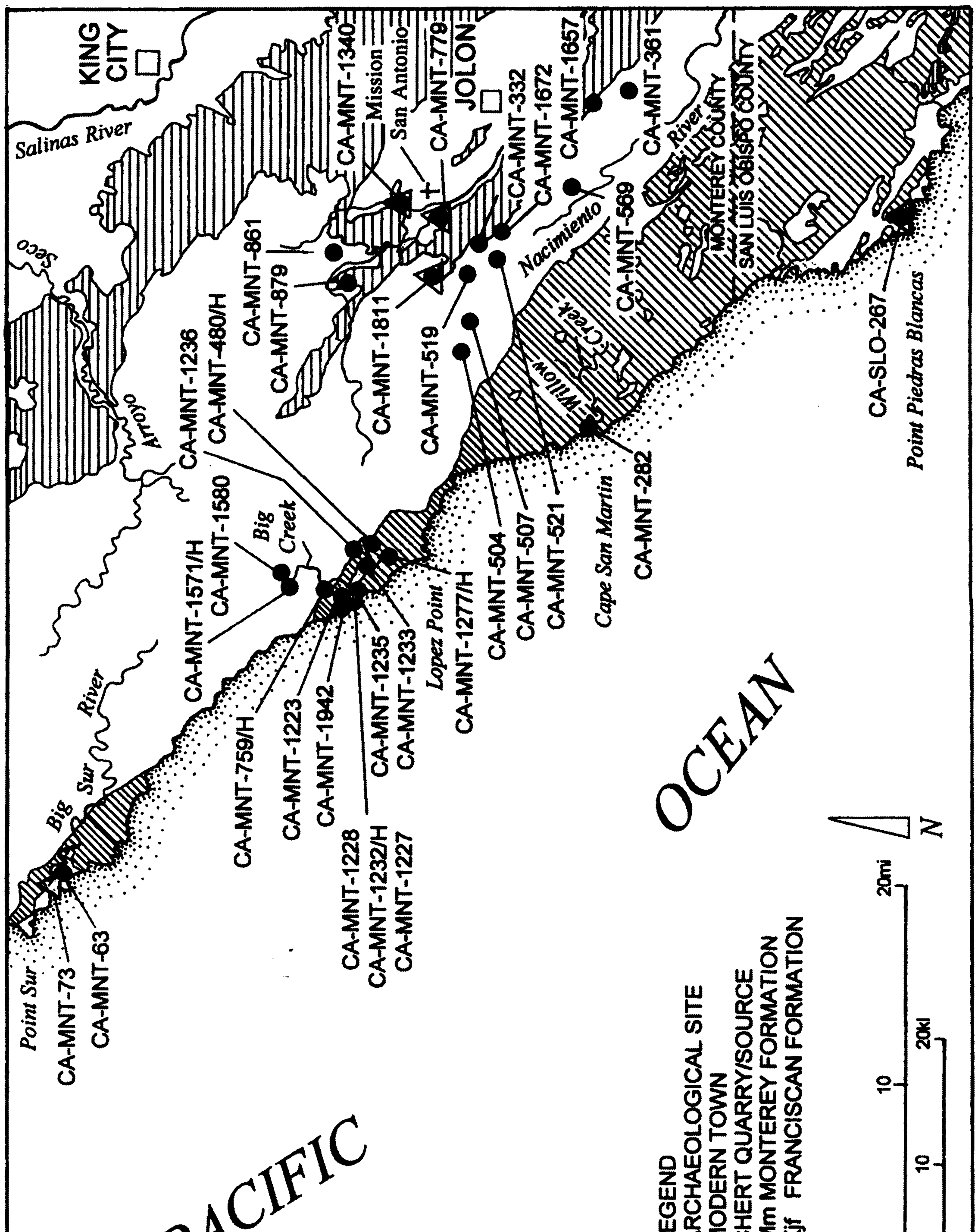


Figure 9 Tool-stone Bearing Geological Formations and Quarry Sites from the Southern Study Area

that tend to be banded in appearance, with alternate layers of white, black, brown, or gray. Heat was frequently applied to these cherts to render them more workable (Parsons 1987, 1990). In the study area, the Monterey Formation occurs inland along the headwaters of Arroyo Seco, and the San Antonio and Nacimiento rivers. At least four significant Monterey chert quarries have been recorded, three inland within the San Antonio River drainage (CA-MNT-779, CA-MNT-1811, and CA-MNT-1340) (Figure 9), and one at Point Piedras Blancas. Many other sources probably occur, as little archaeological survey has been completed in the rugged uplands where the formation outcrops. Conversations with locals suggest that several large quarries are present in the hills east of the community of Lockwood (Figure 9).

Other types of workable stone also occur in the alluvial deposits of the Big Sur, Nacimiento, and San Antonio rivers and Big Creek including quartzite, meta-chert, siltstone, and some igneous rock, but these were used only minimally. Overall, sites at the Big Sur River (CA-MNT-63 and CA-MNT-73) were located in a setting rich with Franciscan chert, sites in the Big Creek area were situated some distance (at least 15 km) from good sources of tool stone, and sites in the interior (Fort Hunter Liggett) were located near several Monterey chert quarries. CA-SLO-267 was located adjacent to a source of Monterey chert cobbles and boulders. Of the 22 sites investigated for this study, Monterey chert dominated the flaked stone assemblages at 20.

Replication

Analysis of the stone tools and debitage from the study sites combined a reduction stage-based classification with replicative work with Franciscan and Monterey cherts. Results of the Franciscan chert study were first reported by Jones and Waugh (1995), as part of the investigation of CA-SLO-175, at Little Pico Creek, just south of the Big Sur coast, where a source of Franciscan chert cobbles, identical to those at the Big Sur River, was identified. Samples of Monterey chert were obtained from CA-MNT-779 and -1813, and specifics of the replication were intially reported by Haney and Jones (1997). Samples of both materials were knapped in an attempt to replicate large bifaces and projectile point types commonly found along the central coast. While there is no way to be certain that the techniques employed were the same as those used by prehistoric stone workers, it was possible to replicate the most commonly occurring types fairly easily.

Franciscan chert from Pico Creek and the Big Sur River occurs in two forms: flat, strongly rounded cobbles and pebbles generally no greater than 10 cm in diameter; and larger, more angular, irregular slabs, generally 15-20 cm in length and 4-7 cm in thickness. Initial reduction of cobbles and slabs was essentially an attempt to generate flake blanks or other pieces large and flat enough to serve as cores that could be reduced into bifacial preforms. The most effective technique for producing suitable cores was bipolar reduction of cobbles. Direct freehand percussion of slabs also yielded usable flakes, but attempts to reduce slabs bifacially into blanks resulted in failures. Flat Franciscan chert cobbles were effectively split into large, flat, useful cores and flakes using the bipolar technique. In many instances, bipolar percussion seemed to be the only way to obtain useful flakes from these sources. Experimentation further showed that the quality of the stone was improved by application of heat (Jones and Waugh 1995).

The Monterey chert samples obtained from CA-MNT-779 and -1813 consisted of large, semi-angular, irregular chunks, generally 10-15 cm in diameter. As with the Franciscan cobble, reduction of these chunks involved generating a flake blank, large and flat enough to serve as a core to reduce into a bifacial preform. In contrast, however, the Monterey chunks proved to be extremely weathered and crumbly, and large quantities of shatter, decortication flakes, and other debris were produced as byproducts of the reduction. Flake blanks were reduced into Stage 3 bifaces that were heat-treated and then pressure-flaked into projectile points.

All of the debitage associated with reduction of single cobbles of each material type was saved, sifted through 3-mm mesh and classified according to the flake types described below. With the Franciscan experiment, only diagnostic flakes were saved and tabulated. For the Monterey chert experiment, a total of 1659 flakes was generated in the creation of a single projectile point. Most of the flakes (N=1056) were non-diagnostic. Using the combined sample of diagnostic and non-diagnostic flakes, ratios of flakes to bifaces were developed as useful indices for evaluating the archaeological collections (Table 4).

Debitage obtained from both replication experiments showed proportional changes in frequency of flake types through the reduction sequence. The 327 diagnostic flakes obtained in reduction of the Franciscan chert cobble showed that no single type is exclusively representative of any one stage of reduction, but that core/flake debitage dominates the collection early and gradually gives way to biface-derived debitage (Table 5). Overall, the collection is dominated by biface-derived debitage (59.5%). Preform production (i.e., reduction of a cobble to obtain a flake blank, in turn, reduced into a Stage 1 biface) shows 73.1% core/flake debitage, whereas reduction of a Stage 1 biface into a Stage 5 tool produces debitage dominated (73.5%) by biface debris (Table 6). The diagnostic debris from Monterey chert showed a different pattern, however, as the reduction was dominated by core/flake debris (N=535; 88.7%) (Table 6). This discrepancy reflects variation in the form in which these materials occur at sources, as the larger Monterey chert chunks produced a greater quantity of non-useable core/flake debris. Debitage profiles obtained from the archaeological sites were compared with the experimental profiles for the appropriate material to assess stages of reduction represented in components.

Table 4 Flake:Biface Ratios from Experimental Reduction of Monterey Chert

Reduction stage	3 mm and 6 mm mesh	6 mm mesh
Flake blank production	760:0	436:0
Reduction of cobble to Stage 5 biface	1659:1	708:1
Reduction of cobble to Stage 1 biface	1215:1	595:1
Reduction of flake blank to Stage 5 biface	899:1	272:1
Stage 1-5 reduction	444:1	113:1
Stage 2-5 reduction	236:1	53:1
Stage 3-5 reduction	75:1	4:1

Analytical Definitions and Methods

Flaked stone was classified on the basis of macroscopic observation into six morphological and functional categories: cores, core tools, bifaces, projectile points, drills, debitage, and flake tools. The length, width, thickness, and weight of all cores, core tools, bifaces, points, and drills were recorded. Additional attributes recorded for cores included type and morphology. Bifaces were classified according to stage of manufacture, following a variation of the Callahan (1979) reduction sequence developed by Gilreath (1989) and Skinner (1986; 1990). Debitage was classified according to twelve flake types defined below.

Cores

Based on the results of the chert replication experiments, cores were defined as any large piece of workable stone, other than a biface or tool, that exhibited at least one exposed scar indicative of working. These included assayed cobbles, large flake blanks, split cobbles, and large pieces of shatter, all of which result from the initial reduction of chert cobbles and slabs.

Core Tools

Core tools are products of a simple core/flake reduction strategy. They are generally cobbles or chunks exhibiting removal of flakes to form a working edge. Many of these could be classified functionally as "choppers," while still others appear to be multi-functional, based on the presence of cutting edges and extensive battering on remaining cortical surfaces. They were uncommon in the assemblages from Big Sur.

Bifaces

Building on the earlier work of Muto (1971), Callahan's (1979) replicative analysis of bifacial tool production provides the most widely accepted system for biface classification in North America. Developed on the basis of an analysis of fluted projectile points from the East Coast of North America, Callahan (1979:9) divided biface production into eight stages, of which only the first five are relevant to non-fluted points:

Stage 1 Obtaining the blank
Stage 2 Initial edging
Stage 3 Primary thinning
Stage 4 Secondary thinning
Stage 5 Shaping

The primary criteria used to define stages in the Callahan system are width/thickness ratios, which are considered indices of cross section (Callahan 1979:18):

Stage 2 2.00-3.00
Stage 3 3.01-4.00
Stage 4 4.01-5.00
Stage 5 4.01-6.00+

Table 5 Experimentally Derived Debitage Frequencies from Bipolar Reduction of Franciscan Chert Cobble (blank production) and Resulting Cortical Flake Blank (blank reduction) into a Stemmed Projectile Point (preform reduction)

Flake Type	Blank Production N	Blank Production %	Blank Reduction N	Blank Reduction %	Stage 1_ Stage 2 N	Stage 1_ Stage 2 %	Stage 2_ Stage 3 N	Stage 2_ Stage 3 %	Stage 3_ Stage 4 N	Stage 3_ Stage 4 %	Stage 4_ Stage 5 N	Stage 4_ Stage 5 %	Total N	Total %
Primary decort.	2	9.5	4	7.0	2	4.3	4	6.3	1	1.4	0	0.0	13	4.3
Secondary decort.	2	9.5	2	3.5	1	2.1	0	0.0	0	0.0	0	0.0	5	1.6
Bipolar	3	14.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	3	1.0
Simple interior	9	42.9	23	40.4	9	19.1	13	20.6	13	17.7	2	4.5	69	22.6
Complex interior	4	19.0	8	14.0	8	17.0	6	9.6	1	1.4	0	0.0	27	8.8
Subtotal	20	95.2	37	64.9	20	42.5	23	36.5	15	20.5	2	4.5	117	38.3
Early biface thinning	0	0.0	5	8.8	4	8.5	4	6.3	6	8.2	1	2.3	20	6.6
Late biface thinning	0	0.0	5	8.8	13	27.7	4	6.3	15	20.5	6	13.6	43	14.1
Edge prep./pressure	1	4.8	10	17.5	10	21.3	32	50.8	37	50.7	35	79.5	125	41.0
Subtotal	1	4.8	20	35.1	27	57.4	40	63.5	58	79.5	42	95.5	188	61.7
Grand total	21	100.0	57	100.0	47	100.0	63	100.0	73	100.0	44	100.0	305	100.0

SUMMARY

Flake Type	Preform Production N	Preform Production %	Stage 1-5 Reduction N	Stage 1-5 Reduction %
Primary decortication	6	7.7	7	3.2
Secondary decortication	4	5.1	1	0.4
Bipolar	3	3.9	0	0.0
Simple interior	32	41.0	37	16.3
Complex interior	12	15.4	15	6.6
Subtotal	57	73.1	60	26.5
Early biface thinning	5	6.4	15	6.6
Late biface thinning	5	6.4	38	16.7
Edge preparation/pressure	11	14.1	114	50.2
Subtotal	21	26.9	167	73.5
Grand total	78	100.0	227	100.0

Decort. = Decortication; Prep. = Preparation.

Table 6 Experimentally Derived Debitage Frequencies from Reduction of Monterey Chert Chunk (blank production) and Resulting Cortical Flake Blank (blank reduction) into a Stemmed Projectile Point (preform reduction)

Flake Type	Blank Production N	%	Blank Reduction N	%	Stage 1_ Stage 2 N	%	Stage 2_ Stage 3 N	%	Stage 3_ Stage 5 N	%	Total N	%
Primary decort.	12	5.2	18	11.5	3	3.0	0	0.0	0	0.0	33	5.5
Secondary decort.	6	2.6	13	8.4	0	0.0	0	0.0	0	0.0	19	3.2
Simple interior	78	33.6	81	51.9	34	34.0	11	21.2	1	1.7	205	34.3
Complex interior	132	56.9	39	25.0	52	52.0	35	67.3	20	35.1	278	46.6
Subtotal	228	98.3	151	96.8	89	89.0	46	88.5	21	36.8	535	89.6
Early biface thinning	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Late biface thinning	0	0.0	0	0.0	4	4.0	2	3.8	0	0.0	6	1.0
Edge prep./pressure	4	1.7	5	3.2	7	7.0	4	7.7	36	63.2	56	9.4
Subtotal	4	1.7	5	3.2	11	11.0	6	11.5	36	63.2	62	10.4
Grand total	232	100.0	156	100.0	100	100.0	52	100.0	57	100.0	597	100.0
Non-identifiable	522		299		108		109		18		1056	

SUMMARY

Flake Type	Preform Production N	%	Stage 1-5 Reduction N	%
Primary decortication	30	7.7	3	1.4
Secondary decortication	19	4.9	0	0.0
Simple interior	159	40.9	46	22.0
Complex interior	171	44.1	107	51.2
Subtotal	379	97.6	156	74.5
Early biface thinning	0	0.0	0	0.0
Late biface thinning	0	0.0	6	2.9
Edge preparation/pressure	9	2.4	47	22.6
Subtotal	9	2.4	53	25.5
Grand total	388	100.0	209	100.0

Decort. = Decortication; Prep. = Preparation.

Callahan's system is often employed with modification in California due to problems with width-thickness ratios. On the central coast, for example, many complete projectile points yield ratios that are less than 3.00. As a consequence, a biface reduction classification employing more qualitative technological criteria was adopted. In this system, applied to California biface industries elsewhere (e.g., Bouey and Basgall 1991; Gilreath 1989; Jones and Waugh 1995; Skinner 1986, 1990) flake or bipolar core blanks, produced from cobbles, are seen as having been reduced through a series of reduction stages, culminating in finished, pressure-flaked bifacial implements (Figure 10). Definition of stages is as follows:

Stage 1 bifaces are thick, crude, bifacial cores. With the locally available Franciscan chert, these bifaces were created by bifacially reducing large heat-treated flakes or small thin slabs. They are generally lenticular or irregular in cross section, with sinuous margins and rough bifacial edges. Less than 50% of the perimeter edge is shaped, except at the ends, and they are irregular in outline.

Stage 2 bifaces, shaped strictly by percussion, are often semi-rectangular in outline. They are generally lenticular in cross section, with closely to semi-regularly spaced flake scars, and exhibit a moderate degree of variability in flake scar morphology.

Stage 3 preforms are percussion-thinned, flattened in cross section, and show relatively regularly spaced flake scars, and a low degree of variability in flake scar morphology. They tend to be regular in outline.

Stage 4 Preforms are thin and partially pressure-flaked. Unlike earlier stages these bifaces reflect intentional shaping to conform with a predetermined outline (Skinner 1990:220).

Stage 5 bifaces are finished, pressure-flaked tools--either a large projectile points or drills, complete with notches, serrations or basal modifications to accommodate hafting (Skinner 1990:220). This class was most useful for characterizing large projectile points that were probably used as atlatl darts or spear tips. Arrow points, which are markedly smaller, were produced via a different reduction sequence in which small flakes were simply pressure-flaked into desired shapes (Figure 11). To adopt it to arrow point industries of the Late Period, arrow point flake blanks, exhibiting pressure flaking, were considered Stage 4 bifaces.

Projectile Points and Drills

Earlier work in the Big Sur area (e.g., Gibson et al. 1976; Pohorecky 1976; Swernoff 1982) illuminated some of the projectile point types that occur in the area, but no formal synthetic typologies were developed before this study was initiated. As with the obsidian hydration and shell beads, some typological research had been completed in areas to the north (Dietz and Jackson 1981; Dietz et al. 1988; Jones and Hylkema 1988) and south of Big Sur (Abrams 1968a, 1968b, 1968c; Greenwood 1972). Building on this research, a typology was developed during the initial phases of the Big Sur study as part of the broader effort to construct a regional culture history. Published in 1993 (Jones 1993), this typology includes the following types: Desert Side-notched (Figure 12), Canalino/Coastal Cottonwood (Figure 13), small leaf-shaped and lanceolates (Figure 14), contracting-stemmed (Figures 15, 16), Rossi Square-stemmed (Figure 17), Large side-notched (Figure 18). The temporal placement of these types will be discussed in Chapter 6.

Drills were another distinct type of stage 5 biface. Implements that exhibited elongated, pointed blades were classified functionally as drills (Figure 19).

Flake Tools

Flake tools are defined as flakes which exhibit patterned macroscopic edge modification (i.e., continuous along a portion of the flake edge). In some instances flake tools reflect a simple core/flake technology, however flake tools could be generated at any stage in either core or biface reduction. Most of the flake tools found at Big Sur were expedient (Figure 20). A few showed intentional shaping, characteristic of formal implements (Figure 21).

Debitage

Debitage was classified according to twelve morphological flake types, which result from reduction of cobbles into bifacial tools and the production of arrow point flake blanks from cores.

Six flake types are most commonly associated with blank production from cobbles and the early stages of biface reduction. Primary decortication flakes are characterized by dorsal surfaces with at least 75% cortex, while the dorsal surfaces of secondary decortication flakes retain from 25-75% cortex. Cortical shatter is angular shatter with 10-75% cortex. Bipolar flakes retain the traits defined by Flenniken (1980), including a sheared bulb of percussion, steep platform angle, and pronounced

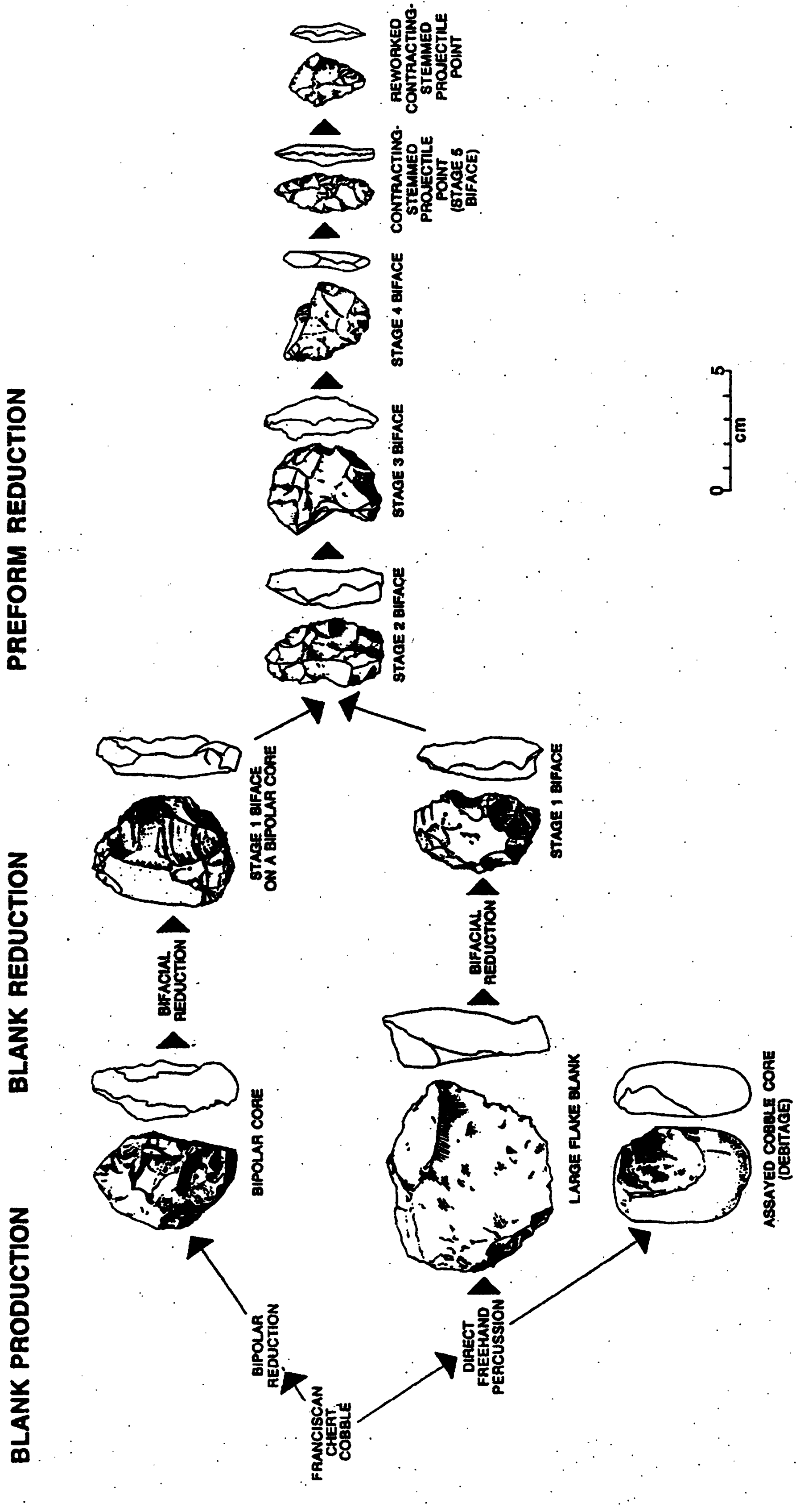


Figure 10 Biface Reduction Sequence for the Big Sur Coast

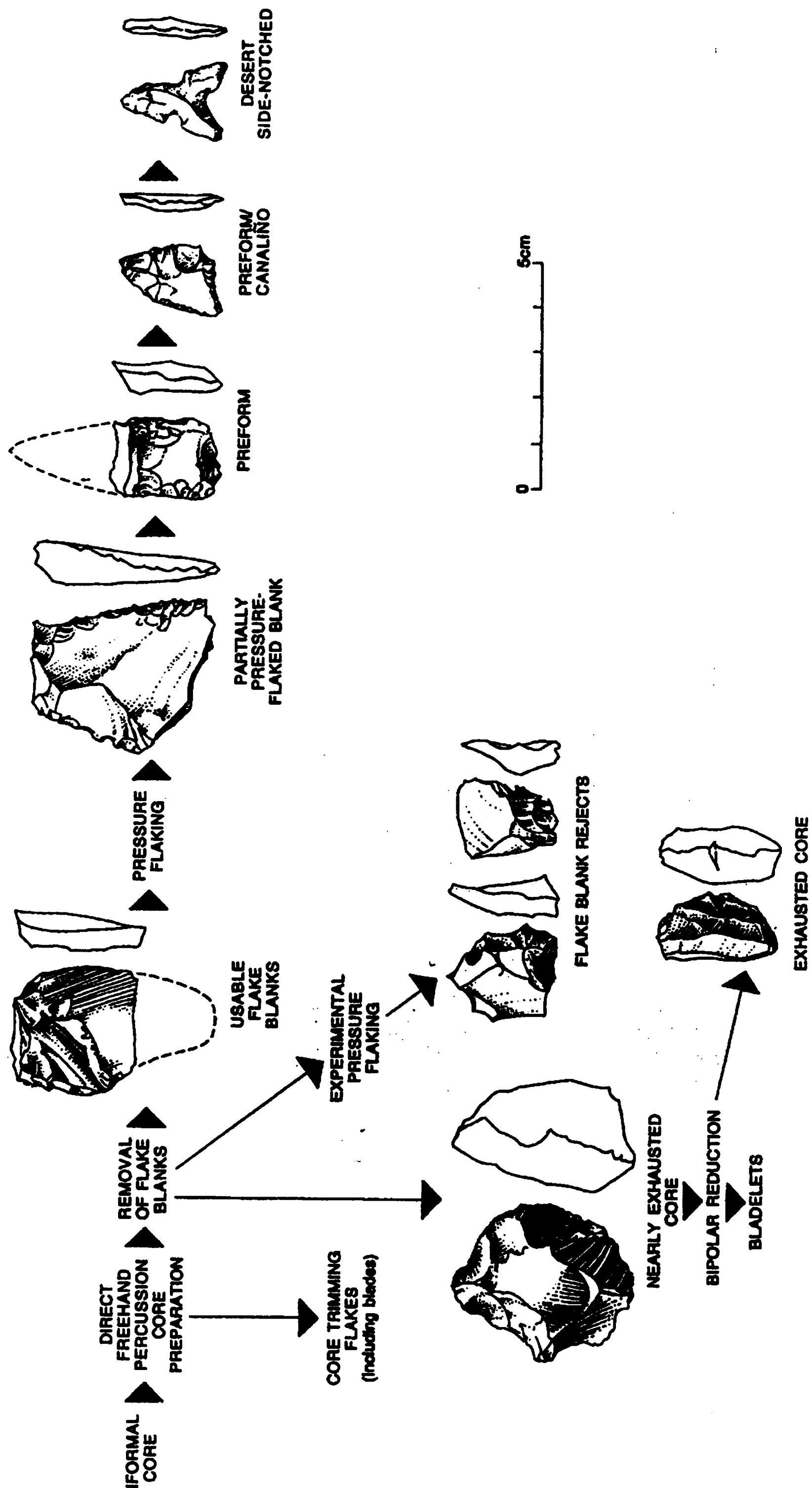


Figure 11 Arrow Point Reduction Sequence for the Big Sur Coast.

Figure 12 Desert Side-notched Projectile Points from Study Sites: a) P893-3-014, b) P893-3-087, c) P893-3-088, d) 894-8-028, e) P894-9-003, f) 504-47, g) 569-600, h) 34-3-03, i) 34-4-04, j) 34-4-20, k) 34-5-37, l) 34-7-18, m) 34-10-5, n) 34-11-45, o) 34-11-45, p) 34-7-30, q) 34-9-19, r) 47-4-21, s) 73-1-23, t) 49-3-5, u) 49-3-6, v) 63-3-105, w) 63-3-14, x) 63-106, y) 63-4-61, z) 63-4-61, aa) 63-4-77, bb) 63-4-129, cc) 63-4-131

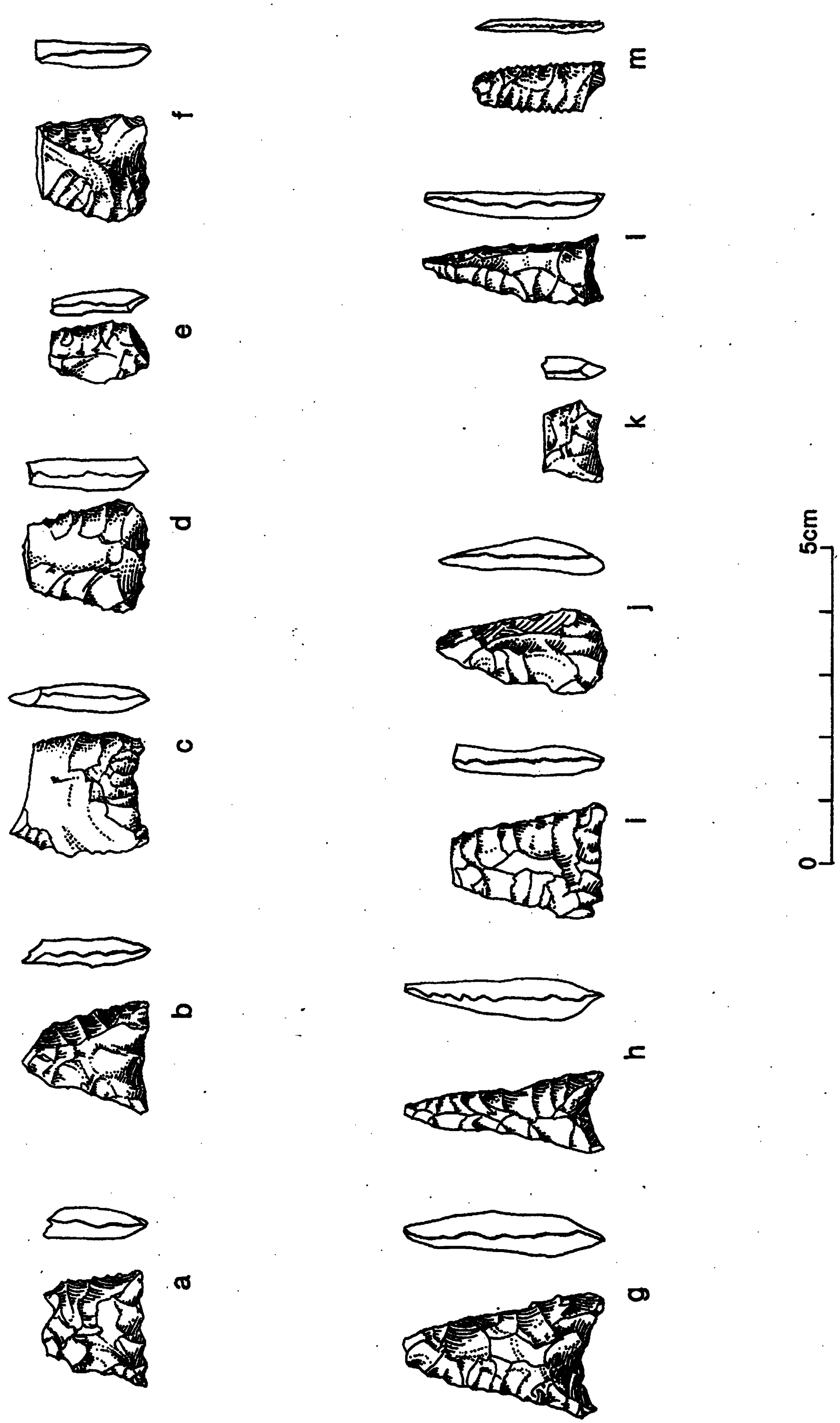


Figure 13 Arrow Points from Study Sites: a) P893-3-04, b) P893-3-25, c) P894-4-02, d) 504-7, e) 569-86, f) 34-7-15, g) 34-7-40, h) 49-2-10, i) 73-1-10, j) 73-1-11, k) 63-3-02, l) 63-4-130, m) 73-1-12

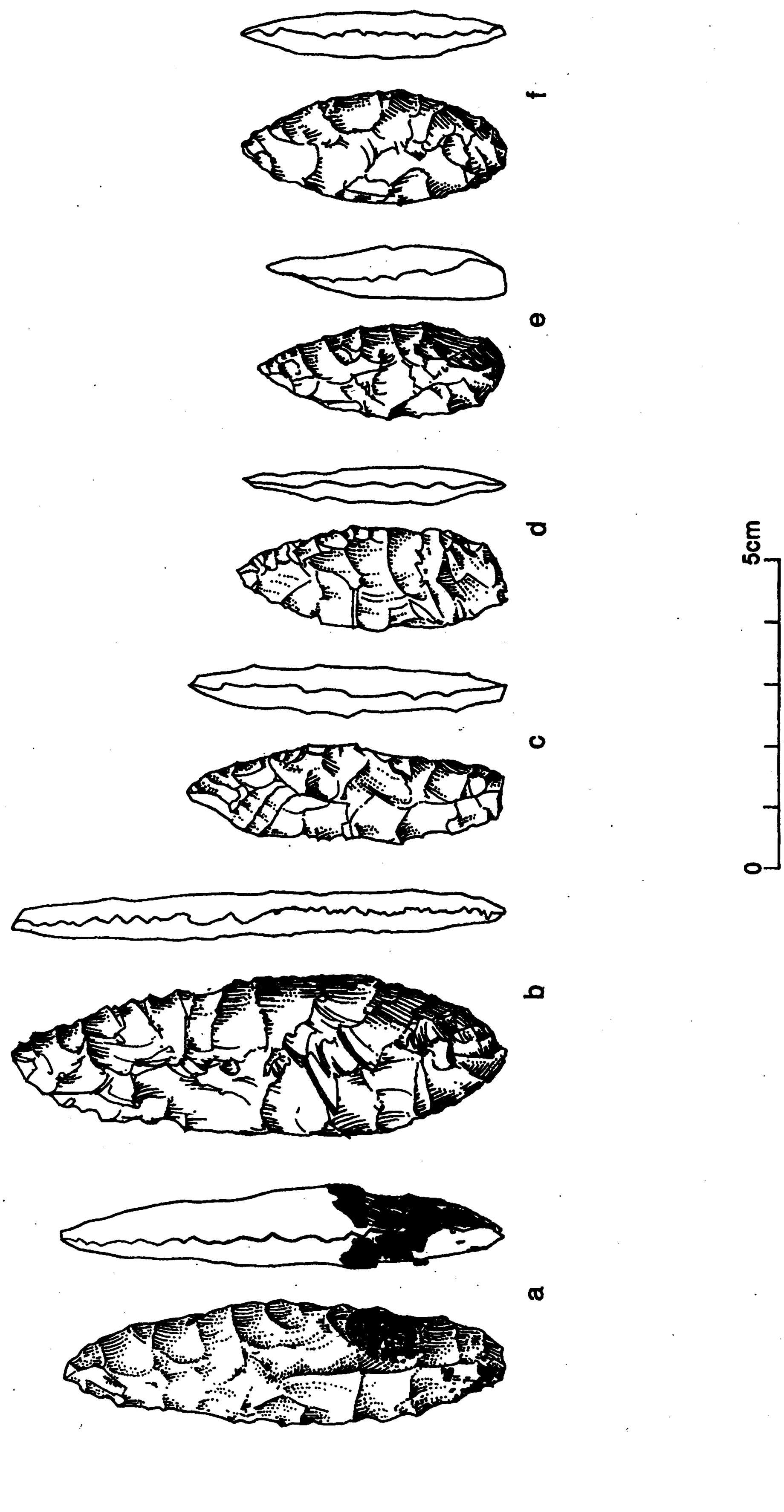


Figure 14 Lanceolate and Leaf-shaped Projectile Points from Study Sites: a) 47-4-122, b) 67-6, c) 48-4-59, d) 48-5-16, e) 67-4, f) 67-5.

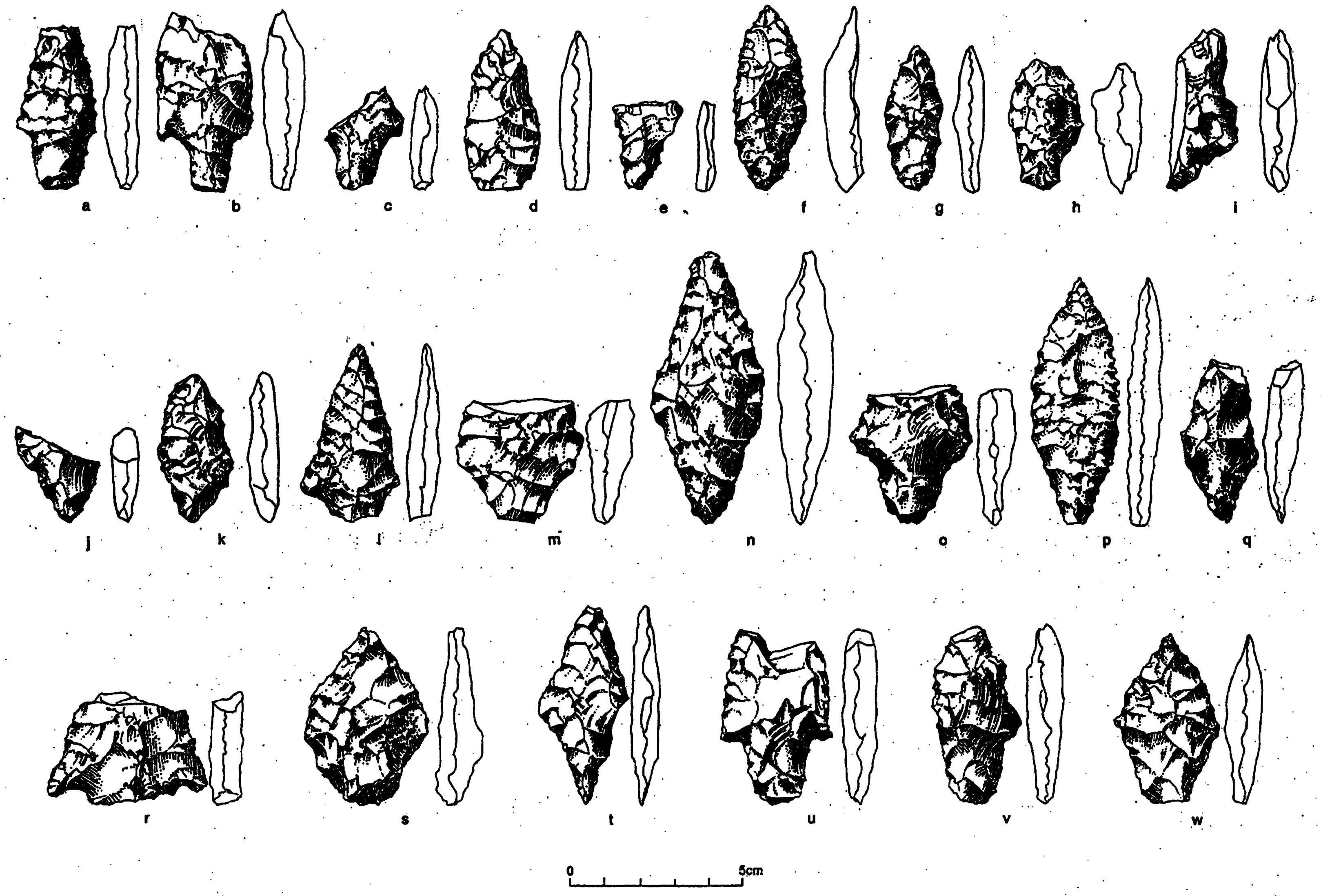


Figure 15 Contracting-stemmed Projectile Points from Study Sites: a) 332-32, b) 332-173, c) 332-174, d)P894-2-3, e) P894-3-003, f) P942-3-094, g) P942-5-043, h) P942-5-063, i) 478-19, j) 478-135, k) P894-11-30, l) 521-51, m) 521-78, n) 521-164, o) 521-208, q) 521-305, r) 521-332, s) 521-391, t) 521-589, u) 521-589, v) 521-687, w) 521-1127.

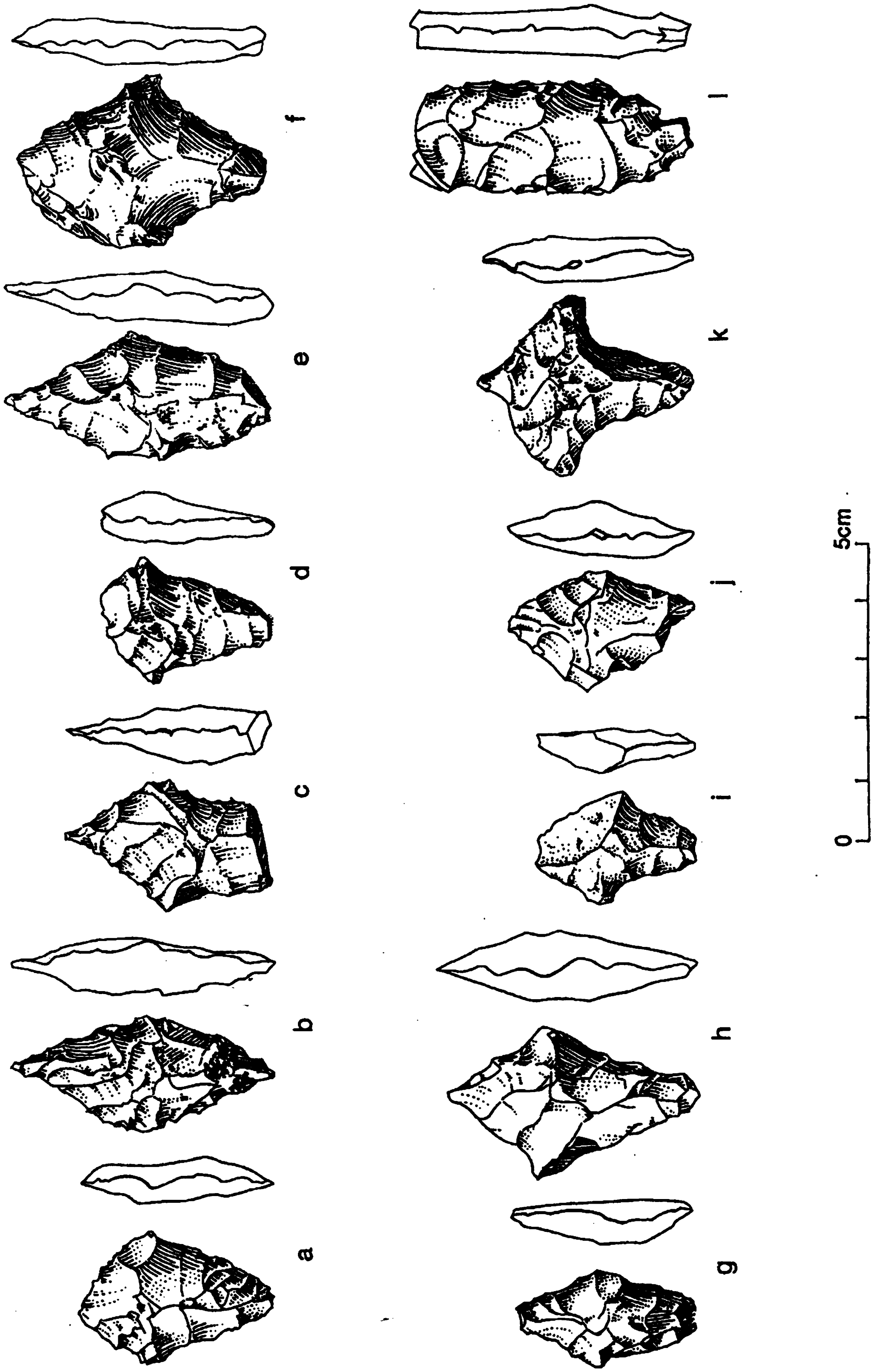


Figure 16 Re-worked Contracting-stemmed Projectile Points from Study Sites: a) P863-2, b) P942-1-055, c) P942-3-010, d) 521-6, e) 521-206, f) 521-941, g) 41-1-19, h) 42-6-33, i) 47-1-12, j) 48-1-85, k) 48-1-85, l) P894-7-057

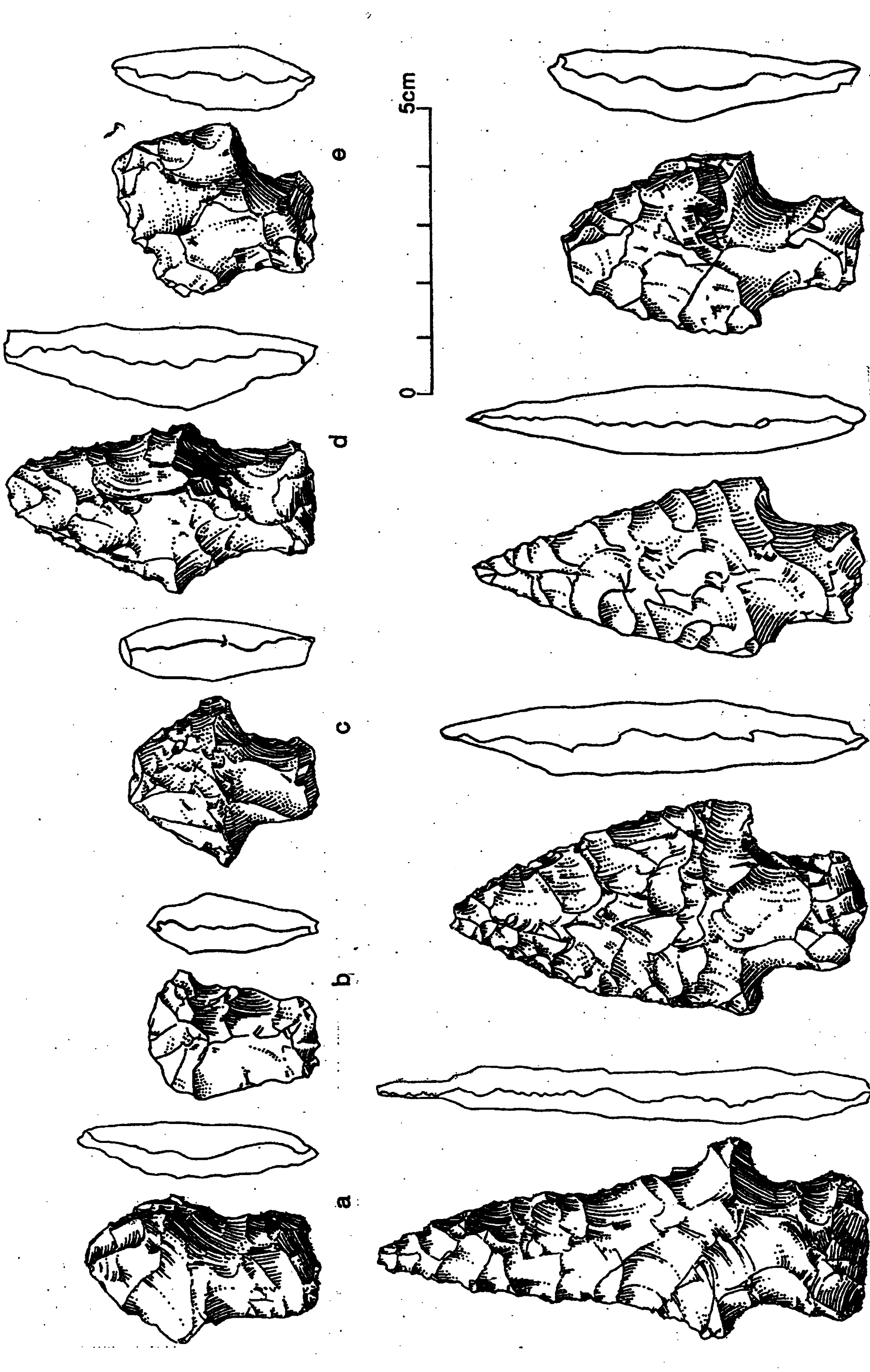


Figure 17 Rossi Square-stemmed Projectile Points from Study Sites: a) P942-4-091, b) 541-323, c) 521-384, d) 521-581, e) 521-904, f) 861-92, g) 42-3-19, h) 48-2-12

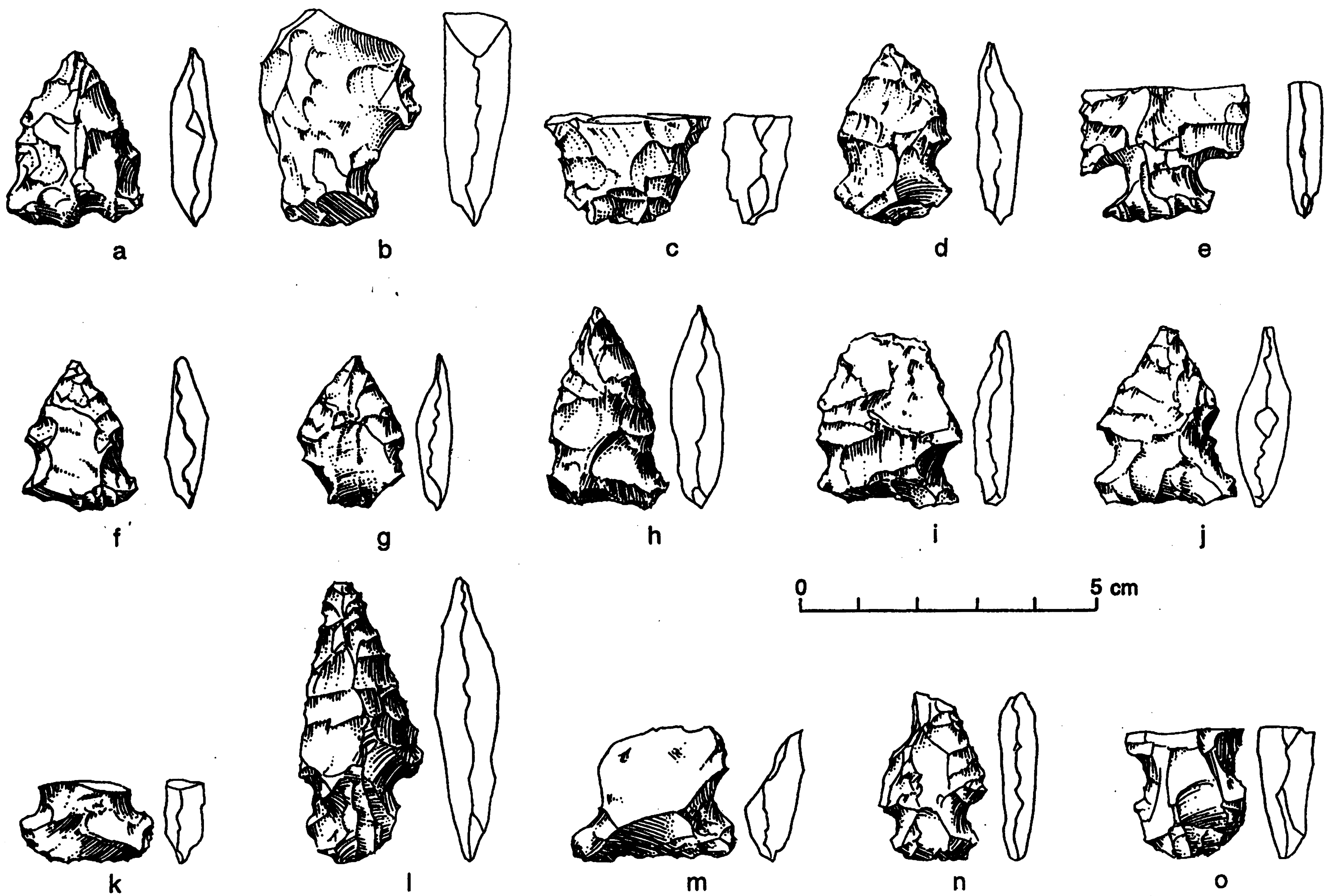


Figure 18 Large Side-notched Projectile Points from Study Sites: a) P893-3-042, b) P942-1-100, c) P942-4-045, d) P942-7-065, e) 478-196, f) 478-191, g) 521-52, h) 521-67, i) 521-76, j)521-642, k) 521-744, l) 569-212, m) 569-220, n) 569-649, o) 569-263

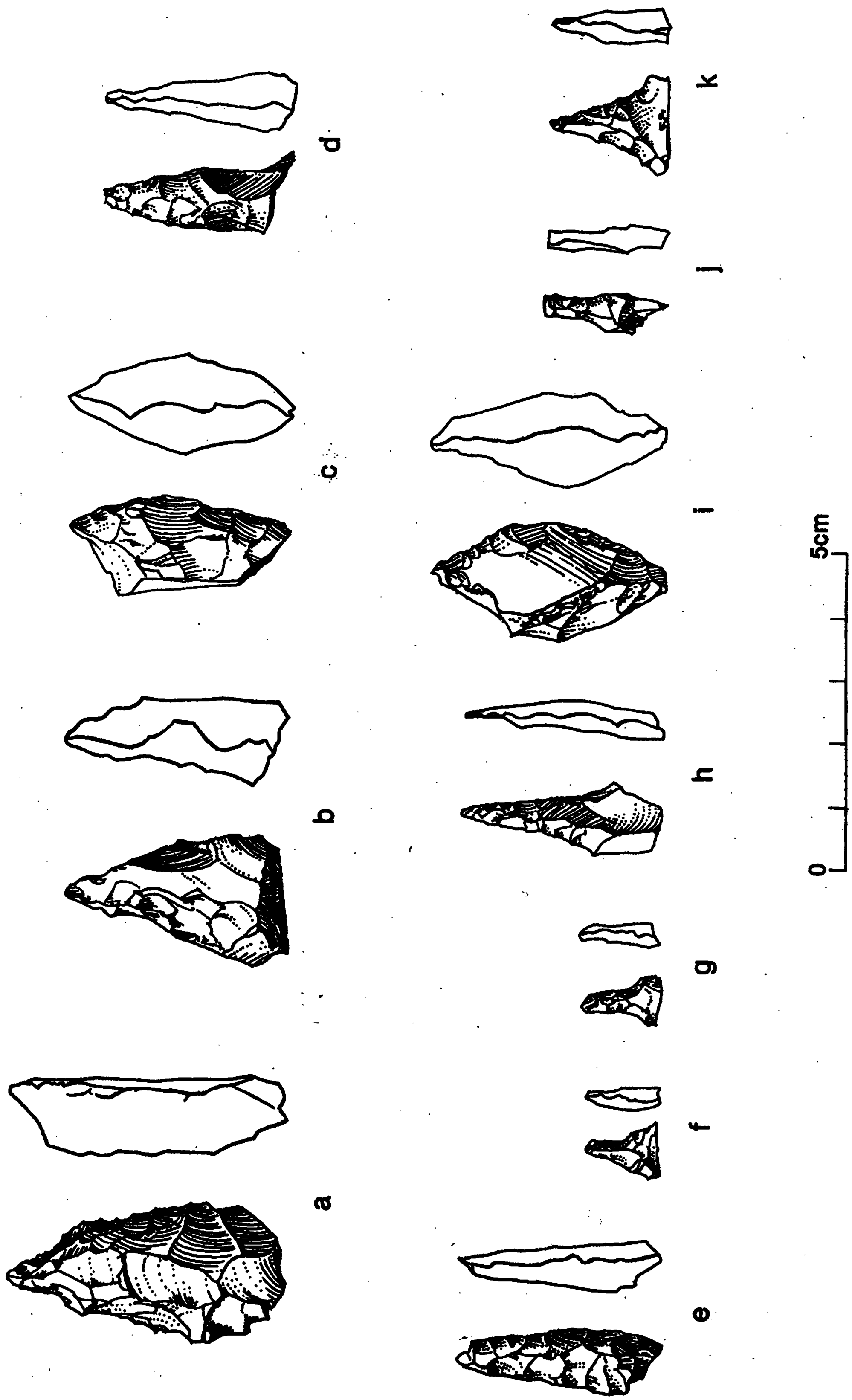


Figure 19 Drills from Study Sites: a) P893-0-001, b) P893-3-017, c) P893-3-132, d) P942-2-068, e) 478-51, f) 34-3-23, g) 34-8-13, h) 34-2-11, i) 34-11-13, j) 34-11-14, k) 34-11-53

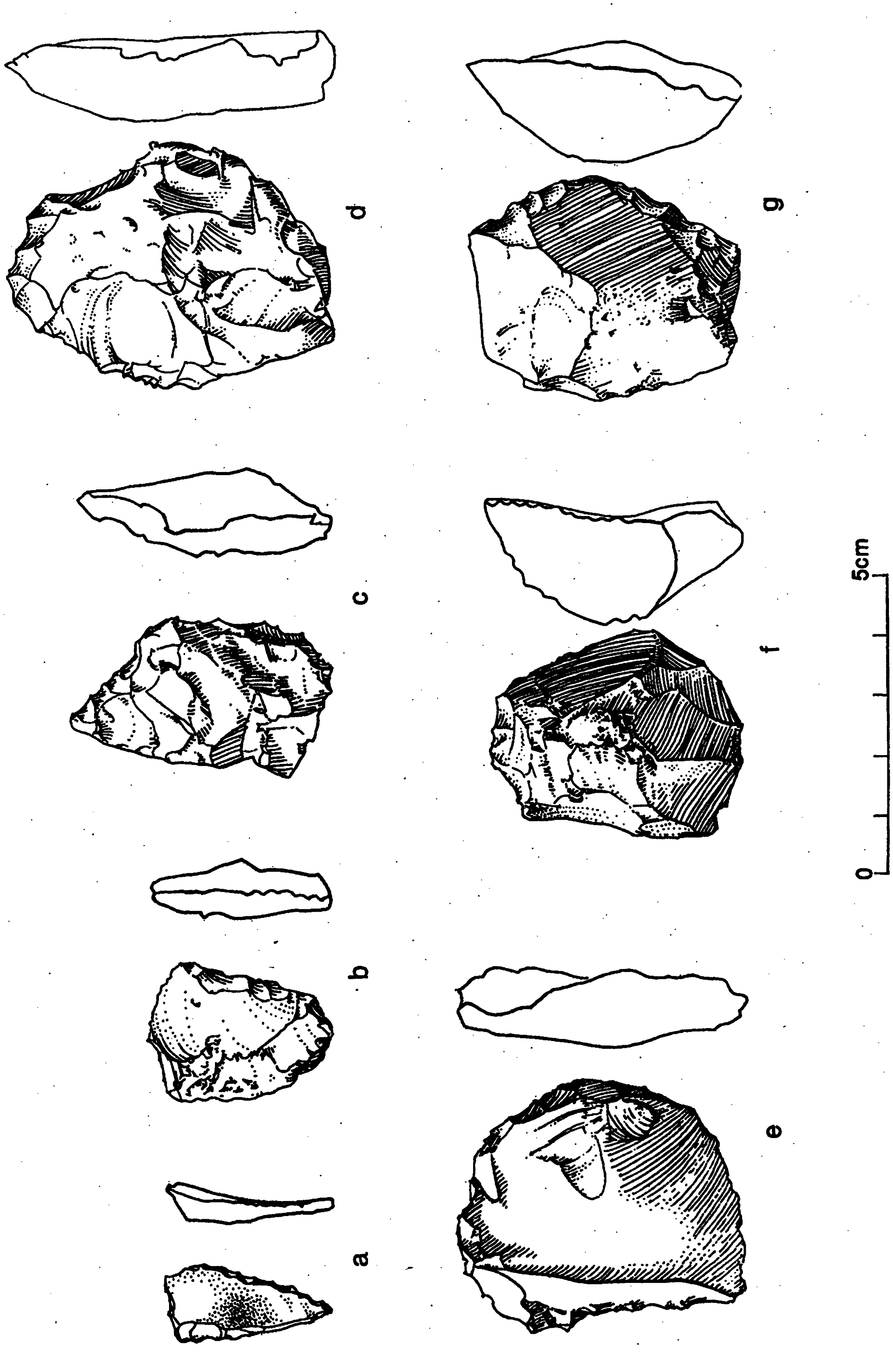


Figure 20 Informal Flake Tools from Study Sites: a) P893-3-003, b) P893-3-037, c) P942-3-164, d) P942-7-100, e) P894-8-017, f) 42-6-16, g) 47-22

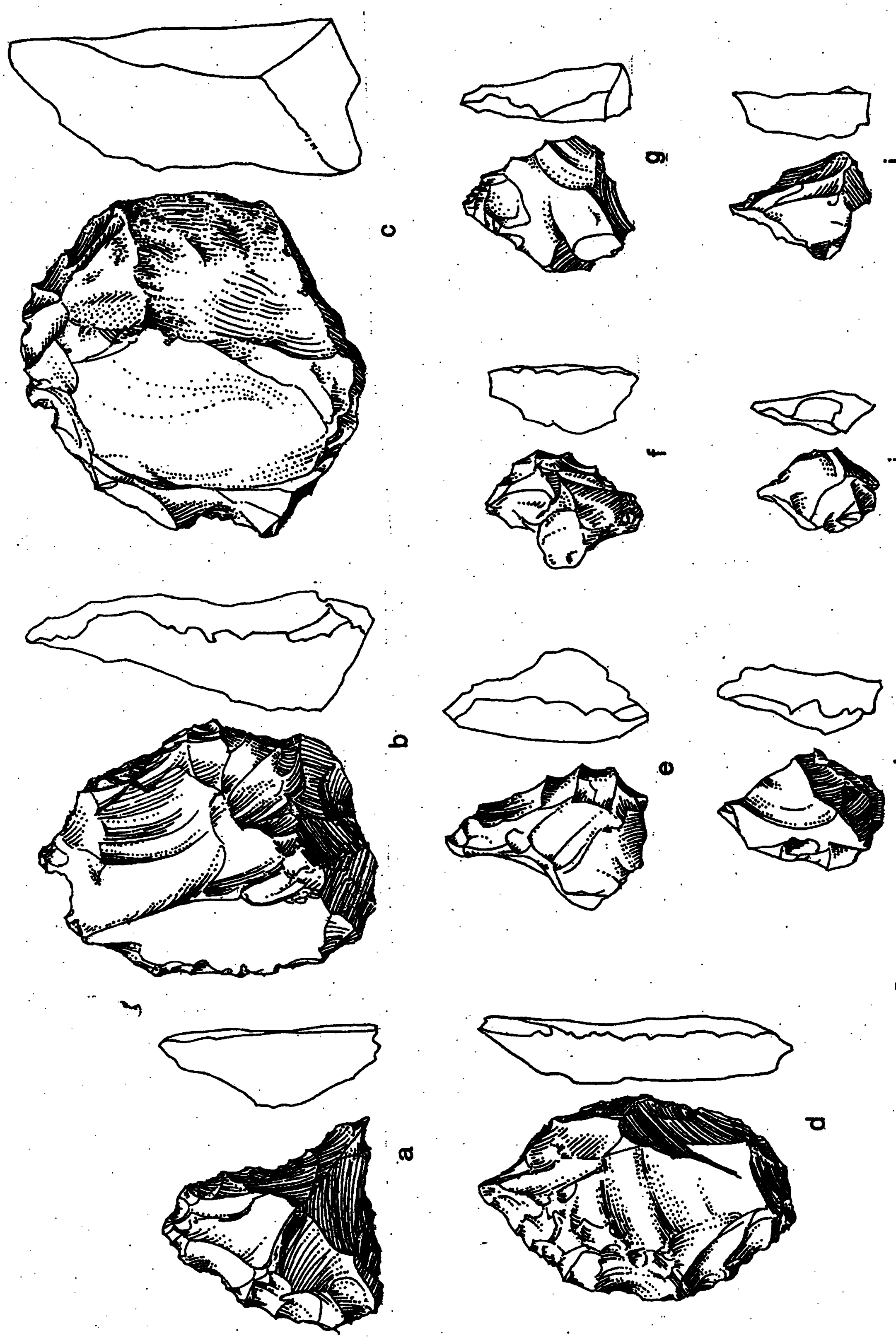


Figure 21 Formal Flake Tools from Study Sites: a) 507-37, b) 1643-30, c) 1637-103, d) 1656-55, e) 40-1-43, f) 40-2-88, g) 40-5-31, h) 40-6-56, i) 40-6-91, j) 40-6-92

compression rings. Bipolar reduction also produces angular and cortical shatter indistinguishable from that generated by direct freehand percussion. Simple interior flakes have less than three dorsal flake scars, and complex interior flakes have three or more. Three flake types are mostly associated with bifacial reduction of blanks into preforms, and preforms into finished tools. Early biface thinning flakes exhibit dorsal complexity, are large, thick and irregular in shape and cross section, and show a great deal of curvature. Late biface thinning flakes are thin and flat, and dorsally complex. Pressure flakes result from the reduction of Stage 3 bifaces to partially pressure-flaked Stage 4 preforms, as well as the reduction of the preform to a finished bifacial tool (Stage 5 biface). Unfortunately, pressure flakes overlap morphologically with edge preparation flakes, and these are combined into a single class: edge preparation/pressure.

Angular shatter and indeterminate percussion flakes can be generated during any stage in the reduction and are considered technologically non-diagnostic.

Two additional flake types were needed to describe core-flake industries represented at several sites. Blade flakes exhibit parallel or sub-parallel lateral edges and are at least twice as long as they are wide (Crabtree 1972:42). Blade flakes result from core reduction and may be incidental byproducts of core trimming. The other ancillary type is a flake exhibiting a few pressure-flaking scars. These reflect the experimental pressure flaking of arrow point flake blanks.

Ground and Battered Stone

Ground and battered stone implements were classified according to conventional morphological/functional types including mortars, pestles, milling slabs, handstones, hammerstones (Figure 22), and notched stones or net weights (Figure 23). In addition to these utilitarian items, locally produced pendants of steatite or talc schist were recovered from many of the sites (Figure 24), as well as natural stone spheres (Figure 25), probably used as gaming pieces.

Bone Tools

Bone tools were also classified according to a simple morphological/functional typology with some reference to Gifford's (1940) descriptive typology. Uncommon in the assemblages, bone tools were often highly fragmented, and many classifications were tenuous. Most abundant were awls (Figure 26), gorge hooks, needles, and pendants (Figure 27).

Shell Artifacts

All of the shell artifacts were classified according to a descriptive/functional typology. Other than beads, the most abundant shell artifacts were fishhooks (Figure 28), and fishhook blanks (Figure 29). Less abundant were shells used for asphaltum application (Figure 30), miscellaneous cut and worked pieces, pendant blanks, and pendants (Figures 31 and 32).

Faunal Remains

The primary objectives of the faunal analysis were to determine the species exploited and their relative frequencies. Once documented, patterns in the faunal assemblages were evaluated with respect to (1) diet; (2) taxonomic diversity; (3) the intensity of human exploitation and the possibility of overexploitation; (4) site function; and (5) seasonality.

Mammals and Birds

All bird and mammal remains were collected from screens in the field. After washing and cataloging, non-identifiable remains were segregated from those judged identifiable to the genus level or better. Taxonomic assignments were made and skeletal elements were determined for identifiable specimens by Dr. Carol Cope using reference collections at the California Academy of Science and the San Diego Museum of Man. Remains from CA-MNT-519, CA-MNT-879, and CA-SLO-267 were identified by Judy Porcasi and Krislyn Taite using reference collections at the UCLA Faunal Laboratory and Sonoma State University Anthropological Studies Center. All of the investigated sites showed clear evidence of recent occupation by ground burrowing rodents, and rodent bones were abundant in the deposits. These elements were identified, and then excluded from further consideration, because there is no way to distinguish intrusive from non-intrusive bones. A total of 1621 non-intrusive elements was identified for the project, summarized as numbers of identifiable specimens per species (NISP) per component. Complete faunal catalogs for the investigated sites are included in the original site reports (see Table 1). For the purpose of reconstructing diet, minimum numbers of individuals (MNIs) were calculated for each 1 x 2 m x 10 cm level. MNIs are highly problematic quantitative units (Lyman 1979; Brewer 1992), of course. They were used in this study only as a means of comparing the edible flesh values of mammals versus shellfish and fish, in order to emphasize the direction of dietary

Table 7 Meat Weights for Birds and Mammals Represented in Faunal Assemblages

Taxon	Common Name	Reference	Mean meat weight (kg)
		MARINE MAMMMALS	
Phoca vitulina	Harbor seal	Hildebrandt (1981:53)	70.00
Zalophus californianus	California sea lion	Hildebrandt (1981:53)	142.00
Arctocephalus townsendi	Southern fur seal	Dietz et al. (1988:344, 348)	72.00
Callorhinus ursinus	Northern fur seal	Hildebrandt (1981:53)	72.00
Enhydra lutris	Sea otter	Hildebrandt (1981:53)	24.00
Eumetopias jubata	Steller sea lion	Hildebrandt (1981:53)	392.00
Delphinus sp.	Dolphin	Mitchell (1988:255)	78.75
		TERRESTRIAL MAMMALS	
Cervus elaphus	Tule elk	Dietz et al. (1988:344, 348)	162.20
Odocoileus hemionus	Black-tailed deer	Simms (1984:89)	34.00
Canis sp.	Dog/coyote	Dietz et al. (1988:344, 348)	6.00
Lepus californicus	Hare	Simms (1984:89)	1.00
Mustela frenata	Weasel	Dietz et al. (1988:344, 348)	1.00
Sylvilagus bachmani	Brush rabbit	Simms (1984:89)	0.60
Taxidea taxus	Badger	Dietz et al. (1988:344, 348)	4.00
Urocyon cinereoargenteus	Gray fox	Dietz et al. (1988:344, 348)	5.50
Taxidea taxus	Badger	Dietz et al. (1988:344, 348)	4.00
Mephitus mephitus	Skunk	Dietz et al. (1988:344, 348)	2.00
Ursus americanus	Black bear	Dietz et al. (1988:344, 348)	90.00
Procyon lotor	Racoon	Dietz et al. (1988:344, 348)	3.00
Lynx rufus	Bobcat	Dietz et al. (1988:344, 348)	2.40
Felis concolor	Mountain lion	Cope (1985)	67.00
		BIRDS	
Pelicanus spp.	Pelican	Dietz et al. (1988:344, 348)	2.80
Anas/Aytha/Melanitta sp.	Duck	Dietz et al. (1988:344, 348)	0.53
Branta/Anser/Chen sp.	Goose	Dietz et al. (1988:344, 348)	2.10
Gavia sp.	Loon	Dietz et al. (1988:344, 348)	2.80
Larus sp.	Seagull	Dietz et al. (1988:344, 348)	0.33
Uria aalge sp.	Murre	Dietz et al. (1988:344, 348)	0.34
Phalacrocorax sp.	Cormorant	Dietz et al. (1988:344, 348)	1.41
Buteo sp.	Hawk	Dietz et al. (1988:344, 348)	1.07
Lophortyx californica	Quail	Estimate	0.20
Strigiformes	Owl	Mitchell (1988:256)	1.59
		INTRUSIVE	
Thomomys bottae	Pocket gopher		
Microtus californicus	Vole		
Spermophilus beecheyi	Ground squirrel		
Perognathus sp.	Pocket mouse		

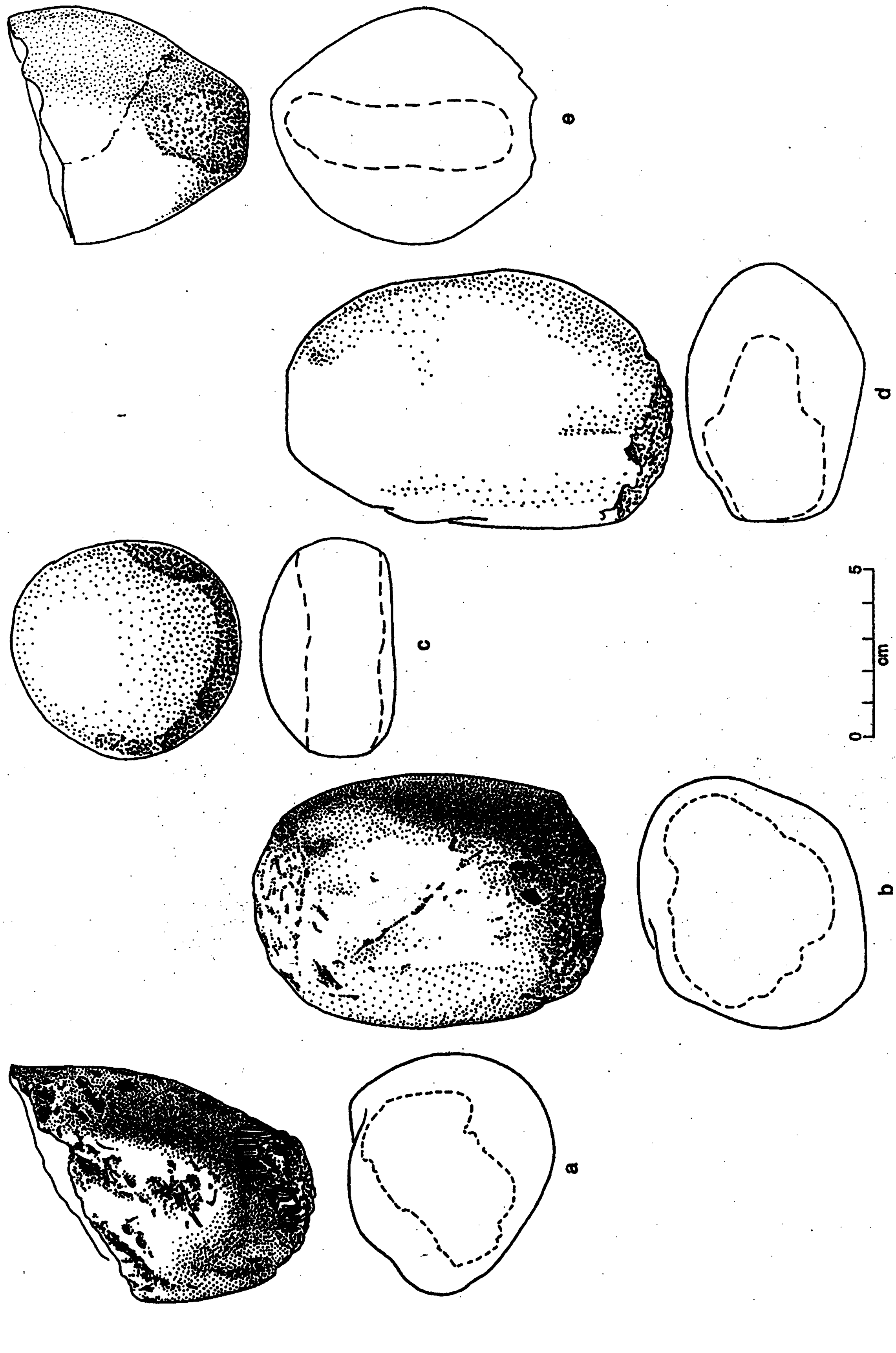


Figure 22 Ground Stone Artifacts from Study Sites: a) P894-3-065, b) P894-3-017, c) P894-7-042, d) P894-8-069, e) P894-8-080

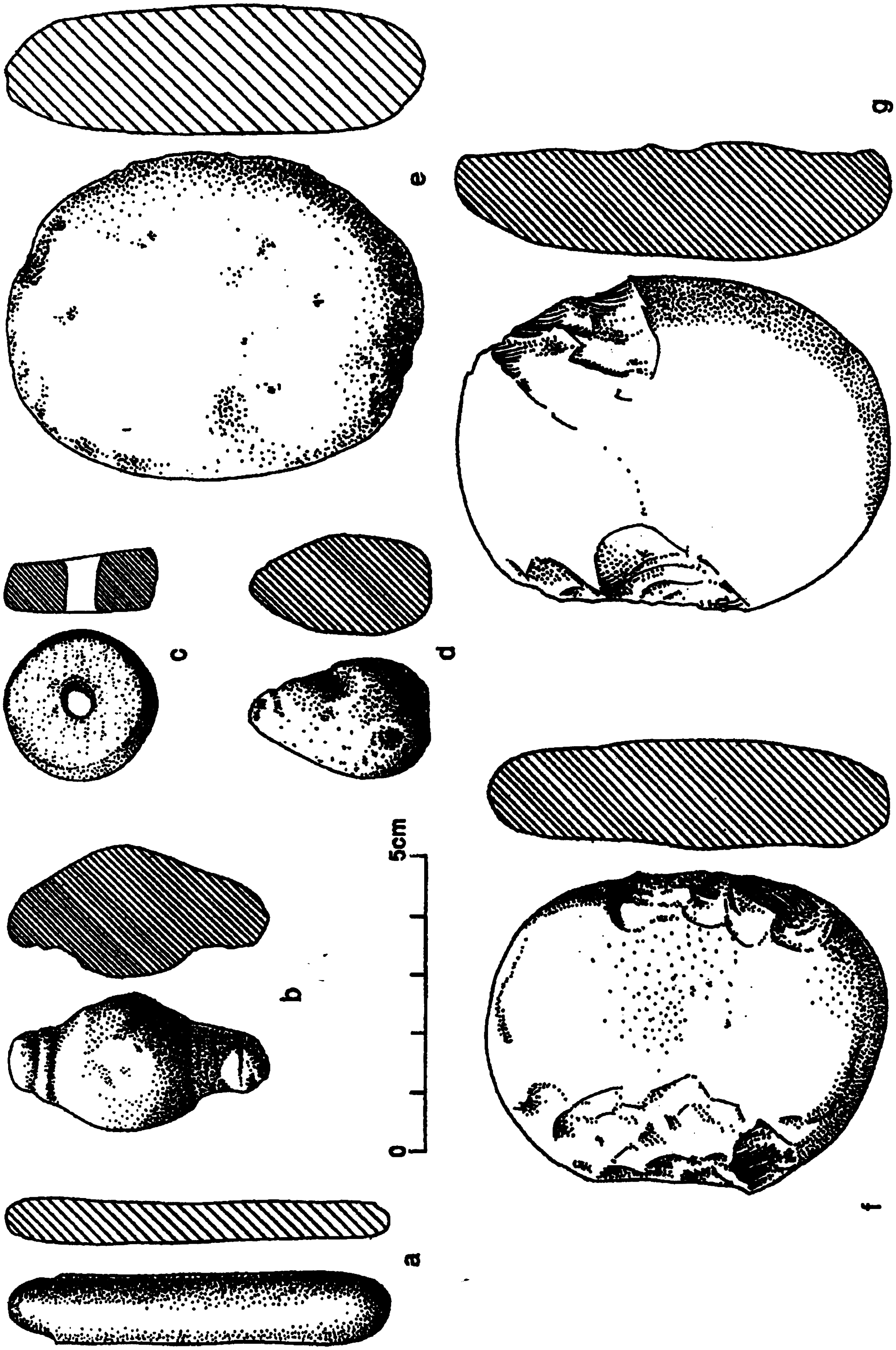


Figure 23 Ground Stone Artifacts from Study Sites: a) 34-5-35, b) 40-2-86, c) 48-1-33, e) P942-3-056, f) 63-2-011, g) 63-4-071

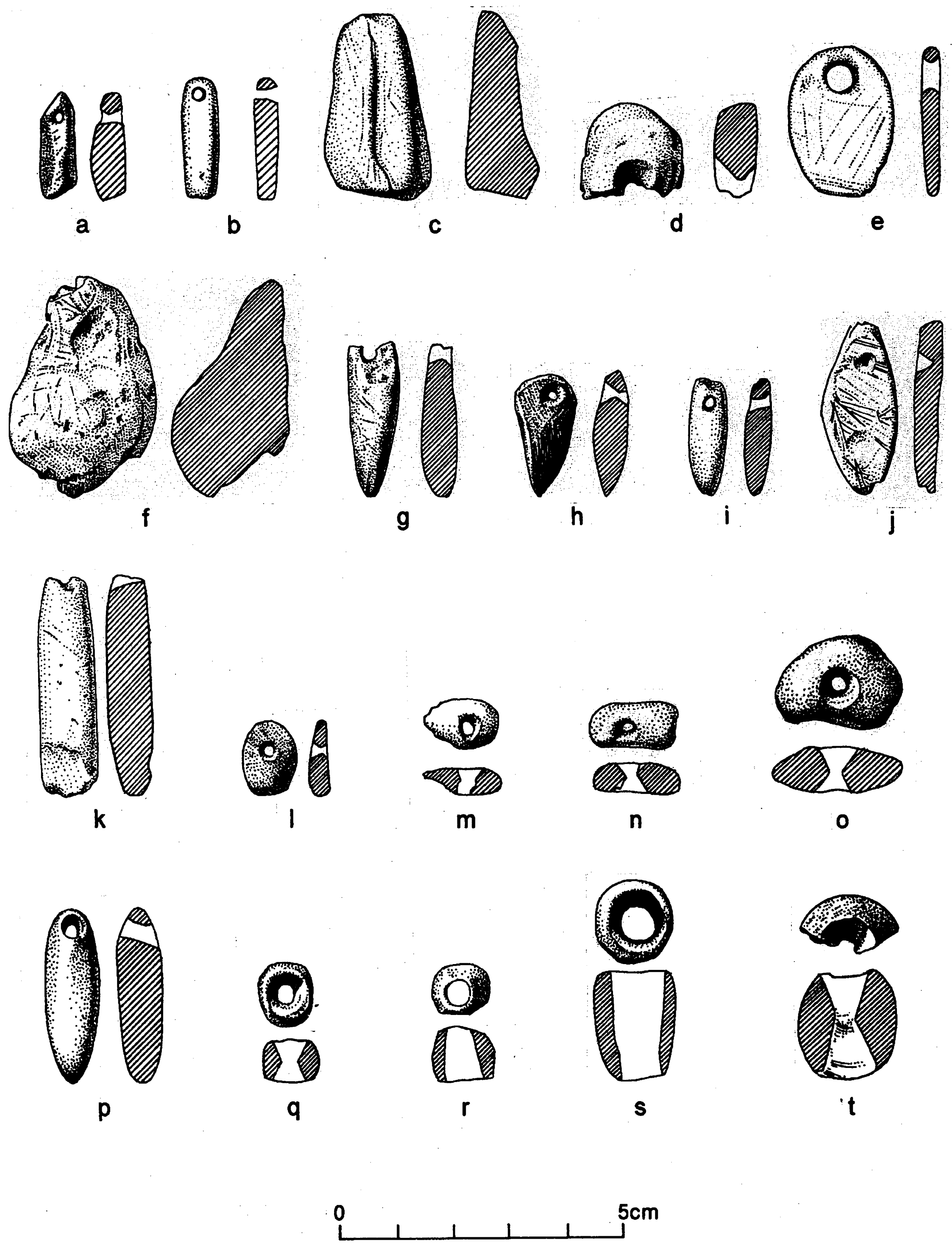


Figure 24 Steatite Artifacts from Study Sites: a) P894-7-029, b) 34-3-37, c) 42-2-42, d) 42-3-08, e) 42-4-17, f) 47-18, g) 47-1-7, h) 47-7-43, i) 47-4-26, j) 47-4-36, k) 47-4-37, l) 47-5-22

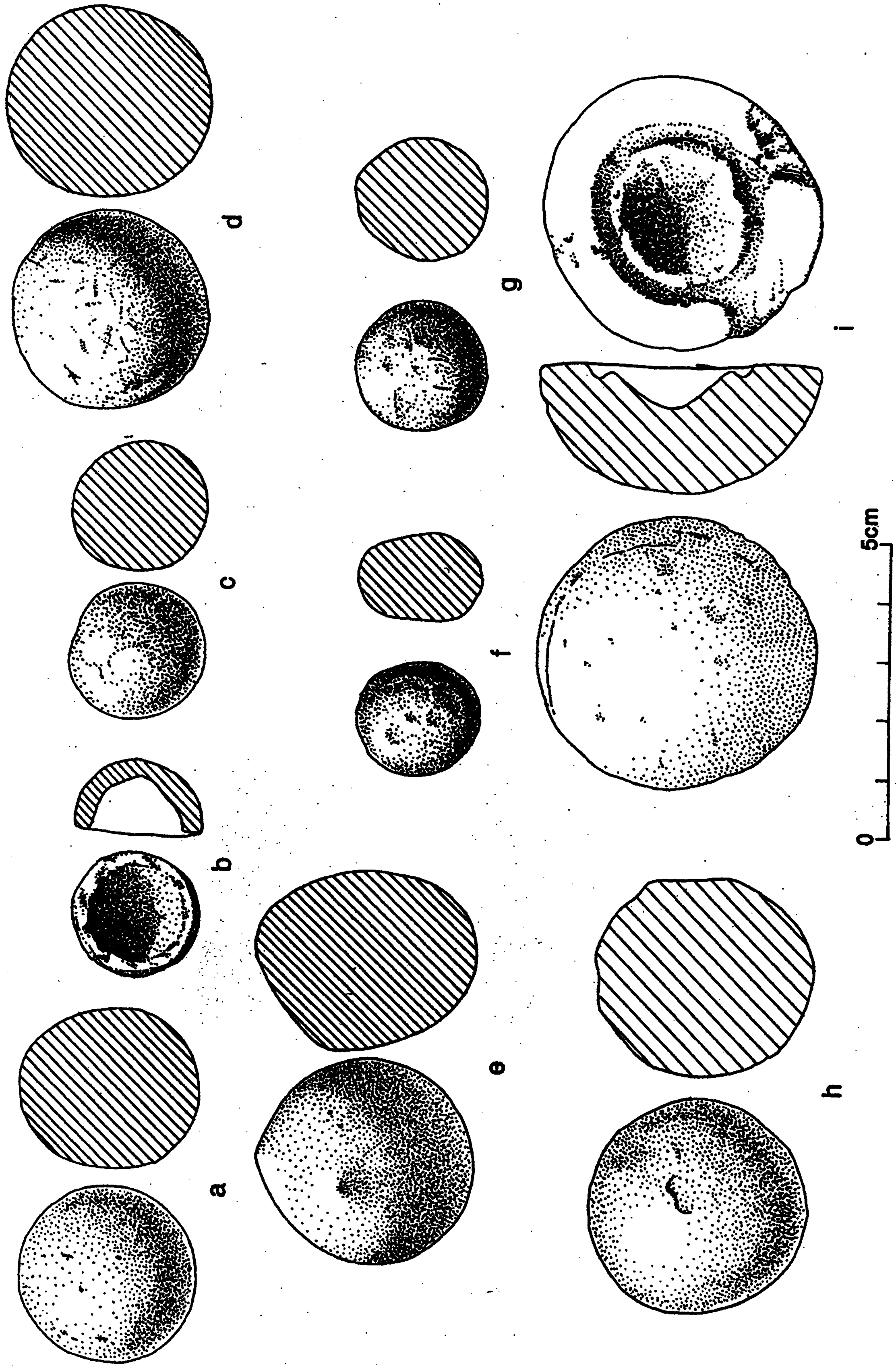


Figure 25 Stone Spheres from Study Sites: a) P894-6-058, b) P894-8-010, c) P894-11-015, d) 478-117, e) 34-5-24, f) 34-9-9, g) 34-11-36, h) 47-1-28, i) 48-2-7

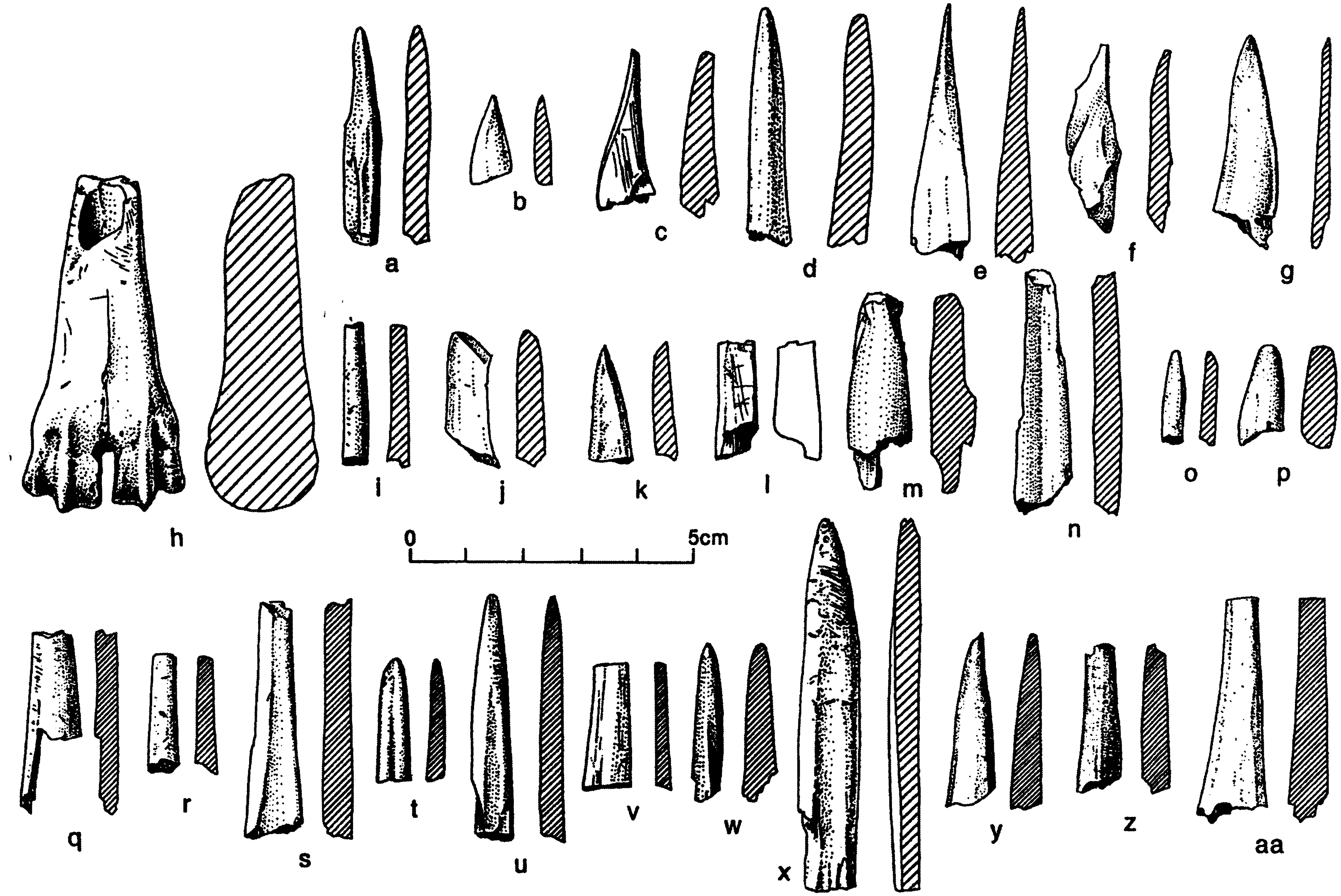


Figure 26 Bone Awls from Study Sites: a) P893-3-222, b) P942-1-057, c) P894-3-023, d) P894-3-029, e) P894-9-029, f) P894-11-037, g) 478-64, h) 478-73, i) 478-89, k) 478-133, l) 34-4-22, m) 34-4-35a, n) 34-4-35b, o) 34-9-23, q) 40-1-20, r) 40-2-80, s) 40-6-47, t) 42-9-032, u) 48-2-39, v) 48-4-03, w) 48-4-67, x) 49-2-04, y) 63-3-027, z) 63-5-045, aa) 63-5-052

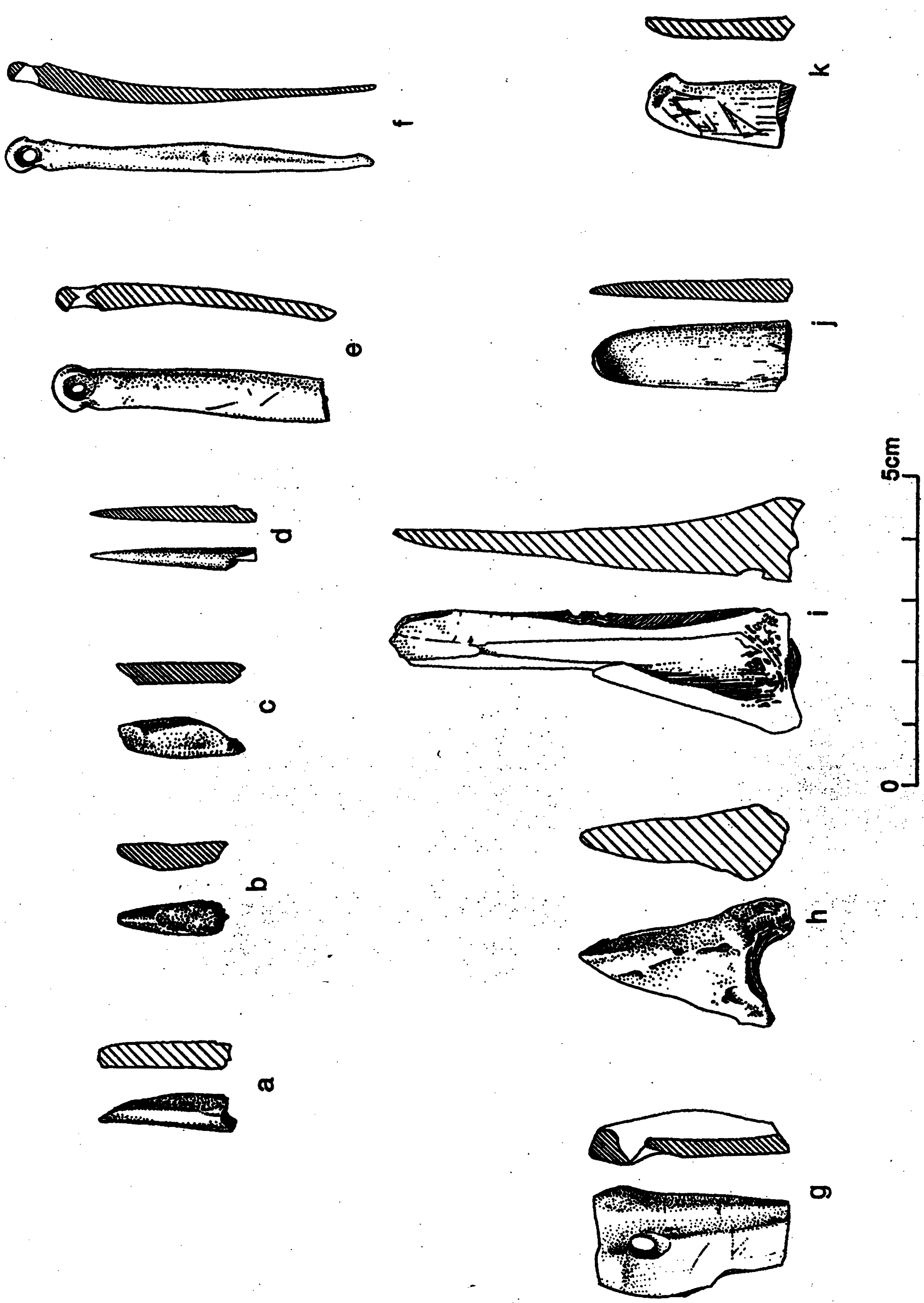


Figure 27 Bone Tools from Study Sites: a)P894-10-032, b) 42-1-030, c) 42-1-042, d) 63-4-116, e) P894-4-029, f) 47-3-64, g) 47-3-151, h) P894-10-60, i) P894-9-047, j) 47-1-14, k) P893-3-221

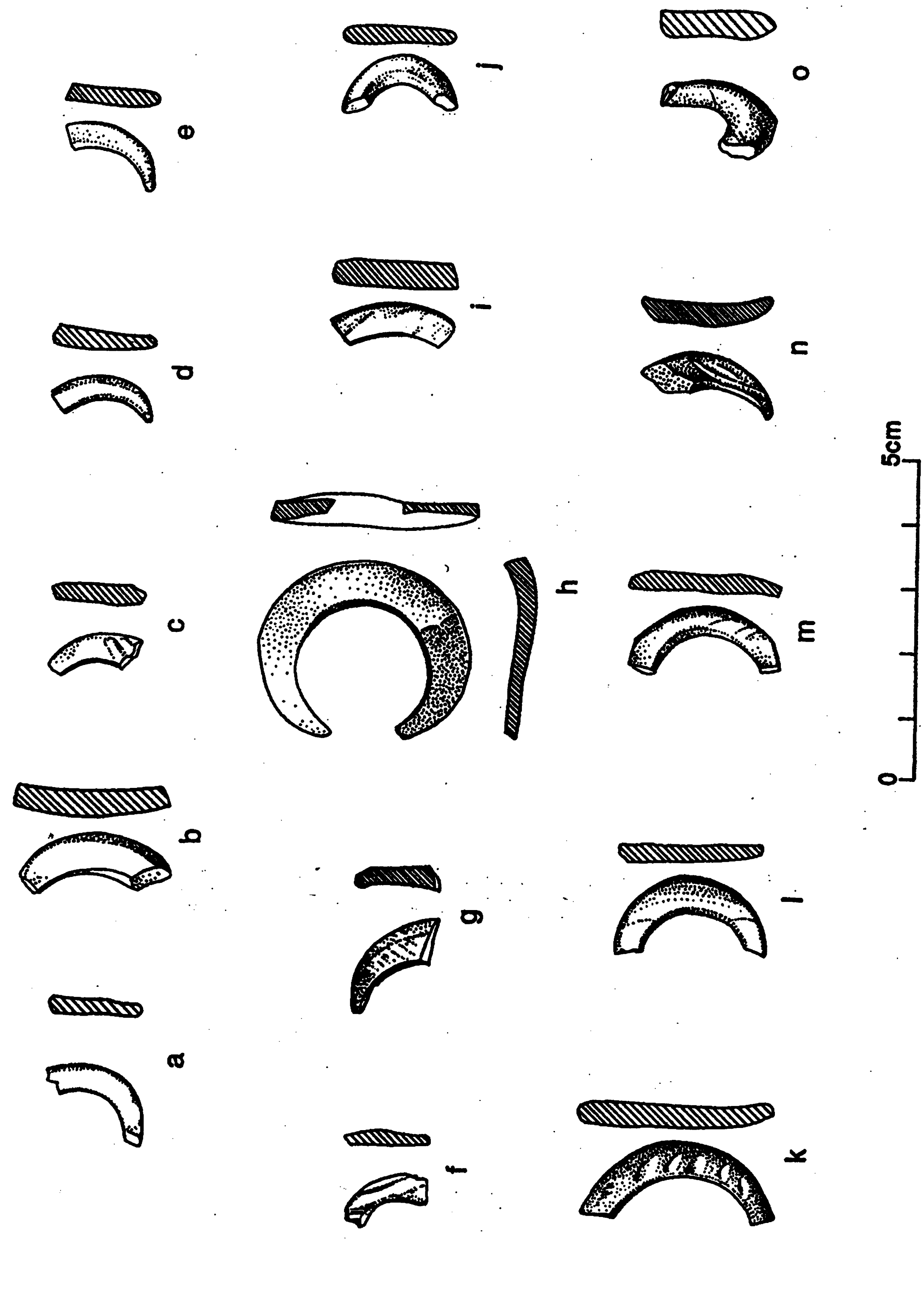


Figure 28 Fishhooks from Study Sites: a) P893-3-215, b) P894-7-008, c) P894-8-009, d) P894-10-033, e) P894-10-47, f) 34-11-41, g) 40-1-27, h) 40-4-60, j) 48-1-72, i) 48-1-31, j) 48-1-72, k) 48-2-75, l) 48-3-21, m) 48-4-14, n) 63-4-006, o) 478-10

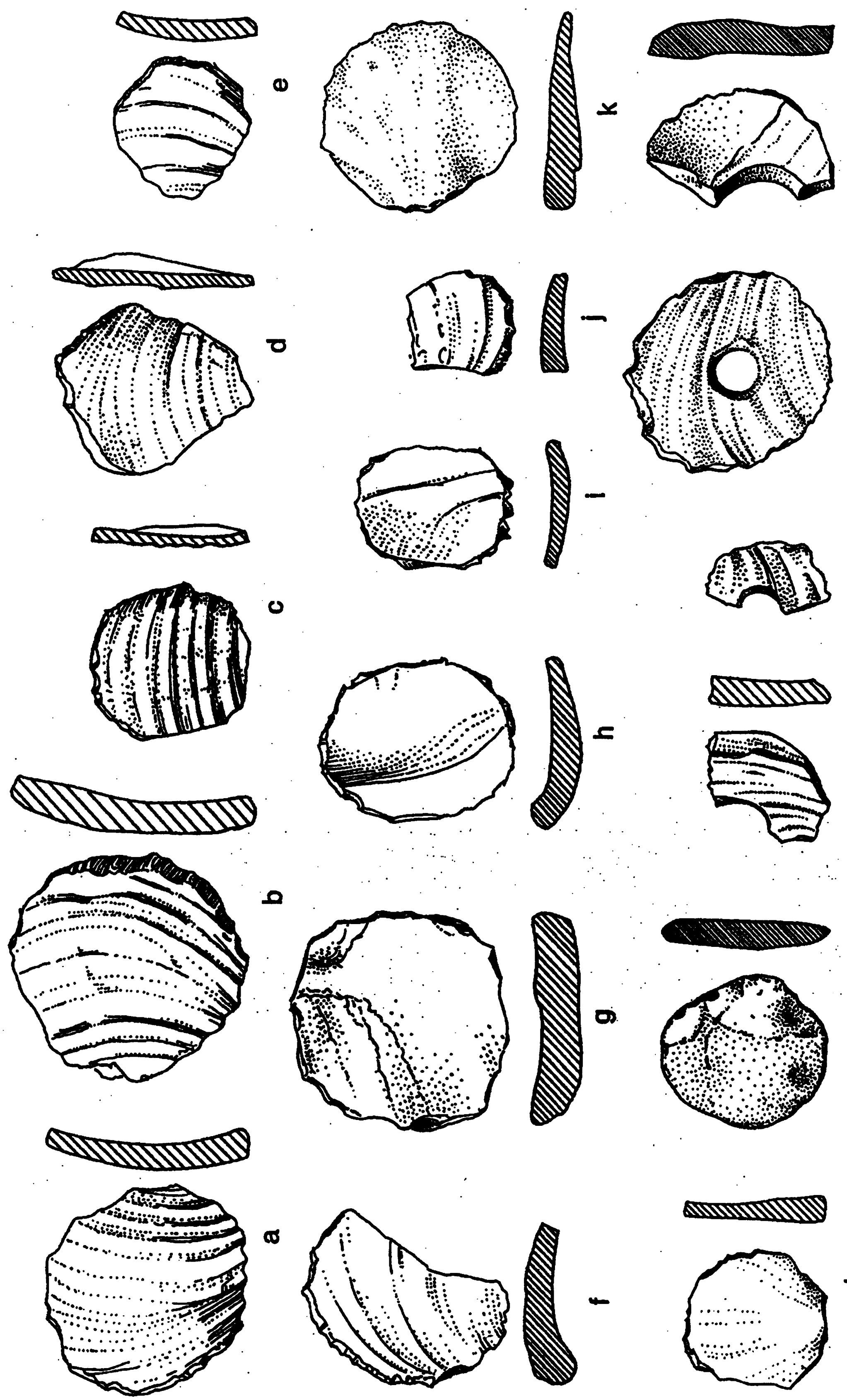


Figure 29 Fishhook Blanks from Study Site: a) P894-3-034, b) P894-4-035, c) P894-4-015, d) P894-4-031, e) P894-4-037, f) P894-6-084, g) P894-8-048, h) P894-8-081, i) P894-8-91, j) P894-9-033, k) P894-10-049, l) 34-11-22, m) 40-4-23, n) P893-3-205, o) P894-10-024, p) 48-2-69, q) 63-2-046

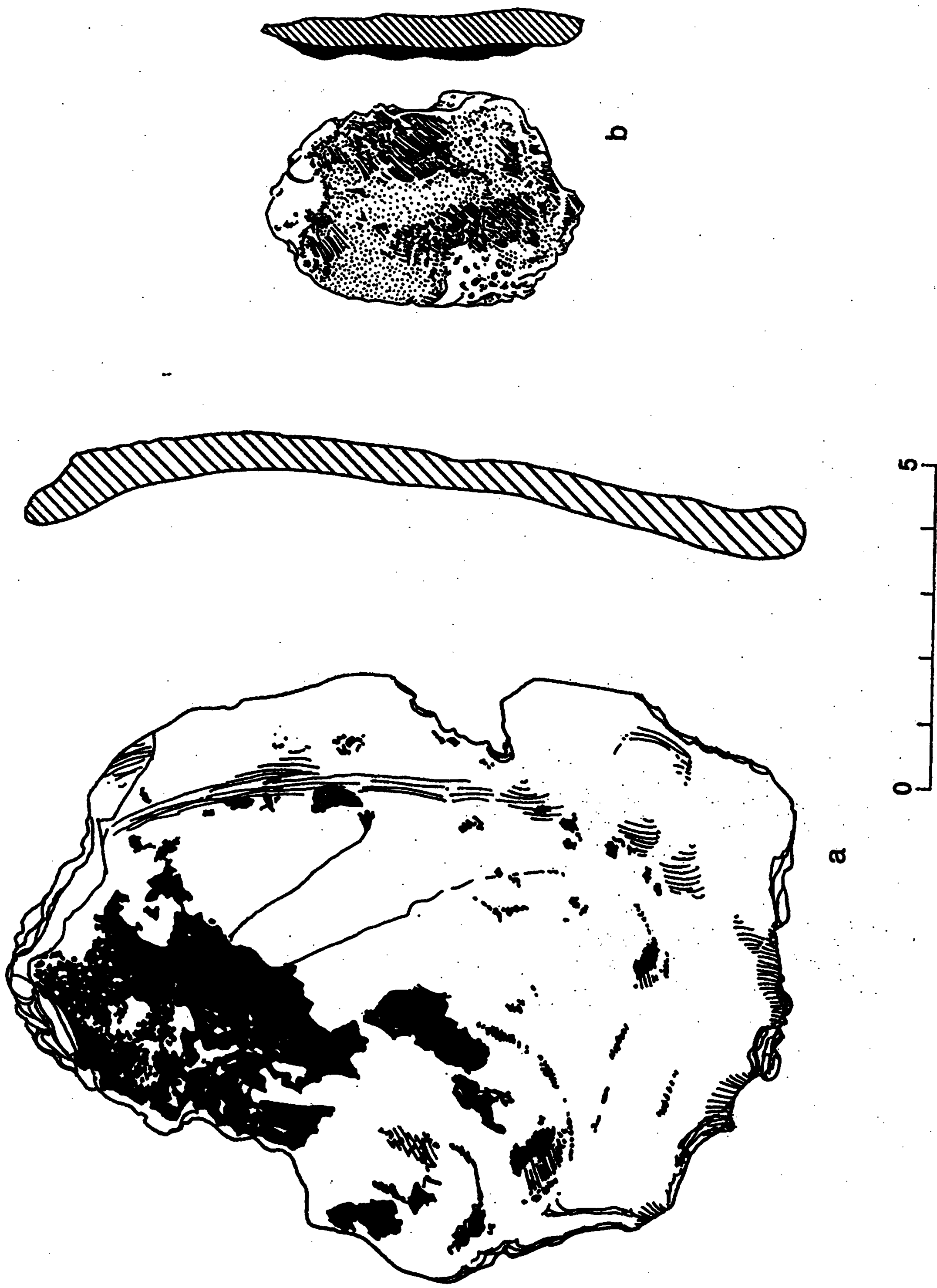


Figure 30 Abalone Shells with Asphaltum from Study Sites: a) P893-3-118, b) P942-2-110

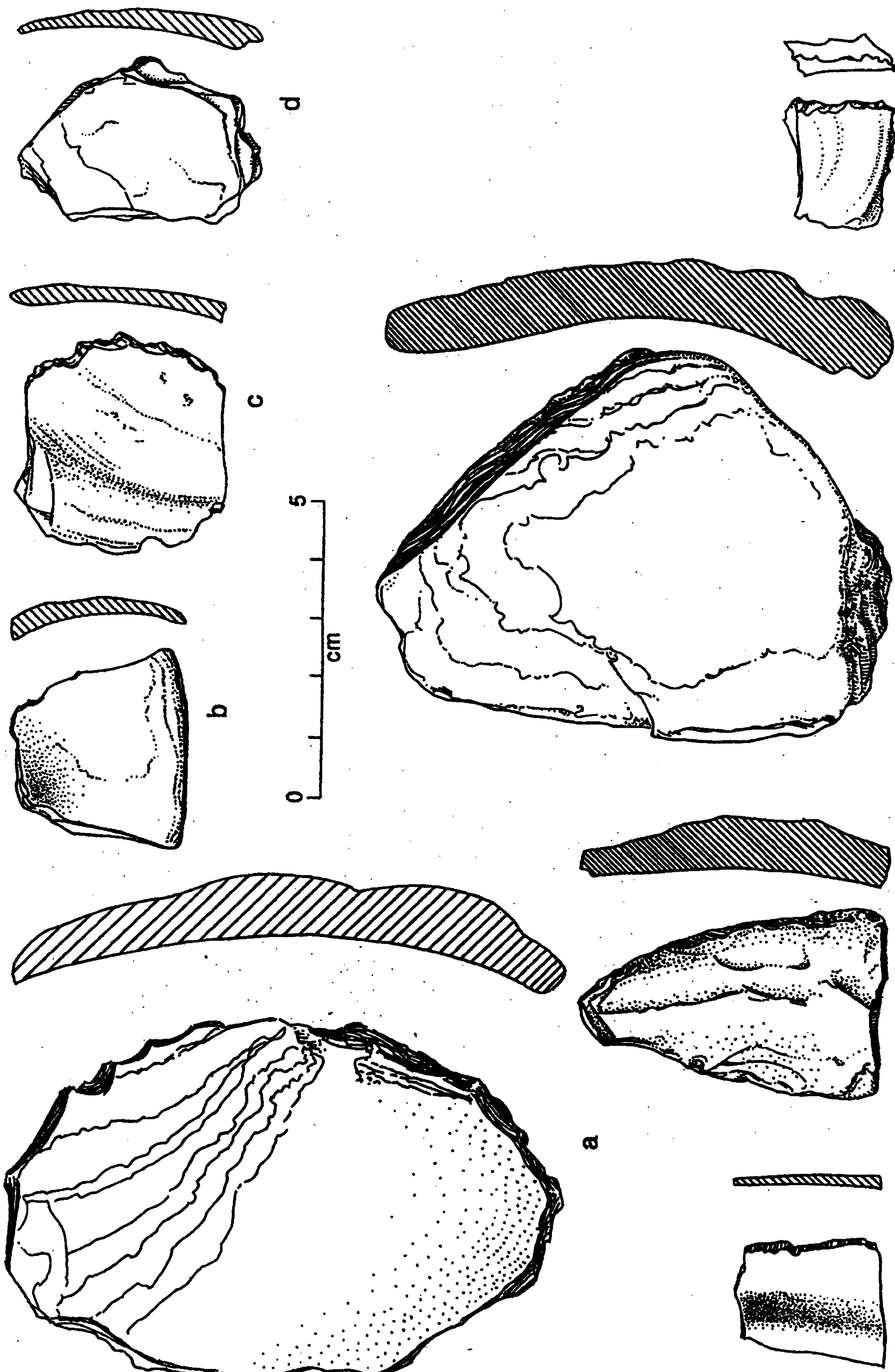


Figure 31 Cut and Worked Abalone Shell fragments and Pendant Blanks from Study Sites: a) P894-8-082, b) 34-5-53, c) 34-9-26, d) 34-10-10, e) 34-10-34, f) 48-3-64, g) 48-5-22, h) 73-1-25

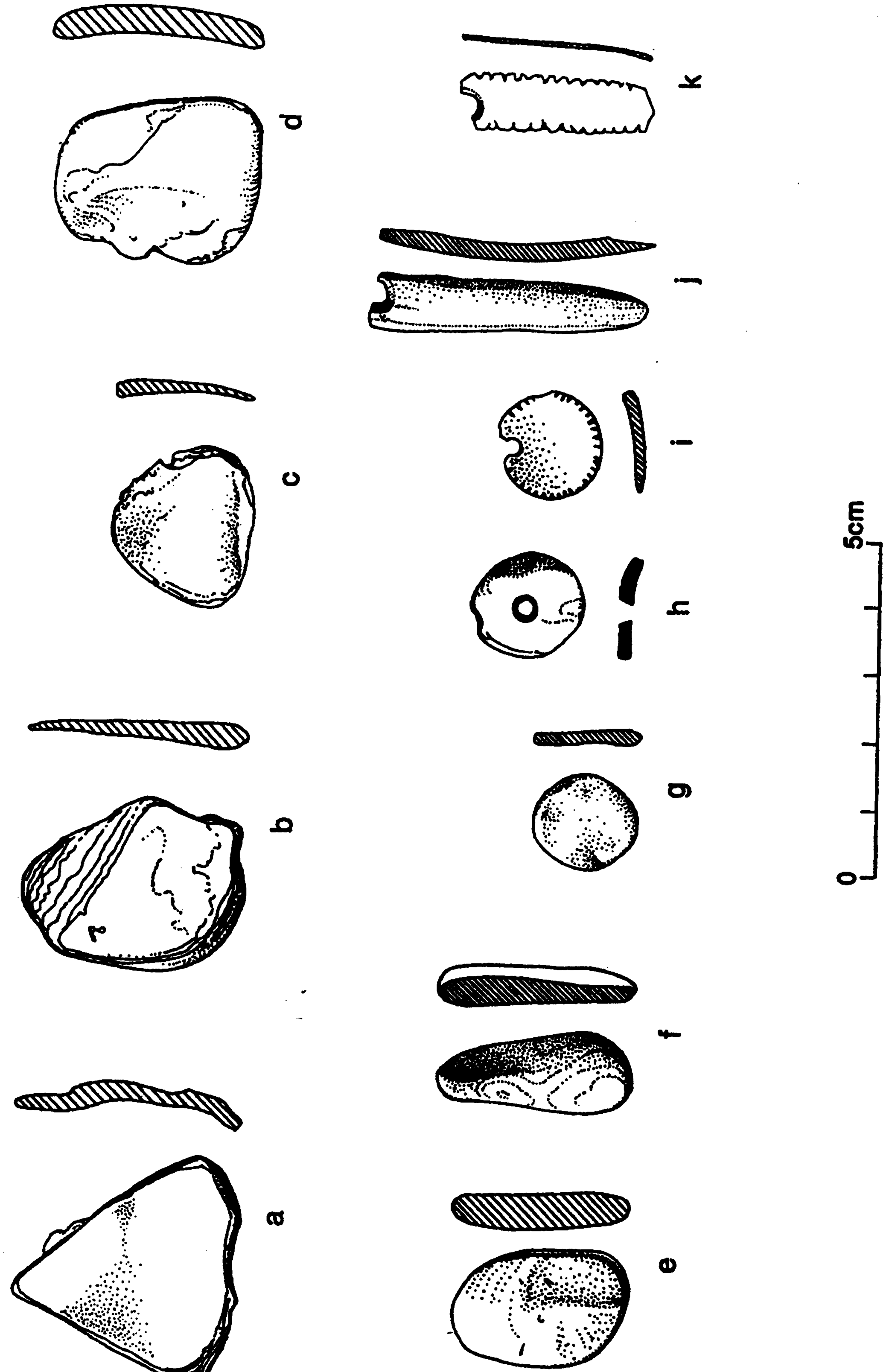


Figure 32 Shell Pendant Blanks and Pendants from Study Sites: a) 34-2-23, b) 34-2-29, c) 34-5-43, d) 34-7-11, e) 34-11-31, f) 48-3-49, g) P893-3-170, h) P893-3-170, i) 48-1-41, j) 48-1-42

change through time. The amount of edible flesh represented by each MNI was calculated via reference to taxon-specific mean meat yields reported by Dietz et al. (1988), Hildebrandt (1981), Mitchell (1988), and Simms (1984) (Table 7). The dietary indices developed in this analysis constitute revisions to preliminary values reported previously by T. Jones (1992) and Jones and Haney (1992).

Unlike other classes of faunal remains, particularly fish, recovery context (i.e., screen size) is not a problem with large mammal and bird remains, since, with the exception of intrusive rodent bones, identifiable elements are not lost with 6-mm (1/4") mesh. Recovery of rodent bone is enhanced through use of smaller mesh (Gordon 1993), but in the fire-effected, bioturbated middens of Big Sur, there is no way to accurately distinguish prehistoric from post-depositional rodent bone.

Body Part Frequency and Carcass Utilization

In his (1978) research on the Nunamiut, Binford demonstrated the manner in which representation of prey body parts can provide insights into site function, through development of what he called the "Modified General Utility Index" (MGUI), used to evaluate skeletal element representation relative to dietary utility. Binford (1978) correlated sets of MGUI values with stages of animal exploitation, specifically those reflected in two types of sites: kill sites where archaeological debris would be dominated with parts of low utility (a reverse utility curve), and consumption sites where high-value parts, transported from kill-sites, were consumed and discarded. These site types later contributed to Binford's (1980) definition of the "collector" settlement/subsistence strategy, distinguished by task-specific sites (e.g., kill sites) and a reliance on stored resources. Binford discussed more briefly the faunal signatures associated with major residential bases, which were occupied through the winter during several consecutive seasons. These sites were characterized by low frequencies of axial skeleton parts and high frequencies of leg parts and parts of marginal utility (Binford 1978:429,430).

Lyman (1985) and Grayson (1988) discussed alternative interpretations of element representations, arguing that patterns may be more reflections of differential survivorship of bones related to their density and transport by carnivores than of site function. The occurrence or over-representation of a given element in an assemblage may, in other words, be more a reflection of its ability to withstand post-depositional destructive forces than a measure of its importance to site inhabitants (Gifford 1981). To control this variable Lyman (1985) developed a ranking of bone densities for *Odocoileus hemionus* and *O. virginianus*. Bones with lowest bulk densities are most likely to be destroyed or modified to an unidentifiable state by carnivore gnawing or transport. Bones with higher densities are more likely to be preserved in an identifiable condition in the archaeological record.

Skeletal element distribution patterns were investigated as potential indices of site function, by evaluating element representation profiles against three alternative idealized profiles derived from the works of Binford (1978) and Lyman (1985). One of the major impediments to this type of analysis in its original form is the need for exceptionally large samples of vertebrate faunal remains, as both Binford and Lyman evaluated the relative frequency of individual skeletal elements. Only deer elements were plentiful enough in the Big Sur collections for this type of analysis, and to generate meaningful numbers, even these had to be combined into skeletal segments, following a method employed by Watts (1984). To develop meaningful numbers, Watts aggregated individual elements into nine skeletal sections: cranial, teeth, axial, forelimb, hindlimb, metapodial, forefoot, hindfoot, and phalanges. For the present study, mean values for each segment were calculated for general utility, bulk density, and marrow value, based on figures reported for individual elements by Binford and Lyman and the number of elements in each skeletal segment. Segments were then ranked according to their mean values. Rankings show variability that reflects differential utility of skeletal segments with respect to the alternative evaluation criteria: in terms of mean dietary utility, the hindlimb and axial segments rank the highest, while the cranium and teeth are least useful; with respect to bulk density, teeth and crania are most likely to survive (highly ranked), while axial elements and phalanges are the lowest ranked; with respect to marrow, metapodials and hindlimbs rank highest, while axial elements and teeth rank at the bottom. Using these rankings, idealized profiles representing asssemblages structured exclusively by each of the criteria were developed (Figure 33).

To evaluate archaeological findings against the idealized profiles, numerical indices were used to determine how fully each segment was represented in the archaeological collection. First, the number of elements per segment per individual deer was established, and then a numerical ratio reflecting that relationship was calculated. For example, a deer has 30 teeth, so a single tooth represents 1/30 (0.033) of a deer. For forelimbs and hindlimbs only the larger carpals and tarsals were counted, as the smaller elements are unlikely to be recovered archaeologically. Deer remains were then tabulated

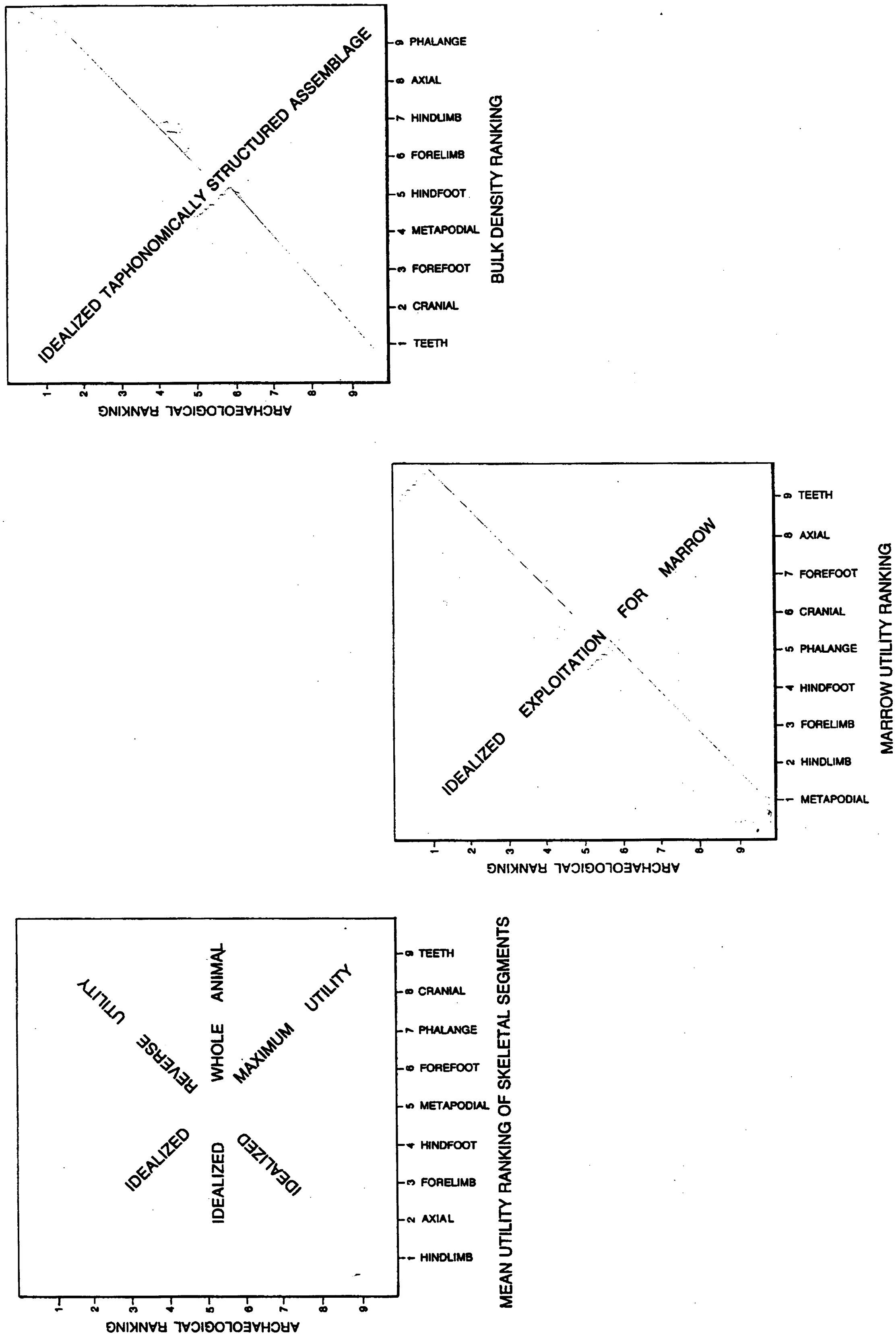


Figure 33 Idealized Skeletal Segment Rankings

according to skeletal segment, and these values were multiplied by the numerical body part indices. Resulting values were ranked in numerical order. To evaluate which forces appeared most responsible for the structure of the assemblages, rankings were also evaluated statistically against the idealized rankings using the Spearman Rank Correlation Coefficient.

Fish

Fish remains were treated much the same as bird and mammal bones. Body part and taxonomic identifications were made for each element by Dr. Ken Gobalet using comparative materials at the Department of Biology, California State University Bakersfield. MNI were calculated for each unit/level. Because mesh size can drastically influence assessments of prehistoric fisheries (see Gordon 1993), subsamples of column residues processed through 1.5 mm (1/16") were examined for fish bone. Proportional samples from one or more column levels were submitted to the fish bone analyst who sorted through the residues for fish remains. Recovered elements were identified, and the volume of midden subjected to microanalysis was recorded for each component. A total of 1.414 m^3 of midden from ten sites was evaluated in this manner. Interpretation of the ichthyofaunal remains was guided by strict attention to mode of recovery. Fish data are summarized by NISP/component both with and without extrapolating the results of the 1.5 mm mesh microsamples to the excavation volumes. Dietary values of the fish were calculated through the use of mean meat weights for each represented species (Table 8) reported by Dietz et al. (1988), Jones and Haney (1992), and Mitchell (1988).

Shellfish

Shellfish remains, collected from 20 x 20 cm column samples, were identified to species using a personal reference collection. After column samples were water-screened over 6 mm (1/4") and 3 mm (1/8") mesh, non-cultural materials (small rocks and organic debris) were removed. All of the shell fragments remaining in the 6-mm residues were identified to species, and a 25% sample of the 3-mm residues was analyzed. Totals of shell recovered from the column samples include extrapolations from the 25% samples to full column volumes. Dietary implications of the remains were assessed by conversion of shell weights into edible meat values through the use of meat/shell ratios (Table 9). Taxa for which exact values are not available were evaluated through use of a value of 0.952, which is the mean of the most commonly represented local species (Jones and Haney 1992:157).

Mussel Collection Strategies

Interpretation of shellfish remains was also aided by experimentation in the collection of mussels, undertaken to supplement seminal studies by White (1989) on prehistoric mussel harvesting strategies at MacKericker State Park on the Mendocino County coast. White suggested that there are two alternative techniques for collecting mussels: a "plucking" strategy in which larger individuals are selectively gathered, and a "stripping" strategy in which entire mussel beds are removed *en masse* with little if any selectivity or culling. Following the work of mussel biologists (Suchanek 1981), White used hypothetical cumulative proportion curves to portray the size frequencies associated with these different collection strategies. Comparing curves generated from archaeological specimens with hypothetical stripping and plucking curves he further suggested that the MacKericker sequence reflected a transition from plucking to stripping, and that plucking was a more efficient strategy than stripping.

Subsequently, Bouey and Basgall (1991) questioned White's hypothetical cumulative proportion curves, and the relative efficiency of alternative techniques. They argued that mussel shells collected from archaeological sites at Piedras Blancas on the San Luis Obispo County coast showed a continuous plucking strategy through time. Since the evaluations of alternative strategies by both White and Bouey and Basgall were largely hypothetical, it seemed plausible that these conflicting perceptions could be reconciled by experimenting with different collection techniques in contemporary mussel beds and evaluating yields quantitatively.

To identify cumulative frequency curves associated with different strategies, and to evaluate their relative efficiency, two mussel collection experiments were undertaken in different locations, employing identical procedures (Jones and Richman 1995; Richman 1993). The first was in at Landels-Hill Big Creek Reserve in Big Sur, where mussel beds have not been subject to human predation for at least 15 years. The second was at Davenport in Santa Cruz County, where mussel beds are regularly subject to harvest by the public. At each location, mussels were collected by a single individual for 20 minutes by stripping and again by plucking. The collected mussels were then transported to base camp where they were boiled, the meats removed, meats and shells weighed and measured (Table 10). Results show distinctive cumulative proportion curves

Table 8 Mean Meat Values for Fish Identified at Study Sites

Taxon	Common name	Reference	Mean meat weight (kg)
Raja spp.	Skates	Mitchell (1988:256)	6.50
Carcharhinidae	Requiem sharks	Gobalet, personal communication	24.00
Elasmobranchii	Sharks, skates, rays	Gobalet, personal communication	5.00
Rhinobatus productus	Shovelnose guitarfish	Gobalet, personal communication	13.80
Clupeidae	Herring and sardine	Mitchell (1988:256)	0.14
Sardinops caeruleus	Pacific sardine	Gobalet, personal communication	0.30
Engraulis mordax	Northern anchovy	Mitchell (1988:256)	0.10
Osmeridae	Smelts	Gobalet, personal communication	0.3
Atherinidae	Silversides	Gobalet, personal communication	1.9
Oncorhynchus mykiss	Steelhead	Mitchell (1988:256)	4.77
Merluccius productus	Pacific hake	Mitchell (1988:256)	1.23
Atherinidae	Topsmelt or jacksmelt	Gobalet, personal communication	0.30
Embiotocidae	Surfperches	Mitchell (1988:256)	0.52
Amphistichus sp.	Barred surfperch	Gobalet, personal communication	1.50
Embiotica sp.	Black or striped surfperch	Gobalet, personal communication	0.50
Damalichthys vacca	Pile perch	Gobalet, personal communication	0.20
Oxyjulus californica	Señorita	Gobalet, personal communication	
Gibosonia metzi	Striped kelpfish	Gobalet, personal communication	1.50
Stichaeidae	Prickleback	Gobalet, personal communication	0.80
Cebibidichthys violaceus	Monkeyface prickleback	Gobalet, personal communication	1.10
Xiphister mucosus	Rock prickleback	Gobalet, personal communication	0.80
Scomber japonicus	Chub mackeral	Gobalet, personal communication	0.70
Sebastes sp.	Rockfish	Mitchell (1988:256)	1.24
Hexagrammos spp.	Greenling	Mitchell (1988:256)	0.31
Ophiodon elongatus	Lingcod	Mitchell (1988:256)	4.11
Scorpaenichthys marmorai	Cabezon	Mitchell (1988:256)	0.50
Gasterosteus aculeatus	Threespine stickleback	Gobalet, personal communication	0.01
Gobidae	Gobies	Gobalet, personal communication	0.10
Gobiesox maeandricus	Northern clingfish	Gobalet, personal communication	0.10
Cottidae	Sculpins	Gobalet, personal communication	0.10

Table 9 Meat:Shell Ratios for Shellfish Identified at Study Sites

Taxon	Common name	Reference	Meat/Shell Ratio
Acanthina sp.	Unicorn	Tartaglia (1976:170)	0.667
Collisella spp.	Limpet	Jones and Haney (1992:157)	0.780
Cryptochiton stelleri	Gumshoe chiton	from related *Nuttalina californica*	1.159
Haliotis spp.	Abalone	Koloseike (1969)	1.363
Lottia gigantea	Owl limpet	Tartaglia (1976:170)	1.360
Mytilus californianus	California mussel	Erlandson (1988a:445)	0.298
Nuttalina californica	Nuttal's chiton	Erlandson (1988a:445)	1.159
Protothaca staminea	Littleneck clam	Dietz et al. (1988:350)	0.527
Strongylocentrotus purpuratus	Purple sea urchin	Jones and Haney (1992:157)	0.426
Tegula funebralis	Turban snail	Erlandson (1988a:445)	0.371
Unidentified		Jones and Haney (1992:157)	0.952

Table 10 Experimental Mussel Collection Results

Location	Collection strategy	Collection time (minutes)	Total load weight (g)	Meat Weight (g)	No. of mussels	%≥ 4.0 cm	Processing time (minutes)	Meat/ hour (g)	Kcal[1]/ hour
Big Creek Reserve	Plucking	20	5954.3	470.7	424	66.5	40.00	470.7	543.2
Big Creek Reserve	Stripping	20	5506.0	343.5	1298	30.1	90.87	185.6	214.2
Davenport Landing	Plucking	20	4863.0	564.0	746	64.6	48.00	497.6	574.2
Davenport Landing	Stripping	20	10,227.2	750.2	1478	32.2	116.57	386.4	445.9

[1]Based on energy values reported by Gilliland (1985:62).

marking plucking versus stripping strategies (Figure 34). More significant is that, in terms of net rate of return, a selective strategy is always superior to stripping; in both settings plucking produced over 500 kilocalories/hour (Table 10). This finding is supported by the practices used by commercial harvesters of California mussel who, under pressure from contemporary markets, suggest that a selective gathering of large individuals is the only way to sustain substantial yields (Yamada and Peters 1988). As White (1989) noted, this optimal strategy could only be maintained by groups who were not exploiting the same mussel beds too frequently (e.g., mobile groups), since it takes at least two years for a mussel to reach a length of 12 cm (Coe and Fox 1942:2). A stripping strategy produces the greatest number of total kilocalories, but only with the input of greater processing labor. In a regularly foraged setting, the absence of large individuals makes the differences between stripping and plucking less extreme, both with regard to cumulative proportion curves and net efficiency.

Whole and nearly whole mussel shells collected from the study sites were measured to develop cumulative proportion curves that could be compared with the experimentally derived curves. Maximum lengths of fragmentary specimens were obtained through the use of a mussel size template developed by White (1989). This template insured that a representative sample of mussel shells present in the midden was used to develop the curves, and that results were not skewed by breakage of shells. Comparison of the archaeological size proportion curves and the experimental curves indicated which strategy was employed by site inhabitants.

Dietary Reconstruction

Dietary calculations generated from faunal remains are relative indices that do not necessarily reflect diet in absolute terms, but they are nonetheless useful for determining the direction of change through time. The technique for dietary reconstruction employed here follows Mitchell (1988), and involves conversion of all bone and shell values into edible flesh totals. Conversions for shell were done with meat:shell ratios, while conversion of vertebrate remains was accomplished by multiplying MNIs by taxon-specific mean edible flesh values. The manner in which MNIs were calculated for this project (i.e., for each 1 m x 2 m x 10 cm level) was intended to control the MNI factor specifically for this analysis. Most analysts calculate MNIs either for an entire collection or per excavation unit. No matter how they are calculated MNIs are problematic (Brewer 1992) and any values obtained through the manipulation of MNIs must be regarded with caution. For that reason, reconstructions of diet based on meat values were compared with results of stable isotope analyses on human bone.

Reconstruction of diet was enhanced by the mussel collection experiments, in that an unanticipated result of that work was identification of intertidal taxa that occur as "riders" when mussels are collected. Many researchers have recognized that barnacles attach themselves to mussel shells, and that their occurrence in middens is probably not the result of intentional harvest. Our experiments found nine additional species that occur as riders, eight of which

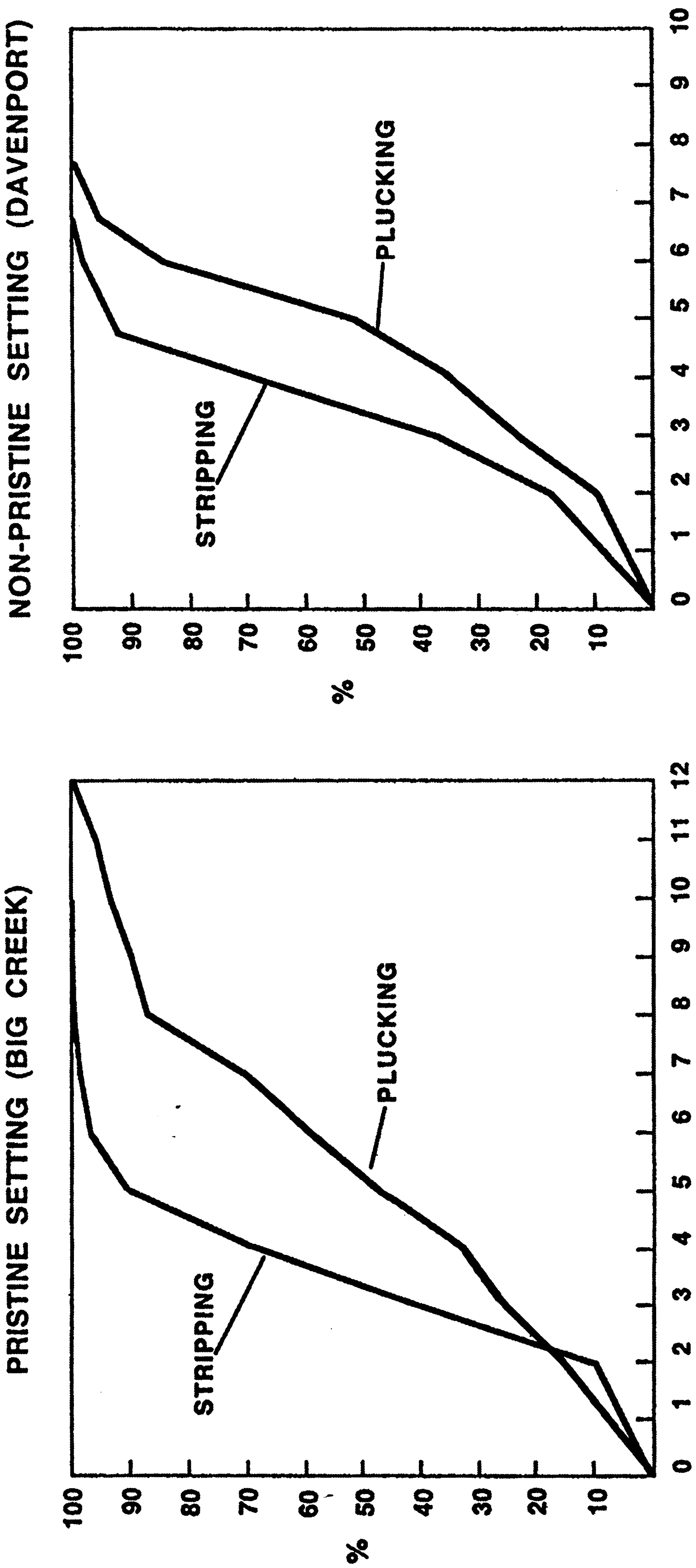


Figure 34 Cumulative Proportion Profiles from Mussel Collection Experiments

are represented archaeologically (Table 11). Furthermore, the proportional frequencies associated with unintentional collection were identified through the experiments. With respect to dietary reconstructions, when percentages of potential "riders" are similar to those identified in the experiments, they were considered non-dietary. In other cases where the percentages of "riders" are significantly higher than those associated with unintentional collection in the experiments, it was assumed that the species was collected for food.

Dietary indices were calculated for all temporal components. Shellfish values obtained from 20 x 20 cm columns were extrapolated to the full volume of each component. Shellfish values are based on materials retained in 3-mm screens. Screen size is not considered a problem for mammals and birds, and all identifiable elements were applied to the calculations, regardless of recovery context. Screen size is a major problem with fish bone, as many taxa are not well represented even in residues derived from 3-mm mesh. The fish component of the diet was based on findings from units screened through 3-mm mesh combined with extrapolations from the 1.5-mm mesh samples.

Diversity

Understanding diversity is critical to developing realistic portraits of diet and mobility. Diversity must be evaluated quantitatively, but this is not accomplished easily. A variety of diversity measures treat the two components of diversity, richness and evenness, differently. Richness, the number of species present, is a critical component of diet breadth, but is directly related to sample size (Jones et al. 1983; Magurran 1988). Evenness, the relative abundance of each species in a sample, reflects the degree of reliance on a particular species, group of species, or more equal use of a suite of species. Many statistical indices have been developed to calculate richness, evenness or combinations of the two. None are without problems. Most are overly sensitive to sample size, particularly in their treatment of small samples (Magurran 1988:79).

To cope with these problems, I first tried to obtain reasonably even and representative field samples. Nonetheless, NISP values are considerably lower from some sites than others. Statistics were calculated from NISP from temporal components focused on richness as an index of diet breadth. To evaluate richness, the Margalef index was used. Because it is sample sensitive (Magurran 1988:79), sites that produced small NISP were not used in this analysis. The Shannon Index, frequently used by archaeologists and ecologists as a combined index of evenness and richness, was calculated in earlier versions of the study (Jones 1995). Margalef scores were calculated for mammalian NISP and fish NISP.

Seasonality

Three methods of seasonal inference were employed. The first, and perhaps most accurate was oxygen isotope analysis of samples taken from mussel shells. This study, completed by Douglas J. Kennett and described in more detail in Appendix I, was undertaken primarily for paleoenvironmental purposes, but readings from the terminal edge of shells also indicate water temperature at the time of the animal's death. Comparison of such findings with historic records allows for seasonal inference. Temperature at death can be compared with those preceding it to determine within a three-four month range when the shell was collected. These determinations were made for five sites.

The second method involved examination of annuli in cross-sections of teeth from black-tailed deer (Appendix II by Steven A. Moffitt). Discovered by biologists attempting to age deer remains (Klevezal and Kleinenberg 1967; Mitchell 1969), this technique was employed successfully by Quintero (1987) in southern California to establish seasonality of deer hunting and site use. Growth of a deer's teeth is incremental and directly tied to seasonality in growth of the animal. Roots of the teeth grow through an additive process in which layers of varying thickness and composition are added to the outside of the tooth. Two layers are added each year, a thick layer deposited during the season of active growth (late spring to early fall), and a thin layer during the period of attenuated growth (late winter to early spring) (Quintero 1987:66). A cross section of a tooth through the root reveals the growth bands. Counting the bands determines the age of the animal, while the relative thickness of the terminal band indicates the season of death. Fifty-five teeth from 11 sites were subjected to this analysis.

Seasonal inferences were also drawn from the remains of migratory animals, although these are not entirely reliable, and were evaluated relative to the other seasonality data. California sea lions breed in June and July on the Channel Islands, and then move northward in pursuit of food. They use Big Sur and other points along the central coast as rest stops, and are most common during September and October, although they haul-out in reduced numbers during the return trip in April and May (LeBoeuf 1981:314-317). While the southernmost breeding colony of Steller sea lions is now located on Año Nuevo Island,

Table 11 Total Recovery from Mussel Collection Experiments

Taxon	Stripping Weight (g)	%	Plucking Weight (g)	%
Mytilus californianus	4611.7	90.21	5079.3	91.95
Balanus glandula	360.0	7.04	348.6	6.31
Lepus pacifica	110.8	2.17	80.4	1.46
Katharina tunicata	8.5	0.17	9.8	0.18
Collisella scabra	6.7	0.13	3.2	0.06
Collisella pelta	3.8	0.07	1.4	0.03
*Pisaster ochraceus**	3.7	0.07	0.0	0.00
Cancer antennaris	1.6	0.03	0.0	0.00
Tegula funebralis	1.1	0.02	0.0	0.00
Tellina modesta	0.1	**	0.0	0.00
Total	5112.0	100.00	5524.1	100.00

*Not represented archaeologically.

**Trace.

these animals formerly established rookeries on the Channel Islands. After breeding in June and July, males of this species also head north, and presumably were once present in Big Sur waters from September to January. Northern fur seals breed in the Bering Sea in the summer, and migrate southward in the winter. The prehistoric migratory patterns of southern fur seals are not known. Some fish represented in the Big Sur collections also have seasonal significance, although the confidence with which seasonal inferences can be drawn is variable. Northern anchovies move offshore during the fall and winter, returning inshore during the spring (Baxter 1967:11). Lingcod move into shallows to spawn between August and January. Cabezon are present year-round, but can literally be taken by hand in the winter, when they spawn in shallow tide pools (Salls 1989:28). Pile surfperch move inshore in large schools in October and November (Salls 1988:590). Steelhead enter central coast streams to spawn in the winter. Seasonality inferences derived from the fish bone were weighed less heavily than those derived from deer teeth.

Floral Remains

Charred floral remains were collected only from discrete features, as the ubiquity of fire and bioturbation render all other vegetative material of uncertain origin. Only five discrete features were encountered that contained floral remains. Samples from these features were subjected to flotation analysis, and recovered floral specimens were identified to fragment type and species. Some of the technical reports completed for the inland study sites include analyses of botanical remains obtained from non-feature column samples. These studies develop conclusions about diet and seasonality, but they should be considered highly suspect because there is no reason to believe that the charred seed remains are cultural in origin. Charred grass seeds and nut fragments can easily make their way into the soil in oak grassland settings such as those of Fort Hunter-Liggett.

Component Function, Settlement Structure, and Assemblage Diversity

Component function was first evaluated by straight-forward assessment of the types of artifacts and features present, and the activities they represent. From this perspective, all of the midden sites were readily interpreted as residential bases, since they all retained fire-altered rock, abundant shell, flaked and ground stone tools, shell beads, and vertebrate remains. Nearly all of the middens also yielded human remains. Variability in the size and location of these residential deposits suggests some level of functional differences between sites. Interpretations of this variability were partially based on carcass utilization strategies and seasonality. Particularly important were patterns in these signatures identified at CA-MNT-1277/H, the Salinan village of *matilcé*, since these distinguish a deposit of known residential function. Tool assemblages were also evaluated quantitatively through use of the same diversity indices applied to faunal remains. For this analysis, tools were considered strictly from a functional perspective, ignoring stylistic types.

Human Remains

All treatment of human remains was undertaken in consultation with the project's Native American consultants. Analysis was conditioned by the type of discovery. One human interment at CA-MNT-1223 was removed for osteological analysis due to threats of erosion, while another burial at CA-MNT-1277/H, unthreatened by erosion, was exposed and left in place without further study. Six small fragments of human bone, found during post-field laboratory processing, were subjected to stable isotope analysis (^{13}C apatite, ^{13}C gelatin, ^{15}N gelatin) by Harold Krueger. Isotope analysis has been shown repeatedly to be valuable for determining the relative proportion of marine versus non-marine foods in prehistoric diets (Ericson et al. 1989; Krueger 1985; Price 1989; Sealy and Van der Merwe 1986; Walker and DeNiro 1986). Results were interpreted with reference to data developed by Ericson et al. (1989), Krueger (1985), and Walker and DeNiro (1986). Non-destructive analyses of all recovered human bones included inventory of elements, calculation of minimum number of individuals, recording of metric and non-metric morphology. Details of these analyses are presented in Jones (1994; 1995) and Jones and Haney (1992).

CHAPTER 5: FINDINGS FROM THE COAST

Findings from archaeological investigation of 18 coastal sites are briefly summarized in this chapter. Investigations at two sites (CA-MNT-1571/H and CA-MNT-1580) were limited to surface observations while data from four others (CA-MNT-281, -282, -480/H, and -1942) were recovered by other investigators. Thirteen of these sites were single-component, two were stratified with multiple components, and one was multi-component and mixed (see Table 1 for a summary of site characteristics). The site components represent occupations spanning from 4400 B.C. to A.D. 1830. Four sites were associated with ethnohistoric place names (CA-MNT-480/H, -1277/H, -1571/H, and -1580). Sites are discussed relative to a regional temporal framework that reflects a compromise between the cultural historical schema of the North Coast Range (Fredrickson 1974), the Santa Barbara Channel (King 1990), and the Sacramento Valley (Bennyhoff and Hughes (1987) (Table 12).

CA-MNT-63

CA-MNT-63 was excavated in 1989 by a small crew of volunteers, under contract from the California Department of Parks and Recreation. The site is located 40 km south of Carmel in Andrew Molera State Park at the mouth of the Big Sur River (Figure 1). Originally recorded as Mound #14 by E. W. Gifford in 1913, the deposit was later re-recorded by Arnold Pilling in 1948, who described it as "an occupation site" situated on a bluff, just east of the mouth of the Big Sur River. He suggested it would be "an excellent place to dig at least one test pit," since it probably contained, "more than one horizon" (Pilling 1948). It is a dense shell midden situated on the edge of a bluff that is bisected by the Big Sur River. Pilling's characterization proved to be fairly accurate, in that excavation showed the site to be somewhat richer, and deeper (210 cm), than many of the other deposits. Because of this, investigations were limited to two test units (units 1 and 3) (Figure 35) for a total recovery volume of 4.6 m^3.

This was one of the few sites to produce multiple stratified components. The bulk of deposit consisted of a fairly homogeneous concentration of black midden soil, shell fragments, fire-altered rock, vertebrate remains, and artifacts, but a. distinctive feature was identified in Unit 3 between 20 and 55 cm below surface. It consisted of a dense concentration of cobbles, fire-altered rock, whole abalone and mussel shells, bone, chunks of charcoal and unburned pieces of redwood, a dense mass of ash, glass beads, shell beads, and other artifacts (Figure 36). The glass beads clearly indicated that this feature dated to the post-contact era. Soil above the feature, a very loose, dark brown (10YR 2/2) shell midden with fine roots and a low frequency of fire-altered rock, was designated Stratum I. Stratum II was the primary cultural deposit beneath Feature 1 (Figure 37). It was a black (10 YR 3/2), relatively homogeneous midden with a fairly heavy concentration of shell fragments and fire-altered rock. A subvariant of this layer, Stratum IIa was detected in the bottom of Unit 1 where midden was intermixed with sterile substrate.

The glass beads were variants of the drawn or "tube" type (Kidd and Kidd 1970). Twenty-three examples were simple monochromes (Class I) without embellishment. The other seven were compound monochromes manufactured from a two-layered gathering of glass. They all were tumbled or reheated (Class IV). They included examples of DIa15 (N=1), DIa22 (N=1), DIIa7 (N=1), DIIa14 (N=1), DIIa27 (N=4), DIIa28 (N=4), DIIa41 (N=4), DIIa51 (N=5), DIIa61 (N=1), DIVa21 (N=8). Based on a zone of temporal overlap common to all of these types, the feature must have been deposited between A.D. 1800 and 1816. In addition to the glass beads, the feature produced 11 *Olivella* H1b, one *Olivella*

E2a, one *Olivella* H2, and three *Haliotis* epidermis disk beads, three Desert Side-notched (one made from bottle glass) and three Canaliño/Coastal Cottonwood projectile points, one hammerstone, one milling slab fragment, one bowl mortar fragment, and one pestle.

Two radiocarbon dates were also obtained from the feature. These were important, not only for dating of the feature itself, but for the information they provided on the magnitude of upwelling on the Big Sur coast. The dates were run from a black abalone shell and charcoal that was contained within the shell. The shell yielded an uncorrected date of 440±80 years B.P. (WSU-4053) and the charcoal dated 105.6±0.70 years B.P. (WSU-4054), which is essentially modern (Table 13). Corrected for isotopic fractionation, the shell date becomes 850±80. As discussed in Chapter 3, an upwelling correction factor of -325 years was needed to bring this date into alignment with the chronology indicated by the glass beads.

Mammal remains were dominated by sea otter, deer, and rabbit. Fish were not abundant, but included cabezon, monkeyface prickleback, and rockfish. Shellfish were dominated by mussels, with lesser amounts of turban snail and black abalone. The diet seems to have been focused on marine mammals, terrestrial mammals, and shellfish. The high frequency of sea otter bones was unique among the sites investigated, and probably reflects acquisition of otters for exchange in the burgeoning market in otter pelts. The presence of trade beads and a glass projectile point indicates that site inhabitants were somehow in contact with non-Native cultures. Site occupation occurred during a period of intensive pursuit of otters for pelts associated with the establishment of Fort Ross in 1812. Indeed, several of the glass beads are types that have been found at the fort (Ross 1976).

Table 12 Cultural Periods of the Central California Coast

Period	Dating	Fredrickson (1974) Equivalence North Coast Range	King (1990) Equivalence Santa Barbara Channel	Bennyhoff and Hughes (1987) Equivalence Sacramento Valley
PaleoIndian	9000-6500 B.C.	PaleoIndian		
Millingstone	6500-3500 B.C.	Lower Archaic	Ex, Eya	
Early	3500-600 B.C.	Middle Archaic	Eyb	Early
Early/Middle Transition	1000-600 B.C.		Ez	
Middle	600 B.C.-A.D.1000	Upper Archaic	M1-M5a	E/M Transition, Middle, Middle/Late Transition
Middle/Late Transition	A.D.1000-1250		M5b, M5c	
Late	A.D.1250-A.D.1500	Emergent, Phase 1	L1	L1
Protohistoric	A.D.1500-A.D.1769	Emergent, Phase 2	L2	L2
Historic	Post-A.D.1769		L3	

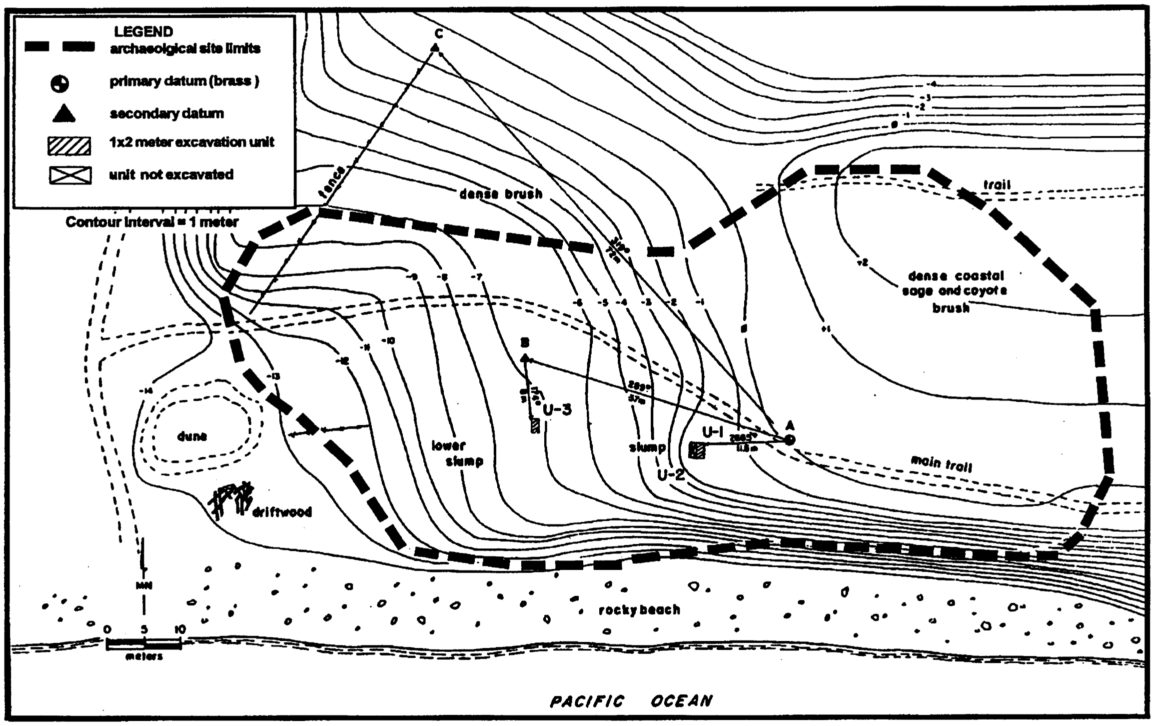


Figure 35 Site Map, CA-MNT-63

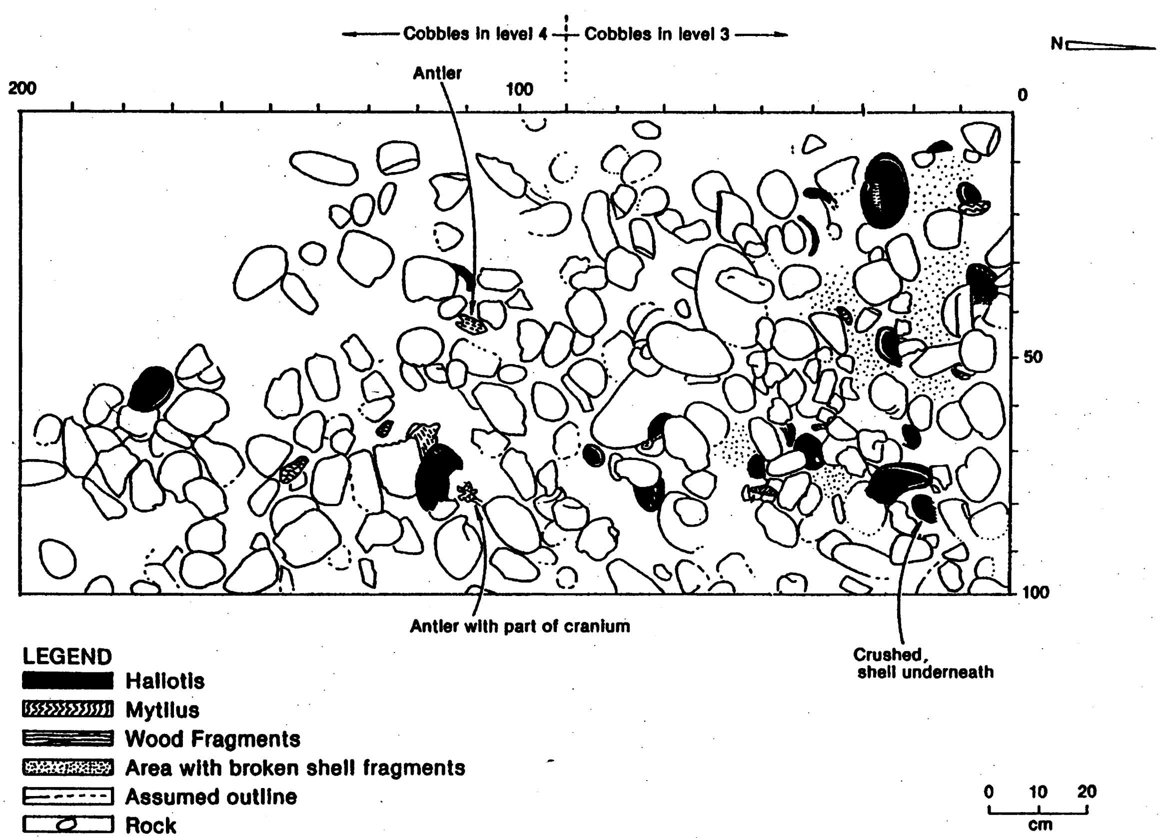
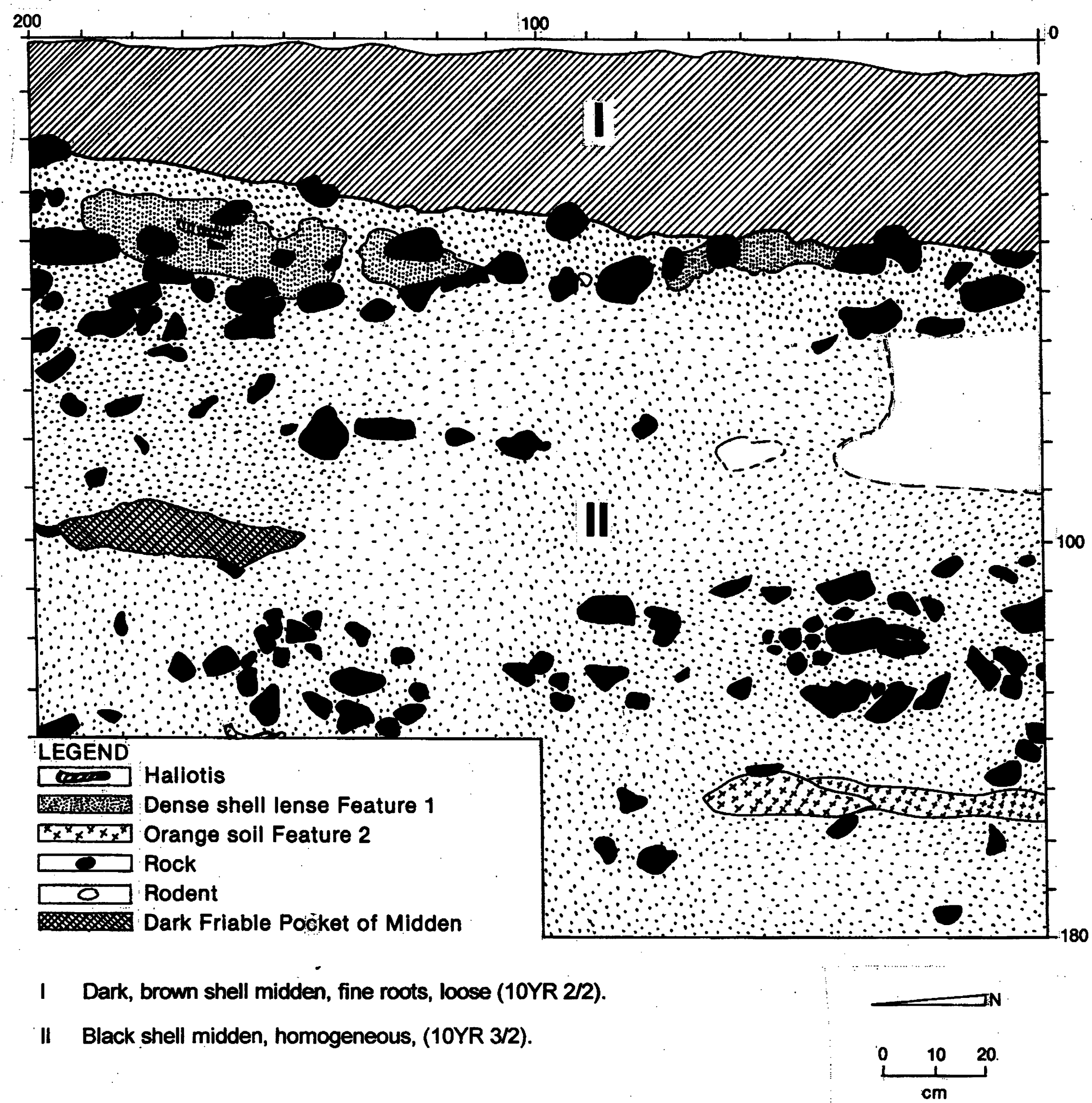


Figure 36 Feature 1, Unit 3, CA-MNT-63



I Dark, brown shell midden, fine roots, loose (10YR 2/2).

II Black shell midden, homogeneous, (10YR 3/2).

Figure 37 Sidewall Profile, CA-MNT-63

A bulk sample from the feature yielded 211 fragmentary floral elements, including 78 pieces of oak nutshell, 32 pieces of tanbark oak nutshell, 21 California bay nutshell pieces, 73 pieces of either tanbark oak or oak, three wild heliotrope seeds, one bedstraw seed, and three unknown fragments. Wild heliotrope blooms between March and June, while acorns are available only in the fall, and bay nuts in the late spring. The nuts and acorns were commonly stored; their co-occurrence with wild heliotrope seeds confirms storage of plant foods. While either the seeds or nuts could represent stored commodities collected elsewhere and brought in, the array of species more likely represents use of this site for an extended portion of the year, if not for the entire year. This estimate is consistent with the seasonality readings obtained from the deer teeth (Appendix II).

The feature also yielded 60 abalone shells including 7 red (*Haliotis rufescens*), and 53 black (*Haliotis cracherodii*), 221 individual mussel shells, 520 mammal and bird bones, and 79 fish bones. The fauna and artifacts allowed for fairly secure conclusions about dating and function. The recovery of apparently uneaten mussels (both halves of the shell articulated and still closed together) among a dense concentration of ash, shell, and fire-altered rock indicates that the feature must have represented a subsurface rock oven used for cooking mussels and possibly other foods. The large number of whole abalone shells, however, suggests that this feature was used for more than one purpose, as these shells probably represent debris from food that was cooked and consumed, not cooked and forgotten. These shells, and the dense concentration of mammal and bird bone suggest this pit feature was re-used to dispose of a wide variety of household debris, including some item(s) to which were attached shell and glass beads.

A passage from Culleton's (1950) history of Mission San Carlos suggests a possible historical association for the feature. In 1786, *Chilichon*, chief of *Jojopan*, a village at the mouth of the Big Sur River, defected from the mission and returned with his followers to their native territory. Recruits from *Jojopan* did not appear at the Mission again until 1806. The feature's dating and the array of implements are consistent with the kind of residential base such a group might have have used. Year-round site use, indicated by the deer teeth and floral remains, is consistent with a refugee group whose movements were constrained by the encroachment of a foreign civilization.

Two radiocarbon assays from the deposit beneath the feature indicated a late Middle Period occupation. An abalone shell from 100-110 cm yielded a corrected date of A.D. 1220, while a sample of charcoal from a small ash concentration 133 cm below surface produced a corrected date of A.D. 410. Two G2 Olivella saucer beads supported the dating indicated by radiocarbon. Obsidian hydration results on Casa Diablo (N=8), Coso (N=9), and Napa (N=4) also generally supported Middle Period dating (Figures 38-40). The vertical distribution of obsidian was revealing with respect to the structure of the deposit. No obsidian was associated with the historic feature, but 14 pieces were recovered from the levels above the feature. Among these were specimens that produced the thickest hydration rims. This distribution suggests that Feature 1 was intrusive into an older Middle Period deposit. Excavation of the rock oven represented by Feature 1 apparently displaced midden and obsidian upward.

The tool assemblage associated with the Middle Period component was dominated by remnants of the exploitation of locally-occurring Franciscan chert cobbles. These included four cores, 301 pieces of debitage, two bifaces, one drill, one flake tool, and four projectile points. Among the latter, were a Monterey chert large side-notched example, and a re-worked contracting-stemmed. The debitage density was 145 flakes/m^3. Similarity between the experimentally-derived proportions associated with the total reduction sequence (38% core/flake debris and 62% biface debris) and the proportions indicated by this assemblage (35% core/flake debris and 65% biface debris) suggests the debitage reflected a full reduction sequence (cobble to flake blank to bifacial preform to bifacial tool). In contrast, Monterey chert does not seem to have been available locally, and apparently arrived on-site in the form of bifaces and finished implements. A total of 83.2% of the Monterey chert debitage represented some form of biface reduction. Dominance of Monterey chert among the projectile points complimented this pattern. The flake:biface ratios were 13.1:1 for Monterey chert and 232:1 for Franciscan chert.

The rest of the formal tool assemblage included two hammerstones, one pestle, three milling slab fragments, one bowl mortar fragment, one handstone, one cobble smeared with asphaltum, one awl fragment (Figure 26), one strigil fragment (Figure 27), one indeterminate piece of polished bone, one fishhook fragment (Figure 28), one perforated fishhook blank fragment (Figure 29), one edge-modified whole red abalone shell that apparently served as a scraping tool (Figure 41), and one piece of red abalone shell smeared with asphaltum (Figure 30).

The faunal assemblage showed a preponderance of rabbit (NISP=52; 33.3%), black-tailed deer (NISP=38; 24.4%), northern fur seal (NISP=15; 9.6%), and sea otter (NISP=14; 8.9%). Fish remains

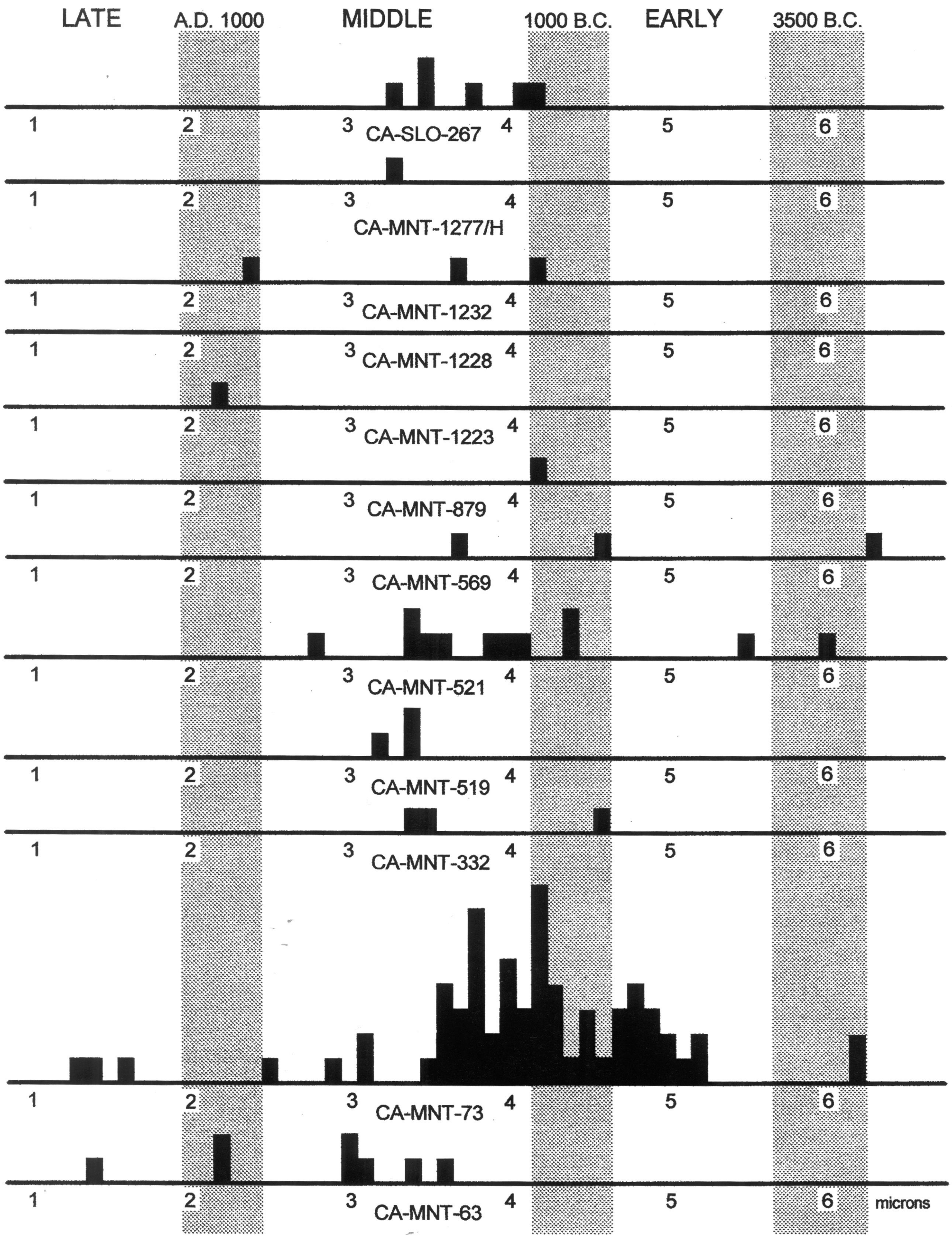


Figure 38 Hydration Results from Study Sites: Casa Diablo Obsidian

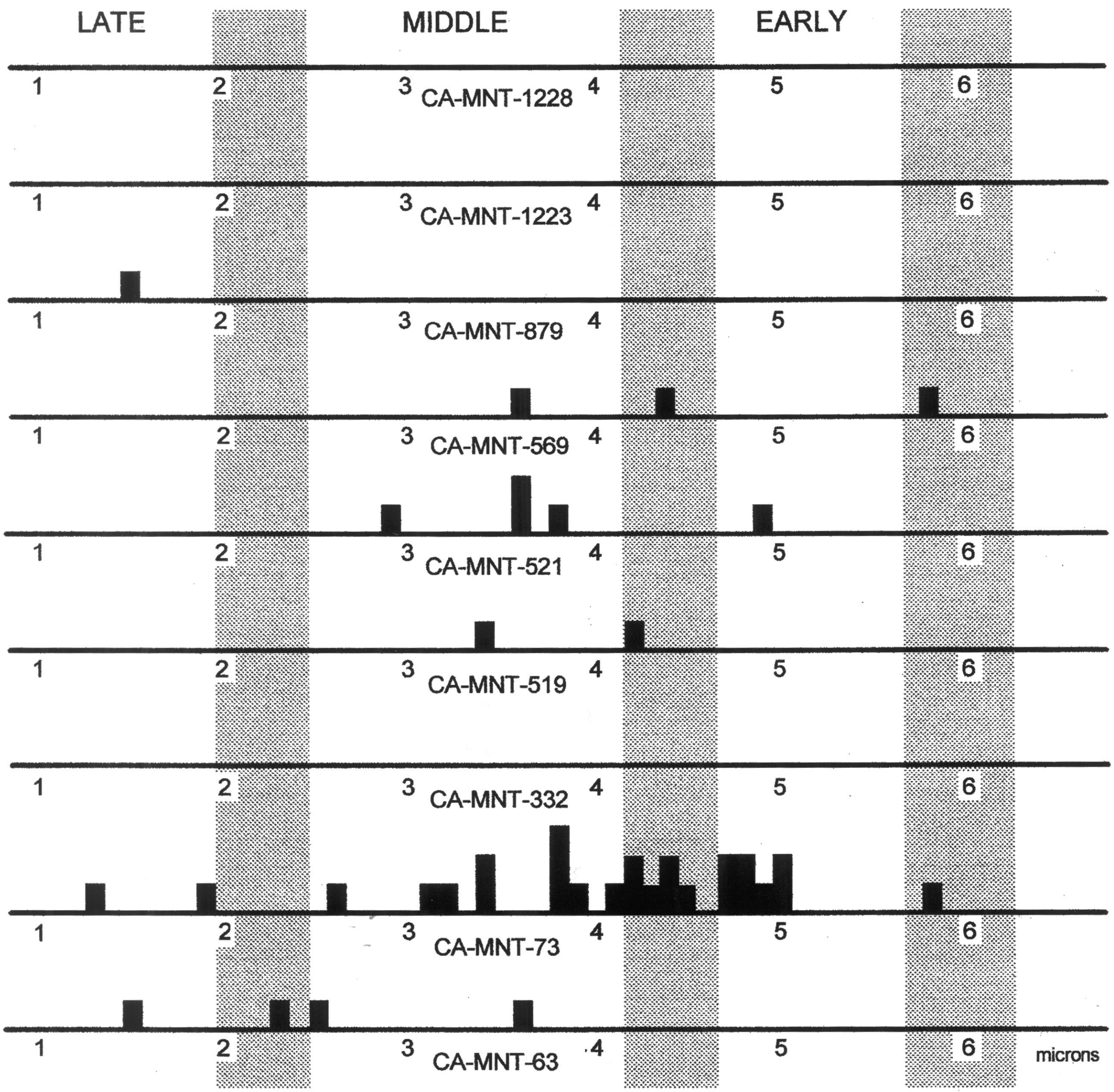


Figure 39 Hydration Results from Study Sites: Napa Obsidian

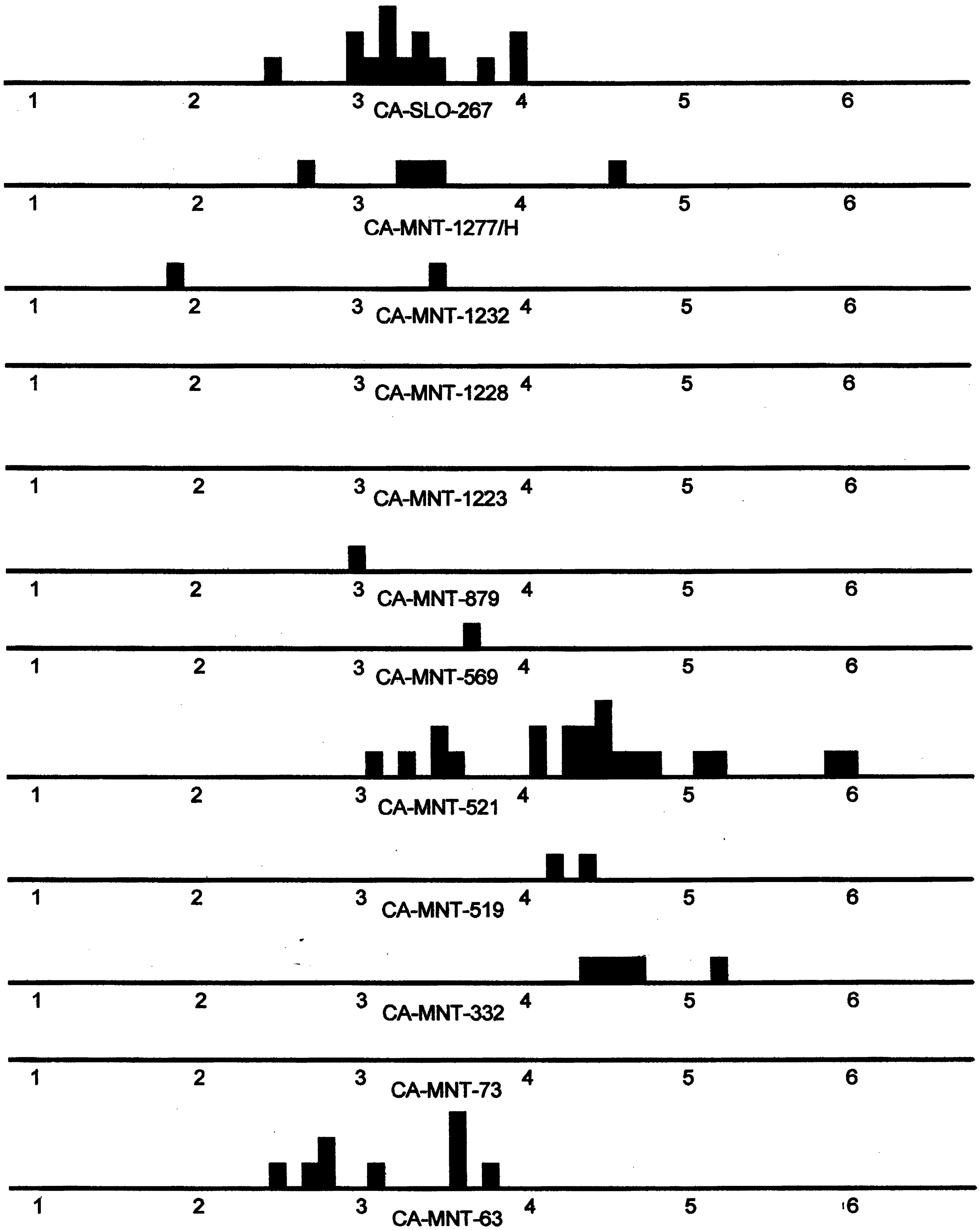


Figure 40 Hydration Results from Study Sites: Coso Obsidian

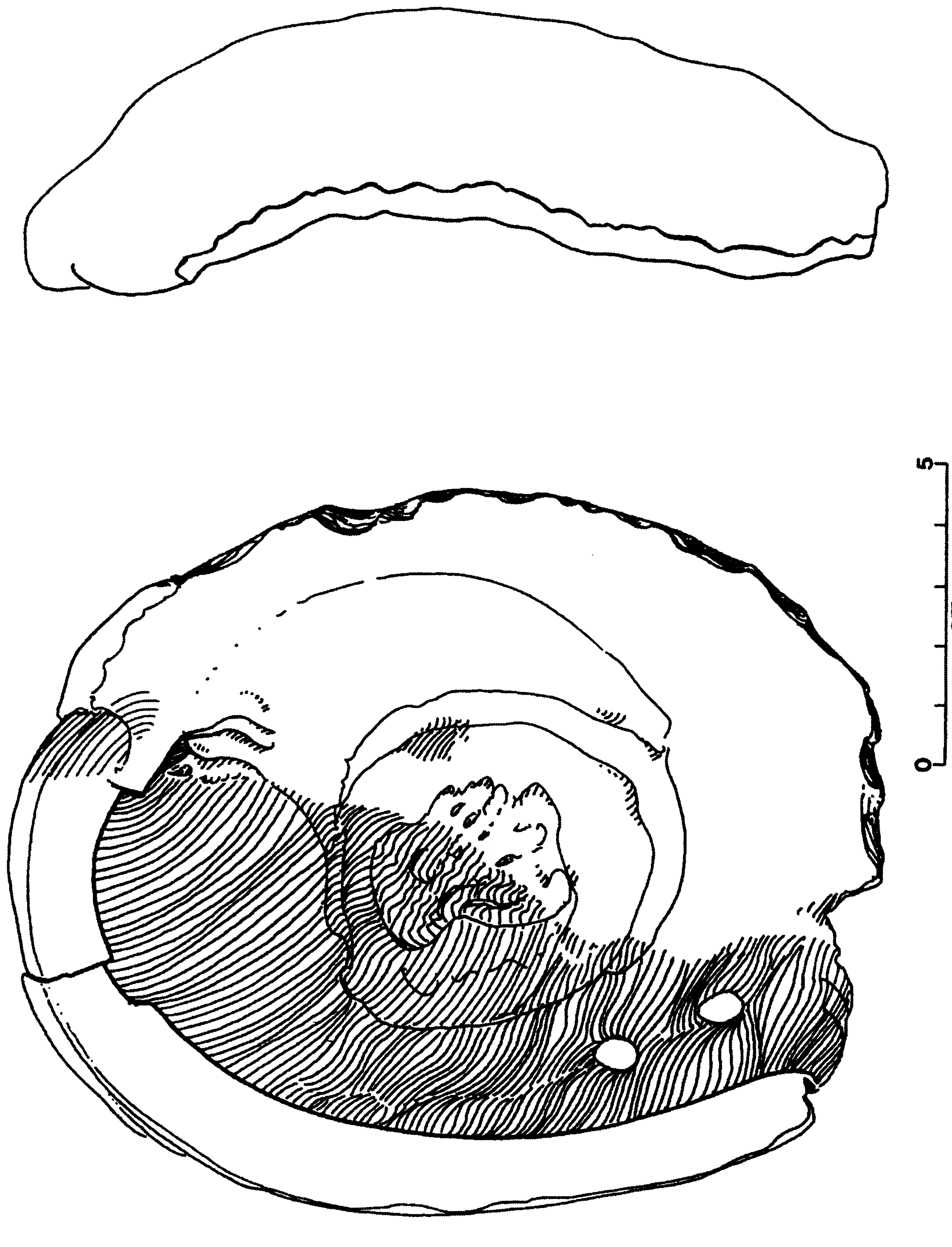


Figure 41 Abalone Shell Scraping Tool from CA-MNT-63

were also abundant. Without considering sample or screen size, this component was dominated by rockfish (NISP=299; 50.8%), cabezon (NISP=117; 19.9%), and monkeyface prickleback (NISP=65; 11.1%). The 1.5 mm control sample showed higher frequencies of northern anchovy and herring. The shellfish assemblage was dominated by mussel (79.1%), gumboot chiton (9.5%) and turban snail (6.1%).

CA-MNT-73

CA-MNT-73 is situated across the Big Sur River from CA-MNT-63 (Figure 42). It was excavated in 1990 by the U.C. Davis archaeological field school under contract from the California Department of Parks and Recreation. Situated within Andrew Molera State Park, the site was originally recorded by Arnold Pilling in 1948. It consists of an extensive shell midden with locally dense scatters of chert debitage, situated on a headland north of the river. Cultural materials occur within a sand dune stabilized by coastal scrub. Portions of the deposit along the edge of the coastal bluff were eroding at an alarming rate, and the 1990 investigation was intended to salvage a sample from the eroding materials. Eight 1 x 2 m units were excavated, for a total recovery of 20.9 m^3.

As is common for dune sites (see Milliken et al. 1999), CA-MNT-73 showed distinct physical stratigraphy (Figure 43) that proved to have little cultural meaning. Three physical strata were revealed during excavation: Stratum I, extending from the surface to depths between 15 and 40 cm below surface was a brown (10 YR 3/2) sand. Although some shell and cultural discoloration were apparent in this layer, it was essentially a sterile cap over the primary cultural layer, Stratum II that was directly beneath it. Three subvariants of Stratum II were identified. The uppermost portion of the layer, Stratum IIa, between 15 and 40-90 cm below surface, was characterized by a very dark grayish brown (10 YR 3/2) sandy midden with a low shell content. In some units the lowest portion of this stratum showed discontinuous concentrations of shell, designated Stratum IIb. In all units, a transitional zone was identified between the dense midden of Strata IIa and IIb, and the sterile submidden. Designated Stratum IIc, the transition was characterized by a light brown (10 YR 5/3) sandy midden. The natural dune soil underlying the cultural materials, Stratum III, was a very pale brown (10 Yr 8/4) compact sand. Evidence of rodent activity was profuse (Figure 43). While discrete layers are visible at CA-MNT-73, they are of minimal cultural significance, as the portion of the deposit excavated in 1990 is essentially a single cultural stratum capped by sterile, post-occupational dune sand. The vertical distribution of materials within Stratum IIa is likely a reflection of dune deflation and mixture from rodent disturbance.

Seven radiocarbon dates taken from a full range of statigraphic proveniences (between 30 and 160 cm) showed that the deposit was a single temporal component dating ca. 2300-1700 B.C. The artifact assemblage was typologically consistent with other Early Period sites on the central coast (e.g., CA-MNT-391 [Cartier 1993a], CA- CA-SLO-175 [Jones and Waugh 1995]). It included contracting-stemmed (5), square-stemmed (2), and large side-notched projectile points (3), one drill, informal flake tools (N=13), one Class L Rectangular *Olivella* bead, handstones (8), milling slabs (6), and pestles (5), and one bone awl. One of the unusual attributes of this component was the high frequency of obsidian; 138 pieces were recovered, from which 134 usable hydration readings were obtained. Constituting one of the largest hydration samples on the central coast, the readings showed impressive clustering between 3.1 and 5.3 microns, on all nine represented sources. Findings from Napa (N=30) and Casa Diablo (N=65) obsidian helped to define the local hydration timescale as discussed in Chapter 3.

Like CA-MNT-63, this site also produced abundant evidence for the exploitation of local Franciscan chert cobbles, including 101 cores, 11,232 pieces of debitage, and 33 bifaces. Of the 33 bifaces 26 were Franciscan chert, 5 were Monterey chert, and 2 were obsidian fragments. The Franciscan chert specimens represented all stages of reduction, with thirteen Stage 1, five Stage 2, three Stage 3, four Stage 4, and one Stage 5. The Monterey chert specimens were limited to two Stage 1 examples and three Stage 5. The obsidian examples were fragments of completed tools (Stage 5). The cores and bifaces suggest that Franciscan chert cobbles were reduced first into flake blanks and then into Stage 1 bifacial preforms, which were, in turn, reduced into finished tools. In short, a full range of reduction activities is suggested. Among the debitage, 56% of the Franciscan chert represented core/flake debris, while the majority of the Monterey chert specimens (70%) reflected biface reduction. These figures also suggest all stages of reduction for Franciscan stone, while working of Monterey chert was limited to reduction of bifacial preforms and re-working of Stage 5 bifaces.

Some attributes of this assemblage contrast with nearby CA-MNT-63, which was primarily occupied during the Middle Period, and briefly during the Historic Period. Core/flake debitage represents a significantly higher proportion (55.9%) of the diagnostic Franciscan chert flakes than at CA-MNT

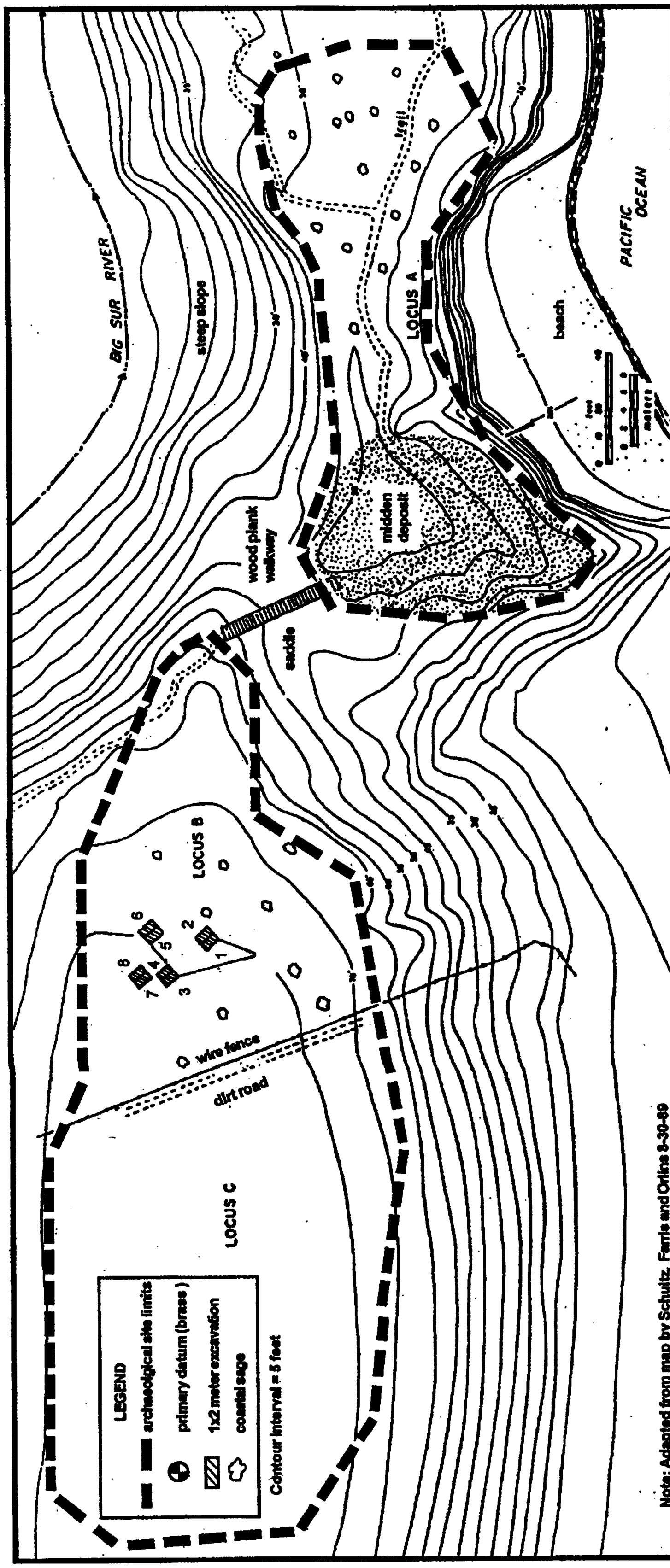
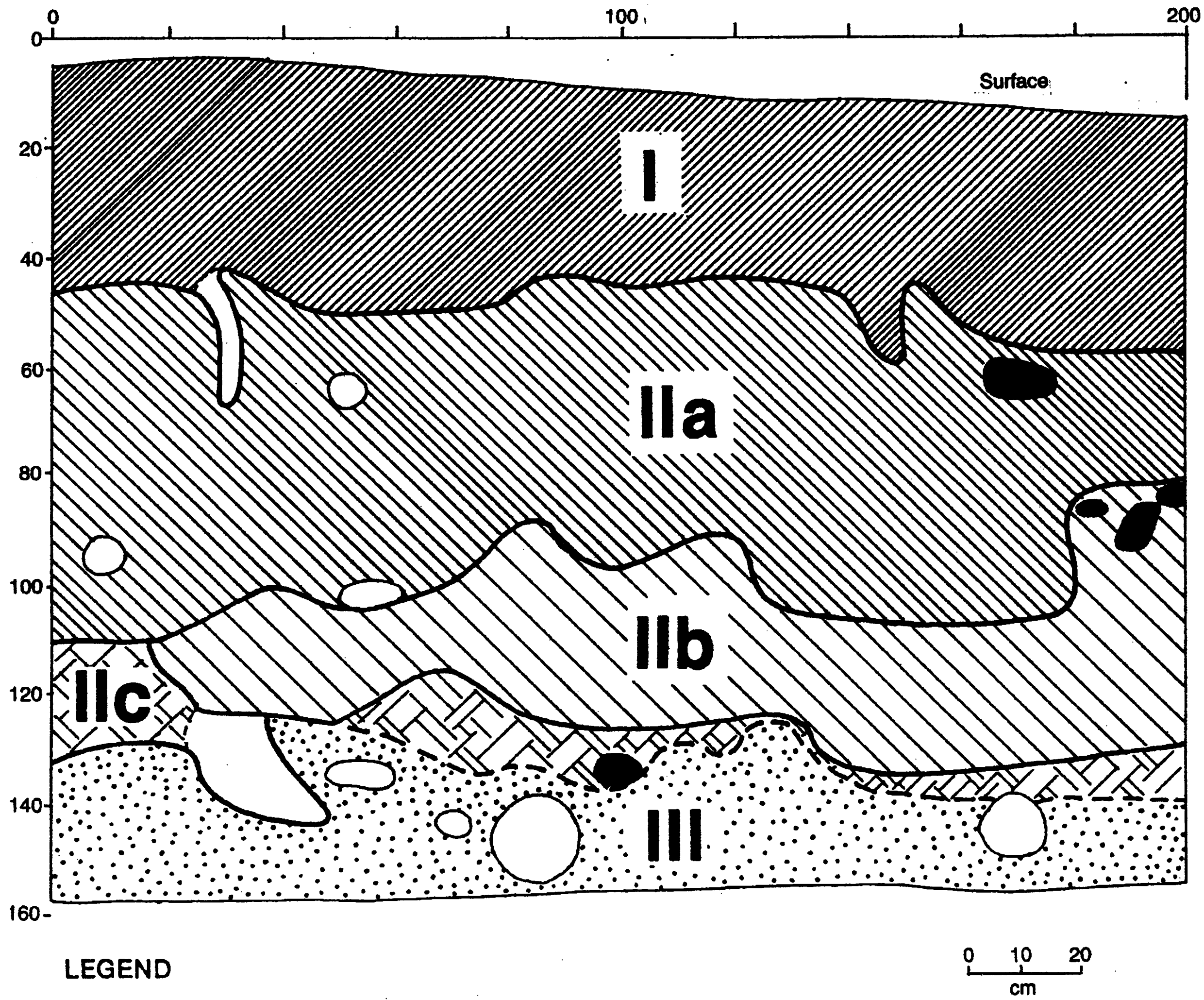


Figure 42 Site Map, CA-MNT-73



LEGEND

I	Brown (10YR 3/2) sand, nearly sterile with minor shell and debitage content.
IIa	Very dark greyish brown (10YR 3/2) sandy shell midden with low shell content.
IIb	Shell concentration zone at base of midden.
IIc	Transition zone between shell midden and sterile substrate. Light brown (10YR 5/3) sandy midden.
III	Light tan sandy subsoil.

Rodent activity

Fire-altered rock

Figure 43 Sidewall Profile, CA-MNT-73

63. The Franciscan assemblage also does not conform nearly as well with the experimental totals associated with full reduction, but rather shows a greater representation of core/flake debris. The Franciscan stone also showed a much higher flake:tool ratio of 296:1. Together these findings suggest that use of the mouth of the Big Sur River during the Early Period included more complete reduction than during the Middle Period, when preforms were often transported elsewhere for final reduction.

The faunal remains were dominated by deer (NISP = 28; 60.9%) and rabbit (NISP = 8; 17.4%) for the mammals, and rock prickleback (78.6%), rockfish (13.0%), and cabezon (2.5%) for the fish. The molluscan assemblage was dominated by mussel (61.5%), red abalone (18.9%), and black abalone (18.6%).

CA-MNT-281

CA-MNT-281 and -282 were investigated by U.C. Berkeley in the early 1950s and were reported later by Pohorecky (1964, 1976). For several decades, the findings from these sites constituted the only excavation data available from Big Sur. Located at the mouth of Willow Creek on the southern Sur coast (Figure 1), the site attracted the attention of Robert Heizer because of the presence of two stratigraphically discrete midden deposits: CA-MNT-281 at the surface and CA-MNT-282 below it. The two layers were separated from one another by a thick layer of sterile gravel. CA-MNT-281, the upper stratum, was not dated by radiocarbon or obsidian hydration, but it is certainly younger than the underlying CA-MNT-282, which was dated to the Middle Period. An asphaltum-stained rock with a cloth textile impression indicated some occupation during the early Historic Period (Moratto 1984:240), but absence of arrow points and glass beads is consistent with occupation before the Late Period. The site shows retention of many older artifact types, including large contracting-stemmed projectile points, notched net weights, and circular shell fishhooks. Innovations included the hopper mortar and perforated stone disks. Slate tablets with incised chevron designs were abundant but were lacking from the older stratum below. Burial mode was flexed. Substantive faunal data are not available.

CA-MNT-282

Because it was thought that it might show significant antiquity, the lower stratum at Willow Creek was heavily sampled in the 1950s. Two radiocarbon dates of A.D. 80 and 130 (Table 13) subsequently showed that the deposit dated only to the Middle Period. In keeping with the excavation strategies of the 1950s, a large volume was recovered from the deposit, and the resulting collection remains among the largest available from the area today. Soils were not screened (David Fredrickson, personal communication 1990), however, and many small constituents are under-represented. Shell beads, for example, were not reported from either midden, nor was fish bone. The artifact-rich collections, generated from temporally discrete contexts retain cultural historical significance, however, and have been used to define the Middle Period in this district. The assemblage was highlighted by large contracting-stemmed points, notched net sinkers, circular mussel and abalone shell fishhooks. A series of burials was recovered, all in the flexed position with no accompaniments.

CA-MNT-480/H

CA-MNT-480/H, situated 200 m south of CA-MNT-1233 on Gamboa Ridge, was investigated by Howard (1973), who incorrectly identified it as an Esselen village. J. P. Harrington's consultants associated this location with the Salinan village of *ts'alák'ak'a'* (Jones et al. 1989; Rivers and Jones 1993). Howard (1973:9) reported a corrected radiocarbon date of A.D. 1300 from charcoal taken from the base of the deposit (Table 13). While site findings are poorly reported, an apparent *Olivella* lipped bead as well as Desert Side-notched and Canaliño/Coastal Cottonwood projectile points support occupation during the Late Period and seem to corroborate this as the remains of a village. Hopper mortars were also found on the site surface when it was re-recorded in 1983 (Jones et al. 1989:101).

Table 13 Radiocarbon Dates from Study Sites

Site	Unit	Depth (cm)	Laboratory number	Radiocarbon age (Years B.P.)	Sample	Conventional C14 Age (13C adjusted Age, Years B.P.)	Calibrated Date 1 sigma range (Upwelling correction = 325+35)
MNT-63	3	33*	WSU-4053	440±80	*Haliotis*	850±106	A.D.1530 (1720) 1870
MNT-63	3	33*	WSU-4054	105.6±0.7	Charcoal	105.6±70	A.D.1690 (1710) 1955
MNT-63	3	100-110	WSU-4052	1130±80	*Haliotis*	1540±80	A.D.1030 (1180) 1290
MNT-63	3	133	WSU-4051	1630±90	Charcoal	1630±90	A.D.260 (420) 540
MNT-73	1	30-40	Beta-69663	4110±80	*Cryptochiton*	4440±80	2440 (2260) 2050 B.C.
MNT-73	1	60-70	Beta-69664	3800±110	*Cryptochiton*	4140±110	2030 (1860) 1650 B.C.
MNT-73	1	110-120	Beta-46055	4030±90	*Haliotis*	4490±90	2480 (2320) 2130 B.C.
MNT-73	1	150-160	Beta-69665	4170±100	*Cryptochiton*	4170±100	2060 (1880) 1690 B.C.
MNT-73	2	70-80	Beta-69666	3820±80	*Haliotis*	4260±80	2180 (1990)1850 B.C.
MNT-73	2	130-140	Beta-69667	3680±100	*Haliotis*	4120±100	1990 (1770) 1640 B.C.
MNT-73	4	80-90	Beta-46054	3900±60	*Haliotis*	4350±60	2290 (2130) 1950 B.C.
MNT-282	-	-	C-628	1879±250	Charcoal	1879±250	410 B.C. (A.D.80) A.D.650
MNT-282	-	-	C-695	1840±400	Charcoal	1840±400	810 B.C. (A.D.130) A.D.1000
MNT-480/H	T-1	94	I-06616	650±90	Charcoal	650±90	A.D.1210 (1300) 1430
MNT-332	TEU 3	50-60	Beta-89645	1310±50	Bone collagen	1370±50	A.D.580 (650) 770
MNT-361	TEU 1	20-30	Beta-69620	140±	Charcoal	--	A.D.1810
MNT-361	TEU 1	20-30	Beta-69621	80±	Charcoal	--	Modern
MNT-504	TEU 10	10-20	Beta-89646	110.8±0.5	Bone collagen	--	Modern
MNT-519	2	0-10	Beta-129897	1060±40	*Mytilus*	1490±40	A.D.1210 (1260) 1300
MNT-519	2	40-50	Beta-129898	1110±40	*Mytilus*	1530±40	A.D.1170 (1230) 1280
MNT-519	STU C N30/120-122	0-20	Beta-133499	590±130	*Cryptochiton*	980±140	A.D.1510 (1670) 1830
MNT-521	1	90-100	Beta-85227	3530±70	*Mytilus*	3950±70	1740 (1600) 1450 B.C.
MNT-521	2	20-30	Beta-85228	1180±120	*Haliotis*	1620±180	A.D.880 (1060) 1290
MNT-521	2	110-120	Beta-86484	1590±60	Bone collagen	1650±60	A.D.340 (420) 530
MNT-521	8	30-40	Beta-85229	2040±90	*Haliotis*	2460±100	A.D.50 (210) 380
MNT-521	8	70-80	Beta-86485	3440±60	Clam shell Bead	3860±60	1640 (1500) 1380 B.C.

Table 13 Radiocarbon Dates from Study Sites (continued)

Site	Unit	Depth (cm)	Laboratory number	Radiocarbon age (Years B.P.)	Sample	Conventional C14 Age (13C adjusted Age, Years B.P.)	Calibrated Date 1 sigma range (Upwelling correction = 325+35)
MNT-521	8	80-90	Beta-85230	5660±60	*Haliotis*	6090±60	4360 (4260) 4140 B.C.
MNT-521	11	80-90	Beta-85231	3250±60	*Haliotis*	3700±60	1440 (1320) 1130 B.C.
MNT-521	13	70-80	Beta-86486	2680±70	Bone collagen	2710±70	970 (830) 770 B.C.
MNT-569	TEU 4	0-10	Beta-93923	370±80	*Mytilus*	790±80	A.D. 1670 (1955) 1955
MNT-569	RRU 2	170-190	Beta-89647	3500±40	Bone collagen	3470±40	1660 (1750, 1760, 1770, 1800, 1810) 1920 B.C.
MNT-569	RRU 4	140-150	Beta-89648	3100±40	Deer bone	3140±40	1320 (1420, 1430) 1502 B.C.
MNT-759/H	1	10-20	Beta-43106	770±70	*Mytilus*	1180±70	A.D.1380 (1450) 1530
MNT-759/H	1	70-80	Beta-43105	720±80	*Mytilus*	1140±80	A.D.1400 (1470) 1620
MNT-879	1	20-30	Beta-146048	940±70	*Mytilus*	1370±80	A.D.1290 (1330) 1420
MNT-879	1	60-70	Beta-146049	550±70	*Mytilus*	970±80	A.D.1590 (1670) 1730
MNT-879	1	120-130	Beta-156050	840±90	*Mytilus*	1260±100	A.D.1330 (1430) 1490
MNT-879	6	50-60	Beta-146051	280±60	Charcoal	260±60	A.D.1530 (1650) 1950*
MNT-1223	3	20-30	WSU-3578	1110±50	*Haliotis*	1520±86	A.D.1040 (1200) 1300
MNT-1223	5	20-30	Beta-105979	470±50	Mytilus***	890±50	A.D.1630 (1690) 1860
MNT-1223	7	40-50	WSU-4059	770±80	*Mytilus*	1180±106	A.D.1340 (1450) 1560
MNT-1223	9	30-40	Beta-46060	460±60	*Haliotis*	900±60	A.D.1610 (1690) 1850
MNT-1223	9	50-60	WSU-3579	920±75	*Haliotis*	1330±103	A.D.1240 (1330) 1450
MNT-1223	10	20-30	Beta-46059	590±	*Haliotis*	1060±70	A.D.1450 (1530) 1670
MNT-1223	11	40-50	Beta-80722	610±60	Mytilus***	1020±60	A.D.1460 (1600) 1700
MNT-1227	2	20-30	Beta-72489	620±50	*Mytilus*	1040±50	A.D.1470 (1550) 1680
MNT-1227	4	30-40	Beta-72490	470±60	*Mytilus*	890±60	A.D.1630 (1690) 1870
MNT-1227	5	90-100	Beta-43107	660±60	Charcoal	660±60	A.D.1290 (1300) 1390
MNT-1227	6	20-30	Beta-80721	610±80	Mytilus***	1040±80	A.D.1460 (1550) 1680
MNT-1227	6	60-70	Beta-43108	870±90	*Mytilus*	1270±90	A.D.1290 (1400) 1480
MNT-1228	1	60-70	Beta-43109	4850±90	*Haliotis*	5290±90	3530 (3360) 3260 B.C.
MNT-1228	2	40-50	Beta-43110	4530±80	*Mytilus*	4950±80	3070 (2900) 2830 B.C.
MNT-1228	10	20-30	Beta-43111	5260±70	*Mytilus*	5670±70	3940 (3780) 3650 B.C.

Table 13 Radiocarbon Dates from Study Sites (continued)

Site	Unit	Depth (cm)	Laboratory number	Radiocarbon age (Years B.P.)	Sample	Conventional C14 Age (13C adjusted Age, Years B.P.)	Calibrated Date 1 sigma range (Upwelling correction = 325+35)
MNT-1232/H	3	120-130	Beta-46062	3380±60	*Haliotis*	3830±60	1600 (1450) 1350 B.C.
MNT-1232/H	3	130-140	Beta-46061	4790±70	*Haliotis*	5240±70	3490 (3330) 3110 B.C.
MNT-1232/H	3	210-220	Beta-43113	5620±80	*Mytilus*	6060±80	4340 (4230) 4070 B.C.
MNT-1232/H	3	270-280	Beta-43112	5390±80	*Mytilus*	5790±90	4060 (3940) 3770 B.C.
MNT-1232/H	4	230-240	Beta-43114	5830±80	*Mytilus*	6250±80	4540 (4420) 4310 B.C.
MNT-1232/H	5	50-60	Beta-46506	3600±60	*Haliotis*	4050±60	1880 (1720) 1590 B.C.
MNT-1232/H	5	70-80	Beta-43115	5650±90	*Mytilus*	6070±90	4350 (4240) 4070 B.C.
MNT-1233	2	70-80	Beta-80723	850±80	*Mytilus****	1270±80	A.D.1300 (1400) 1470
MNT-1233	3	30-40	Beta-43118	980±60	*Mytilus*	1400±60	A.D.1210 (1300) 1400
MNT-1233	3	40-50	Beta-80724	800±100	*Mytilus****	1220±100	A.D.1310 (1430) 1520
MNT-1233	3	50-60	Beta-82400	1260±60	*Mytilus****	1620±60	A.D. 980 (1060) 1220
MNT-1233	3	60-70	Beta-43117	1250±80	*Mytilus*	1670±80	A.D. 910 (1030) 1180
MNT-1233	3	100-110	Beta-43116	110±80	*Mytilus*	1530±80	A.D.1040 (1190) 1300
MNT-1233	4	120-130	Beta-46057	1130±70	*Mytilus*	1569±70	A.D.1020 (1150) 1270
MNT-1235	3	0-10	WSU-3580	1210±75	*Mytilus*	1620±103	A.D.910 (1120) 1300
MNT-1235	4	10-20	WSU-4060	780±70	*Mytilus*	1190±99	A.D.1320 (1460) 1650
MNT-1236	1	30-40	WSU-4062	470±80	*Haliotis*	880±106	A.D.1530 (1800) 1950
MNT-1236	1	50-60	WSU-4063	750±60	*Mytilus***	1160±92	A.D.1340 (1480) 1670
MNT-1236	1	100-110	WSU-4061	1220±70	Charcoal	1220±99	A.D.640 (780, 790, 800) 1000
MNT-1277/H	1	10-20	Beta-43120	660±70	*Haliotis*	1020±70	A.D.1480 (1600) 1810
MNT-1277/H	1	80-90	Beta-43119	560±70	*Haliotis*	990±60	A.D.1490 (1640) 1700
MNT-1277/H	4	90-100	Beta-46058	540±60	*Haliotis*	1100±70	A.D.1430 (1500) 1650
MNT-1754	TEU 1	20-30	Beta-89649	430±40	Bone collagen	450±40	A.D. 1410 (1440) 1490
MNT-1942	1	17-25	Beta-145647	170±70	Charcoal	170±70	A.D.1660 (1680, 1740, 1750, 1760, 1760, 1810, 1940, 1954) 1954
MNT-1942	1	17-25	Beta-145650	480±40	*Mytilus*	900±40	A.D.1680 (1710) 1820
MNT-1942	1	52-67	Beta-146481	800±60	Charcoal	800±60	A.D.1210 (1260) 1280
MNT-1942	1	52-67	Beta-145651	1180±40	*Mytilus*	1600±40	A.D.1060 (1150) 1210

Table 13 Radiocarbon Dates from Study Sites (continued)

Site	Unit	Depth (cm)	Laboratory number	Radiocarbon age (Years B.P.)	Sample	Conventional C14 Age (13C adjusted Age, Years B.P.)	Calibrated Date 1 sigma range (Upwelling correction = 325+35)
MNT-1942	4	45-58	Beta-145640	330±80	Charcoal	330±80	A.D.1450 (1530, 1560, 1630) 1660
MNT-1942	4	45-58	Beta-143874	550±50	*Haliotis*	1000±60	A.D.1560 (1660) 1690
MNT-1942	5	133-152	Beta-145644	410±40	Charcoal	340±40	A.D.1490 (1520, 1570, 1580, 1630) 1640
MNT-1942	5	133-152	Beta-143875	580±50	*Haliotis*	1030±60	A.D.1530 (1640) 1680
MNT-1942	5	115-136	Beta-145643	210±60	Charcoal	210±60	A.D.1650 (1670, 1780, 1800, 1950) 1954
MNT-1942	5	115-136	Beta-143876	410±70	*Haliotis*	860±70	A.D.1670 (1810) 1870
MNT-1942	Feature 2	145-182	Beta-145645	110±50	Charcoal	110±50	A.D.1680 (1700, 1720, 1820, 1840, 1880, 1920, 1950) 1954
MNT-1942	Feature 2	145-182	Beta-143873	480±70	*Haliotis*	930±80	A.D.1650 (1690) 1820
MNT-1942	5	115-132	Beta-146482	350±70	Charcoal	350±70	A.D.1450 (1520, 1600, 1620) 1650
MNT-1942	5	115-132	Beta-145649	490±40	*Mytilus*	910±40	A.D.1680 (1700) 1810
MNT-1942	5	125-155	Beta-145648	360±50	Charcoal	360±50	A.D.1450 (1500, 1510, 1520, 1600, 1620) 1640
MNT-1942	5	125-155	Beta-143877	690±100	*Haliotis*	1140±100	A.D.1440 (1500) 1630
MNT-1942	5	165-218	Beta-145646	410±70	Charcoal	410±70	A.D.1440 (1450) 1630
MNT-1942	5	165-218	Beta-143878	370±70	*Haliotis*	800±70	A.D.1670 (1880, 1940) 1870
MNT-1942	Trench 1	60-110	Beta-143872	300±110	*Haliotis*	740±120	Historic/Modern
MNT-1942	2	20-40	Beta-146483	530±80	Charcoal	530±80	A.D.1330 (1410) 1440
MNT-1942	2	20-40	Beta-145652	440±40	*Mytilus*	870±40	A.D.1690 (1800) 1860
MNT-1942	2	56-80	Beta-146484	720±70	Charcoal	720±70	A.D.1260 (1290) 1380
MNT-1942	2	56-80	Beta-145653	740±40	*Mytilus*	1180±40	A.D.1440 (1470) 1510
MNT-1942	Trench 2	15-28	Beta-145641	240±70	Charcoal	240±70	A.D.1640 (1660) 1954
MNT-1942	Trench 2	15-28	Beta-145654	460±40	*Mytilus*	890±40	A.D.1680 (1720) 1830
MNT-1942	Trench 2	77-90	Beta-145642	280±60	Charcoal	280±60	A.D.1520 (1650) 1670

Table 13 Radiocarbon Dates from Study Sites (continued)

Site	Unit	Depth (cm)	Laboratory number	Radiocarbon age (Years B.P.)	Sample	Conventional C14 Age (13C adjusted Age, Years B.P.)	Calibrated Date 1 sigma range (Upwelling correction = 325+35)
MNT-1942	Trench 2	77-90	Beta-145655	640±50	*Mytilus*	1070±50	A.D.1500 (1550) 1650
MNT-1942	3	0-10	Beta-146487	460±80	*Charcoal*	460±80	A.D.1410 (1440) 1490
MNT-1942	3	0-10	Beta-145658	600±40	*Mytilus*	1040±40	A.D.1530 (1630) 1660
MNT-1942	3	30-40	Beta-146488	590±80	Charcoal	590±80	A.D.1300 (1330, 1340, 1430
MNT-1942	3	30-40	Beta-145659	1020±40	*Mytilus*	1460±40	A.D.1240 (1280) 1310
MNT-1942	6	20-30	Beta-146485	640±70	Charcoal	640±70	A.D.1290 (1310, 1320, 1390) 1410
MNT-1942	6	20-30	Beta-145656	760±60	*Mytilus*	1180±60	A.D.1430 (1470) 1520
MNT-1942	6	50-60	Beta-146486	630±70	Charcoal	630±70	A.D.1290 (1320, 1350, 1370, 1390) 1410
MNT-1942	6	50-60	Beta-145657	870±40	*Mytilus*	1290±40	A.D.1360 (1410) 1440
SLO-267	N19/E37	50-60	Beta-37487	540+60	*Haliotis*	990+60	A.D.1580 (1660) 1700
SLO-267	N19/E37	10-20	Beta-38124	840+70	*Haliotis***	1270+70	A.D.1350 (1420) 1460
SLO-267	N1/E0	30-40	Beta-37479	2560+70	*Haliotis*	3000+70	490 (390) 340 B.C.
SLO-267	N60/E10	20-30	Beta-37480	1290+70	*Haliotis*	1660+70	A.D.1010 (1060) 1170
SLO-267	N39/E7	50-60	Beta-37481	2590+70	*Haliotis*	3040+70	540 (410) 370 B.C.
SLO-267	N180/W60	20-30	Beta-37482	1380+60	*Haliotis*	1820+60	A.D.840 (920) 1000
SLO-267	N160/W70	20-30	Beta-37483	2370+70	*Haliotis*	2820+70	320 (180) 80 B.C.
SLO-267	N115/E35	80-90	Beta-37484	1900+60	*Haliotis*	2340+60	A.D. 310 (400) 460
SLO-267	N39/E7	20-30	Beta-37485	2550+70	*Haliotis*	2990+70	470 (380) 340 B.C.
SLO-267	N115/E35	80-90	Beta-37486	1980+80	*Haliotis*	2430+80	A.D. 170 (270) 400
SLO-267	N60/E0	40-50	Beta -38122	2480+70	*Haliotis*	2920+70	390 (340) 200 B.C.
SLO-267	N9/E11	20-30	Beta-38123	1030+70	*Haliotis*	1470+70	A.D.1210 (1280) 1320
SLO-267	N115/E35	30-40	Beta-38125	1310+70	*Mytilus***	1730+70	A.D.940 (1020) 1060
SLO-267	N0/E0	20-30	Beta-38126	1320+60	*Mytilus***	1730+60	A.D.950 (1020) 1070
SLO-267	N0/E0	20-30	Beta-38127	1850+80	*Tegula*	2270+80	A.D.380 (460) 570
SLO-267	N115/E35	30-40	Beta-38128	1230+70	*Tegula*	1660+70	A.D.1010 (1060) 1170
SLO-267	8	10-20	Beta-105984	1090+40	*Mytilus****	1520+40	A.D.1180 (1240) 1280

Table 13 Radiocarbon Dates from Study Sites (continued)

Site	Unit	Depth (cm)	Laboratory number	Radiocarbon age (Years B.P.)	Sample	Conventional C14 Age (13C adjusted Age, Years B.P.)	Calibrated Date 1 sigma range (Upwelling correction = 325+35)
SLO-267	8	20-30	Beta-105985	3000+50	*Mytilus****	3440+50	1000 (910) 840 B.C.
SLO-267	12	30-40	Beta-05986	2260+50	*Mytilus****	2670+50	B.C. (A.D.10) A.D.80
SLO-267	28	70-80	Beta-105987	3100+60	*Mytilus****	3500+60	1100 (990) 900 B.C.
SLO-267	8	60-70	Beta-145452	2100+30	Deer bone collagen	2180+30	350 (200) 170 B.C.
SLO-267	11	40-50	Beta-145453	2940+30	Deer bone collagen	3020+30	1370 (1250) 1130 B.C.

*Associated with Feature 1.
**Multiple fragment sample.
***Used in oxygen isotope study.

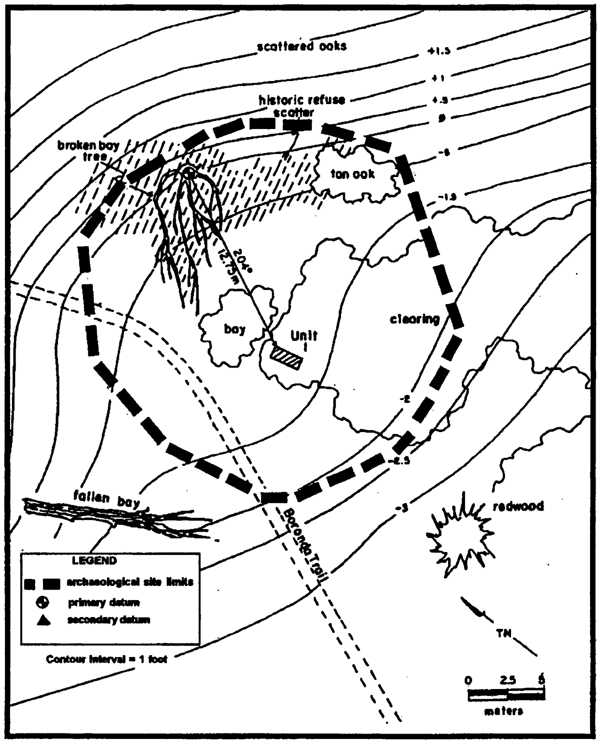


Figure 44 Site Map, CA-MNT-759/H

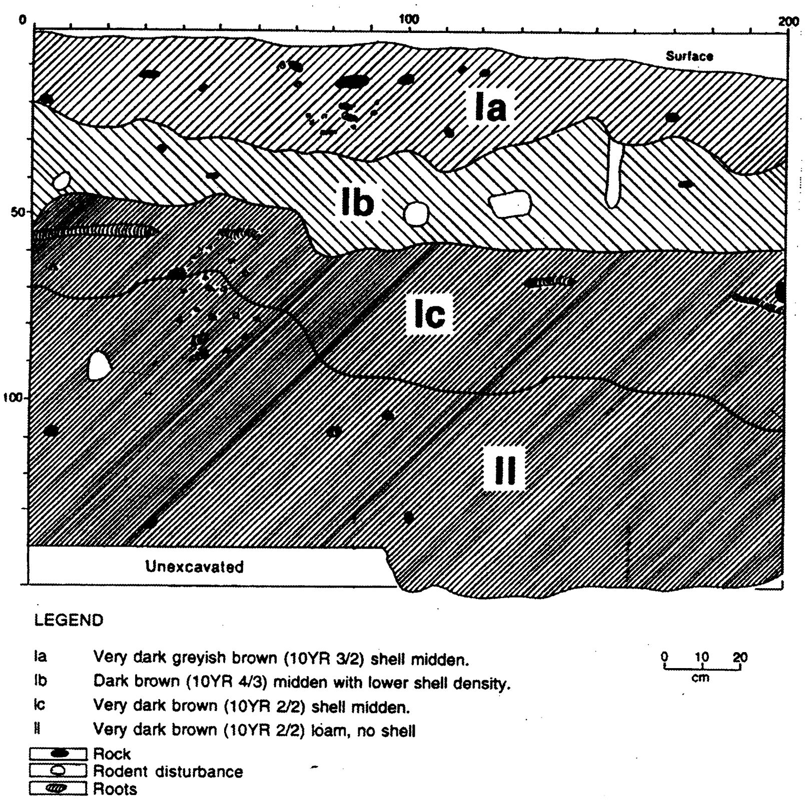


Figure 45 Sidewall Profile, CA-MNT-759/H

Corrected radiocarbon dates of A.D. 1450 and 1470 indicated that this was a single component site occupied during the Late Period. Curiously, the artifact assemblage produced not arrow points but rather examples of larger, generally older contracting-stemmed (N=1) and large side-notched side-notched (N=1) points. *Olivella* beads were consistent with the radiocarbon dates with one normal round thin lipped (E1a1) and two normal full lipped (E2a1). Ground stone included three handstones, a milling slab fragment, and a small pebble, approximately 5 cm in length, with a shaped and polished end. Faunal remains showed a striking emphasis on terrestrial resources, primarily deer, with very minimal use of fish or shellfish. No marine mammal remains were found.

Stone working debris was not abundant. Debitage density was modest at 18.9 flakes/m^3, and the flake:biface ratio was 13.8:1. As elsewhere, the debitage was dominated by Monterey chert (89.1%). Chert seems to have arrived on-site in a variety of forms including Stage 2 and Stage 3 bifaces, finished tools, and cores. A heavy representation of core/flake debitage suggests that arrow points were made here, even though they were unrepresented in the artifacts. Their absence is probably a product of small sample size.

Among the fauna were the remains of a newly born deer, which suggest the site was occupied in the spring. Annuli in the teeth from adult deer suggested late summer and fall occupation. Together, these indicators constitute a small sample, but they suggest occupation through at least half of the annual cycle. This site certainly functioned as a residential base, given the diversity in its artifact assemblage. Its small size indicates that it could not have been occupied by more than one or two families at any given time. The faunal inventory also shows a heavy focus on deer, suggesting the site may have had a function similar to the ethnohistoric site of tracteń, the Salinan hunting camp, identified by Harrington's informants and associated with archaeological sites CA-MNT-1571 and CA-MNT-1580. The small size and inland setting of CA-MNT-759 are also traits shared with the ethnohistorically identified hunting camp. The relative abundance of ground stone implements suggests that site inhabitants exploited seasonally available vegetable foods. While this may have been a hunting site, it was used for perhaps half of the year by a small social group, who also undertook a variety of other tasks. Its tool assemblage is not very different or distinctive functionally in comparison with the other sites.

CA-MNT-1223

CA-MNT-1223, the Dolan I Site, was excavated in 1986 by the U.C. Santa Cruz archaeological field school, with grant funds from the Giles Mead Foundation. Located in Landels-Hill Big Creek Reserve (Figure 1) on Dolan Ridge at an elevation of 370 m, the site (Figure 46) is a very small (1365 m^2) shell midden on the edge of a ridgetop overlooking the Pacific Ocean, 0.8 km from the shoreline. The site was originally recorded by members of a previous field class, who noted that the midden was actively eroding down the face of a steep slope. Erosion was accelerated by a wildfire in 1985, and the goal of the 1986 excavation was to salvage as much as possible from the eroding deposit. Twelve 1 x 2 m units were excavated for a total recovery of 13.4 m^3. Stratigraphy was very uncomplicated, with a single cultural layer consisting of a very dark grayish brown (10 YR 3/2) silty sand shell midden (Stratum I) that extended only to 40-50 cm below surface. A sterile yellow rocky clay soil (Stratum II) was present beneath the midden (Figure 47). Artifactual materials were recovered from a depth of 90 cm in rodent burrows, which were abundant. Two burials were also found; the first (Burial 1) was recovered from the eroding edge of the deposit. Fully exposed and removed, the interment was incomplete, but showed a tightly flexed position, with the head facing down (Figure 48). Post-field analysis showed the remains to represent a female of approximately 35 years old at the time of death. No pathologies were evident except for lipping on the vertebrae which suggested arthritis. No artifacts were associated.

Burial 2 was found 96-117 cm below surface in Unit 5. It consisted of a diffuse unarticulated scatter of bones representing a 4-month-old infant. No grave posture or orientation could be defined.

Radiocarbon results indicated that the deposit represented a single Late Period component dating A.D. 1200-1690. A single obsidian hydration reading of 2.2 microns on a piece of Casa Diablo obsidian was consistent with the radiocarbon findings. A substantial bead assemblage was also very consistent with the radiocarbon dating. Eight classes and 13 types were represented including 18 A1 spire-lopped *Olivella*, 3 A4c, 1 A5c, 1 B3, 7 E1a, 4 E1b, 3 E2a, 3 E2b, 1 G2 (previously defined as G6; see Mikkelson et al. 1999), 5 K1, 7 steatite or talc schist disks, 1 *Mytilus* blank (M2b), and 1 clam shell disk. The absence of glass or historic (Class H) beads suggests that site use terminated prior to the onset of the historic era. Beads and radiocarbon, further suggest that most occupation was post A.D. 1500.

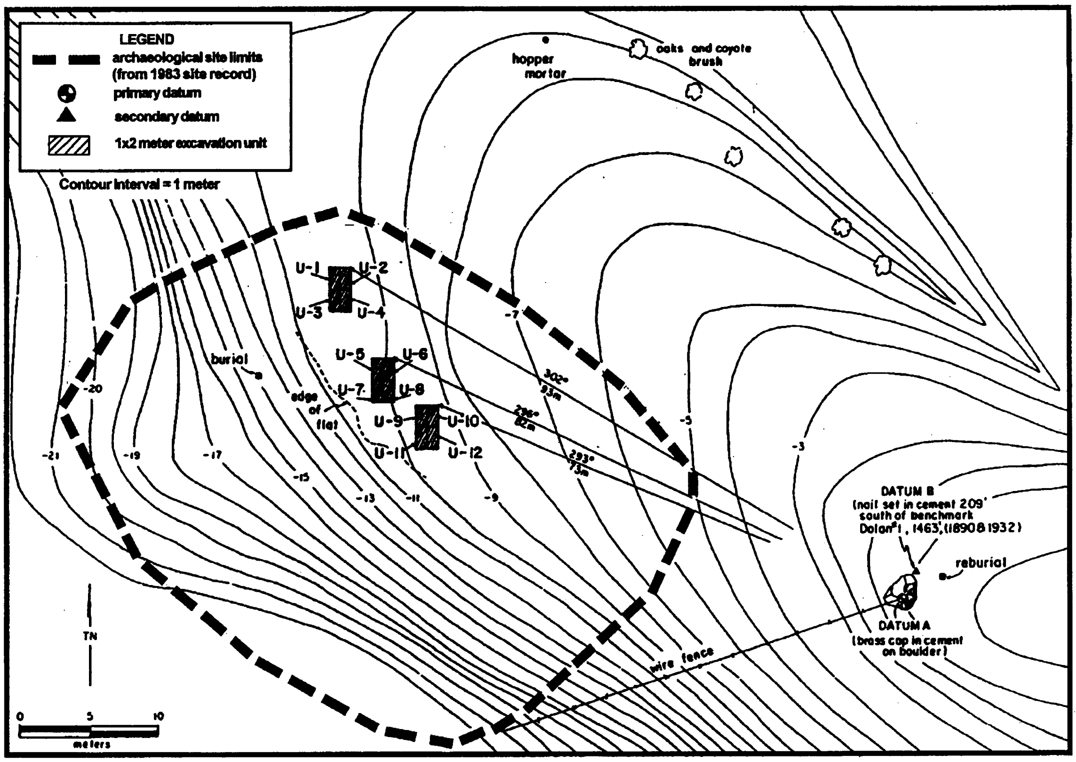


Figure 46 Site Map, CA-MNT-1223

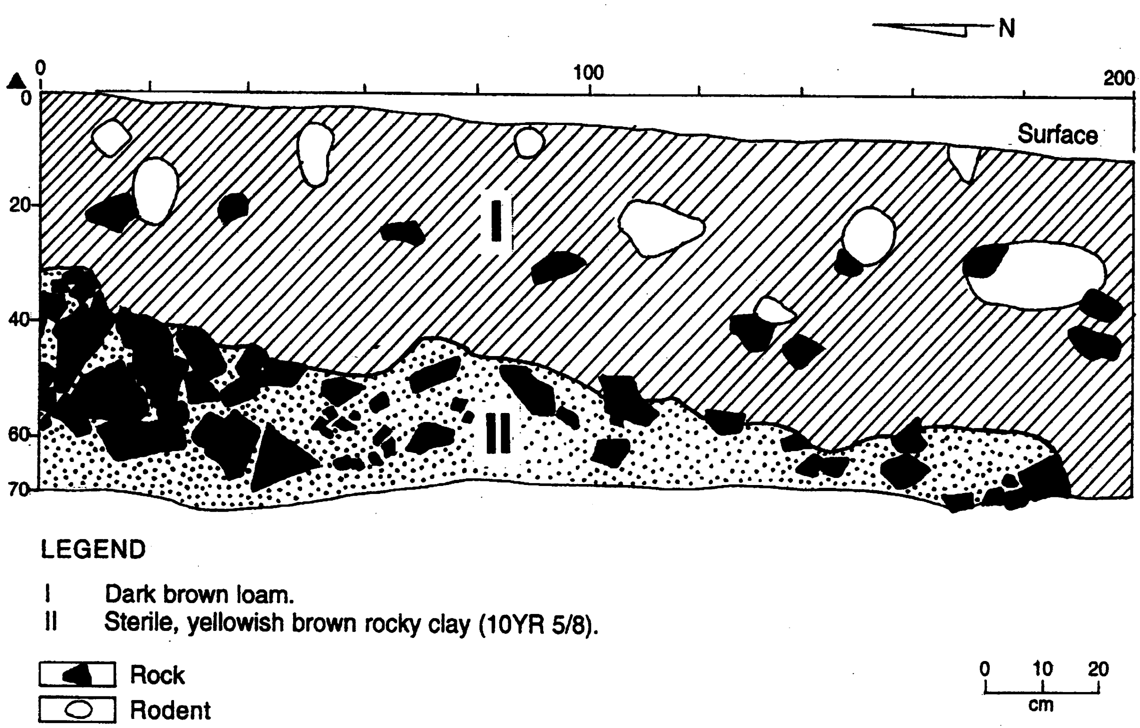


Figure 47 Sidewall Profile, CA-MNT-1223

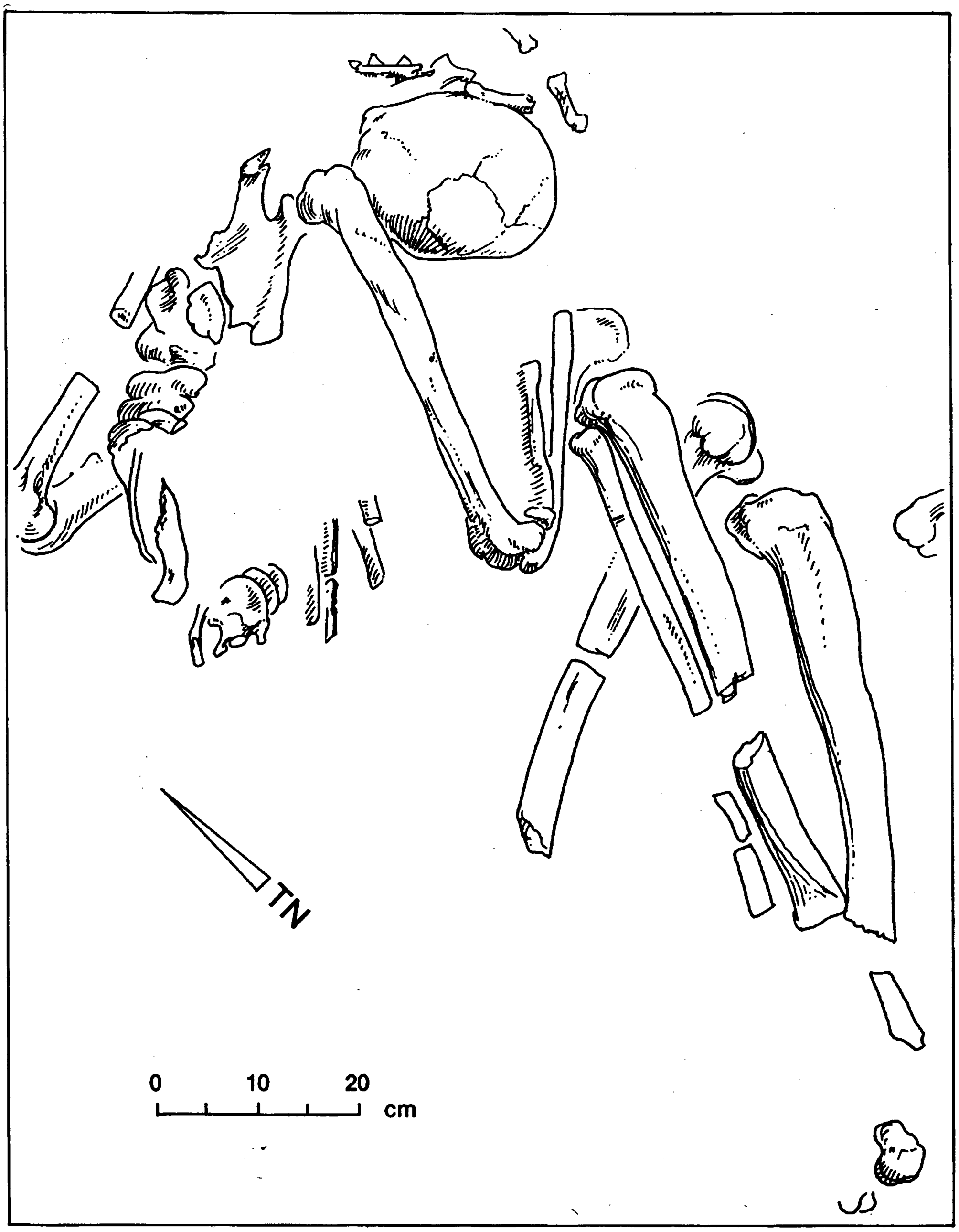


Figure 48 Burial 1 CA-MNT-1223

The flaked stone assemblage was unique among the coastal sites in that it documents Late Period production of arrow points and other small, well-made tools. As illustrated by debitage and production rejects, the manner in which stone was worked here was different from the large biface industry employed during earlier periods. Late Period stone-working was focused on a simple core/flake technology, in which flakes were struck from cores and pressure flaked into bifacial implements. Staged reduction of large bifacial implements, was used only sparingly. The assemblage included 8 cores, 8 bifaces, 21 projectile points, 8 drills, 3 flake tools and 488 pieces of debitage. The projectile points included 13 Desert Side-notched, 3 Canaliño/Coastal Cottonwood, and 5 fragments. One of the Desert Side-notched points was made from abalone shell. It has been discussed in detail elsewhere (Jones 1988).

The majority of the debitage was Monterey chert (N=475; 97.3%), with a high frequency of core-derived debitage (80.8%). Nineteen small blade flakes that appear to represent core trimming were also identified. This modest blade industry is mildly reminiscent of that found in the Santa Barbara Channel, in that the blades distinguish themselves from the earlier biface industry, but these blades are by no means as abundant or formalized as in the Channel. Together with the cores, the debitage generally reflects a core/flake industry devoted to production of thin arrow point flake blanks, arrow points, and drills. The simple and complex interior flakes represent initial core reduction by percussion. Many flakes exhibit crushed, well-prepared platforms, reflecting careful core reduction. One of what appears to have been a rejected flake blank (Figure 11) shows a trapezoidal cross-section which may have been desirable for arrow points or drills. Removal of blade flakes may have facilitated creation of flakes with such a cross-section.

The remainder of the tool assemblage included three stone spheres (Figure 23), one handstone, one hammerstone, one complete hopper mortar, one unusual elongate schist object of indeterminate function (Figure 23), and one talc schist/steatite pendant (Figure 24), five awls (Figure 26), fourteen indeterminate fragments of polished bone, eight cut and ground, unperforated abalone shell pendant blanks, one small nacreous sphere or pearl of abalone, one piece of cut abalone shell, one *Mytilus* fishhook fragment (Figure 28), and one *Cryptochiton* fishhook blank (Figure 29).

The faunal assemblage shows a heavy emphasis on terrestrial taxa. Deer dominated the mammal remains (88.9%). Fish were not abundant and no identifiable elements were found in a 0.012 m^3 sample of midden processed through 1.5 mm (1/16") mesh. Column samples show a prevalence of mussel (94.2%), barnacle (2.5%), and turban snail (0.7%). Oxygen isotope readings from one mussel shell suggest occupation during the time of peak ocean temperature, between August and October; a second indicated collection in the winter/early spring. Annuli from six deer teeth indicated fall/winter (November-February) kills, and one indicated late fall/early winter (December-February). Together, the data indicate occupation minimally between August and March.

CA-MNT-1227

CA-MNT-1227, the Harlan Spring Site, is located 0.6 km inland on a small mid-slope bench overlooking the Pacific Ocean at an elevation of 1000 ft (305 m). The site was marked by an extensive shell midden with little debitage or formal artifacts. It covered an area of 4135 m^2. Five 1 x 2 m units were excavated by students from the U.C. Davis field school in 1990 (Figure 49). Total recovery volume was 9.0 m^3. The soil profile showed one cultural stratum, with three relatively insignificant subvariants. The cultural layer (Stratum I) was a shell midden extending from the surface to a maximal depth of 80 cm (Figure 50). The upper portion of the midden (Stratum Ia) was characterized by a low shell content, little fire-altered rock, and dark brown (10 YR 3/3) loamy soil. The low density of constituents in this substratum seems to reflect post-occupational sheet wash from the steep hillside east of the site, and mixture of non-cultural and cultural sediments. Stratum Ib consisted of a dense concentration of shell fragments and thermally-affected rock. This layer represented the relatively undisturbed prehistoric occupation. The soil matrix was a dark gray (10 YR 4/1) loam. Stratum Ic was a transition between the midden and sterile substrate. Beneath the midden was a sterile deposit (Stratum II), composed mostly of angular, decomposing shale. Evidence for rodent activity was abundant. Three features were identified: a dense concentration of ash and burnt shell between 53 and 65 cm below datum in Unit 4 (Figure 50) that appeared to represent a fire pit or hearth, another fire pit found in the northeastern corner of Unit 5 between 84 and 100 cm, and a third fire pit beneath the second one in Unit 5. The latter two features were part of a distinctive lens (Ib1) of particularly dense shell and ash (Figure 50) that appeared to represent a poorly defined house floor in which Features 1 and 2 were centralized hearths. This was the only house floor identified during the project.

Five radiocarbon dates, including one obtained from a sample of charcoal extracted from the upper hearth in Unit 5, indicated that CA-MNT-1227 was a single component Late Period site occupied between A.D. 1300 and 1690 (Table 13). Two *Olivella* shell beads, an oval thin-lipped (E1b) and a normal small full-lipped (E2a1), support that dating. Two other *Olivella* beads, an A1 spire-lopped and a G1 tiny saucer, were non-diagnostic (Bennyhoff and Hughes 1987:128).

The artifact assemblage included 7 cores, 5 bifaces, 16 flake tools, and 88 pieces of debitage. All but one flake was Monterey chert. The cores were all quite small (< 37 mm in maximum length), and seemed to reflect the same core/flake arrow point industry identified at CA-MNT-1223 although no projectile points were recovered. The flake tools included 10 formal examples not seen elsewhere. These specimens were all small and thick with small, blunted beak-like projections (Figure 23). These beaked tools may have been used as reamers or drills. The total of 88 flakes was very low, representing only 9.8 flakes/m^3. The flake:biface ratio was 17.6:1.

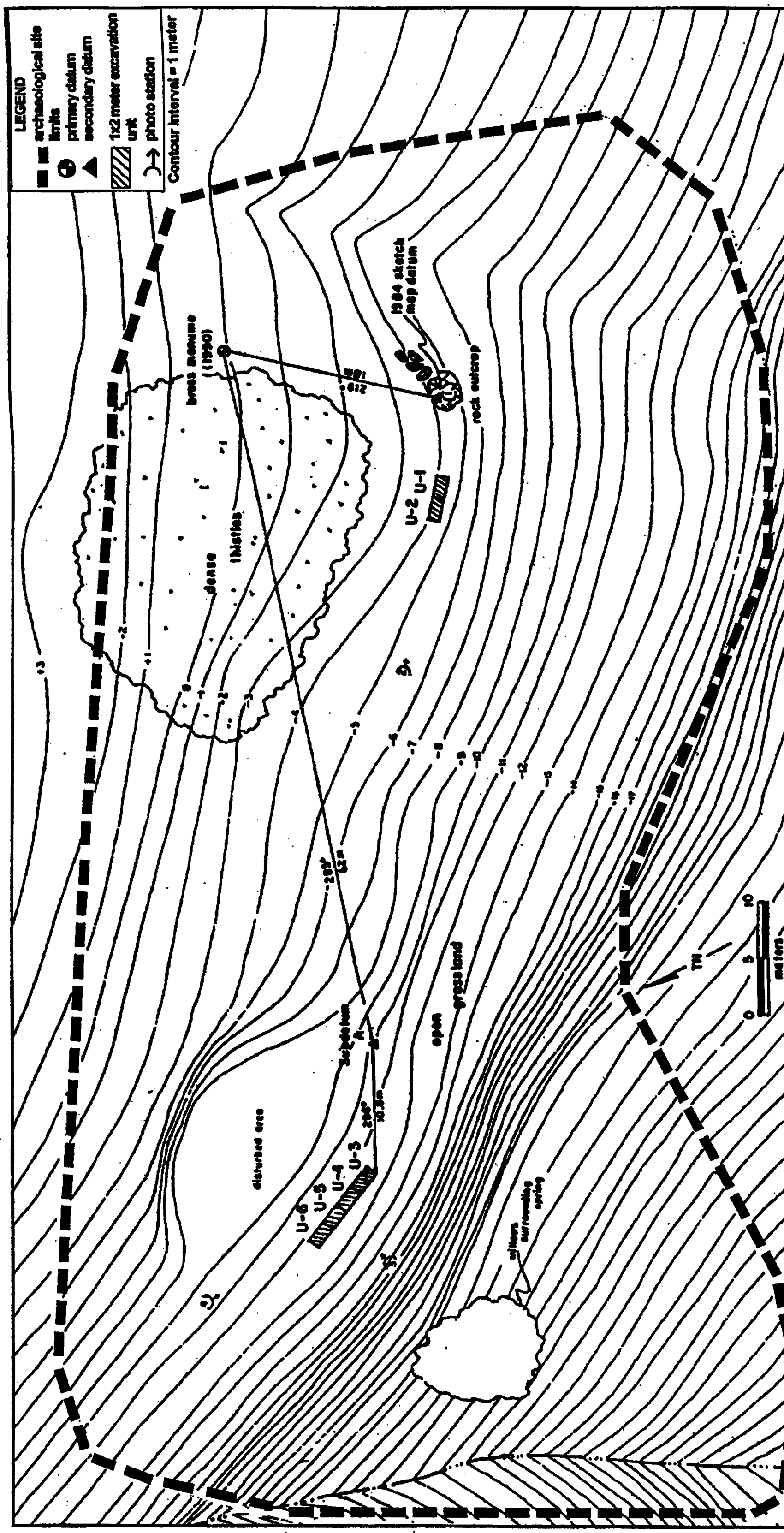
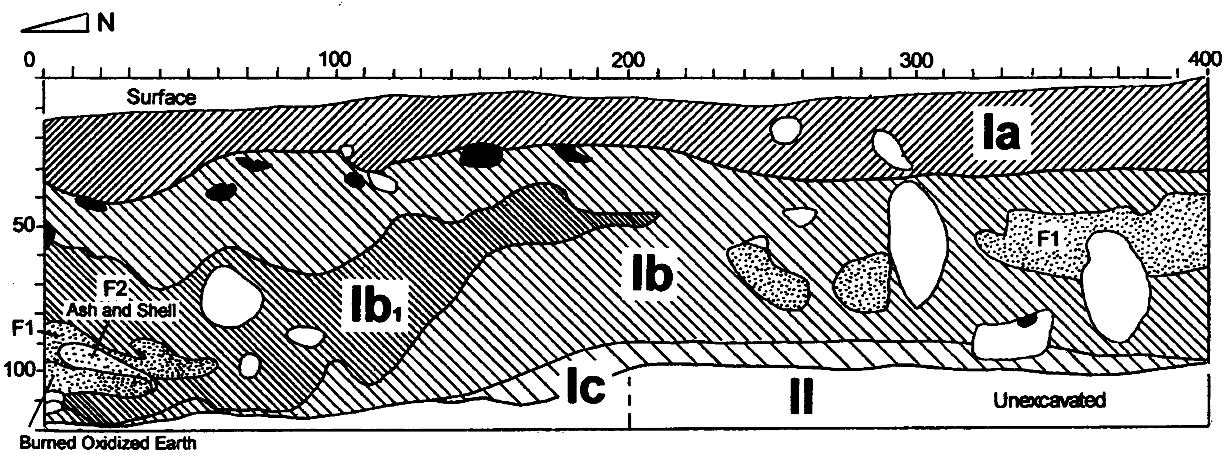


Figure 49 Site Map, CA-MNT-1227



LEGEND

0 20
cm

1a	Mixed shell midden and natural sheetwash soil (10YR 3/3) with low shell and fire-altered rock content.
1b	Dense shell midden with a noticable concentration of shell and fire-altered rock in a dark grey (10YR 4/1) soil matrix.
1b1	Particularly dense concentration of shell and ash evident only in units 5 and 6.
1c	Transition zone between shell midden and sterile substrate. Lighter shell midden deposit, brown (10YR 4/3) loam with high shell content and admixture of light yellowish brown (10YR 6/4) sandy loam with clay and angular fragments of bedrock.
II	Sterile subsoil derived from bedrock. Brownish yellow (10YR 6/6) sandy loam with some clay, angular rocks and occasional pockets of midden created by rodent activity.

Rock
Rodent disturbance

Unit 4 Feature 1: Fire pit.
Unit 5 Feature 1: Second, intrusive fire pit.
Unit 5 Feature 2: Original fire pit.

Figure 50 Sidewall Profile, CA-MNT-1227

Debitage was dominated by core/flake debris Groundstone included one handstone, one hopper mortar, four pestles, one anvil, one hammerstone, one unmodified cobble with some asphaltum on the surface, and an unusual plummet-shaped object (Figure 23) that may have been used as a netsinker. The remainder of the tool inventory included three awl fragments (Figure 26), a possible flaking tool, an antler tine, two shell fishhooks (Figure 28), one hook blank (Figure 29), one chipped bipointed gorge hook (Figure 31), one pendant blank (Figure 31), and one cut fragment of abalone shell. The pendant blank is an edge-ground teardrop-shaped piece of abalone shell. Lacking incisions, it is similar to types that date A.D. 1400-1500 in the Santa Barbara Channel (C. King 1982:378).

Faunal remains were dominated by deer (NISP=109; 87.2%) and rabbit (NISP= 14; 11.2%), reflecting a decidedly terrestrial focus. Ten taxa of fish were identified among 513 elements, dominated by striped surfperch (NISP=1480; 67.6%), rockfish (NISP=412; 18.8%), and cabezon (NISP=149; 6.8%). Molluscan remains were dominated by mussel (88.5%), followed by leaf barnacle (2.9%), barnacle (2.7%), and urchin (2.3%). Oxygen isotope readings from a mussel shell suggested occupation immediately after the period of warmest ocean temperatures (between September and December). Six seasonality estimates from deer teeth suggested late summer (August to October; N=3), and fall/winter (November-February; N=3). Flotation samples taken from the hearths yielded acorn and bay nut shells, grass and *Chenopodium* seeds. Acorns are a fall/winter crop, and their occurrence is consistent with the oxygen isotope and deer teeth data. Grass seeds were harvested in the spring. Together, these finds suggest plant storage was employed, and corroborate the notion of a fall/winter occupation continuing into spring. Six isolated human bones, representing at least two individuals, were also recovered.

CA-MNT-1228

CA-MNT-1228, the Redwood Terrace Site, was located 1.2 km inland on a small bench along the east fork of Brunnette Creek at an elevation of 245 m (Figure 1). A small shell midden (548 m^2) found here in 1983 amidst a dense stand of redwoods was seriously damaged by the Rat Creek fire in 1985 which burned intensely through the grove, destroying undergrowth and causing considerable erosional damage. Excavation in 1990 by members of the U.C. Davis field school was intended to salvage materials and attempt to stabilize the deposit. Ten 1 x 2 m units were excavated in a single large block (Figure 51) for a total recovery volume of 14.7 m^3. Excavation revealed a single cultural stratum, a very dark grey shell midden (Stratum Ia), overlain by a thin layer of redwood duff (Figure 52). The midden showed many signs of fire-related earth movement and rodent disturbance, including apparent slumping of soils. The deposit averaged 50 cm in depth, but pockets of gopher spoils extended as deep as 140 cm below surface. The midden was underlain by a sterile decomposing brownish-yellow sandstone (Stratum IIa), with scattered pockets of yellowish-red clay (Stratum IIb). A mixed zone of combined midden and sterile subsoil (Stratum Ib) was apparent in some units (Figure 52).

Three radiocarbon dates showed that the deposit was single-component, occupied for a brief interval between 3800 and 2900 B.C. Two obsidian specimens were in partial agreement with the radiocarbon dating. One specimen from the Queen/Mt. Hicks source produced a hydration reading of 6.8 microns. The other produced a reading of only 3.8 microns on Coso obsidian, which is too thin for the time span indicated by the radiocarbon. *Olivella* shell beads included two non-temporally diagnostic spire-lopped (A1), one medium barrel (B3), and one small thick shelved rectangle (L2). The latter is an early type, consistent with radiocarbon dating.

The flaked stone inventory included 1 core, 23 bifaces, 13 projectile points, 8 flake tools, and 337 pieces of debitage. The projectile points included eight contracting-stemmed, two Rossi Square-stemmed (Figure 17), and three fragments. The bulk of the debitage was Monterey chert (90%). The assemblage was dominated by biface-derived flakes (70.4% of the Monterey chert and 73.2% of the Franciscan chert). Debitage density was 22.9 flakes/m^3, and the flake:biface ratio was 9.4:1. The proportion of biface-related debris is similar to the percentage associated with Stage 3-5 reduction in the experiment with Monterey chert. Chert apparently arrived on-site as preforms and finished tools that were subsequently reduced and reworked.

The rest of the artifact inventory included four milling slab fragments, one mortar, one pestle, two handstones, two hammerstones, three unidentifiable ground stone tools, two talc schist or steatite pendants, one piece of worked steatite, one awl fragment (Figure 26), one antler tine, and two fish gorges (Figure 27). The two talc schist pendants included one complete and one partially completed specimen indicating that some working of steatite took place at this location.

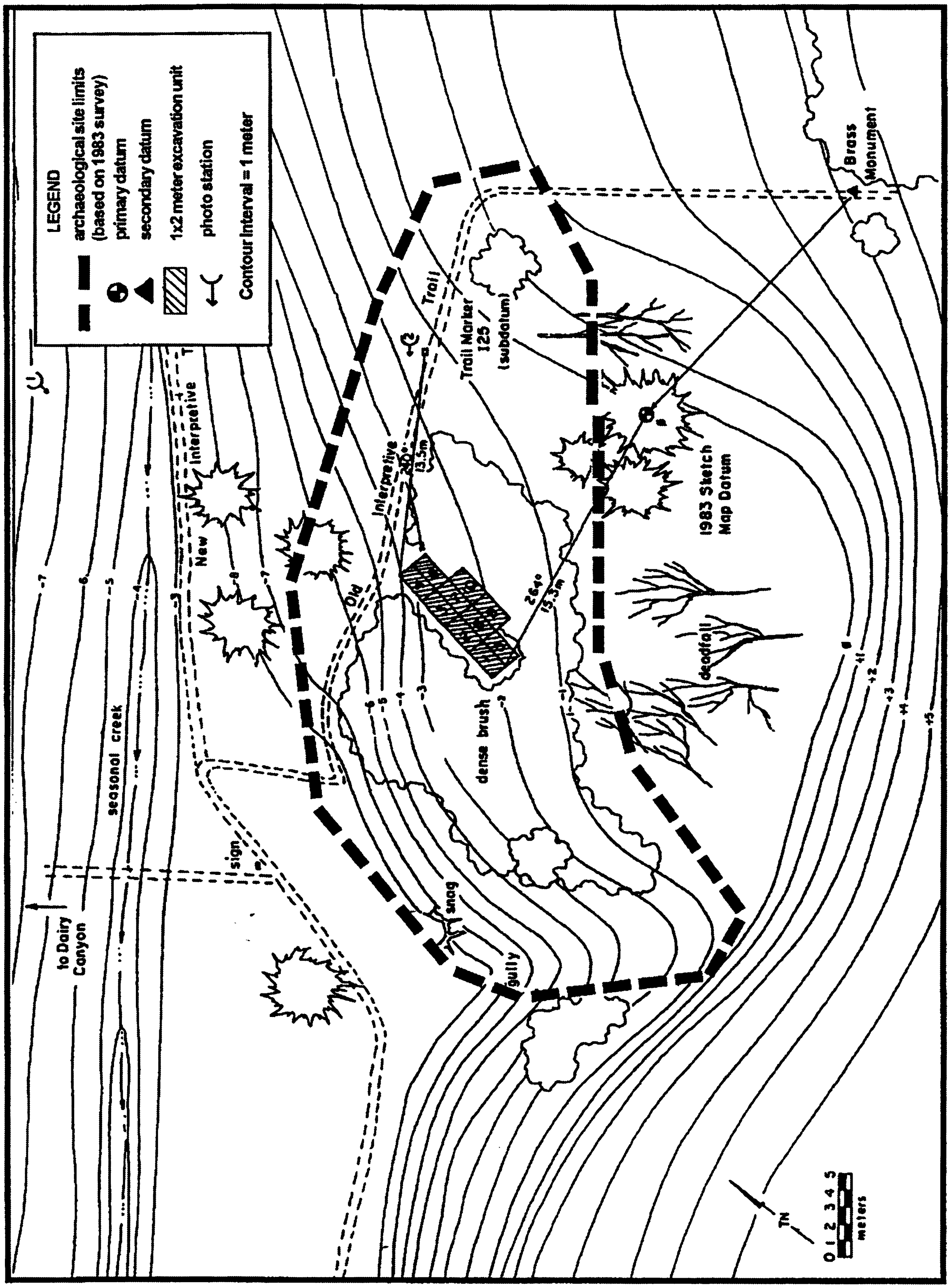


Figure 51 Site Map, CA-MNT-1228

The faunal collection included a total of 2510 bird and mammal bones, from which only 84 elements could be identified. These were dominated by black-tailed deer (NISP = 76; 90.5%). One Steller sea lion element was recovered. This species passes off the Big Sur coast from September to January. Two elements from one individual deer represent a neonate, suggesting a spring kill. One deer tooth suggested occupation in the late summer (August-October). Only ten fish elements were recovered, dominated by cabezon (NISP=7; 70%). Molluscan remains were 98% mussel. Four isolated human elements were recovered, representing a minimum of one adult and one child.

CA-MNT-1232/H STRATUM II

The Interpretive Trail Site, CA-MNT-1232/H, is situated on a small bench along the Landels Hill Big Creek Reserve Interpretive Trail at an elevation of 245 m (800 ft) (Figure 1). The site was marked by a relatively small shell midden (3756 m^2) and a bedrock mortar outcrop with two cups. Excavation was completed by field class students in the summer of 1990. The Reserve's interpretive trail which passes through CA-MNT-1232/H was constructed along the remnants of a road built in the 1920s. This road was intended to accommodate automobile travel, and its construction through the midden created a major erosional face along the northeastern edge of the deposit (Figure 53). The work in 1990 was an effort to salvage and stabilize this portion of the deposit.

CA-MNT-1232/H was deeper and more complex than any other investigated site. The deposit extended to a depth of 280 cm, with two discrete superimposed layers (Figure 54). The uppermost layer, Stratum I, was a remarkably homogeneous dark grayish-brown (10YR 3/2) loamy shell midden that extended from the surface to a maximum depth of 170 cm in Unit 3 and 150 cm in Unit 4 (Figure 54). Radiocarbon dates obtained from this Stratum were earlier than 3500 years B.C. Stratum II, immediately beneath Stratum I, was a light brownish-gray (10 YR 6/2) midden with a distinctive precipitate of calcium carbonate adhering to everything in the matrix. Similar deposits have been identified at the base of older sites on the Monterey peninsula, particularly CA-MNT-391 (Cartier 1993a), occupied from 3000 B.C. to A.D.1. This type of residue is caused by groundwater action, specifically the dissolution of calcium carbonate into the groundwater and subsequent redeposit of dissolved solids when groundwater retreats and dissolved solids go out of solution. The transition between Stratum I and Stratum II is therefore post-depositional in origin, however the zone of dissolved calcium carbonate, because of its cemented quality, seems to have resisted admixture from upper components and therefore marks a highly discrete component. Furthermore, superposition of radiocarbon dates indicated vertical segregation of temporal components. A total of 14.5 m^3 of midden was excavated from the site as a whole, but only 5.4 m^3 were from Stratum II.

Radiocarbon results and diagnostic artifacts indicated that CA-MNT-1232/H was witness to an unusually long occupation from ca. 4400 B.C. into the Late Period. Four radiocarbon assays dated Stratum II from 4400 to 3900 B.C. with the most recent date marking the Stratum I/II interface. The vertical distribution of dates within Stratum I, however, suggested significant mixing, so that only the materials from Stratum II were useful for interpretive purposes. A total of 5.4 $m.^3$ of deposit was recovered from Stratum II. The Stratum II assemblage included two *Olivella* barrel (B3) beads, a single complete lanceolate projectile point, a non-diagnostic tip fragment, three cores, two bifaces, three informal flake tools, nineteen pieces of chert debitage, five handstones, two milling slabs, two hammerstones, two antler tines, and a bone pendant fragment. Obsidian was absent although eight pieces were recovered from Stratum I. Among the three cores, specimen 47-3-211, an angular cobble of Monterey chert, weighing 461.1 g was unusual. This was the largest piece of chert recovered from any of the sites at Big Creek or the Big Sur River. This large piece must have been transported over the crest of the Santa Lucias to the coast from an inland source. Other than this large specimen, Stratum II produced very little evidence for flaked stone manufacturing activities. A flake:biface ratio of 4.8:1 indicated an exceptionally high rate of curation. Tool stone in the form of cores and flake blanks may have been cached here for occasional use. Stone-working apparently involved cores, flake blanks, and final reduction and re-working of Stage 3-5 bifaces. The occurrence of biface thinning flakes as the most abundant form of debitage probably reflects these later reduction stages, although this activity was not undertaken on a frequent basis, based on the recovery of only a single edge preparation/pressure flake.

The Stratum II faunal assemblage was highlighted by a dense concentration of mollusc shells. Column samples showed heavy dominance of mussel (97.3%), with minor amounts of barnacle (1.7%), and purple sea urchin (0.5%), Vertebrate remains included 40 identified specimens, dominated by black-tailed deer (NISP=27; 75.0%), harbor seal (NISP=3; 8.3%), and gray fox (NISP=3; 8.3%). A total of 77 fish bones was dominated by cabezon

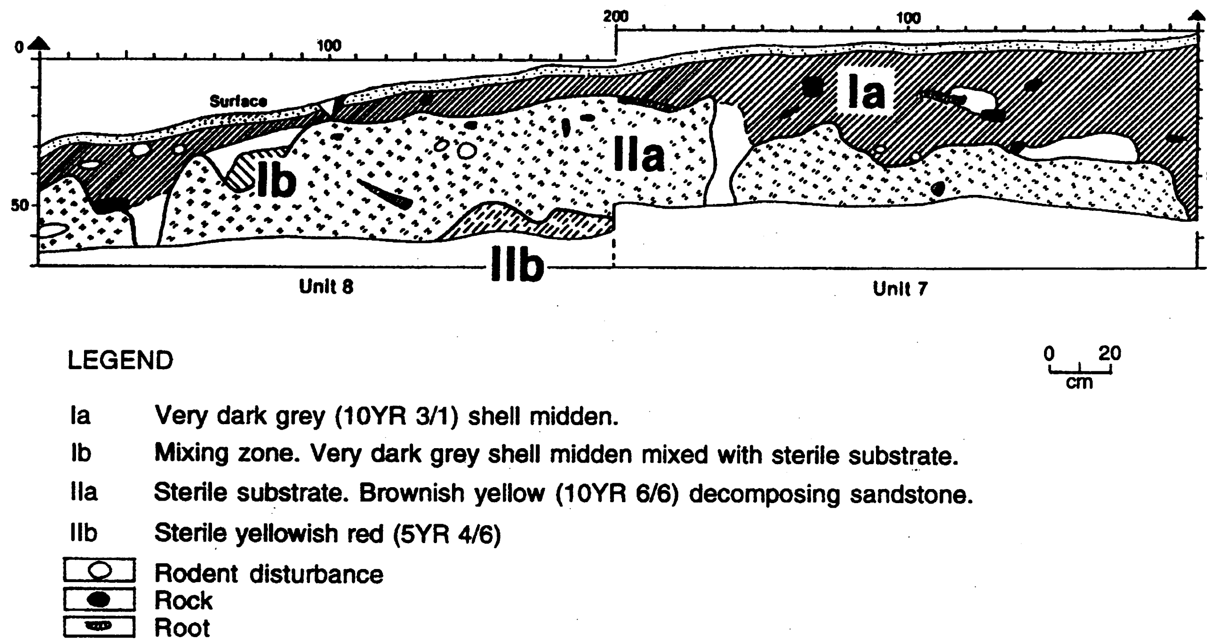


Figure 52 Sidewall Profile, CA-MNT-1228

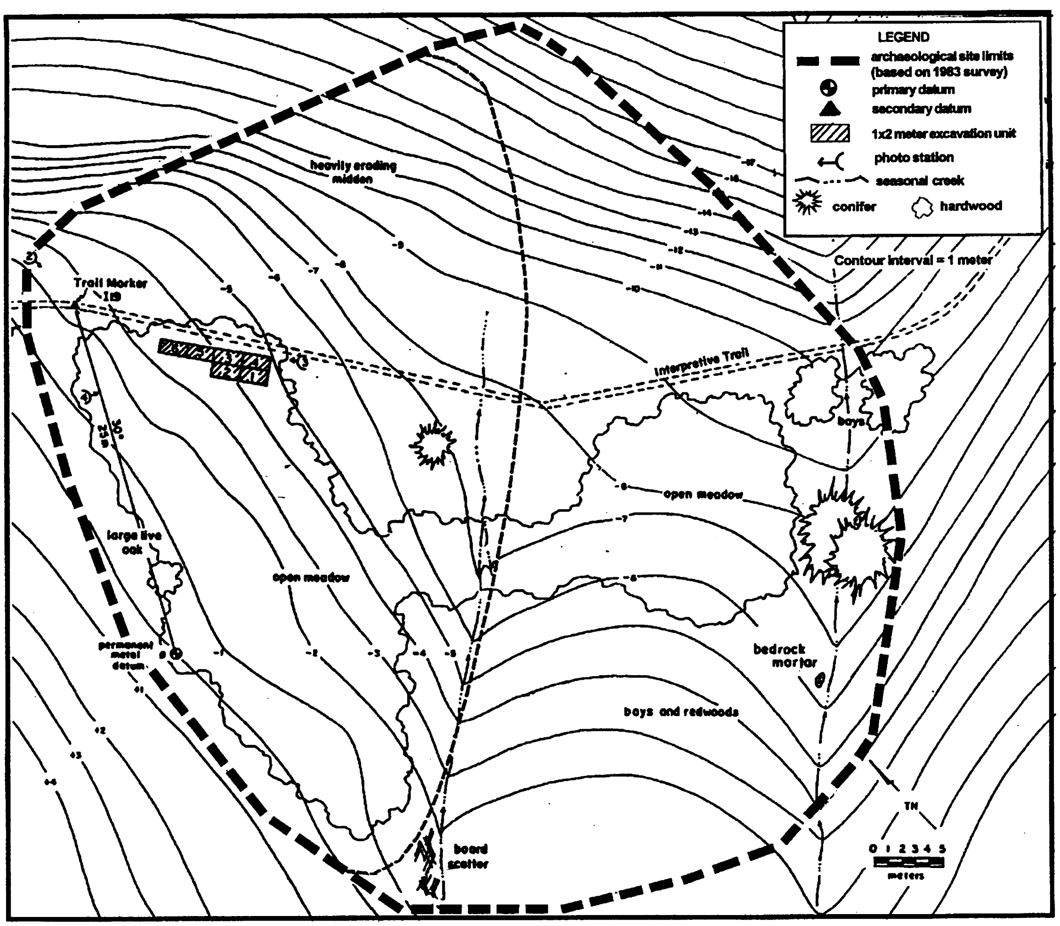


Figure 53 Site Map, CA-MNT-1232/H

(NISP=33; 42.8%), rockfish (NISP=17; 22.0%), and lingcod (NISP=8; 10.3%). Four pieces of human bone were also recovered, of which two cranial fragments were associated with Stratum II. One of these was subjected to isotopic analysis discussed in more detail below.

CA-MNT-1233

Recorded in 1983 by field school students, CA-MNT-1233 is a shell midden of moderate size (2413 m^2) situated 1.6 km inland on the edge of a small finger ridge. In a situation that was unusual for the investigated sites, most of the deposit was found on steep slopes below the ridge top--not on its flat surface. It appeared that cultural materials originally deposited on the flat surface were pushed downslope during fire suppression efforts sometime within the last 50 years. Excavations were completed by students in 1990 with the goal of salvaging material from the continually eroding deposit. Five 1 x 2 m units were excavated (Figure 56) for a total recovery volume of $10m^3$. As at most of the coastal sites, stratigraphy was fairly simple. A single cultural stratum (I) with two vertically discrete variants (Ia and Ib) was identified (Figure 57). The lower variant was distinguished by a slightly higher concentration of shells and a dark brown (10 YR 3/3) color. Stratum Ia, in contrast, was a dark grayish-brown (10 YR 4/2). Seven radiocarbon dates indicated occupation between A.D. 1030 and 1430.

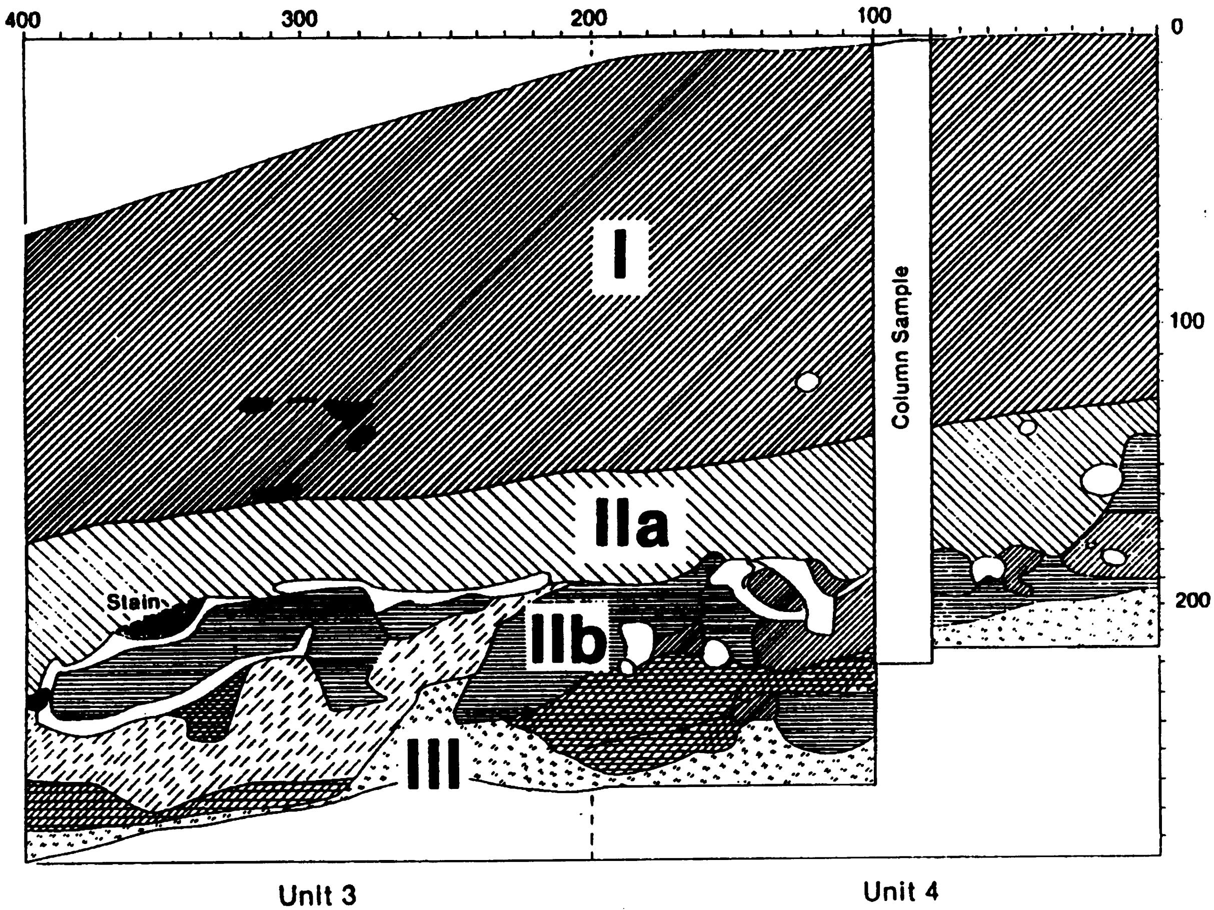
The bead assemblage recovered from the midden included seven *Olivella* tiny saucers (G1), three normal *Olivella* saucers (G2), one cupped *Olivella* bead (K1), four *Olivella* spire-lopped (A1), one end ground *Olivella* (B2), two barrel *Olivella* beads (B3b). The Tiny Saucers (G1), Spire-lopped *Olivella* (A1b and A1c), and Medium Barrel (B3b) are temporally non-diagnostic. The collection was consistent with the radiocarbon dating, and together the available data suggested a single Middle/Late Transition component, with minor occupation during the early Late Period (ca. A.D. 1000-1400). The rest of the artifact inventory included ten cores, eleven bifaces, five contracting-stemmed projectile points, one Rossi Square-stemmed point, two small leaf-shaped points, six flake tools, one handstone, one millingslab fragment, two pestles, one teardrop-shaped netsinker, one hopper mortar, one stone sphere, one perforated netsinker, three awl fragments, an antler tine, the medial fragment of a mammal bone with four notches along one edge, five *Mytilus* fishhook fragments (Figure 28), one *Mytilus* fishhook blank (Figure 29), one *Haliotis* fishhook blank (Figure 29), five worked and cut shell fragments, one scraping tool, two *Haliotis* pendants, and two *Haliotis* pendant blanks. The yield of debitage was fairly low with 171 pieces, of which 163 were Monterey chert. Debitage density was 17.1 flakes/m^3 with a flake:biface ratio of 9:1. The flake type profile showed a high frequency of core/flake debris and a stronger suggestion of full reduction. This may reflect an apparent arrow point industry reflected by the small leaf-shaped points.

The faunal assemblage included 259 non-intrusive mammal and bird elements dominated by deer (NISP=203; 78.4%) and rabbit (NISP=21; 8.1%). Fish remains were dominated by northern anchovy (57.4%), herring or sardine (19.1%), and rockfish (14.8%). As elsewhere, California mussel was the most heavily exploited shellfish taxon (93.1%), followed by barnacle (2.4%), and turban snail (2.2%). A total of fifteen human bone fragments was also recovered, from which a minimum of two adult individuals was inferred. Oxygen isotope values from three shells suggested collection between April and October. Seasonal layering in a deer indicated a late summer/early fall kill (Appendix II).

CA-MNT-1235

CA-MNT-1235 was a very small (452 m^2) site tested by field students. It consisted of a shell midden perched precariously on the edge of a cliff overlooking the mouth of Devil's Creek in Landels-Hill Big Creek Reserve (Figure 1). With the intent of salvaging midden before it eroded downhill, seven 1 x 2 m units were excavated in 1986 (Figure 57) for a total recovery volume of only 2.4 m^3. The deposit proved to be very shallow and was apparently displaced from a flat above it. Corrected radiocarbon dates of A.D. 1120 and 1460 along with an E1 *Olivella* lipped bead and a steatite disk bead suggested this was a single-component Late Period deposit. Two Desert Side-notched projectile points, one Canaliño/Coastal Cottonwood point, and one incipient arrow point of indeterminate type were consistent with Late Period dating. The rest of the tool assemblage consisted of a hopper mortar, one pitted stone, two pestles, two hammerstones, a bone awl, and two indeterminate bone tool fragments. Only 30 flakes were recovered for a debitage density of 10.4 flakes/m^3, and a flake:biface ratio of 6.3:1.

Only 106 bird/mammal bones were recovered and among these, only 11 were identified to species. One was from a woodrat and the rest were black-tailed deer. Twelve fish bones were recovered, of which six were identified as rockfish. Shellfish fragments showed a preponderance of mussel shell (94.4%).



LEGEND

0 20 cm

I	Homogeneous very dark greyish brown loamy shell midden (10YR 3/2).
IIa	Light brownish grey (10YR 6/2) and brown (10YR 4/3) shell midden with caliche.
IIb	Greyish brown shell midden with locally dense concentrations of shell and heavy caliche.
III	Sterile substrate mottled red/brown.

Rodent activity
Rock

Grey
Brown
Red/Brown
Grey-Brown
White

Figure 54 Sidewall Profile, CA-MNT-1232/H

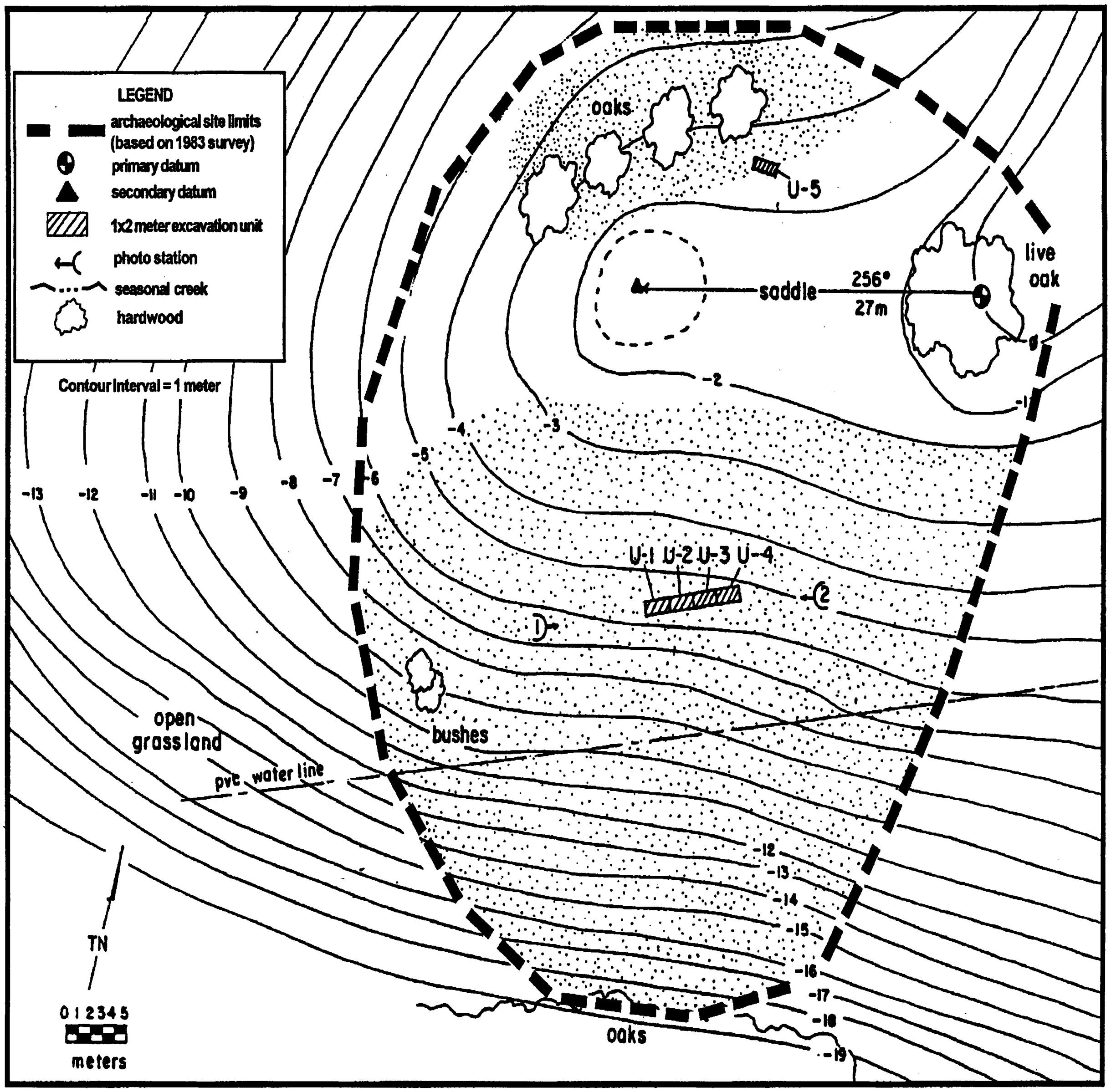


Figure 55 Site Map, CA-MNT-1233

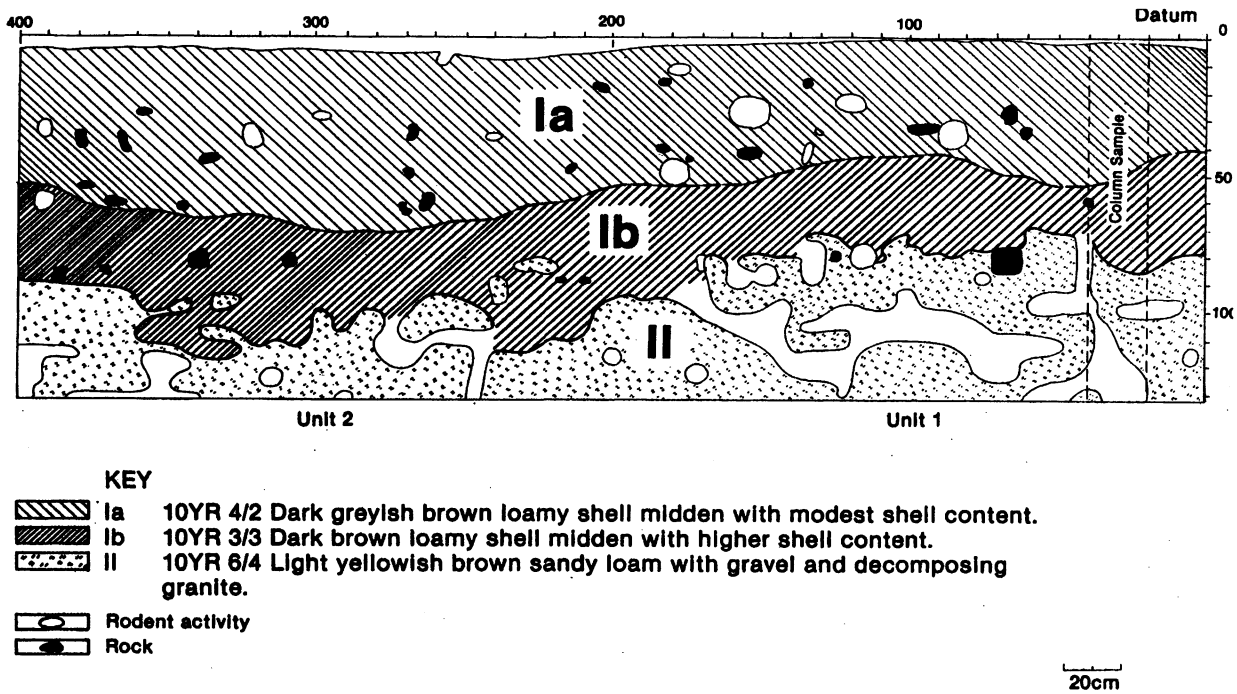


Figure 56 Sidewall Profile, CA-MNT-1233

CA-MNT-1236

CA-MNT-1236, the Shakemaker Site, was tested in 1989 in anticipation of proposed facility development by Landels-Hill Big Creek Reserve. The site was located further inland (3.3 km) and was higher in elevation (713 m) than any other coastal site where subsurface work was completed. It was marked by a very small shell midden (981 m^3), above the south fork of Devil's Creek (Figure 1). A single 1 x 2 m test unit (Figure 58) showed a loose, grayish brown shell midden (Stratum Ia) that extended to a depth of 50 cm (Figure 59). Beneath that was a reddish brown subsoil with an occasional shell fragment and pieces of debitage. Two radiocarbon dates obtained from shells indicated occupation between A.D. 1480 and 1800. A sample of charcoal recovered from beneath the midden produced an earlier date of A.D. 790, but this applies to the sterile substrate, not the cultural deposit.

The artifact assemblage included one Desert Side-notched, two Canaliño/Coastal Cottonwood, and two contracting-stemmed projectile points, a sixth point of unknown type, one biface, one flake tool, one fragmentary handstone, one millingslab fragment, one faceted hammerstone, and one incipient pestle fragment. Only 30 pieces of debitage were recovered, 28 of Monterey chert. Most of the flakes (67%) were core/flake types. The flake:biface ratio was 4.3:1.

From a total of 247 mammal bone fragments, 32 represented black-tailed deer. No fish bones were found. A single shell column showed a molluscan assemblage dominated by mussel (98%).

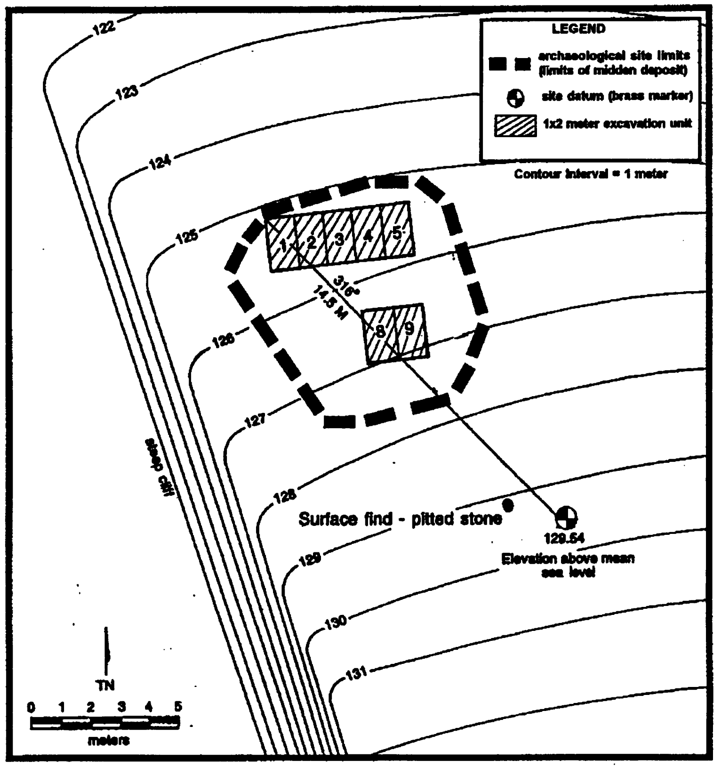


Figure 57 Site Map, CA-MNT-1235

CA-MNT-1277/H

Discovered in 1984, CA-MNT-1277/H was an unusually large, complex site associated with the José de los Santos Boronda homestead, established in the early 1870s (Jones et al. 1989:141). Located 2 km inland at an elevation of 566 m (1840 ft), the prehistoric component was marked by an extensive shell midden covering an area of approximately 18,870 m^2. The ethnographic field notes of J. P. Harrington clearly linked this site with the Salinan village of *Matilcé*. A bedrock mortar outcrop with two cups was recorded as a separate site (CA-MNT-1284) adjacent to the midden. The site had suffered modest impacts from erosion, and subsurface work was undertaken in 1990 to salvage and stabilize a small portion of the deposit. Five 1 x 2 m units were excavated (Figure 60) for a total recovery of 8.5 m^3. The deposit proved to extend to a maximal depth of 100 cm, with two simple layers: the culturally-derived shell deposit (Stratum I) and the sterile substrate (Stratum II) (Figure 61). A human burial was found between 93 and 120 cm in Units 2 and 3. The remains were exposed, drawn, and photographed, but left in place. The interment was in a tightly flexed position on its left side (Figure 62), oriented on a 190° axis. No artifacts were associated. A broad sciatic notch indicated that the remains represented a female who was approximately 18-20 years of age at the time of death.

The majority of the chronometric data suggested a single Late Period component, but some ambiguities were apparent as well. Three radiocarbon dates from 10-100 cm showed tight clustering between A.D. 1500 and 1640 (Table 13), but no superposition was evident, as the youngest date came from the 90-100 cm level. The bead assemblage showed an abundance of Late Period types, including three punched spire-lopped *Olivella* (A4), two medium end ground *Olivella* (B2b), one barrel *Olivella* (B3), the only split punched *Olivella* (D1) recovered during the study, three thin lipped *Olivella* (E1), two thick lipped *Olivella* (E2), twenty-one cupped *Olivella* (K1), four bushing *Olivella* (K2), one cupped/lipped *Olivella* (K/E1b), two *Haliotis* epidermis disks (H5 [Bennyhoff and Fredrickson 1967]), three clam shell disks, twelve small steatite disks, and a single simple drawn monochrome glass bead (DIIa39). The split-punched bead marks the Middle-Late Transition in central California, while the remainder of the assemblage was consistent with the Late Period. Obsidian hydration results included five readings on Coso obsidian between 3.0 and 4.0 microns. The Coso hydration rate is disputed on the central coast. The calendric conversions endorsed by

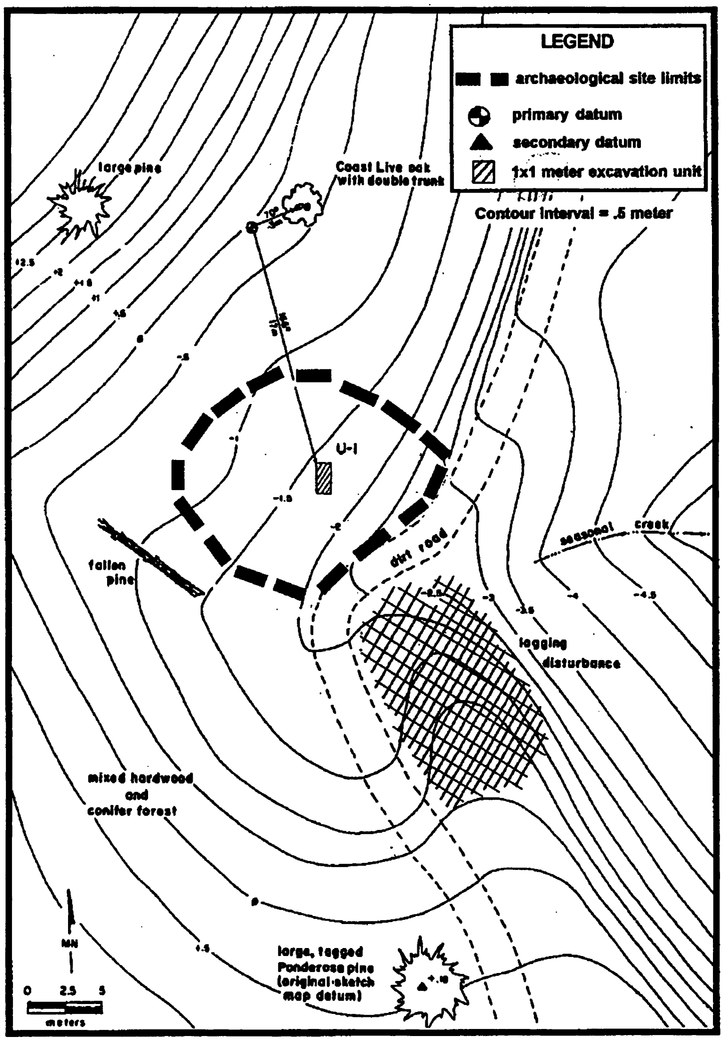


Figure 58 Site Map, CA-MNT-1236

Mikkelsen et al. (1999) ascribe readings between 3.0 and 4.0 microns to the late Middle Period. Jones and Waugh (1995) suggest a slightly earlier Middle Period dating. In either case, the hydration suggested some limited occupation before the onset of the Late Period. A single reading on Casa Diablo glass (3.3 microns) was also more consistent with the Middle Period.

The flaked stone inventory also included specimens indicative of site use prior to the Late Period. While the projectile point inventory was dominated by Late types, including six Desert Side-notched and three Canaliño/Coastal Cottonwood, the site also produced three contracting-stemmed, one square-stemmed, two large side-notched, and an unusual corner-notched specimen. The square-stemmed and large side-notched types are not part of the Late Period assemblage as it was defined by single-component Late Period sites (e.g., CA-MNT-1223). These types were more common during the Early Period. Their presence at CA-MNT-1277/H seems to reflect the remains from minor earlier occupation mixed in with the predominantly Late Period materials. The rest of the flaked stone collection consisted of 12 cores, 87 bifaces, 57 flake tools, and 1063 pieces of debitage. The profusion of bifaces is also more characteristic of earlier sites in this region. The yield of debitage (N=1063) was relatively high for the coastal portion of the study

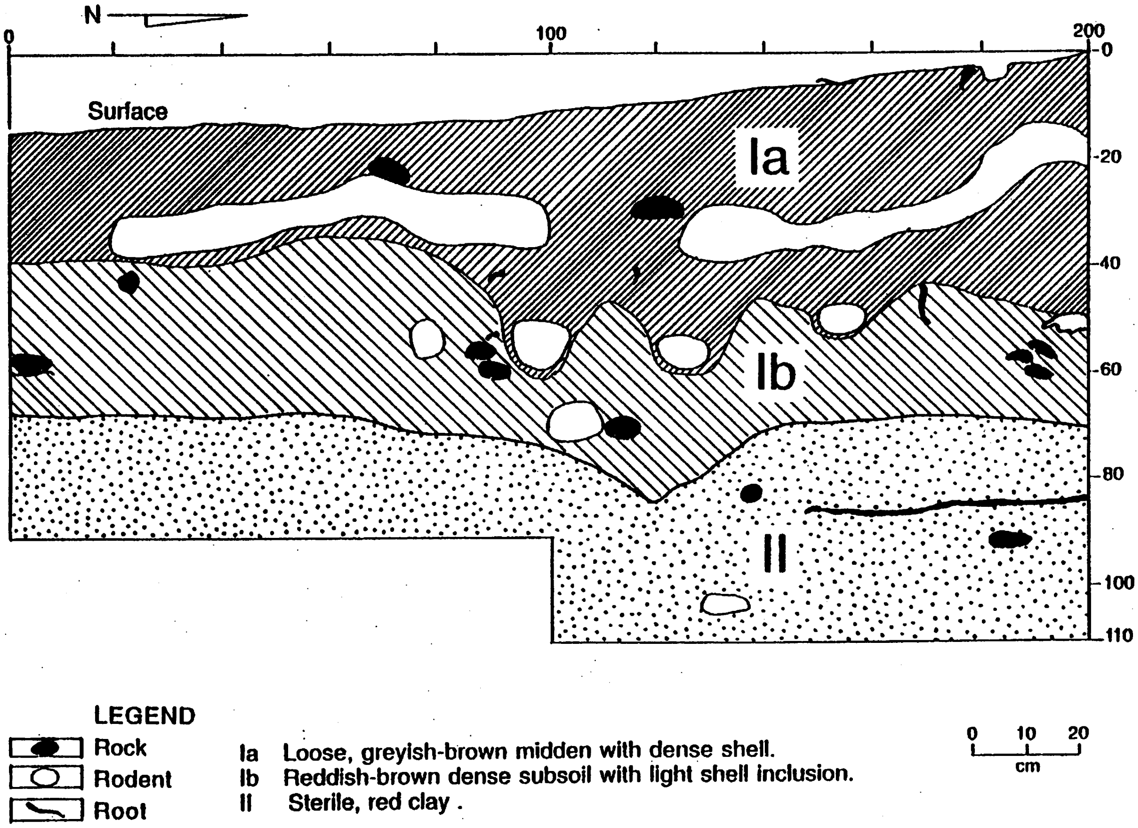


Figure 59 Sidewall Profile, CA-MNT-1236

area. Of this total, 922 (87%) were Monterey chert. Debitage density was 125/m^3. The technologically diagnostic flakes showed an emphasis (60%) on core/flake technology, consistent with arrow point production. The flake: biface ratios were 9.9:1 Monterey chert and 12.3:1 for Franciscan chert.

The remainder of the formal artifact collection consisted of one millingslab fragment, six handstones, ten pestles, one bowl mortar fragment, one hopper mortar, two anvils, two notched stone net sinkers, three hammerstones, three awl fragments (Figure 26), one needle (Figure 27), one bone tube, one polished fragment, one *Mytilus* fishhook fragment (Figure 28), one fragment of a fishhook blank, and one apparent ornament blank.

The faunal assemblage included 2234 bird and mammal bones, of which 121 non-intrusive elements were identified to species. This collection was dominated by black-tailed deer, (NISP=96; 79.3%), dog or coyote (NISP=13; 10.7%), and rabbit (NISP=5; 4.1%). One northern fur seal bone represented an animal that was probably killed during its winter migration past this stretch of coast. A deer mandible with unerupted milk teeth represented a fetal/neonate that was probably killed in the spring. Cross-sections of two deer teeth including one incisor (which are the most reliable) indicate fall/winter kills (Appendix II). Among the fish remains (218 elements), rockfish were the most abundant taxon (NISP=144; 66.1%), followed by cabezon (NISP=48; 22%), and greenling (NISP=15; 6.9%). Column sample showed California mussel to be the most heavily exploited shellfish species (90.5%), followed by barnacle (3.3%), and turban snails (1.9%).

CA-MNT-1571 AND CA-MNT-1580

CA-MNT-1571/H and CA-MNT-1580 are associated with the location of *Tr'actên*, a Salinan hunting camp. CA-MNT-1571/H is a small shell midden at an elevation of 866 m. CA-MNT-1580 is an associated outcrop with bedrock mortars (Huddleson and Jones 1992). While no precise chronometric data are available, ethnographic association and the bedrock mortars suggest late and contact period dating. The bedrock mortars, strongly associated with women in Native California (see Jackson 1991), suggest this encampment was occupied by a multi-gender social group, not merely by task-specific male hunting parties.

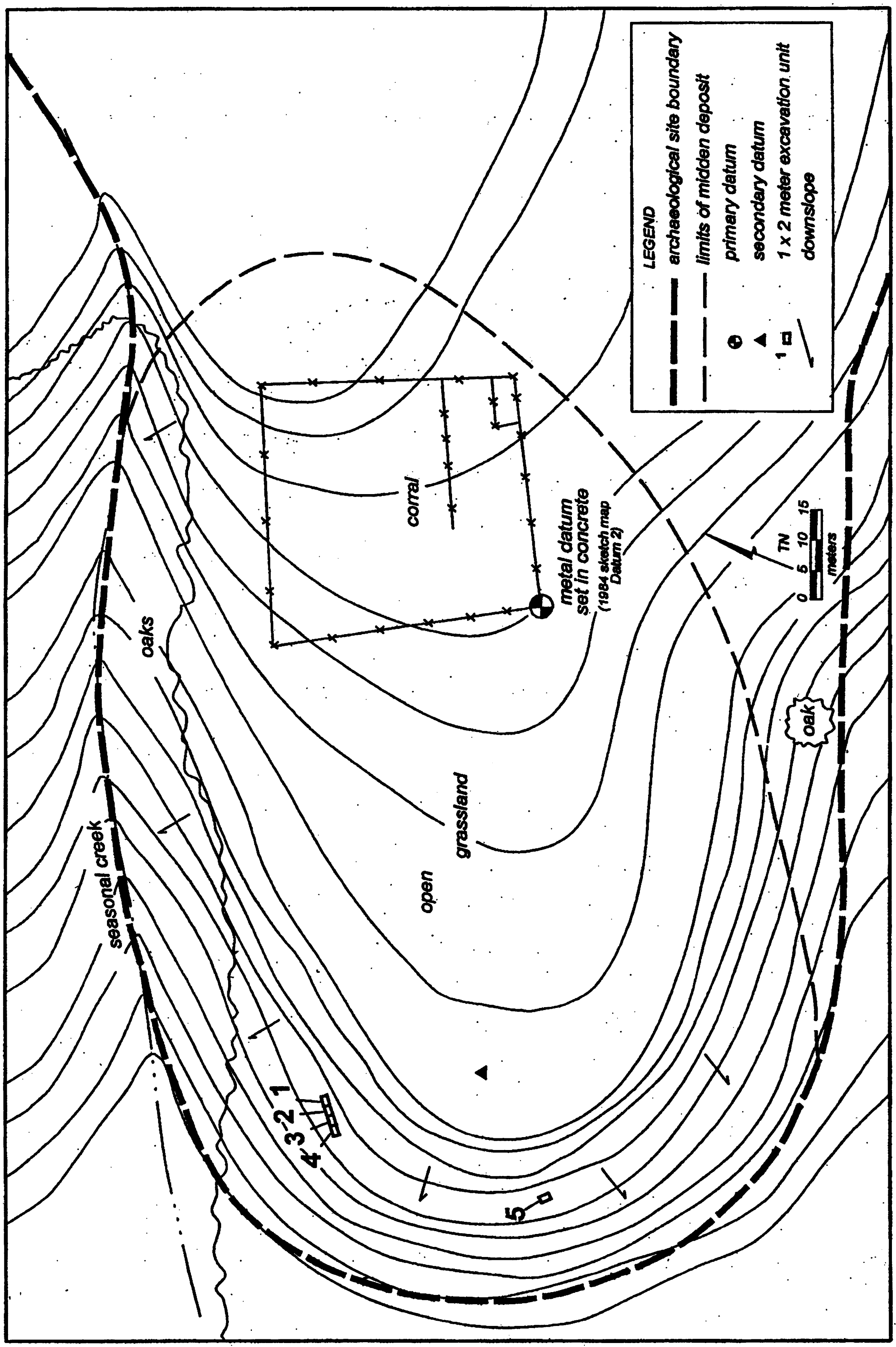


Figure 60 Site map, CA-MNT-1277/H

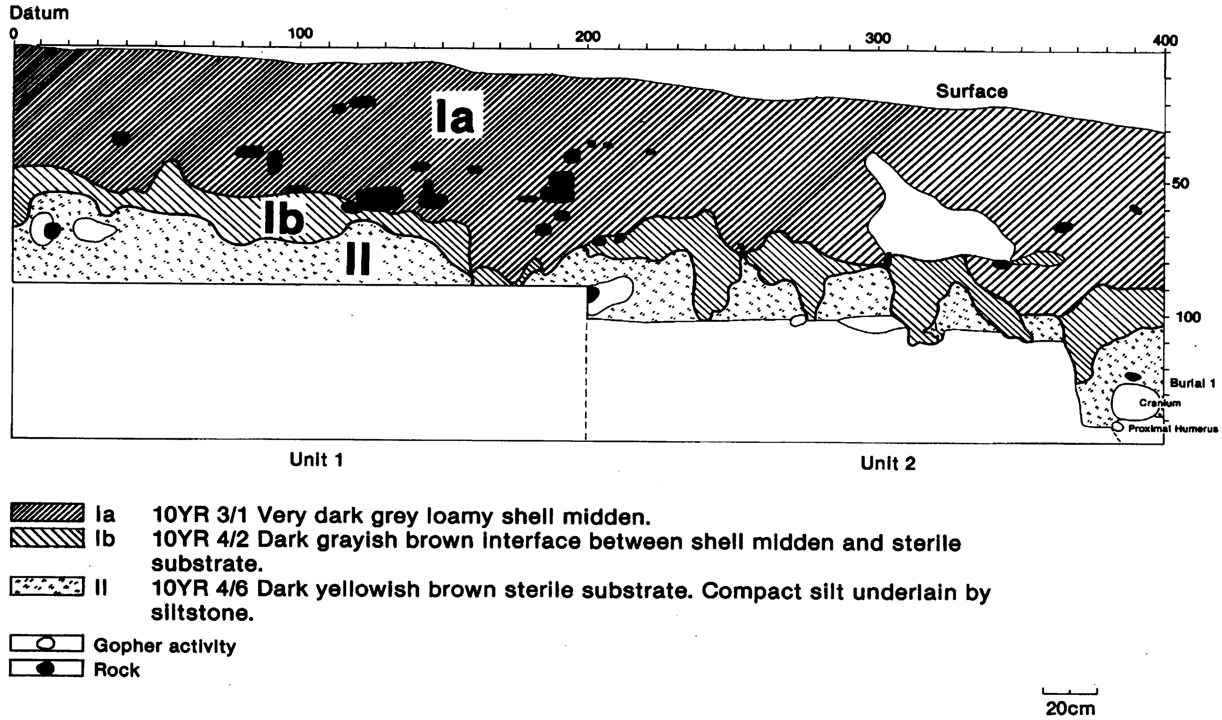


Figure 61 Sidewall Profile, CA-MNT-1277/H

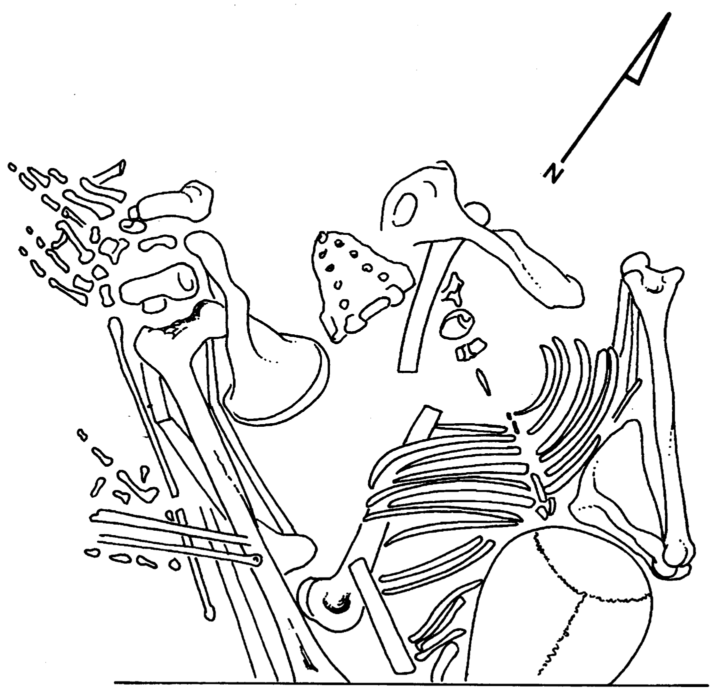


Figure 62 Burial 1, CA-MNT-1277/H

CA-MNT-1942

CA-MNT-1942 is an extremely important coastal site identified by the California Department of Transportation (Caltrans) at the mouth of Big Creek in 1998. The deposit is a shell midden that was partially buried during construction of the Big Creek Bridge in 1937. It is was situated adjacent to one of the bridge piers on the northern bank of Big Creek, 25 m inland from the creek mouth. The inland portion of the deposit was buried by natural alluvium so that the boundaries of this entirely subsurface deposit could only be defined approximately. Backhoe trenches suggested a small midden, roughly 1500 m^2 in size (Wolgemuth et al. 2002:17).

A data recovery investigation was completed at the site in the summer of 2000 by a crew of Caltrans archaeologists and consultants from Far Western Anthropological Research Group (Wolgemuth et al. 2002). The recovery program included three mechanically excavated trenches used to delineate the deposit, and six hand-excavated units (1 x 1 m and 1 x 2 m in dimension) (Figure 63). Soils from the latter were all processed with 3 mm mesh screen for a total hand recovery volume of 7.9 m^3. A substantial effort was also made to recover microconstiuents in the form of eight column samples and nine bulk flotation samples. A total of 338.6 liters (0.3386 m^3) of soil was subjected to micro-processing: 183.1 liters floated to recover botanical remains and 153.5 liters water-processed with 1/16th in mesh.

Site stratigraphy was complicated by the presence of multiple construction related layers in the vicinity of trench 1 nearest the bridge pier (Figure 63). Disturbance in the form of re-deposited midden was recorded as deep as 58 cm below surface and a nearly modern radiocarbon date (110±50 years B.P. Beta-145645) obtained from beneath older prehistoric layers suggests disturbance as deep as 182 cm below surface in this site area. In the vicinity of trench 1, an intact human burial (representing an adult male at least 21 years of age interred in a flexed position) indicated that the deposit was intact below 197 cm beneath the surface although the act of interrment itself would likely disrupt stratigraphy. Away from trench 1, stratigraphy was considerably less complex, with a 40-50 cm thick midden layer (Stratum II) buried beneath 20-30 cm of natural alluvium (Figure 64). Radiocarbon dates and stratigraphic profiles clearly indicate a single stratigraphic component (Stratum II) that was severely compromised by the construction of the bridge pier in 1937. Away from the pier, the deposit was relatively intact, but it exhibited only modest evidence of internal superposition of materials. Radiocarbon results from the top of the midden were, in most cases, not significantly younger than those obtained from the base.

Fortunately, radiocarbon results were extremely cohesive with regard to overall site dating so the apparent stratigraphic problems were mitigated by the presence of a single temporal occupation. With 35 radiocarbon assays, this is the most heavily dated site on the Big Sur coast. When calibrated and corrected, 34 of these date intercepts fall between A.D.1280 and 1810 although several charcoal dates produced multiple intercepts within the historic era (Table 13). A single calibrated date of A.D. 1150 is at odds with the rest of the dating sample, and seems to be an unreliable outlier. Excluding this single date and focusing on the remaining, densely clustered ^{14}C results, the occupation of CA-MNT-1942 appears to span from A.D. 1260 to ca. 1810.

The site produced a very small artifact assemblage that included one Desert Side-notched projectile point, two bifaces, two drills, two flake tools, two handstones, one hopper mortar fragment, five pestles (three shaped and two unshaped), three battered cobbles, one bone awl fragment, two shell beads, and one piece of modified shell. The beads were both non-diagnostic types: a G1 tiny saucer and and an A1c spire-lopped *Olivella*.

The faunal assemblage included remains of mammals, birds, and fish. From a total of 1175 bird and mammal remains, 91 elements were identified to species of non-burrowing, economically significant taxa. This assemblage was dominated by deer (NISP=38; 41.8%), cottontail rabbit (NISP=36; 39.6%), and sea otter (NISP=13; 3.3%). Three pinniped bones of unknown species were also recovered. A total of 1697 fish elements was recovered from the 7.9 m^3 of sediments processed with 3-mm mesh. Of these, 277 elements were to family or genus level. This collection was dominated by rockfish (NISP=168; 60.6%), cabezon (NISP=29; 10.5%) and rock or black prickleback (NISP=19; 6.9%). Fish remains from the 1.5 mm mesh (1/16 inch) samples, not surprisingly, showed a higher frequency of diminutive taxa. Among 138 identified elements recovered from the fine mesh screening, 82 (59.4%) represented northern anchovy or the anchovy family. The rest of the assemblage was dominated by rock or black prickleback (NISP=12; 8.7%) and surfperches (NISP=10; 7.2%).

A substantial effort was also made to recover botanical remains from the deposit through flotation. Processing of 183.1 liters of sediments yielded impressive results in the form of 918 charred large seed fragments (inedible nutshell and berry pits) and 527 small seeds. The majority of the large specimens clearly represented food debris as the fragments were derived from plants with edible seeds or nuts that

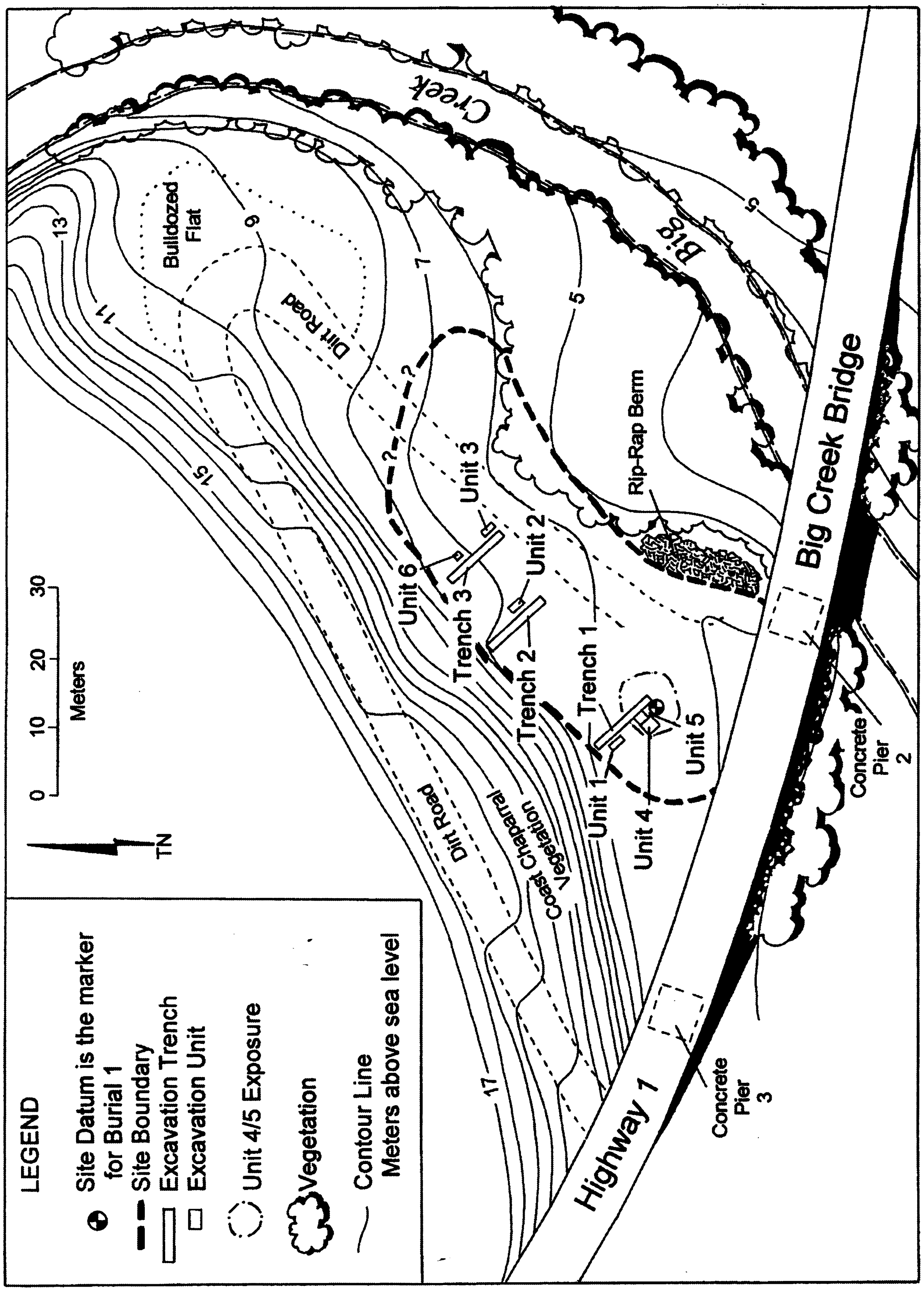


Figure 63 Site Map CA-MNT-1942

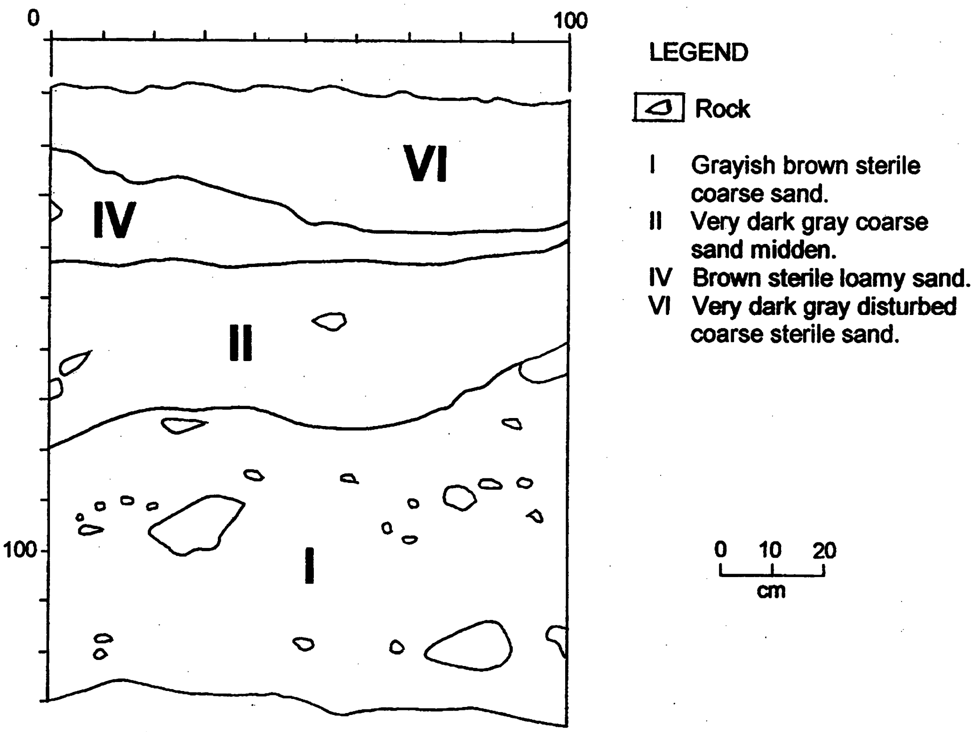


Figure 64 Representative Stratigraphic Profile from CA-MNT-1942 (Adapted from Wolgemuth et al. 2002)

could not possibly have occurred naturally at this location. Foremost among these were the remains of acorns, bay nuts, buckeye nuts, manzanita berries, and pine nuts (Wolgemuth et al. 2002:52-53). The smaller seeds can be attributed to diet with much less confidence as some of these taxa (e.g., *Rosa* sp., *Rubus* sp.) occur naturally in riparian settings like that adjacent to CA-MNT-1942. Implications of these finds for site seasonality are somewhat ambiguous, but the nut remains almost certainly were collected in the fall. None of the botanical remains represent winter, but few plants produce seeds in the winter in central California. Either the nuts were harvested in the fall and stored for later consumption in the winter or they were consumed immediately in the fall. Since acorns and other nuts were so commonly stored in Native California, the former explanation seems most likely. The small seeds suggest occupation from the spring through summer. If they could be considered reliable cultural indicators, they would suggest the possibility of year-round occupation, however, questions of natural versus cultural origin persist.

CA-SLO-267

CA-SLO-267 is situated at Point Piedras Blancas in northern San Luis Obispo County, 13 km south of San Carpoforo Creek (Figure 1), which is generally considered the southern limit of the Big Sur coast. Indeed, coastal terrain south of San Carpoforo Creek is noticeably less rugged than that to the north. While the site was slightly outside the official limits of Big Sur, it was too close to exclude from the present study, particularly in light of artifact and faunal materials that showed many similarities with findings from the north. The site was a complex of shell midden loci and flaked stone scatters covering approximately 37,200 m^2, along two shallow drainages. In 1996, a substantial quantity of midden (70.3 m^3) was excavated for Caltrans in anticipation of a major re-alignment of Highway 1. The site was tested previously Bouey and Basgall (1991) who defined nine separate areas within the overall site boundaries (Figure 65). The investigation in 1996 was limited to locus C2, a midden deposit on the southern fringe of the site. The deposit was fairly shallow, with one cultural stratum extending to a depth of 80 cm (Figure 66). Twenty-two radiocarbon dates were obtained from the site as a whole. These indicated an overall span of occupation between approximately 1250 B.C. and A.D. 1700. All of the dates from site area C2, however, were between 1250 B.C. and A.D. 1250. The more recent dates were all obtained from Site Area E2. Site area C2, therefore, represented a single Middle Period component that included both the Early/Middle and Middle/Late transitions. Only area C2 has been considered in the current presentation.

The artifact assemblage associated with the C2 component was substantial and typologically cohesive. *Olivella* beads included drilled spire-lopped A3 (n=1), end-ground B2 (n=4), barrels B3 (n=2), tiny saucers G1 (n=2), normal saucers G2 (n=3), oval saucers G5 (n=1), cupped K1 (n=1), and three limpet rings. Projectile points included 27 contracting-stemmed, two large concave base, one Rossi Square-stemmed, one small leaf-shaped, two large concave base, one large side-notched, and one Desert Side-notched. The preponderance of contracting-stemmed points was consistent with the Middle Period dating indicated by the radiocarbon results. The ground stone assemblage consisted of 258 pitted stones, 40 hammerstones, 15 pestles, 11 grooved stones, 5 tarring stones, and a variety of drilled steatite objects including 3 drilled pebbles, 2 barrels, 2 tubes, 1 pipe, and 1 lenticular ornament. Also recovered were twelve bone gorge hooks, eight one awl/gorges, three bone awls, three fishhook blanks, two bone awls/pins, and one shell fishhook.

The mammal and bird assemblage was dominated by terrestrial taxa- particularly the mammals. Birds were generally insignificant with only 4 identified elements from a total NISP of 280. The most numerous taxon was black-tailed deer (NISP 93; 33.2%) followed closely by cottontail rabbits (NISP 88; 31.4%). Dog/coyote remains were also represented in significant numbers (NISP=50; 17.9%). The most abundant marine taxon was California sea lion (NISP 13; 4.6%) followed by sea otters (NISP 12; 4.3%). The fish bone collection from this site is significant in that the recovery volume from 1.5 mm mesh was considerably larger than from any other site. This sample produced 367 identifiable specimens for a density of 459 elements/m^3. Dominant taxa were pricklebacks (NISP=94; 25.6%), rockfishes (NISP=75; 20.4%), surfperches (NISP=41; 11.2%), and herring (NISP=31; 8.4%). Shellfish remains were dominated by California sea mussel 84.9% and turban snail for 4.9%. Oxygen isotope analyses suggested that mussels were collected from summer through fall. Deer teeth annuli suggested hunting from fall through winter. The two data sets together showed a gap in occupation during the spring.

Piedras Blancas was also important as a source of Monterey chert and much of the material recovered from the excavation reflected the reduction of Monterey chert boulders, cobbles, and pebbles. Large flakes probably obtained from the boulders provided blanks suitable for staged reduction while small tabular pebbles and cobbles were used with a distinct core-based reduction strategy. Many characteristics of the flaked stone assemblage reflected heavy exploitation of chert in all of its forms. Debitage density was inordinately high (16,563 Monterey chert flakes/m^3). Sheer numbers of flaked stone items also support this trend: 265 cores, 4 core tools, 465 bifaces, 173,548 pieces of debitage, and 24 flake tools. Debitage was dominated by core/flake debris which was represented in a proportion higher than the figure associated with full reduction (89.6%) in the experiment with Monterey chert. The site's flake-to-biface ratio was 2297:1 which is an extremely high figure, greater than the experimental value of 1659:1 associated with reduction of a single block of toolstone to a bifacial projectile point. This suggests that while a full sequence of reduction was undertaken, a certain fraction of bifaces was taken away for use elsewhere, resulting in a greater representation of debitage. Of course, this is consistent with the behavior expected at a source location.

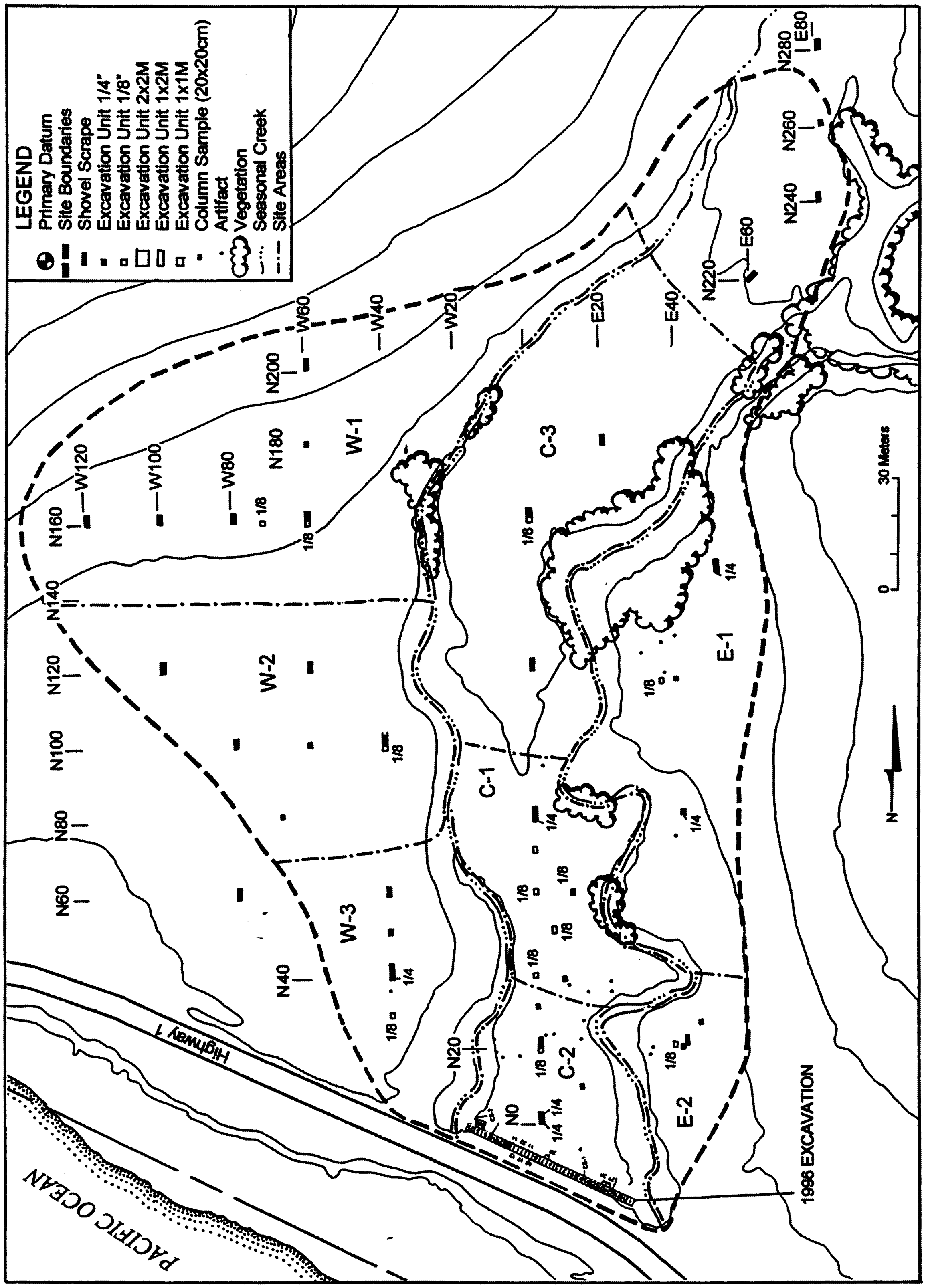


Figure 65 Site Map, CA-SLO-267

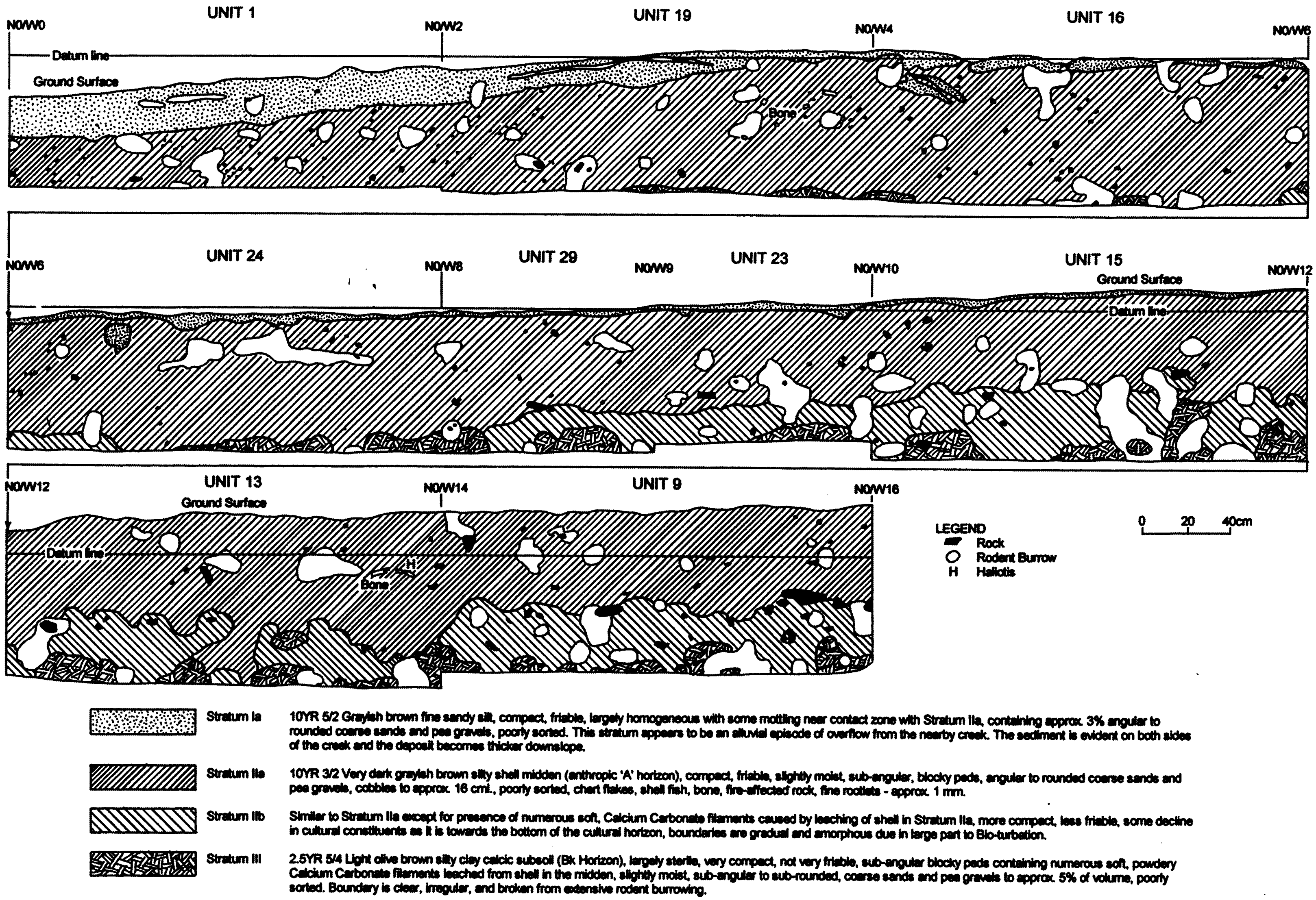


Figure 66 Sidewall Profile, CA-SLO-267

CHAPTER 6: FINDINGS FROM THE INTERIOR

Subsurface data have been available from the interior of the South Coast Ranges for several decades, (e.g., Meighan 1955; Swernoff 1982), but the earlier studies were of such limited scope that they provide little insight into the patterns of interior prehistory, and/or the manner in which the interior articulated with the coast through time. Fortunately, more substantive excavations have recently been undertaken on land held by the Fort Hunter Liggett Military Installation. Since 1992, more than 40 prehistoric sites have been investigated in the interior valleys of Fort Hunter Liggett (see Wickstrom and Jackson 1994; Haney 1997a, 1997b; Haney and Jones 1997; Haney et al. 2001; Jones 2000). Because some of the programs for which these studies were undertaken emphasized low density/low visibility deposits that produced very little material (Wickstrom 1995; Haney and Jones 1997), not all research yields from the interior were substantial. Findings from 12 of the inland sites that produced meaningful information are discussed below.

In addition to filling in the interior portion of coastal/interior settlement systems, these investigations were important because they included some scatters of flaked stone and/or bedrock milling features that were the only non-midden sites investigated for the project. The limited materials at these locations reflect less intensive site use, and therefore provide an important dimension to settlement variability not represented in the coastal data. Most of the interior sites - with two important exceptions- represent single time periods. The earliest evidence for occupation was provided by a single, unassociated radiocarbon date from CA-MNT-521, a site that was mostly occupied during the Middle Period. This date of 6090±60 radiocarbon years was obtained from a fragment of *Haliotis* shell from a depth of 80-90 cm. It corrected to 4230 B.C. with a two-sigma probability of 4348-4042 B.C., and clearly indicates movement between the coast and the interior as early as the Millingstone period. The rest of the materials from CA-MNT-521 are discussed in more detail below. CA-MNT-569 also was multi-component, but the occupations were spatially discrete in the form of one midden representing the Early Period and another the Protohistoric/Historic periods. The remaining sites were single-component.

CA-MNT-332

CA-MNT-332 was a midden and flaked stone scatter situated on a knoll just west of Stony Creek (Figure 67). A testing program completed in 1995, involving 6.5 m^3 of subsurface recovery, showed the midden to extend to a depth of only 50 cm (Figure 68). A deer bone from the deposit produced a corrected and calibrated radiocarbon date of A.D. 650. Hydration readings from 13 pieces of obsidian (Coso and Casa Diablo) were generally consistent with Middle Period dating, ca. 600 B.C. – A.D. 1000. The artifact assemblage included 9 projectile points, 22 bifaces, 13 cores, 1 core tool, 2 flake tools, 10,082 pieces of debitage, 2 handstones, 1 milling slab fragment, 1 bowl mortar fragment, 1 pitted stone, 1 battered cobble, and 1 steatite pendant. Faunal preservation was very poor, but a total of 164 specimens was recovered. Most of these were small and highly fragmented, and only four could be identified to species. They represented black-tailed deer, tule elk, a carnivore, and a mole. The diversity of tools indicated a residential base, where a complete range of stone reduction was undertaken, along with a variety of hunting

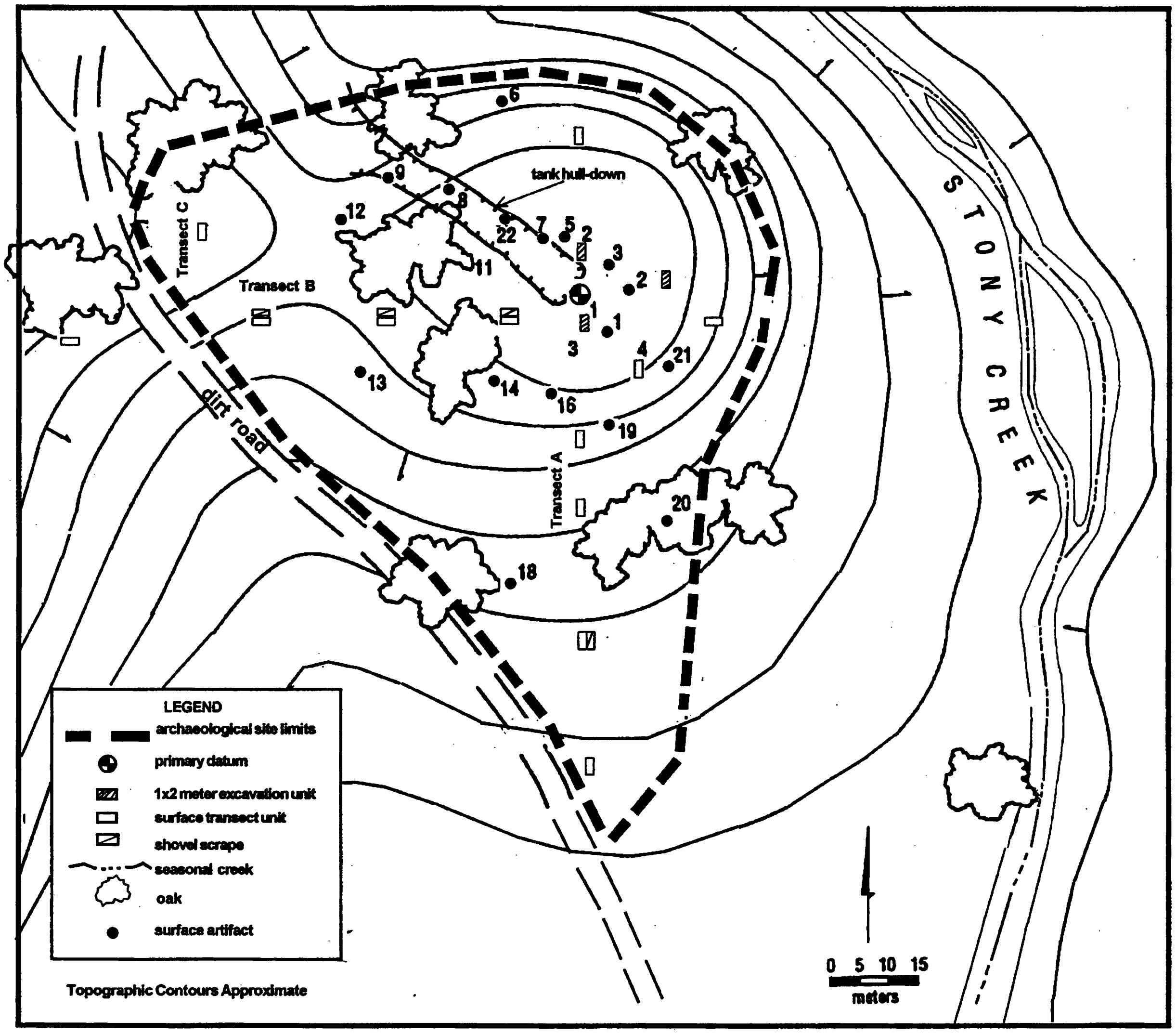
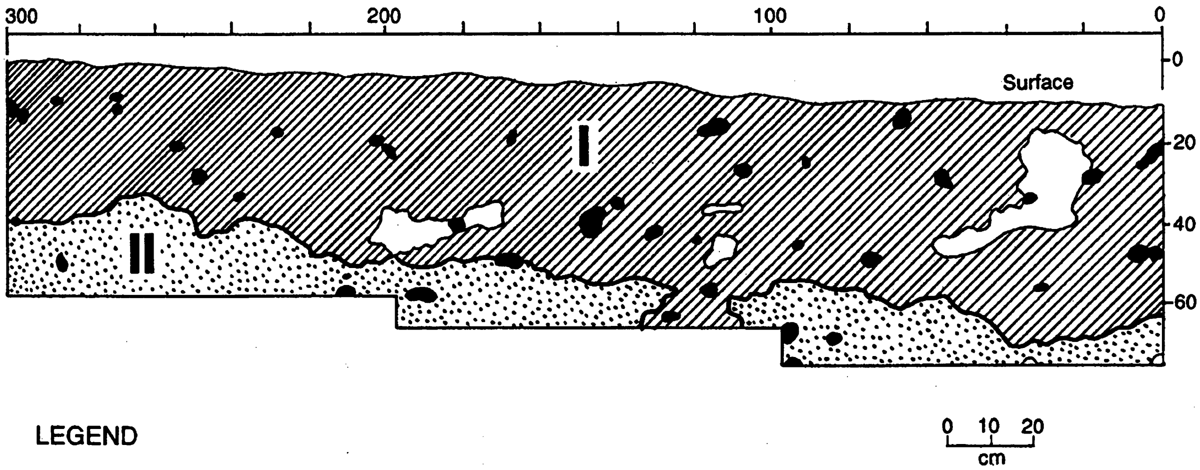


Figure 67 Site Map, CA-MNT-332



LEGEND

I Coarse sandy loam midden, very dark grayish brown (10YR 3/2).

II C horizon: coarse sandy loam, sterile substrate with decomposing rock, brownish yellow (10YR 6/6).

Rock

Rodent Disturbance

Figure 68 Sidewall Profile, CA-MNT-332

and collecting activities. Debitage frequencies, and the range of flaked stone materials suggested the site was also a significant flaked stone tool production locus, where implements were pro-duced for transport and use elsewhere.

CA-MNT-361

Unexpectedly important data were recovered from CA-MNT-361, situated in west central Piojo Valley, where surface features were limited to a bedrock mortar outcrop with two cups (Figure 69). Excavation of 2.1 m^3 of soil adjacent to the outcrop revealed two subsurface concentrations of charcoal, ash, fire-affected rocks, and reddened soil that appeared to represent hearths (Figure 70). An informal cobble pestle was also found below the surface, along with 1 chert core and 47 pieces of debitage. Radiocarbon results from the hearths suggested the features were created early in the post-contact period. Flotation samples produced charred remains of gray pine, acorn, and buckeye nuts. The nut remains suggest the site was occupied in the fall. This site is situated in the immediate vicinity of the place referred to as *Ke* in the Harrington notes, and "*Campo de los piñones*" in the diaries of the Portolá expedition of 1769. The recent dates returned from the subsurface features and the preponderance of pine nut remains suggest the feature could have been used when the expedition passed through the El Piojo drainage in September of 1769.

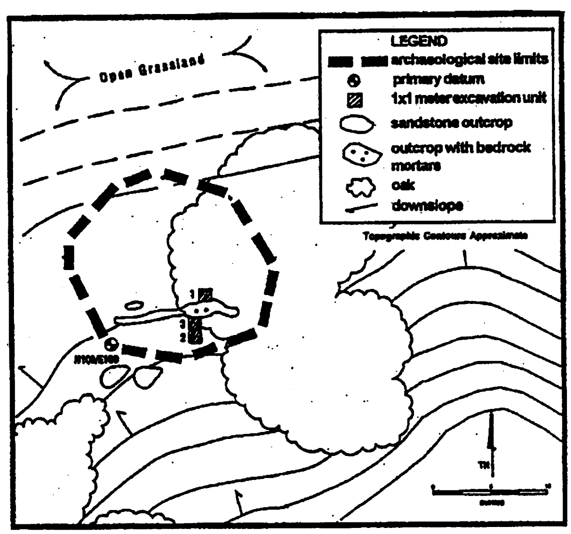


Figure 69 Site Map, CA-MNT-361

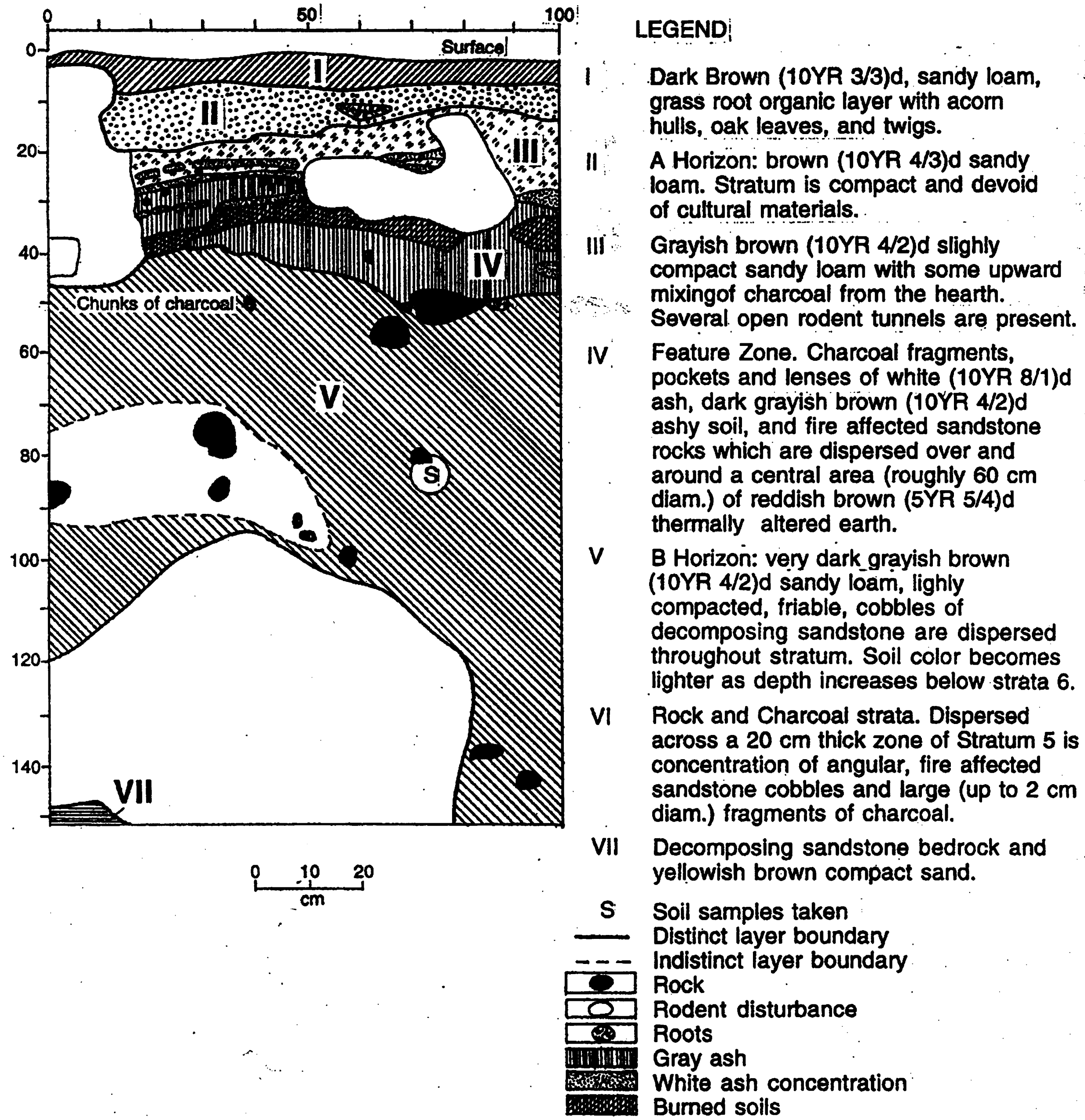


Figure 70 Sidewall Profile, CA-MNT-361

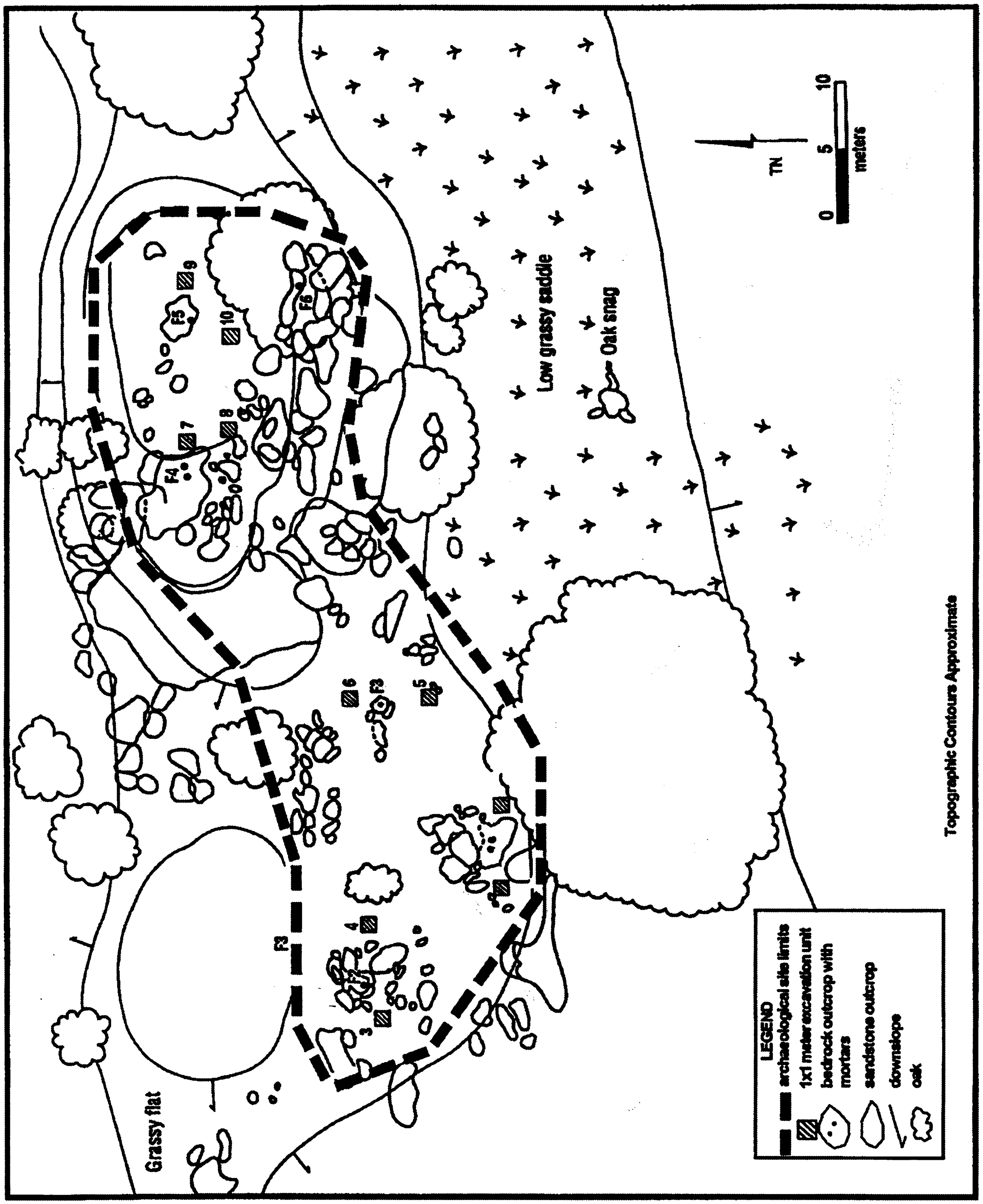


Figure 71 Site Map, CA-MNT-504

CA-MNT-504

CA-MNT-504, situated along a ridgetop in the northwest end of Nacimiento Valley (Figure 71), was investigated in the fall of 1993. It included six bedrock milling features with a total of eight mortar cups outcrop and a scatter of chert debitage. A pocket of soil containing ash and charcoal, possibly representing a hearth, was found near the outcrop (Figure 72). A deer calcaneus from 10-20 cm yielded a modern date. If the

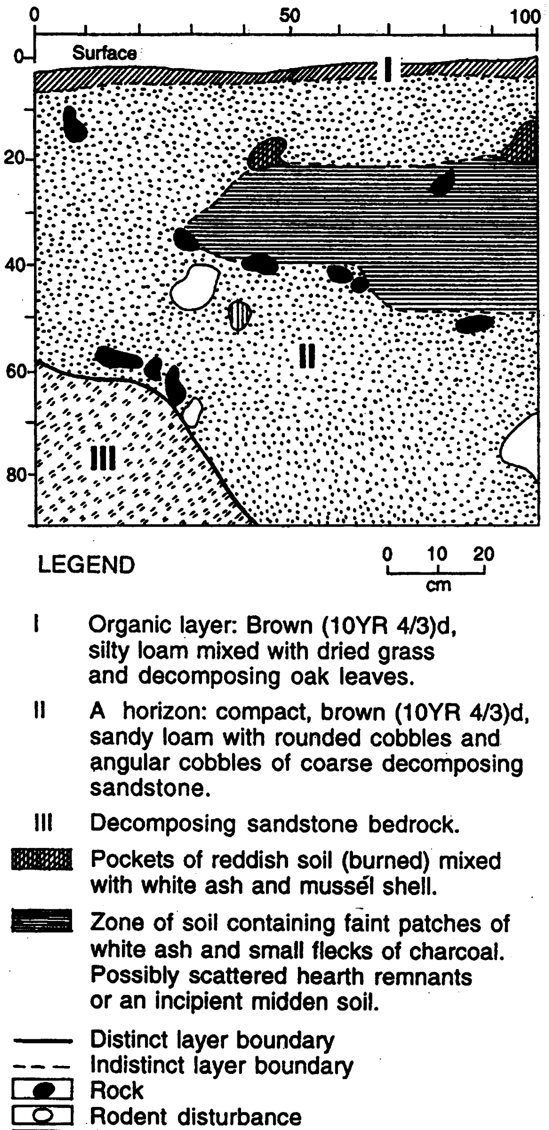


Figure 72 Sidewall Profile, CA-MNT-504

date is not an intrusion into the prehistoric deposit, it suggests use of the site very late in the prehistoric era or early in the post-contact period. The assemblage recovered included two cores, one biface, three projectile point fragments, one hundred and thirty-two pieces of debitage, and one informal cobble pestle. The projectile points included one Desert Side-notched, a tip, and a base fragment from a larger type. The biface was a broken arrow point preform. From 13 bone fragments, only one could be identified to species: a deer calcaneus, used for the radiocarbon dating. A total of 43.2 g of marine shell fragments was also recovered. California mussel was by far the dominant species.

CA-MNT-507

Another Late Period site, CA-MNT-507, marked by a flaked stone scatter and 14 bedrock mortars (Figure 73) was investigated in 1993. It occupies an

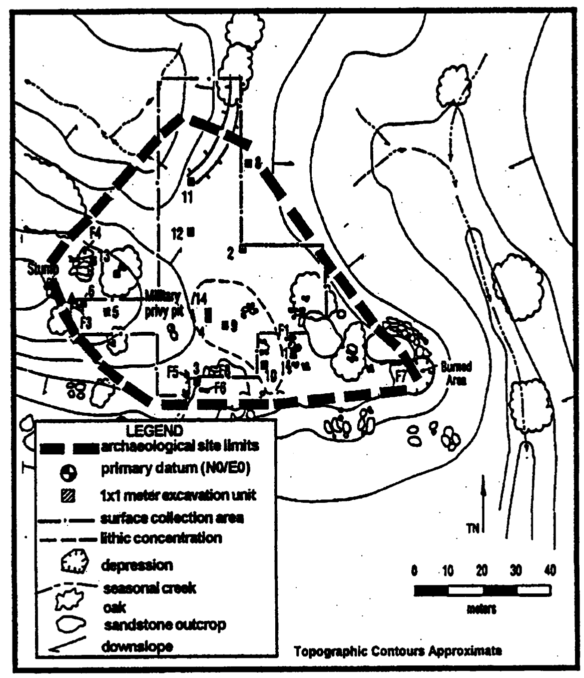


Figure 73 Site Map, CA-MNT-507

area of 5,105 m^2 on a small knoll in the Nacimiento Valley. Surface collection and excavation of 6.2 m^3 produced five bifaces, one projectile point fragment, three flake tools, 761 pieces of debitage, and six unshaped cobble pestles. Cultural materials were found in a sterile matrix of brown sandy loam which showed three distinct soil horizons: an A horizon marked by dark yellowish brown (10 YR 4/4) sandy loam that extended from just below the surface to depths between 15 and 40 cm (Stratum I), a B horizon, a brown (7.5 YR 4/3) sandy loam with a slight clay content (Stratum II), and decomposing bedrock (Stratum III) (Figure 74). Soil acidity tests produced pH

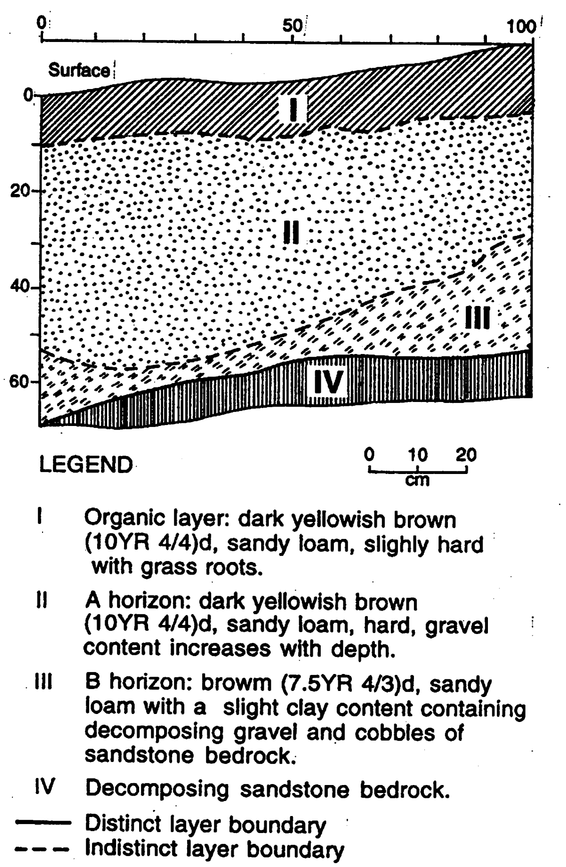


Figure 74 Sidewall Profile, CA-MNT-507

readings between 6.25 and 6.5, indicating some acidity which is consistent with the standard characterization of most local soils (Soil Conservation Service 1978:68). A single obsidian flake from the Casa Diablo source failed to produce a hydration rim, and the projectile point fragment was too incomplete to define type. The debitage profile was consistent with arrow point reduction, however, and it is likely the site marks a short-term residential location used during the Late Period.

CA-MNT-519

CA-MNT-519 was investigated in December 1998 by Albion Environmental under contract to Fort Hunter-Liggett. The site is marked by an unusually large (170 x 115 m) central midden (Locus 1), two smaller peripheral midden areas (Loci 2 and 3), and a more extensive scatter of flaked stone (Locus 4) (Figure 75). These features occur on an alluvial terrace above the Nacimiento River, 16 km inland from the Pacific Ocean. Locus 1 was damaged in the summer of 1998 when, as part of a small-scale fire suppression effort, a trench was excavated into the deposit with a piece of heavy equipment. A testing program was undertaken to determine whether the deposit was eligible for inclusion in the National Register of Historic Places. The field program included a series of Surface Transect Units (STUs) measuring 2 x 0.5 x 0.2 m deep and vertical units (1 x 2 m) excavated to the base of the deposit. The STUs were excavated to define site boundaries, while the vertical units were completed to evaluate potential research yields. Total excavation volume was 10 m^3.

The deposit proved to be fairly homogeneous. It consisted almost entirely of a midden with a high frequency of debitage, some marine shell, animal bone fragments, fire-altered rock, flaked and ground stone artifacts. It showed a maximum depth of only 1 m (Figure 76), and stratigraphic profiles showed unmistakable signs of disturbance from burrowing animals. The site's surface was clearly affected by tank traffic in the past, but the deposit was nonetheless in very good condition. Surface artifacts were abundant and, in most cases, intact and complete. Testing revealed two temporal components. Radiocarbon and obsidian hydration findings from the large central midden (Locus 1) indicated occupation during the Middle Period through the Middle-Late Transition, ca. 1000 B.C. – A.D. 1250. There was no evidence of occupation of this site area after ca. A.D. 1250. Locus 2, a small discrete pocket of midden and shells southwest of the main deposit produced a radiocarbon date of A.D. 1660, indicating occupation during the Protohistoric Period

Only Locus 1 produced a significant artifact assemblage consisting of twenty contracting-stemmed projectile points, seven square-stemmed points, one shouldered lanceolate point, two large side-notched points, five bone awls, five handstones, three milling slabs, and one steatite ornament. Whether the square-stemmed and side-notched specimens reflected an earlier, pre-Middle component unrepresented in the hydration and radiocarbon results was unclear, but the rest of the collection was generally consistent with other Middle Period assemblages (e.g., CA-MNT-63, CA-MNT-282, and CA-SLO-267). Notable by its absence was the small leaf-shaped point type commonly represented in Middle/Late Transition components at locations like CA-MNT-1233 on the coast. Locus 2, on the other hand, appeared to represent a Protohistoric Period occupation separate from the Middle and Middle/Late occupation indicated at Locus 1. Unfortunately, no formal artifacts were associated with the Locus 2 date.

A total of 1057 bird and mammal bones was recovered from Locus 1, weighing 435.9 g. Only 44

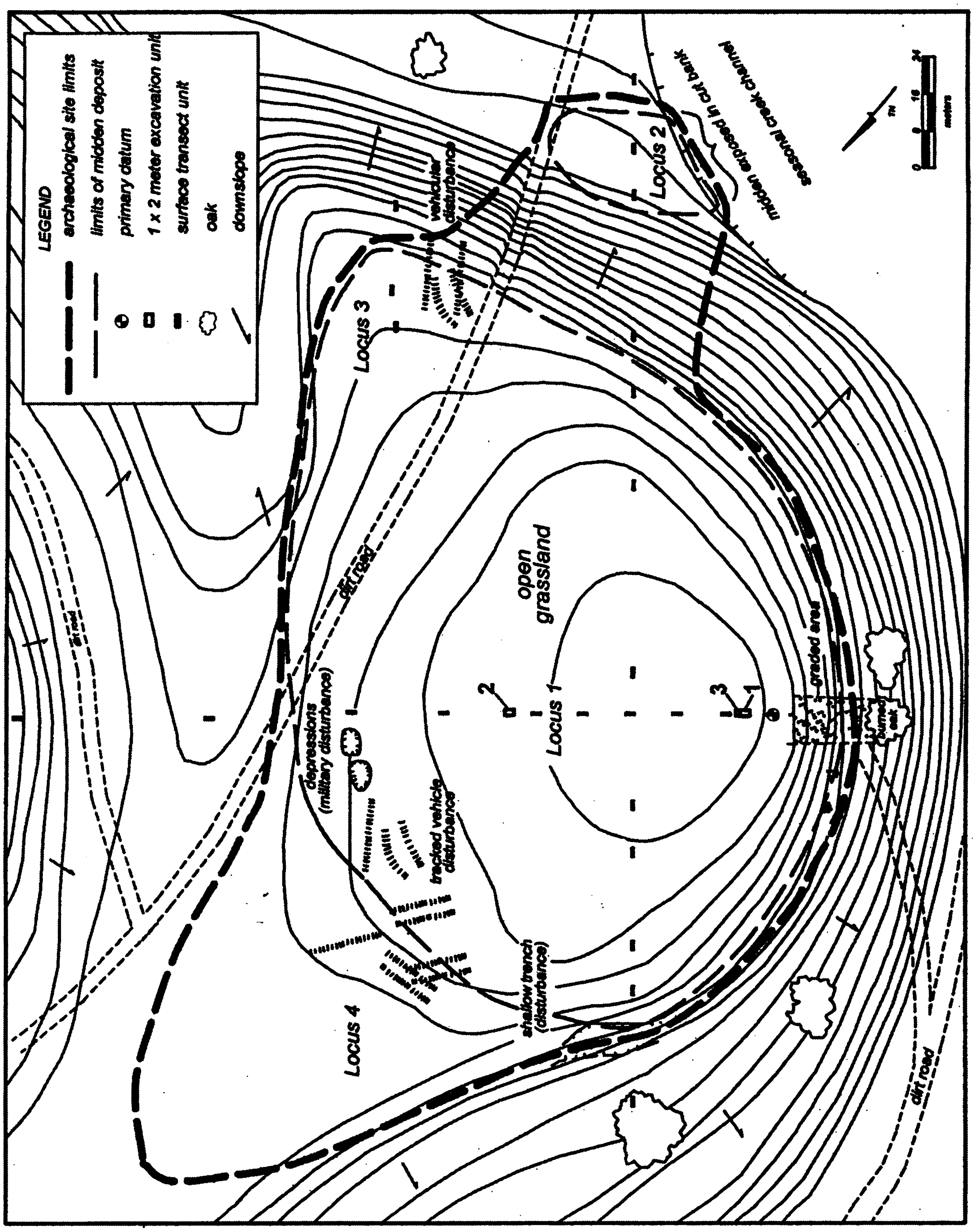


Figure 75 Site Map, CA-MNT-519

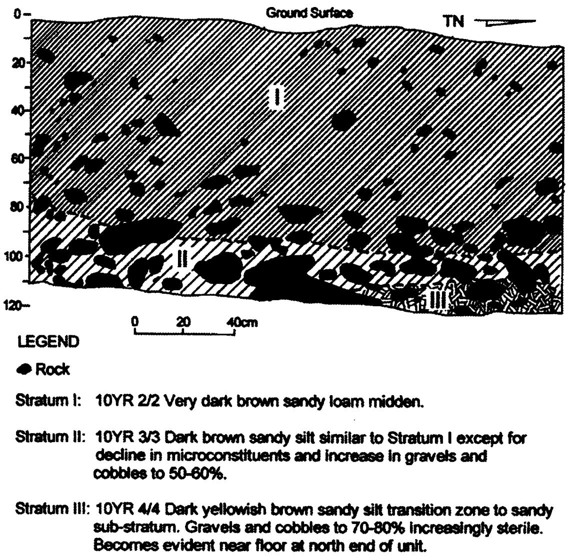


Figure 76 Sidewall Profile, CA-MNT-519

of these could be identified to the family level. This low recovery was undoubtedly due to the preservation characteristics of the deposit, as pH tests showed that site soils were fairly acidic. Elements representing the squirrel family (Scuridae) (N = 14), ground squirrel (N = 1), and pocket gopher (N = 4) accounted for nearly half of the total bones identified to the family level or better. Pocket gophers, of course, are notorious burrowers. Excluding the remains of burrowing and otherwise intrusive animals, the excavation produced a total of only 23 elements likely to represent the diet of prehistoric inhabitants. This collection was dominated by deer (NISP = 12; 52.2%), followed by rabbit (NISP = 5; 21.7%). Also represented were dog/coyote (NISP = 4; 17.4%) and jack rabbit (NISP = 2; 8.7%). Only six fish bones were recovered. They included one vertebra from an indeterminate ray-finned fish, four vertebrae from rockfish, and one vertebra from a lingcod. No freshwater fish were identified, despite the proximity of the Nacimiento River. Remains of marine shells were evident on the site's surface, but their density within the deposit was very low. A recovery volume of 2 m^3 from Locus 1 yielded only 3.8 g of shell. This sample was dominated by barnacle (2.4 g; 63%) and California mussel (1.1 g; 28.9%). Slightly greater amounts were obtained from an STU in Locus 2 which produced 102 g, dominated by California mussel (91 g; 89.2%) and barnacle (7.7 g; 7.5%). The low density of shell in Locus 1 was consistent with the low soil pH.

CA-MNT-521

In 1997, Jones and Haney reported the results of the two largest excavations yet undertaken at Fort Hunter Liggett. The first of these was at CA-MNT-521, marked by two large middens (A and B), a flaked stone scatter, and bedrock mortars (Figure 77). The site occupies a low knoll overlooking the Nacimiento River at an elevation of 373 m (1230 ft). Total recovery was 24.9 m^3. As was typical of sites in the interior, excavation showed no culturally meaningful vertical stratigraphy and abundant evidence of rodent activity. Most excavation units showed gradual increases in gravel and cobbles with depth. An upper zone of very dark grayish brown loamy midden, lacking gravel, was defined as Stratum I. At depths of 60-80 cm a distinctive concentration of gravel and cobbles was detected representing the C soil horizon. This zone, which showed mottling of dark brown (10 YR 3/3) midden with underlying soil, was defined as Stratum III. Intermediate levels with some gravel, above the C horizon, were designated Stratum II. Beneath Stratum III was a culturally-sterile, dark yellowish brown (10 YR 3/4) sandy loam with a high density of gravel and cobbles. Tests of soil acidity produced pH values between 6.25 and 8.5 with a site mean of 7.04 which is essentally neutral. Nearly all (10 of 11) of the most alkaline readings (greater than 7.4) were obtained from the central portion of Area A. Two of the most acidic readings (6.25) came from the extreme southern and northern edges of the site, beyond the middens. A majority (7 of 11) of the most alkaline values were obtained from below 90 cm. Human activities seem to have amplified the relatively neutral acidity of the natural soil to create an environment favorable for bone preservation. With respect to soil acidity, the preservation climate here was superior to many other sites in the interior.

Two subsurface features were identified: a modest concentration of orange heat-affected soil, ash, charcoal flecks, and fire-altered rock, found between 50 and 70 cm in Unit 1 (Feature 1), and a subsurface pit, found in the bottom of units 2, 11, and 13 (Figure 78). Similar features are known from CA-MNT-229 in the Monterey Bay Area (Dietz et al. 1988). Surface features included four groups of bedrock mortars on the southwest edge of Area A in sandstone boulders. A total of 32 mortar cups was identified. The deposit was dated with 8 radiocarbon assays, and 44 obsidian hydration readings. A single radiocarbon date from a fragment of abalone shell provided modest evidence for occupation ca. 4300 B.C. When corrected and calibrated, the other seven

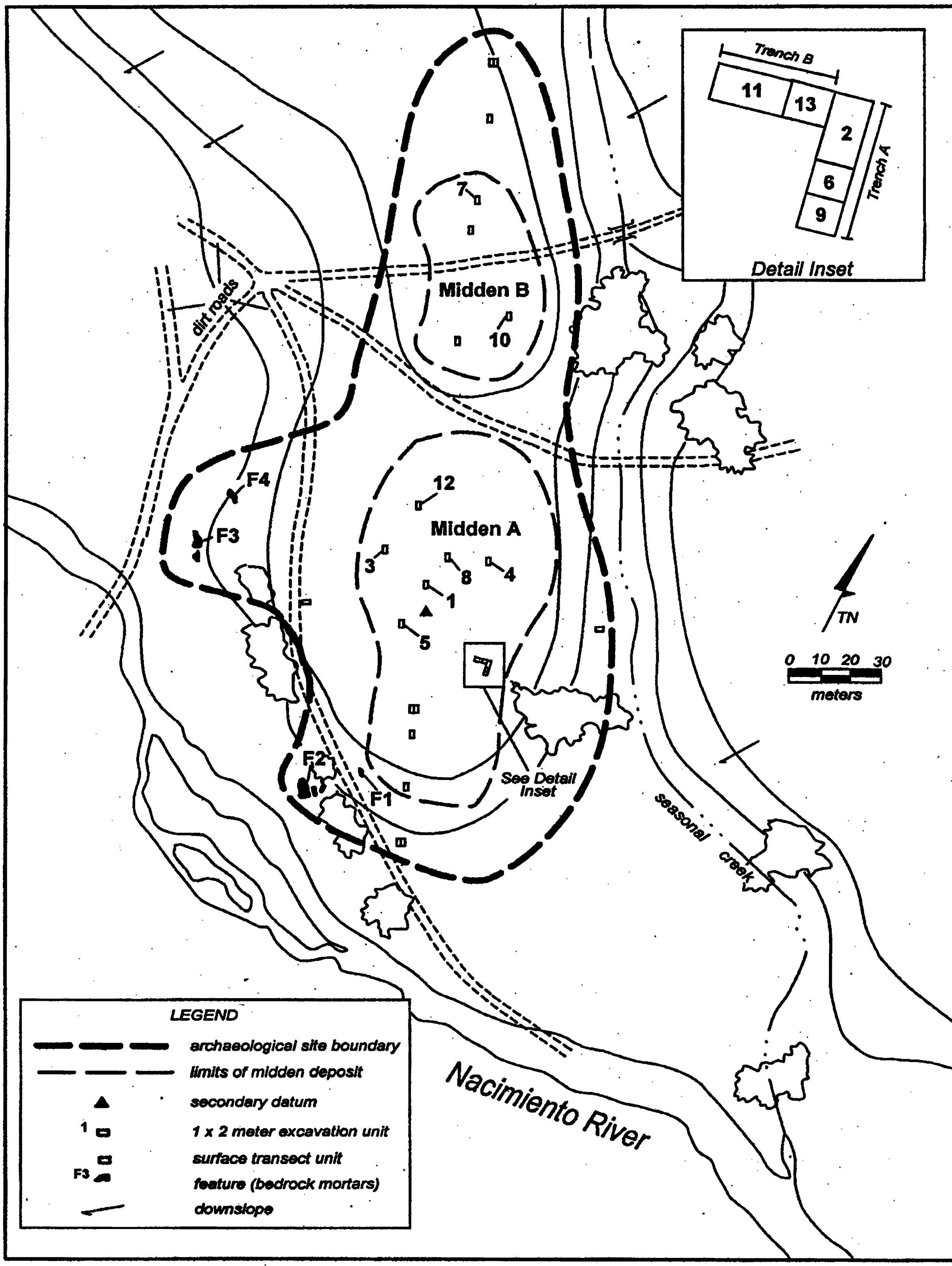


Figure 77 Site Map, CA-MNT-521

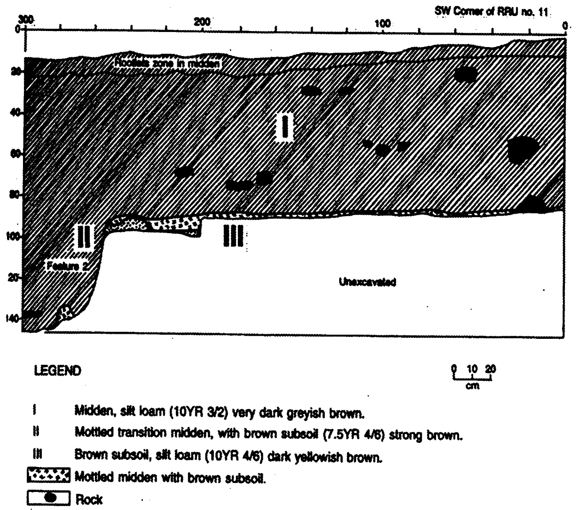


Figure 78 Sidewall Profile, CA-MNT-521

radiocarbon dates spanned between 1600 B.C. and A.D. 1060. Obsidian hydration results were internally consistent, and generally corroborated the radiocarbon results. Very minor use of the site during the Late Period was suggested by a single small thin steatite disk bead, and possibly the bedrock mortars. A clam shell disk bead produced a corrected and calibrated date of 1450 B.C. The rest of the artifact assemblage included 45 cores, 151 bifaces, 83 projectile points (contracting-stemmed [N=43], Rossi Square-stemmed [N=12], large side-notched (N=5), and small leaf-shaped [N=1]), 28 flake tools, 2 core tools, 2 drills, 37,847 pieces of debitage, 12 handstones, 8 millingslab fragments, 4 mortar fragments, 2 shaped thick, cylindrical pestles, 6 pitted stones, 3 hammerstones, 1 stone sphere, 11 bone awl fragments, and 1 antler flaking tool. A total of 4456 pieces of mammal and bird bone was also recovered, weighing 1613.4 g. From this, 81 elements were identified to the species level. These were comprised mainly of deer (NISP=44; 54.3%), cottontail rabbit (NISP=16; 19.8 %), jack rabbit (NISP=9;11.1%), and bobcat (NISP=2; 2.5%). No remains of marine mammals were recovered. Among fifteen identifiable fish elements were five herring bones and five from rockfish. Shell fragments were recovered from nearly all levels in the units, albeit in very low densities. Thirteen taxa, all derived from the rocky intertidal of the Big Sur coast, were represented in combined column and unit samples. Only four species, California mussel, turban snail, barnacle, and sea urchin, were abundant enough to show up in the column. Analysis of cementum from seven black-tailed deer teeth indicated that deer hunting was undertaken in the fall/winter (November-February). Isotope analysis of mussel shells indicated that site inhabitants returned from the coast with shellfish in spring or early summer.

The flaked stone residues from CA-MNT-521 also provided a fairly coherent portrait of stone working. Monterey chert was the preferred raw material, and its relative abundance speaks to the existence of a source of this toolstone somewhere in the Monterey Formation probably within a few kilometers. Debitage frequency, while high (4478 flakes/m^3), was lower than several other sites closer to the formation. The high proportion of biface-derived debitage (48.4%) suggested that, while an occasional core was transported to the site, the most common form in which stone arrived was as bifacial preforms. Primary reduction, involving decortication and production of flake blanks was probably done at the stone source. Correlation between the site flake:biface ratio (443:1), and an experimentally derived ratio associated with stage 1-5 reduction (444:1) supported the conclusion that bifacial preforms were the most commonly worked form of stone.

CA-MNT-569

While CA-MNT-521 represented a single temporal component, CA-MNT-569, the subject of the second large-scale investigation in 1995, was more complex. Located in the Nacimiento River drainage, the site includes three discrete middens (each dating to a different period), an extensive flaked stone scatter, and a series of bedrock mortars (Figure 79). The most important findings came from Midden A (dating to the late Early Period) and Midden B (dating to the Protohistoric/Contact Period). Midden C was not accurately dated; nor was the lithic scatter. A total of 36.4 m^3 was excavated from the site as a whole, of which 30.1 m^3 came from Midden A.

Sidewall profiles from Midden A all showed a dark grayish brown (10 YR 4/2) silty loam midden (Stratum Ia) underlain by decomposing sandstone (Stratum III) (Figure 80). PH tests showed that Midden A was slightly alkaline (pH=7.5), while the decomposing bedrock was slightly acidic (pH=6.75). One subsurface feature was identified: a modest cache of two large stage 3 bifacial preforms (Figure 81). Dating of Midden A was accomplished with radiocarbon and obsidian source and hydration analysis. Unfortunately, due to the slightly acidic soil, Midden A lacked marine shell so potential dating samples were not abundant. Bone preservation was also poor, and only two bones large enough for AMS analysis were recovered. One from the base of the deposit was so small that collagen extraction was unsuccessful, and the dated sample was classified only as "organic material." It yielded a corrected date of 1770 B.C. Another sample from actual bone

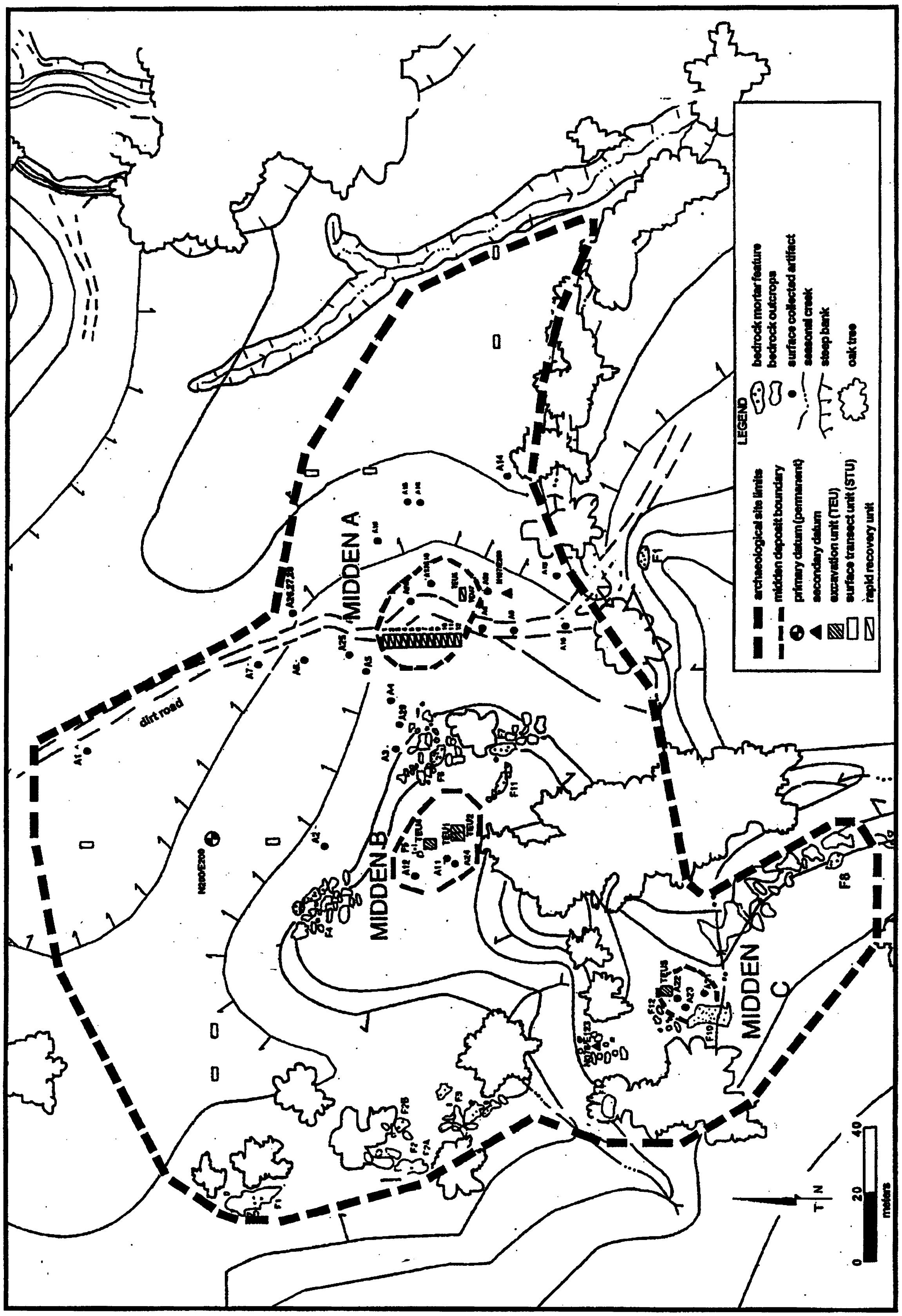


Figure 79 Site Map, CA-MNT-569

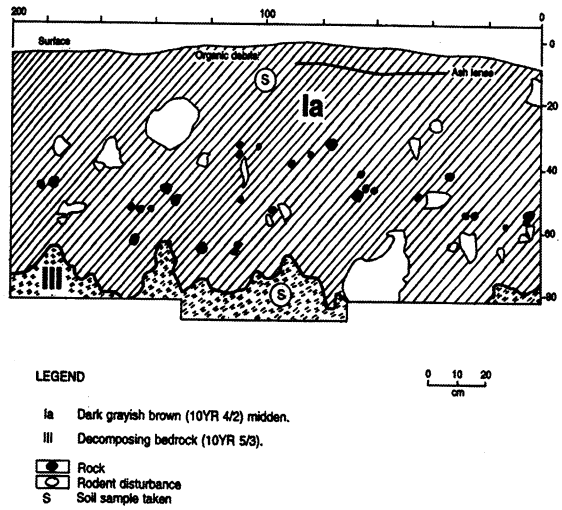


Figure 80 Sidewall Profile CA-MNT-569

collagen yielded a corrected date of 1430 B.C. These dates suggested that the base of Midden A marked occupation from the late Early Period. The terminal date of the occupation could not be accurately determined since no dating samples were recovered from the upper portion of the deposit, but it is most likely that occupation continued into the early Middle Period. An obsidian hydration sample of 12 specimens showed clustering between 3.6 and 6.5 microns which is generally consistent with the Early Period. Single readings of 3.7 microns on flakes of Casa Diablo and Coso obsidian suggested occupation during the Middle Period.

The flaked stone assemblage from the site as a whole included a total of 25,136 items, of which 15,467 were collected from Midden A including 53 cores, 77 bifaces, 77 projectile points (33 contracting-stemmed, 11 square-stemmed, 4 large side-notched, 1 concave base, 24 indeterminate), 14 flake tools, 4 drills, 4 core tools, and 15,252 pieces of debitage. In addition to flaked stone, Midden A yielded nineteen handstones (mostly unshaped cobbles), one complete shallow basin millingslab, one formal shaped cylindrical pestle, five pitted stones, one hammerstone, one steatite/talc schist pendant, and eight small bone awl fragments. A total of 2981 pieces of mammal and bird bone was recovered from the site as a whole, weighing 774.4 g. From this total, 42 elements were identified to the species level, and one (a bird bone) was identified only to class. The Early Period occupation represented by Midden A was dominated by deer (NISP=15; 65.2%) and rabbit (combined NISP of cottontail and jack rabbit=6;- 26.1%). No fish bone or shellfish remains were recovered from Midden A, and the diet represented by the fauna was considered wholly terrestrial.

Midden B was a small, shallow deposit, 30 m above Midden A on a low ridge, situated amidst five bedrock mortar outcrops with 45 cups. This deposit was dated with a single radiocarbon assay, shell beads, and one glass bead. The date obtained from a mussel shell was 370±80 years (uncorrected). When corrected and calibrated, this converted to A.D. 1955, with a two-sigma probability of A.D. 1670-1950. Seven diagnostic beads, included one glass type DIIa27 (Kidd and Kidd 1970), one type H1a *Olivella* (most common during the early Mission Period A.D. 1770-1800), one type G1 *Olivella* (temporally ubiquitous, but not found in any pre-A.D. 800 context on the coast), and one type B3 *Olivella* (also not a strong temporal marker), and three steatite small disks. The radiocarbon and beads suggested that Midden B was occupied during the Protohistoric/ Historic Periods (ca. A.D. 1500-1800). The rest of the assemblage from Midden B included seven cores, three core tools, four bifaces, six projectile points (four contracting-stemmed, one square-stemmed, and one Desert Side-notched), one drill, three flake tools, 8679 pieces of debitage, one unshaped cobble pestle, one handstone, one milling slab, one pitted stone, one asphaltum-covered cobble, one notched stone, and two bone awl fragments. The projectile points (including larger older types and one late type [DSN]) indicated mixing of earlier with later site materials in Midden B. The Midden B fauna was dominated by deer (NISP=9; 43%) and rabbit (NISP= 3; 14%). Three fish vertebrae were also recovered representing one each of rockfish, lingcod, and kelp greenling. Unlike Midden A, Midden B produced shell fragments in all levels of all units. Three taxa, all derived from the rocky intertidal of the Big Sur coast, dominated: California mussel, turban snail, and purple sea urchin.

CA-MNT-861

CA-MNT-861 covers an area of 6048 m^2 on a small rise along Upper Milpitas Road at an elevation of 376 m (1240 ft) in the northern portion of Fort Hunter-Liggett (Figure 1). The site was originally recorded in 1978 as a sparse scatter of flakes and ground stone. Field work was undertaken in December 1993, when a systematic surface collection was completed, and a total of 5.1 m^3 of soil was excavated from eight 1 x 1 m units and twenty-five shovel probes (Figure 82). Soils showed some variability but were generally characterized by a shallow organic layer (Stratum I) overlying an A horizon of a brown (10 YR 4/3) sandy loam (Stratum II) (Figure 83). A gradual transition was evident horizon was a yellowish brown (10 YR 5/4) loam.

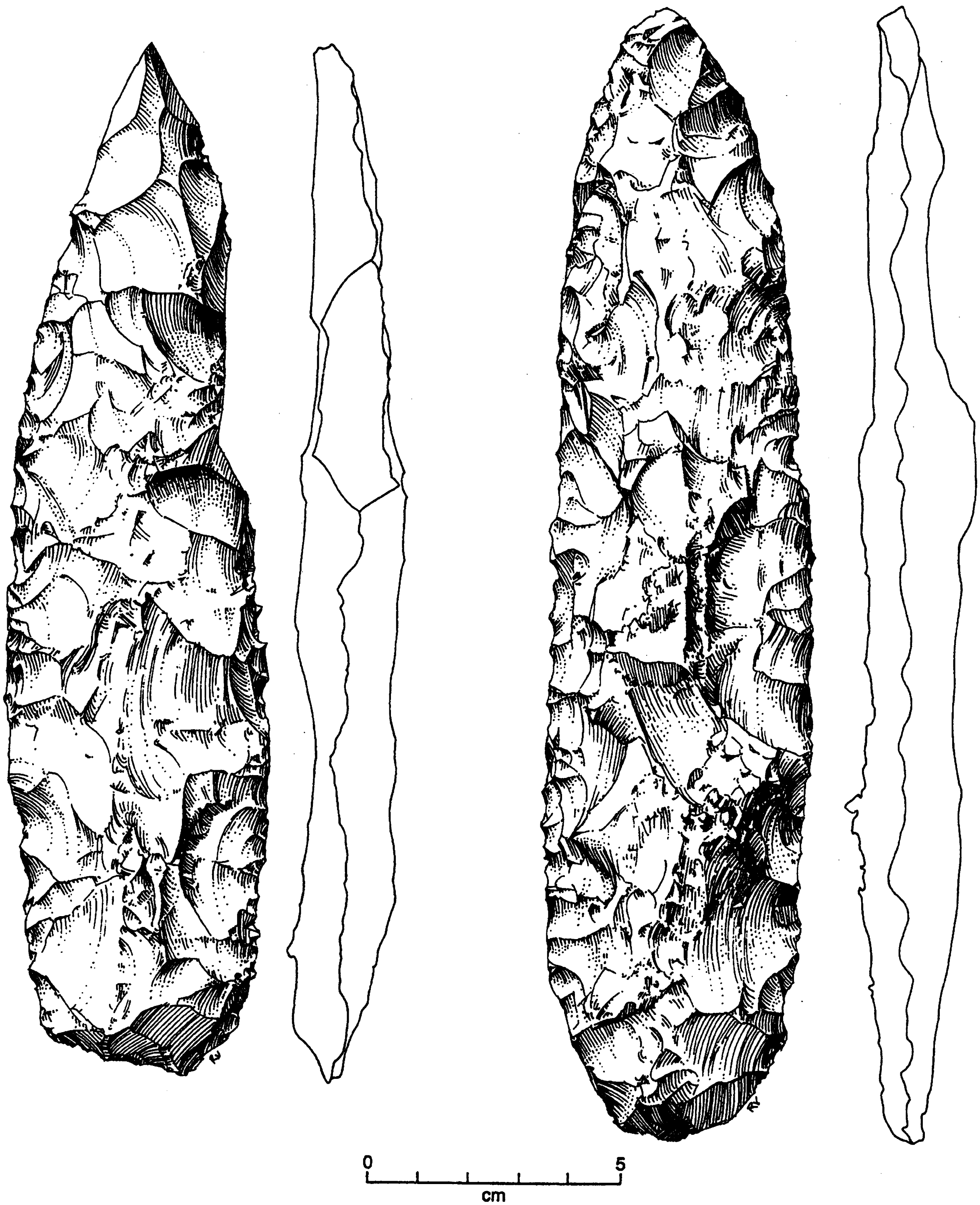


Figure 81 Stage 3 Bifaces from Cache, Midden A, CA-MNT-569

The B horizon overlay a layer of very pale brown (10 YR 7/4) decomposing bedrock (Stratum IV) that was encountered between 10 and 100 cm. Both the brown sandy loam and the yellowish sandy loam yielded pH readings of 6.5, while the layer of decomposing bedrock was 7.0.

The site yielded one core, one core tool, three bifaces, four projectile point fragments, two flake tools, 918 pieces of debitage, one handstone, and one battered stone. A large portion of the flaked stone tools--including two biface fragments, two projectile point fragments, one core, and a flake tool--were recovered from Unit 4. The projectile points included two Rossi Square-stemmed examples. This type is commonly recovered from Early Period contexts on the central California coast. These were the only temporal diagnostics found at this location, and they suggest provisionally that the site dates accordingly. The debitage profile was dominated by core reduction debris (76%). The ratio of flakes to bifaces was 131:1, which is close to the ratio associated with stage-5 preform reduction in the Monterey chert biface replication experiment.

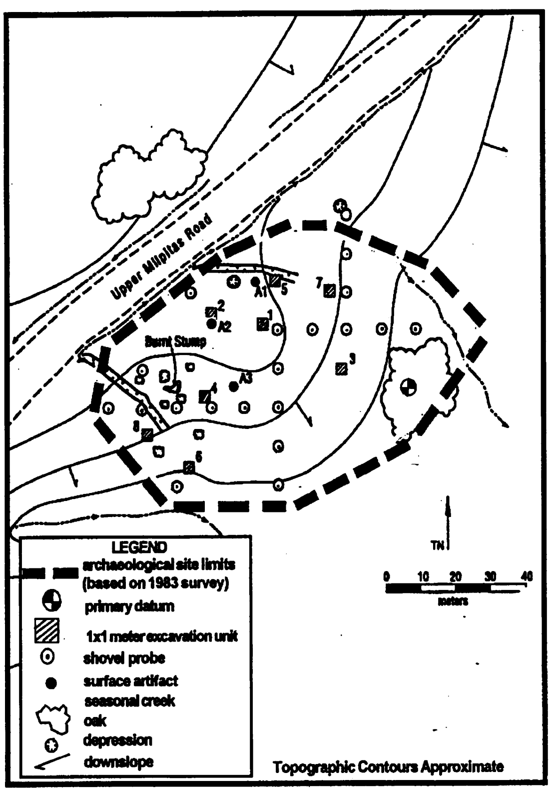
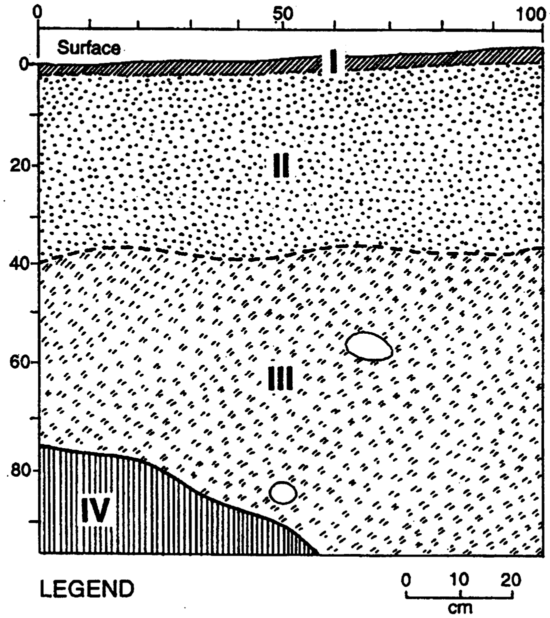


Figure 82 Site Map, CA-MNT-861



LEGEND 0 10 20 cm

I Brown (10YR 4/3)d, sandy loam, loose with grass roots.

II A Horizon: brown (10YR 4/3)d, sandy loam, loose, very little gravel.

III B Horizon: brown (10YR 5/3)d, loamy sand, very loose, some rounded cobbles (app. 20 cm diam.) and some rounded and subangular gravel (<2 cm diam.).

IV Decomposing sandstone bedrock.

—— Distinct layer boundary

– – – Indistinct layer boundary

Rodent disturbance

Figure 83 Sidewall Profile, CA-MNT-861

CA-MNT-879

CA-MNT-879 is marked by a midden deposit covering 5,856.9 m^2 adjacent to the San Antonio River in the northern portion of Fort Hunter-Liggett. Field investigations in the summer of 2000 involved mapping, surface collection, and excavation of a series of Surface Transect Units (STUs) and vertical 1 x 2 m units (Figure 84). Total excavation volume was 14.7 m^3. Subsurface excavations showed that the central portion of the site contained a fine, ashy gray midden approximately 30 x 30 m in size with a maximum depth of 1.5 m. Stratigraphic profiles showed that this gray midden was underlain by a less powdery brownish midden (Figure 85). Like most of the other investigated sites, especially those in the interior, this site showed unmistakable signs of disturbance from burrowing animals.

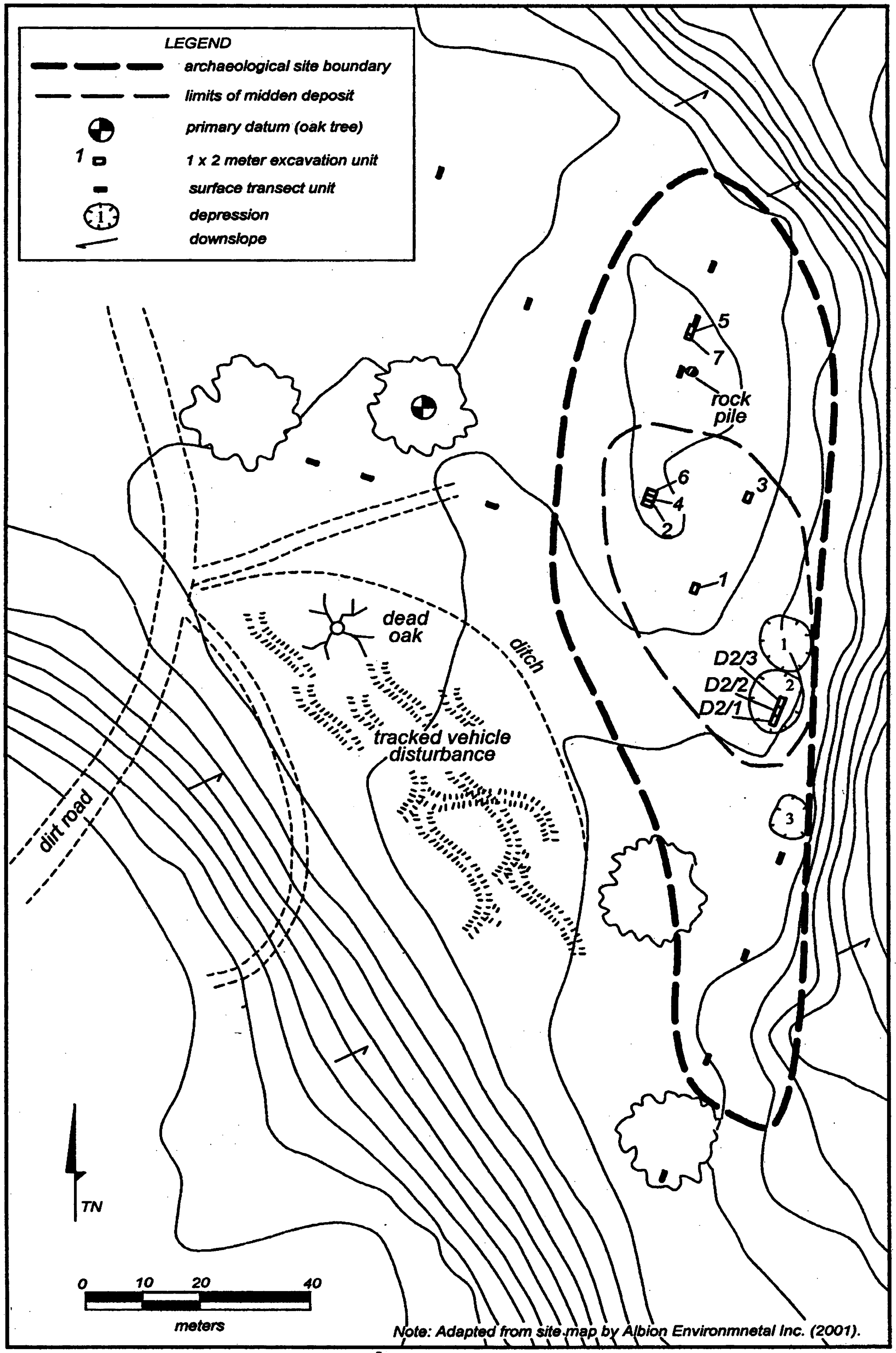
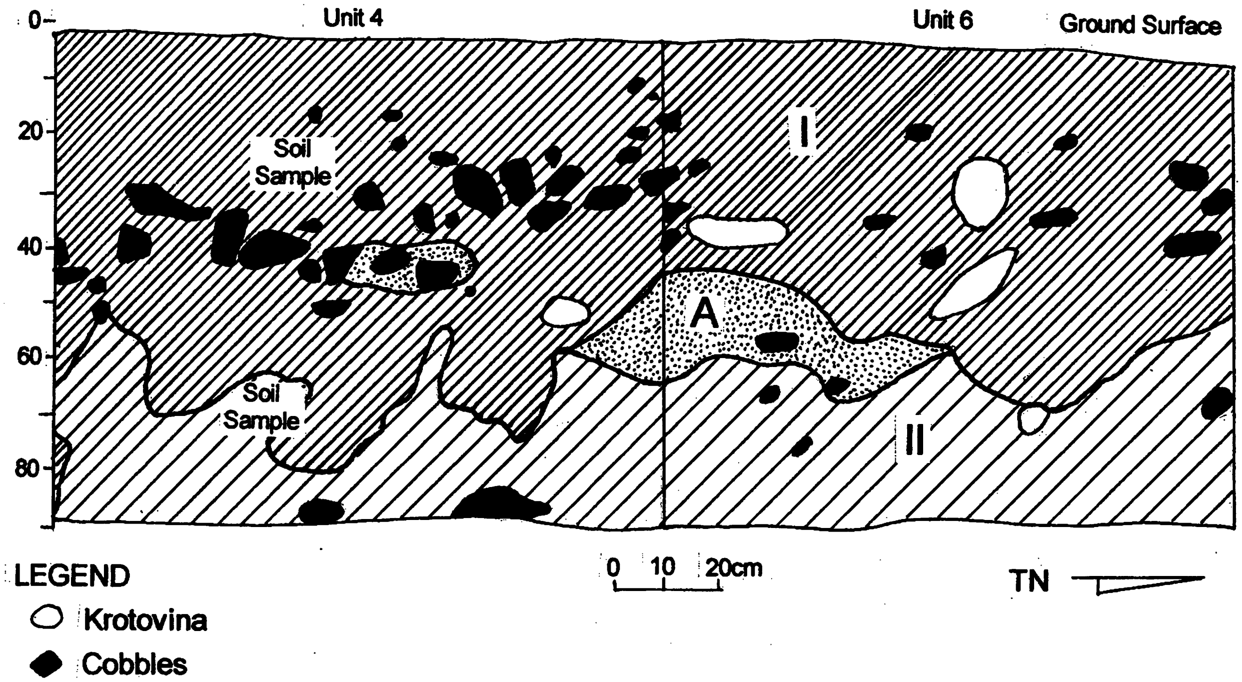


Figure 84 Site Map, CA-MNT-879



Stratum I: 10YR 4/2 Dark grayish-brown fryable midden deposit. Fine particles with seashell and cobbles.

Stratum II: 10YR 5/3 Brown compact sediment deposit with less cobbles and cultural material.

Stratum A: 10YR 5/2 Grayish-brown base ashy material with charcoal. Associated with the feature in unit 6.

Figure 85 Sidewall Profile, CA-MNT-879

The artifact assemblage from both the gray and brownish middens was dominated by Late Period markers, including eight Desert Side-notched and four Canaliño/Coastal Cottonwood projectile points, twenty-one steatite disk beads, eight *Haliotis* shell disk beads, contracting-stemmed points, and one G2 *Olivella* saucer bead, suggesting that a minor Middle Period component is present. Minor occupation during the Middle Period was also suggested by a hydration reading on Casa Diablo obsidian of 4.2 microns and another reading of 4.6 microns on an unknown obsidian.

A total of 2504 bird and mammal bones was recovered from which a total of 988 fragments was identified to species, genus, family, or order level. Excluding the remains of burrowing and otherwise intrusive animals (which were abundant in the collection), the excavation produced a total of 272 elements that were most likely of economic significance to prehistoric site inhabitants. This collection was dominated by cottontail rabbit (NISP = 104; 38.2%), deer (NISP = 61; 22.4%), and dog/coyote (NISP = 51; 18.75%). Also represented in low numbers were wood rat (*Neotoma* sp.) (NISP=39; 14.3%) and jack rabbit (*Lepus californicus*). A total of 71 fish bones was also recovered. Of these, 31 were identified to the family level or better. The collection of identified specimens was dominated by rockfish (*Sebastes* sp.) (NISP=16; 51.6%), followed by cabezon (*Scopaenichthys marmoratus*), and monkeyface prickleback (*Cebidichthys violaceus*). Remains of two freshwater fish: Sacramento perch (*Archoplites interruptus*) and Sacramento sucker (*Catostomus occidentalis*) were also recovered. These were the only freshwater fish remains found at any of the investigated sites. A fossilized tooth from a shortfin mako shark was also found, but this probably was of some ornamental value rather than dietary. Column samples were dominated by the remains of California mussel (94.8%) followed by barnacles (2.9%), sea urchin (0.5%), and turban snail (0.4%).

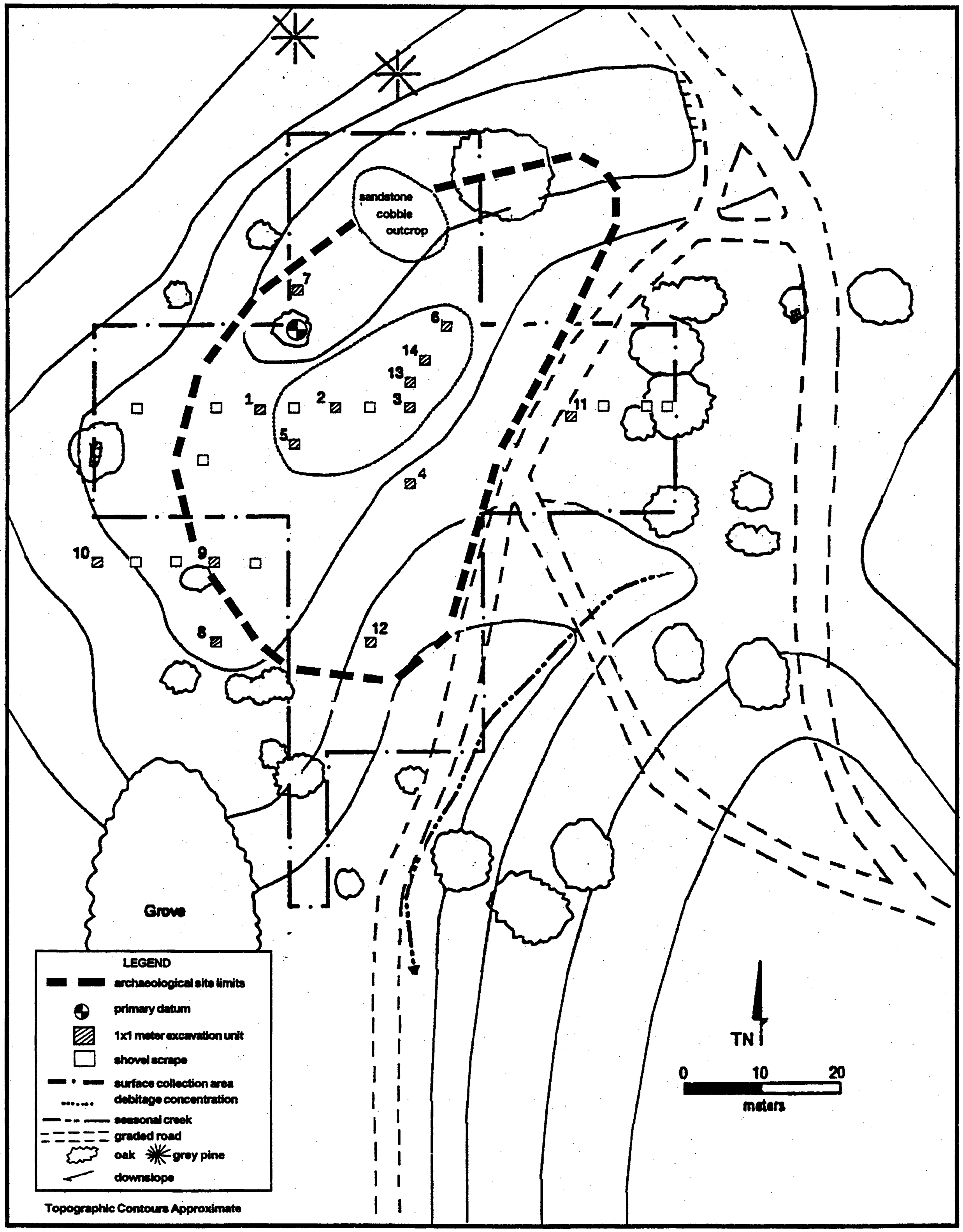


Figure 86 Site Map, CA-MNT-1657

CA-MNT-1657

CA-MNT-1657 was a light scatter of chert debitage and flaked stone tools covering an area of 2,356m^2 in the El Piojo drainage. Field study involved intensive surface collection and excavation of 4.4 m^3 of soil from 12 shovel scrapes, 14 STUs, and a series of 1 x 1 m units (Figure 86). Cultural materials were found in a sterile brown, sandy loam matrix. Most excavation units showed four distinct strata: a shallow organic layer (Stratum I) containing grass roots and oak leaves, an A horizon (Stratum II) that was a brown (7.5 YR 5/4) sandy loam between 20 and 50 cm., a brown (7.5 YR 4/3) sandy loam C Horizon (Stratum III) composed of decomposing sandstone, and bedrock (Stratum IV), 30 to 50 cm below the surface (Figure 87). Soil samples produced pH readings between 5.5 and 7.0, indicating slightly acidic soil

The deposit produced two cores, four bifaces, three projectile point fragments, one flake tool, and 1214 pieces of debitage. The only chronological indicator was a single Rossi Square-stemmed projectile point which is a reasonably reliable marker of the Early Period (ca. 3500 - 800 B.C.). The diagnostic debitage was dominated by core (57%) over biface reduction (43%). The flake:biface ratio is 173:1 which suggests preform reduction, based on comparison with the Monterey chert replication experiment. This ratio, in combination with the biface fragments and prevalence of biface reduction flakes, suggests that only certain stages of reduction took place at this location, and that these activities were dominated by biface reduction. Some core reduction took place as well, however. Cores and bifacial preforms were probably brought to the site where they were partially reduced.

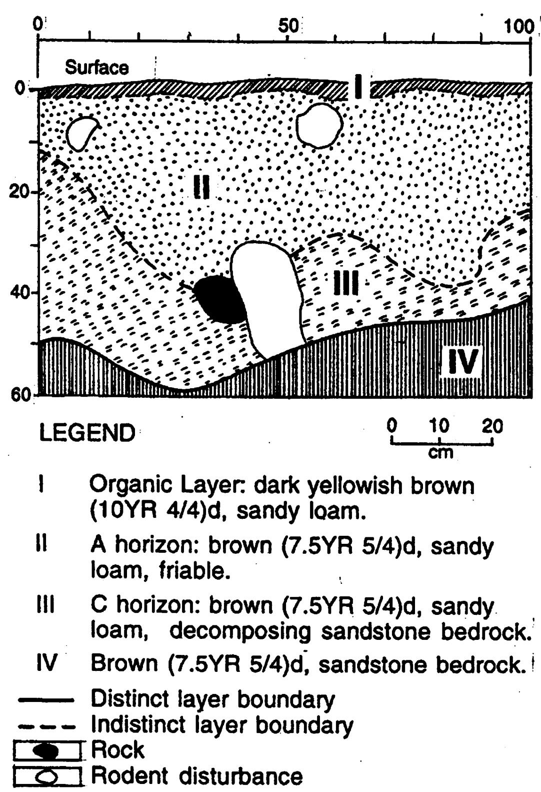


Figure 87 Sidewall Profile, CA-MNT-1657

CA-MNT-1672

Situated on a knoll at an elevation of 400 m (1320 ft) above Stony Creek, CA-MNT-1672 was a sparse scatter of Monterey chert debitage and a single handstone. A trench (20 m in length, 1 m wide, 1 m deep) was cut through the deposit by the military prior to its identification in 1993. Field investigation in 1995 included a systematic surface collection, and excavation of a series of surface transect units, shovel probes, and two 1 x 2 m units (Figure 88). The test excavation revealed two horizons: an A horizon composed of a medium brown (10 YR 4/3) coarse sandy loam between the surface and approximately 45 cm, and a C horizon between 45 and 80 cm, consisting of brown (10 YR 4/6) sandy loam with a high proportion of decomposing rock (Figure 89). No shell, bone or other prehistoric organic debris was present. PH tests showed that the soil was slightly acidic.

Recovered from the deposit were: four projectile points, five bifaces, one core tool, three cores, 709 pieces of debitage, and one handstone. Two of the projectile points that were complete enough to assign to type were Rossi Square-stemmed examples, suggesting that the deposit dates to the Early Period. The debitage was dominated by core-flake debris, suggesting the site was associated with a nearby, but as yet unidentified, source of Monterey chert. This assemblage is obviously not very large, but the handstone and flaked stone materials suggest it functioned as some type of temporary residential base.

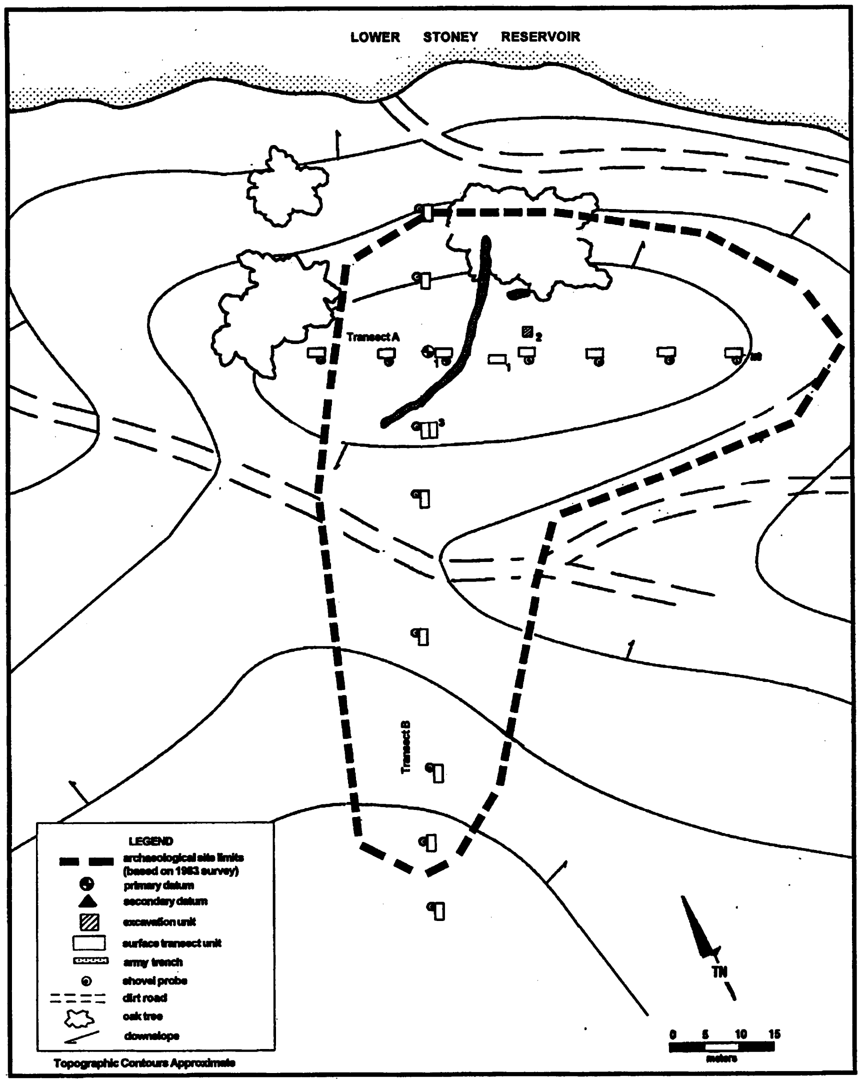


Figure 88 Site Map, CA-MNT-1672

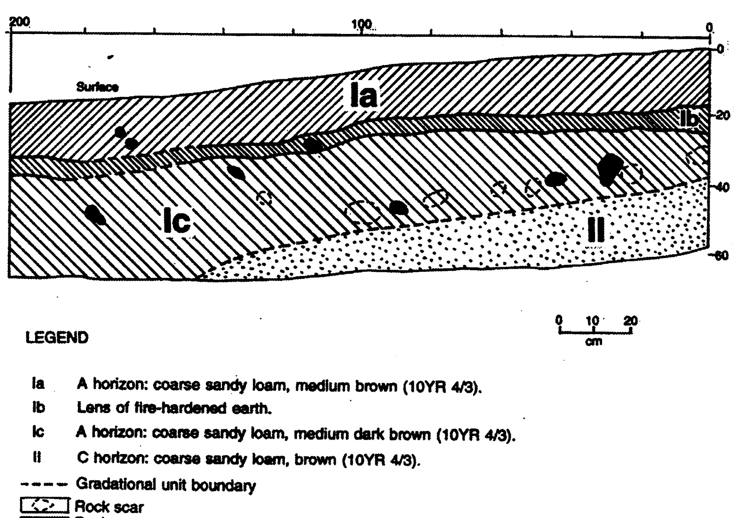


Figure 89 Sidewall Profile, CA-MNT-1672

CA-MNT-1754

Field work at CA-MNT-1754 was undertaken in 1995 as part of a program sponsored by Fort Hunter-Liggett to investigate low density/low visibility sites. The deposit was a light scatter of chert debitage from which a total of 4.9 m^3 of soil was excavated (Figure 90). No midden was apparent, and cultural materials were generally limited to flaked stone items which were found in a matrix of very dark brown sandy loam (Figure 91). Organic preservation was very poor, but a fragment of deer bone was submitted for radiocarbon analysis. The specimen was so small that organic residue used for dating was not restricted to collagen. It yielded a corrected date of A.D. 1440. Because the sample's composition was not limited to collagen, there is reason to question its accuracy. In addition to this one date, the site produced two contracting-stemmed projectile points, one point fragment, five biface fragments, four cores, one flake tool, 1,157 pieces of debitage, and 67 bone fragments. Four of the latter represented black-tailed deer. Based on the contracting-stemmed point and lack of arrow points, the site was thought to be older than what was suggested by the radiocarbon result, and was interpreted as a Middle/Late Transition component.

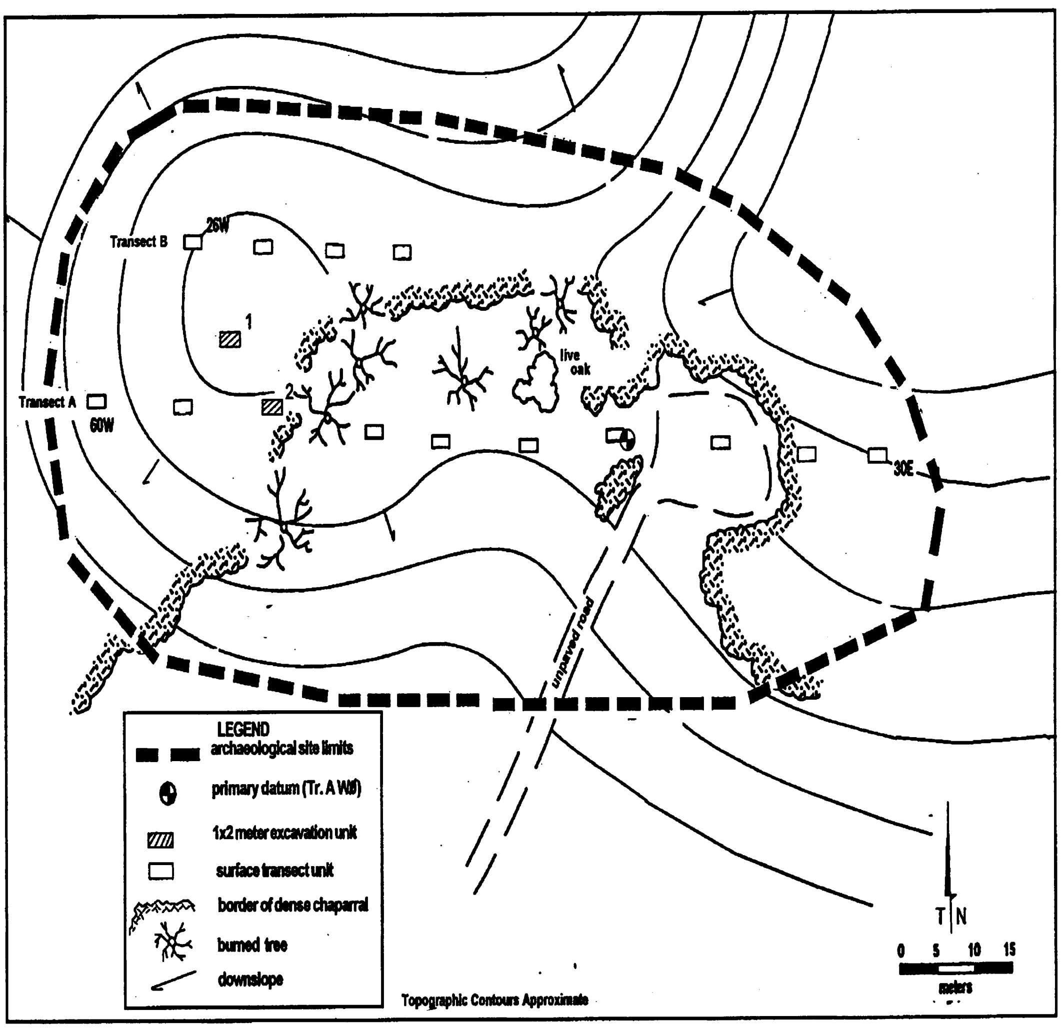
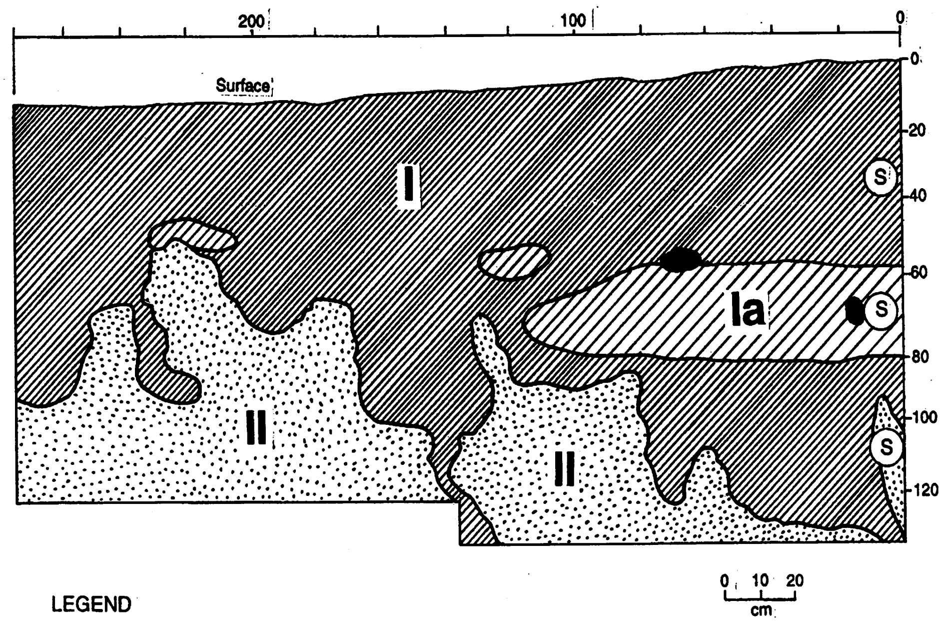


Figure 90 Site Map, CA-MNT-1754



LEGEND

I	A horizon: sandy loam, very dark brown (10YR 2/2).
Ia	Sandy loam, dark brown (10YR 3/3).
II	C horizon: decomposing granite, dark yellowish brown (10YR 4/6).
[hatched]	Mottled areas
[rock symbol]	Rock
S	Soil samples taken

Figure 91 Sidewall Profile, CA-MNT-1754

CHAPTER 7: CULTURAL HISTORICAL SYNTHESIS

Because so little research was previously completed in the Big Sur area, development of a basic temporal/cultural framework was a high priority at the onset of the project. Most of the cultural historical implications of the findings from the coast were summarized in 1993 (Jones 1993). Projectile point and bead types defined in that work were referred to in the presentation of site data in chapters 5 and 6. Excavation data from the interior, however, were unavailable at the time of the 1993 synthesis, and the following represents a slightly improved cultural chronology that incorporates findings from interior sites within Fort Hunter Liggett obtained between 1994 and 2000.

Sample sizes varied from the study sites, making the findings from some locations considerably more important than others. Chronological placement was also more certain for some sites (e.g., those with larger recovery volumes, good radiocarbon profiles, and bead assemblages), than for others. Virtually all investigated sites showed evidence of disturbance from ground burrowing animals, and, as a consequence, vertical stratigraphy (with a few important exceptions) was unreliable for distinguishing temporal components. Fortunately, many sites proved to be single-component while others were horizontally stratified. Radiocarbon results and shell beads indicated good component integrity at most locations. On the coast, all sites were dated with radiocarbon, and most also produced shell beads. Ten coastal sites were single-component: CA-MNT-73, -759/H, -1223, -1227, -1228, -1233, -1235, -1236, -1942, and CA-SLO-267); two were stratified with multiple components (CA-MNT-63 and -1232/H); and one was multi-component and mixed (CA-MNT-1277/H). The mixed deposit provided some information because it was occupied for only a relatively short period from approximately A.D. 800 to 1830. Most of the items recovered from that location reflected occupation between A.D. 1500 and 1769. On the interior, seven sites were dated chronometrically (with radiocarbon and/or obsidian hydration), while five others were cross-dated using projectile point types. Of the seven interior sites that produced radiocarbon dates, six were essentially single component (CA-MNT-332, -361, -519, -521, -879, and –1754), and one, CA-MNT-569 was multi-component and horizontally stratified. In total, the coastal sites represent 19 temporal components while the interior produced 14. These components represent occupations dating between 4400 B.C. and A.D. 1810 both on the coast and in the interior.

DEFINITIONS

A long history of varied usage in central California makes it necessary to define nomenclature before discussing the local chronological sequence. Cultural historical taxonomy employed below is essentially a compromise between systems employed in adjacent regions. Two terms are emphasized: *Period* and *Phase*. Period is employed exclusively as a temporal unit, following the definition developed by Fredrickson (1973:112, 1994). Absolute dating of periods is both approximate and somewhat arbitrary, but the importance of this construct is that it allows for time to be held constant, facilitating inter-regional comparisons. Periods were identified in Table 12 in Chapter 5 and were used to structure the data presented in chapters 5 and 6. Since no Paleoindian occupation was identified, seven periods are represented so far in the Big Sur area. The local sequence is composed of six phases framed against these periods. The definition of phase follows Willey and Phillips:

> An archaeological unit possessing traits sufficiently characteristic to distinguish it from all other units so conceived, whether of the same or other cultures or civilizations, spatially limited to the order of magnitude of a locality or region and chronologically limited to a relatively brief interval of time (Willey and Phillips 1958:22)

As employed here, phases constitute locally identified assemblages of artifact types that cluster temporally.

CULTURAL SEQUENCE

The earliest occupations were represented at the base of CA-SLO-1232/H (Stratum II) and by a single unassociated radiocarbon date from CA-MNT-521 (Figure 92). Substantial Early Period components were identified at CA-MNT-73, -569A, and -1228. The Middle Period was represented at CA-MNT-63, -332, -521, CA-SLO-267C, and by materials reported from CA-MNT-282 (Pohorecky 1976). Middle/Late transition components were identified at CA-MNT-1233 and -1754. Late Period sites included CA-MNT-759/H and CA-MNT-1235, occupied prior to A.D. 1500; CA-MNT-569B and 1236 occupied A.D. 1500-1750 (the Protohistoric Period); and CA-MNT-1223 (A.D. 1250-1700), CA-MNT-1227 (A.D. 1300-1750), and CA-MNT-1942 (A.D.1280-1810). An important Late-Protohistoric Period component was identified in the interior at CA-MNT-879. Late Period materials were also recovered from CA-MNT-1232/H (Stratum I), and CA-MNT-1277/H. Most materials from CA-MNT-1277/H dated to the Protohistoric Period. The Historic Period was best represented by Feature 1 at CA-MNT-63, and at CA-MNT-361. Historic materials were also evident at CA-MNT-1277/H in mixed context.

Combined with the findings from Willow Creek, the data from Big Sur and Fort Hunter-Liggett have been used to define six local phases. A seventh phase (Arbuez) discussed in the preliminary synthesis (Jones 1993) has been relegated to provisional status. Throughout much of the early portion of the sequence, artifact change is largely additive in nature, as new technologies and types appeared, but older styles seem to have persisted. Typological continuity was particularly evident for the period between 3500 B.C. and A.D. 1250.

Millingstone Period: Interpretive Phase

This phase was provisionally defined on the basis of CA-MNT-1232/H Stratum II. A radiocarbon date of ca. 4300 B.C. from CA-MNT-521 probably also marks this phase, but no artifacts were associated with the date, and no component was defined. While the excavation volume from CA-MNT-1232/H was small, the component was stratigraphically discrete. It was highlighted by the absence of mortar/pestles and a paucity of flaked stone tools. Marked by handstones, a millingslab, a lanceolate projectile point, and barrel *Olivella* (B3a and B3b) beads, the assemblage is consistent with those reported from contemporaneous contexts to the south (Figure 93). The point and handstones correlate with Rogers' (1929) Oak Grove, while the beads are consistent with C. King's (1982, 1990) Early Period types. None of the artifacts representing the Interpretive Phase are restricted to pre-3500 B.C. contexts; later phases simply add to the Millingstone inventory, albeit affecting major changes in the relative frequency of certain classes (e.g. ratios of ground stone tools to flaked stone).

The tools marking the Interpretive Phase are typical of the California Milling Stone Culture, first defined in the southern part of the state (Rogers 1929; Wallace 1955) and long thought to be restricted to areas south of Point Conception. Findings from the last decade, however, from sites like CA-SCL-65 (Fitzgerald 1993), CA-SCR-177 (Cartier 1993b), CA-FRE-61 (McGuire 1995), CA-SLO-1756 (Fitzgerald 1997), CA-SLO-1797 (Fitzgerald 1998, 2000), and CA-LAK-1682 (Rosenthal et al. 1995) show that the Milling Culture was present throughout much of central and northern California during the early Holocene. The findings from CA-SLO-1797 at Cross Creek further show that the Millingstone Culture was present in central California by 8300 B.C. (Fitzgerald 2000; Jones et al. 2002).

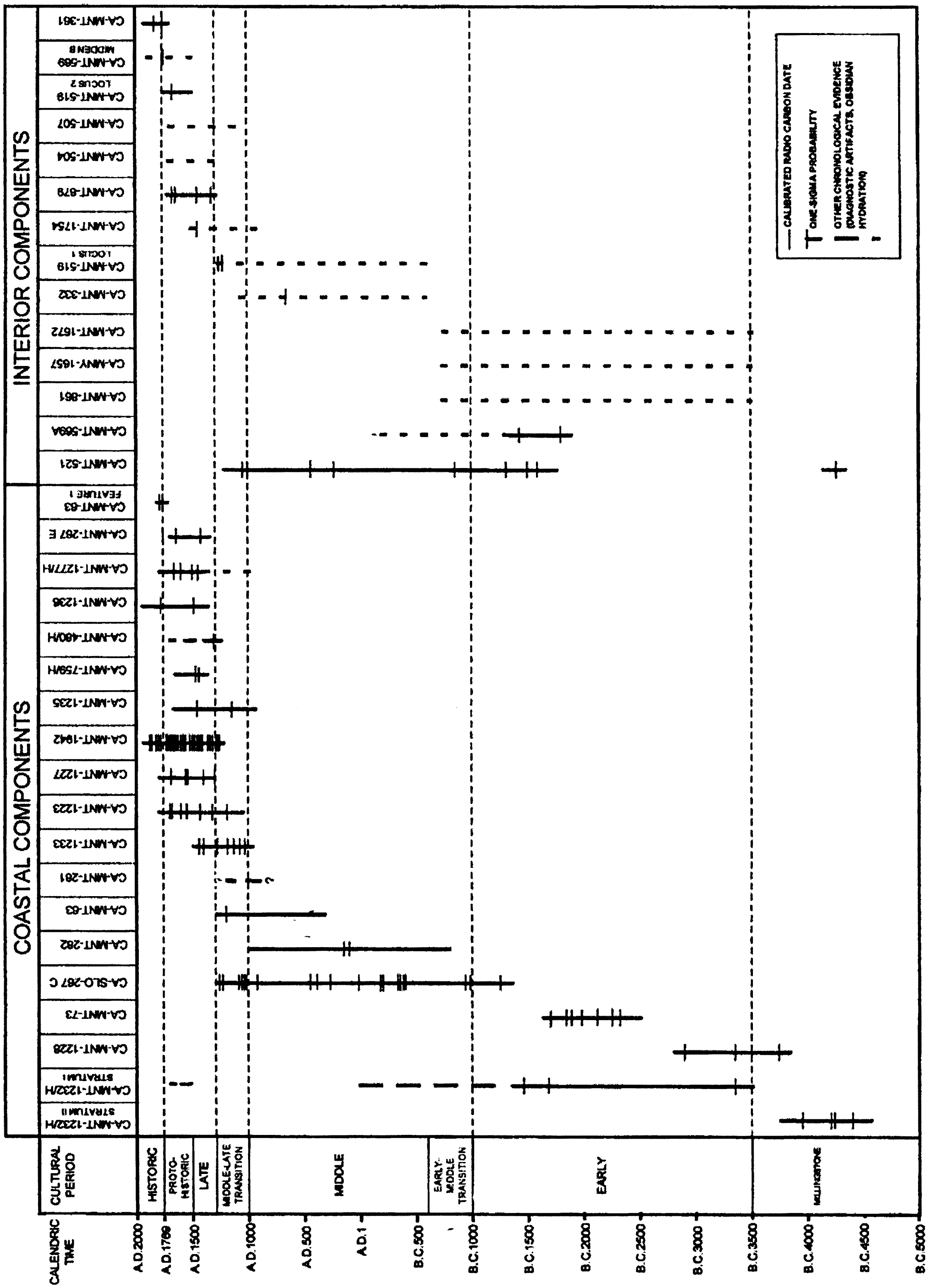


Figure 92 Summary of Site Chronologies

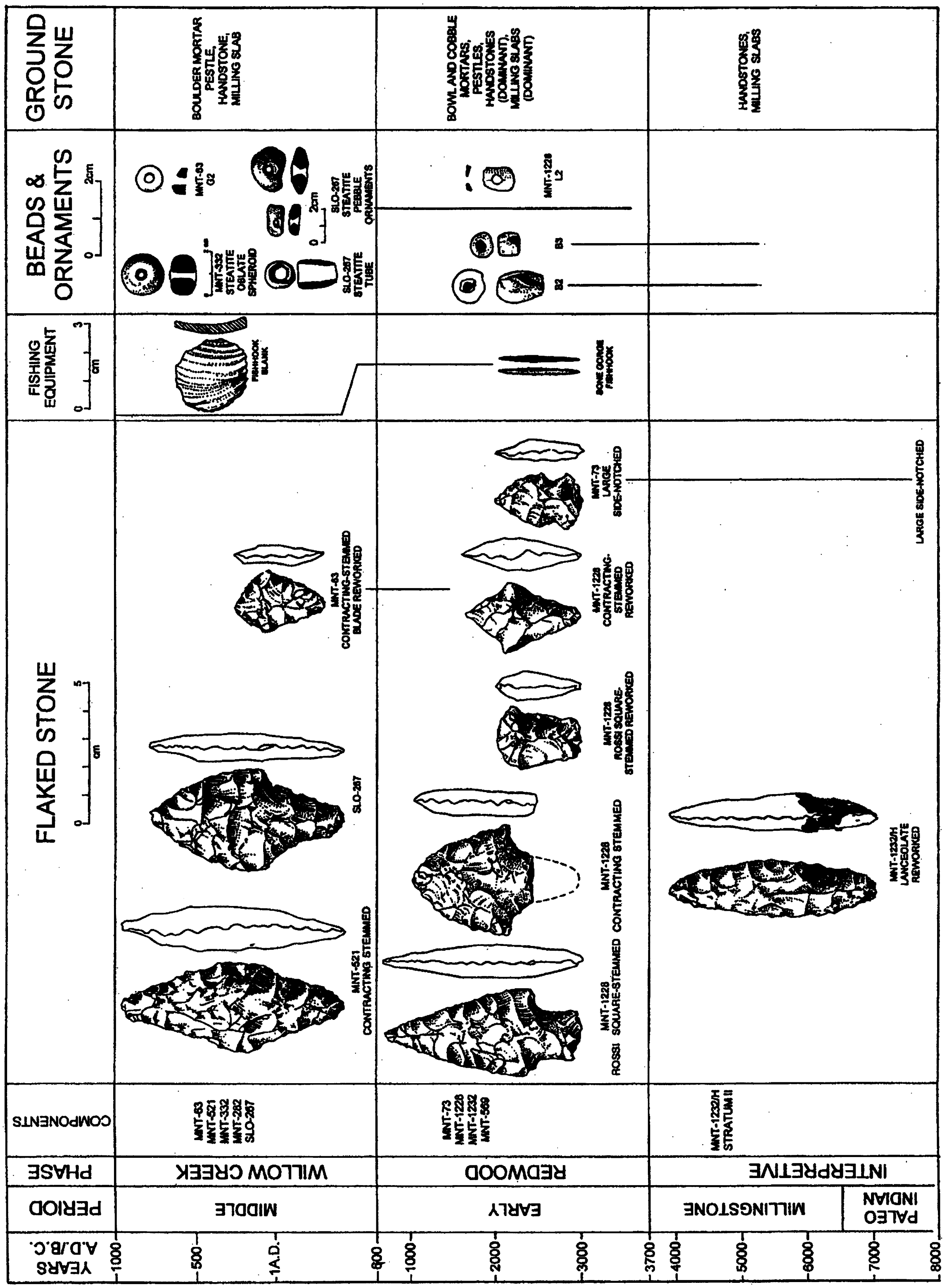


Figure 93 Culture History for the Big Sur District: Millingstone through Middle Period

Findings reported by Fitzgerald (1997) from CA-SLO-1756, the Salinas River Crossing Site, near Santa Margarita 50 km south of Fort Hunter Liggett represent more significant local expressions of the Milling Stone culture. Excavated in 1995, the site produced five milling slabs, eight shaped and fourteen unshaped handstones, four hammerstones, three smoothing stones, a bi-pitted stone, five large side-notched projectile points, four bifaces, a knife, a cobble chopper, twenty-four cores, six hundred pieces of debitage, and three flake tools. Datable organic samples were not abundant, and the site was also impacted by bioturbation. The large side-notched projectile points represent a type that was formerly thought to post-date 3500 B.C. (see Jones 1993), but it has been repeatedly recovered from older Milling Stone contexts in San Luis Obispo County. A similar inventory was recovered from CA-SLO-1797 near Arroyo Grande (Fitzgerald 2000). Based on these findings, it appears that a south central California variant of the southern California Milling Stone Horizon is marked by milling slabs, handstones, crude core and flake tools, and side-notched and lanceolate projectile points. It dates from 8000-3500 B.C.

Early Period: Redwood Phase

This phase is based on data from CA-MNT-73, CA-MNT-569A, and CA-MNT-1228 (Table 14, Figure 92), from which good samples with strong temporal cohesiveness were obtained. The phase is marked by the initial appearance of contracting-stemmed and square-stemmed projectile points, mortars, and pestles. Milling slabs and handstones, holdovers from the Millingstone Period, dominate the ground stone implements. Many of these artifacts are relatively formal and well made; milling slabs show only one used face but were shaped on the exterior surface, as were the mortars. Shell beads were not abundant, but types (Class L thick rectangles and Class B barrels) are consistent with those found in Early contexts in the Monterey Bay area (Dietz 1991; Cartier 1993a) and the Santa Barbara Channel (C. King 1982). A new variant of Class L, the Trapezoid Thick Rectangle (L4), is associated with this phase, although the single example was recovered from the mixed zone at CA-MNT-1232/H. A clam shell disk bead found at CA-MNT-521 was directly dated to 1447 B.C., and apparently marks the Early Period as well. Clam shell disks occur in Early contexts in the Santa Barbara Channel (King 1990). Fishing related artifacts were more common than during the Millingstone Period, and included bone gorges and notched net sinkers, which persisted into later phases.

Middle Period: Willow Creek Phase

Important single-component Middle Period deposits were identified at CA-MNT-63, -282, -521, and CA-SLO-267 (Table 15). Samples recovered from CA-MNT-521 and CA-SLO-267 were substantial, and an equally large artifact inventory was reported previously from CA-MNT-282, the Willow Creek Site. CA-SLO-267 was instrumental in definition of the Little Pico II Phase on the northern San Luis Obispo coast, but there appears to be no discernable differences between Willow Creek and Little Pico Creek Phase II in most of the cultural inventory. The majority of materials from CA-MNT-282, particularly large stemmed points, reflect continuity from earlier phases. An important innovation was the shell fishhook (abalone and mussel), the dating of which is consistent with the Santa Barbara Channel and most other areas, although hooks may have appeared ca. 1000 years earlier on San Clemente Island (Mark Raab, personal communication, 1994). Milling slabs and bowl mortars continued to be used. Because sediments were not screened, a shell bead assemblage is lacking from CA-MNT-282, but limited bead inventories from CA-MNT-63 and CA-SLO-267 indicate that *Olivella* saucer variant G2 (Bennyhoff and Hughes 1987) was characteristic which is consistent with the Middle Period in the Santa Barbara Channel (C. King 1982) and the Sacramento Valley (Bennyhoff and Hughes 1987).

Middle-Late Transition: Highland Phase

This phase was best represented by materials from CA-MNT-1233, the Highland Site (Table 16, Figure 94). Findings from CA-MNT-281 reported by Pohorecky (1976) are also important, although exact dating of that deposit has not been established. Typological continuity is evident for this phase, particularly for projectile points, which show retention of large stemmed types from the Redwood Phase. Ground stone also shows general continuity, although the hopper mortar seems to occur for the first time. No hopper mortars have been found at Big Sur sites in pre-A.D. 1000 contexts. This is consistent with

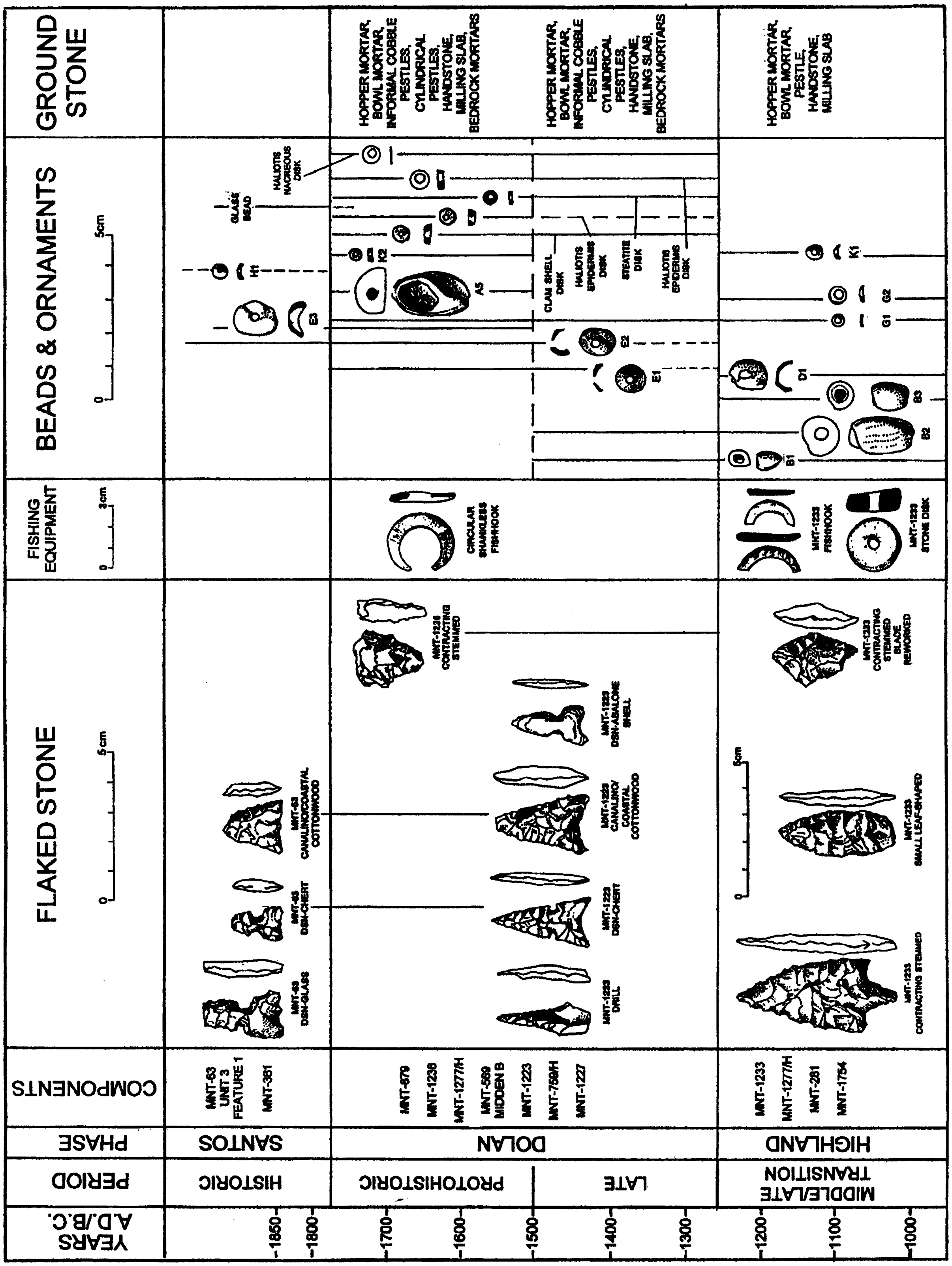


Figure 92 Culture History for the Big Sur District: Middle-Late Transition to Historic Contact

Table 14 Assemblage Summaries: Millingstone and Early Periods

Artifact	CA-MNT-1232/H 4400-3300 B.C. Stratum II Interpretive Phase	CA-MNT-1228 3700-2900 B.C. Redwood Phase	CA-MNT-73 2300-1700 B.C. Redwood Phase	CA-MNT-569 A 1500 B.C.- A.D.1 Redwood Phase
Olivella A1	1	2	0	0
Olivella B3	2	1	0	0
Olivella L2	0	1	1	0
Subtotal	3	4	1	0
Contracting-stemmed	0	8	5	37
Square-stemmed	0	2	2	11
Side-notched	0	0	3	4
Lanceolate	1	0	0	0
Concave base	0	0	0	1
Indeterminant	1	2	1	26
Subtotal	2	12	11	79
Pestles	0	1	5	1
Hopper mortars	0	0	0	0
Bowl mortars	0	1	1	0
Handstones	5	2	8	19
Milling slabs	2	4	6	1
Pitted stones	0	0	12	5
Stone spheres	0	0	0	0
Net weights	0	0	1	0
Anvils	0	0	1	0
Hammerstones	2	2	5	1
Steatite pendants	0	2	0	0
Steatite pendant blanks	0	1	0	0
Subtotal	9	13	39	27
Bone awls	0	1	1	8
Bone gorges	0	2	0	0
Antler tines	2	1	0	0
Bone pendants	1	0	0	0
Subtotal	3	4	1	8
Grand total	17	33	52	114

Table 15 Assemblage Summaries: Middle Period

Artifact	CA-MNT-63 A.D.1-1200	CA-MNT-521 1500 B.C.-A.D. 1000	CA-MNT-282 A.D. 1-1000 Late Middle	CA-SLO-267 C2 1000 B.C. - A.D. 1200	CA-MNT-332 1000 B.C.-A.D.1000	CA-MNT-519	Total
Olivella A3	0	0	0	1	0	0	1
Olivella A4	1	0	0	0	0	0	1
Olivella B2	0	0	0	4	0	0	4
Olivella B3	0	0	0	2	0	0	2
Olivella K1	0	0	0	1	0	0	1
Olivella G1	1	0	0	2	0	0	3
Olivella G2	2	0	0	3	0	0	5
Olivella G5	0	0	0	1	0	0	1
Haliotis cCA2j	1	0	0	0	0	0	1
Steatite disks*	0	1	0	0	0	0	1
Clam shell disks	0	1	0	0	0	0	1
Limpet rings	0	0	0	3	0	0	3
Subtotal	5	2	0	17	0	0	24
Fishhooks	1	0	0	1	0	0	2
Fishhook blanks	1	0	0	3	0	0	4
Scrapers	1	0	0	0	0	0	1
Shells w/asphaltum	1	0	0	0	0	0	1
Subtotal	4	0	0	4	0	0	8
Contracting-stemmed	1	42	20	27	4	20	114
Square-stemmed	0	12	0	1	1	7	21
Concave base	0	0	1	2	0	0	3
Large side-notched	1	5	0	1	1	2	10
Leaf-shaped	0	1	0	1	0	0	2
Desert Side-notched	0	0	0	1**	0	0	1
Indeterminant	2	22	0	18	3	18	63
Subtotal	4	82	21	51	9	47	214
Pestles	1	1	2	15	0	0	19
Hopper mortars	0	0	0	0	0	0	0
Bowl mortars	0	4	0	2	1	0	6
Handstones	1	12	0	0	2	5	20
Milling slabs	3	8	0	0	1	3	15
Pitted stones	0	6	1	258	1	0	266
Stone spheres	0	1	0	0	0	0	1
Stone disks	0	0	0	0	0	0	0
Net weights	0	0	6	11	0	0	17
Hammerstones	2	3	8	40	1	3	57
Steatite pendants	0	1	0	9	1	1	12
Abrading stones	0	0	1	0	0	0	1
Tarring pebbles	0	0	1	5	0	0	6
Slate pencil	0	0	0	1	0	0	1
Subtotal	7	37	17	341	7	12	421
Bone awls	1	11	0	3	0	5	20
Bone awl/gorges	0	0	0	8	0	0	8
Bone awl/pins	0	0	0	2	0	0	2
Bone whistles	0	0	1	0	0	0	1
Bone strigils	1	0	0	0	0	0	1
Bone gorge hooks	0	0	0	12	0	0	12
Antler tines	0	1	3	0	0	0	4
Subtotal	2	12	4	25	0	5	48
Grand total	22	133	42	438	16	47	698

*Formerly classified as talc-schist
**Not temporally consistent with rest of component

Table 16 Assemblage Summaries: Middle/Late Transition Period

Artifact	CA-MNT-281	CA-MNT-1233 A.D. 1000-1400	CA-MNT-1754 A.D. 1000-1400	Total
Olivella A3	4	0	0	4
Olivella B2	0	1	0	1
Olivella B3	0	2	0	2
Olivella K1	0	1	0	1
Olivella G1	0	6	0	6
Olivella G2	0	3	0	3
Haliotis EB3f	0	1	0	1
Haliotis EB3j	0	1	0	1
Subtotal	4	15	0	26
Fishhooks	1	5	0	6
Fishhook blanks	20	2	0	22
Scrapers	69	1	0	70
Cut shells	112	5	0	117
Subtotal	202	13	0	215
Contracting-stemmed	4	5	2	11
Square-stemmed	0	1	0	1
Leaf-shaped	0	2	0	2
Indeterminant	0	0	0	0
Subtotal	4	8	2	14
Pestles	15	2	0	17
Hopper mortars	4	1	0	5
Handstones	0	1	0	1
Milling slabs	0	1	0	1
Pitted stones	12	0	0	12
Stone spheres	0	1	0	1
Stone disks	4	1	0	5
Net weights	2	0	0	2
Hammerstones	129	0	0	129
Plummet-shaped weight	0	1	0	1
Abrading stones	1	0	0	1
Tarring pebbles	9	0	0	9
Incised slate	21	0	0	21
Subtotal	197	8	0	205
Bone awls	5	3	0	8
Bone whistle	1	0	0	1
Antler tines	10	1	0	11
Subtotal	16	4	0	20
Grand total	423	48	2	473

their chronology in northern California (Fredrickson 1974). There are, however, locations where hopper mortars seem earlier (e.g., the Saratoga Site [Fitzgerald 1993] and possibly the Santa Barbara Channel). Their apparent restriction to later contexts at Big Sur could be a product of the limitations of the present sample. Also marking the phase at both CA-MNT-1233 and CA-MNT-281 were medium-sized (4-7 cm diameter) ground, perforated disks of serpentine or talc schist which probably served as net weights.

Artifacts reported in substantial numbers from CA-MNT-281 but missing from CA-MNT-1233, were small incised slate pieces, generally marked with a chevron pattern. Twenty-one were recovered from CA-MNT-281, but none from CA-MNT-282 (Pohorecky 1976:43, 226). A single example of this unusual artifact was also reported by Howard (1973) from CA-MNT-480/H, only 150 m south of CA-MNT-1233. These objects have also been reported from the Vandenberg coast.

Bead types represented at CA-MNT-1233 include the barrel (B3), tiny Saucer (G1), regular saucer (G2), large end-ground (B2c), and cupped (K1) (Bennyhoff and Hughes 1987). Types A1, B3, G1, and G2 are all consistent with C. King's (1982, 1990) Middle Period in the Santa Barbara Channel, while types B2c and K1 are early Late Period types. The transitional position of the Highland Phase is consistent with the dating of these beads. Although not represented at CA-MNT-1233, a single Split Punched type (D1) from CA-MNT-1277/H is probably also a marker of the Middle/Late Transition. CA-MNT-281 yielded four perforated and spire-lopped *Olivella* (A3). Bennyhoff and Hughes (1987) date this type to Phase 1 of the Late Period in the Sacramento Valley, and their occurrence at CA-MNT-281 appears consistent with that dating.

Late and Protohistoric Sites: Dolañ Phase

Fourteen sites yielded Late and/or Protohistoric materials, eight on the coast (Table 17) and four from the interior (Table 18). Discrete components were isolated at CA-MNT-504, -507, -759/H, -1223, -1227, -1235, -1236, and -1942. In an earlier synthesis of Big Sur culture history, I proposed three phases to cover the A.D. 1250-1830 period: Dolan and Arbuez (both dating A.D. 1250-1650), and Santos (dating A.D. 1650-1830) (Jones 1993). The Dolan Phase, established on the basis of materials from CA-MNT-879 and -1223, includes a suite of well-made shell and stone artifacts, including Desert Side-notched and Canaliño/ Coastal Cottonwood projectile points, punched spire-lopped (A4), applique spire-lopped (A5), end-ground (B2), thin lipped (E1), thick lipped (E2), tiny saucer (G1), cupped (K1), cupped/lipped K1/E1, bushing (K2) *Olivella* beads, mussel shell disk beads, *Haliotis* nacreous disks, *Haliotis* epidermis disks, and steatite or talc schist disk beads. The cupped and saucer beads were hold-overs from the previous phase. Ground stone included the slab hopper mortar, and apparently the bedrock mortar. The Arbuez Phase was based tentatively on materials from CA-MNT-759/H, the Arbuez Boronda Site, and CA-MNT-1227, the Harlan Spring Site. These sites suggested a retention of older flaked and ground stone technologies, and little, if any, adoption of arrow points. Two projectile points from CA-MNT-759/H, a contracting-stemmed and large side-notched, represent larger types that are more common in earlier contexts. Neither of these were found at CA-MNT-1223. Ground stone included handstones and milling slabs. Bead types represented at both MNT-759/H and CA-MNT-1227 were thin (E1) and thick (E2) variants of the Lipped Class (Bennyhoff and Hughes 1987:127). The Santos Phase was defined by materials from CA-MNT-1277/H, where a process of comparative subtraction was used to isolate a distinct assemblage. Projectile points show ongoing emphasis on the Desert Side-notched and Canaliño types with possible ongoing use of the contracting-stemmed. Ground stone included mortars, pestles, hand stones, and milling slabs. Mortars include bowl, cobble, hopper, and bedrock types. Bead types were also difficult to isolate, but included mussel, abalone, clam, and steatite disks, *Olivella* thick lipped (E2), large lipped (E3), bushings (K2), and ground cupped (K4).

Since 1993, re-evaluation of the Late Period data from several of these sites and new radiocarbon dates from CA-MNT-1227 have necessitated rethinking of the Arbuez Phase and revision of the Santos Phase. The occurrence of large points dating ca. A.D. 1400 at CA-MNT-759/H remains intriguing, particularly in comparison with the exclusive occurrence of arrow points at contemporaneous CA-MNT-1223. The sample from CA-MNT-759/H is so small, however, that the absence of arrow points cannot be assured. CA-MNT-759/H and -1227 were thought to represent non-arrow point assemblages, but the debitage from both sites suggests arrow point manufacture. The Santos Phase has been revised based on radiocarbon dates that indicate occupation of CA-MNT-1227 after A.D. 1650 (Table 13).

A more conservative approach to Late Period culture history posits a major cultural transition ca. A.D. 1250, marked by the beginning of the Dolan Phase, and a subsequent transition to the Santos Phase at the beginning of the Historic Period at A.D. 1769. Desert Side-notched and Canaliño/Coastal

Table 17 Assemblage Summaries: Late, Protohistoric, and Historic Periods (coastal sites)

Artifact	CA-MNT-1235 A.D.1100-1500	CA-MNT-759/H A.D.1450-1500	CA-MNT-1223 A.D.1250-1700	CA-MNT-1227 A.D.1300-1750	CA-MNT-1236 A.D.1500-1750	CA-MNT-1277/H A.D.1500-1830	CA-MNT-63 Feature A.D.1800-1816	Total
Glass beads	0	0	0	0	0	1	30	31
Olivella A4	0	0	3	0	0	3	0	6
Olivella B2	0	0	0	0	0	2	0	2
Olivella B3	0	0	1	0	0	1	0	2
Olivella E1	1	1	11	1	0	3	0	17
Olivella E2	0	2	6	1	0	2	1	12
Olivella H1	0	0	0	0	0	0	8	8
Olivella G1	0	0	0	1	0	2	0	3
Olivella G2	0	0	1	0	0	0	0	1
Olivella K1	0	0	5	0	0	21	0	26
Olivella K2	0	0	0	0	0	3	0	3
Olivella K/E	0	0	0	0	0	1	0	1
Olivella K4	0	0	0	0	0	1	0	1
Haliotis epidermis disk	0	0	0	0	0	2	1	3
Clam shell disk	0	0	1	0	0	3	0	4
Steatite disk	1	0	8	0	0	12	0	21
Mytilus bead blank	0	0	0	0	0	1	0	1
Steatite spheroid	0	0	0	0	0	3	0	3
Subtotal	2	3	36	3	0	61	40	145
Fishhook	0	0	1	2	0	1	0	4
Fishhook blank	0	0	1	1	0	1	0	3
Worked shell	0	0	1	1	0	0	0	2
Pendant blank	0	0	12	0	0	1	0	13
Bipointed hook	0	0	0	1	0	0	0	1
Subtotal	0	0	15	5	0	3	0	23
Corner-notched	0	0	0	0	0	1	0	1
Desert Side-notched	2	0	13	0	1	6	3	25
Coastal Cottonwood	1	0	3	0	2	3	2	11
Contracting-stemmed	0	1	0	0	2	3	0	6
Square-stemmed	0	0	0	0	0	1	0	1
Large side-notched	0	1	0	0	0	2	0	3
Subtotal	3	2	16	0	5	16	5	47
Pestle	2	0	0	4	1	10	1	18
Hopper mortar	1	0	1	1	0	1	0	4
Bowl mortar	0	0	0	0	0	1	1	2
Bedrock mortars	0	0	0	0	0	2	0	2
Handstone	0	3	1	1	1	6	0	12
Milling slab	0	1	0	0	1	1	1	4
Pitted stone	1	0	0	0	0	0	0	1
Stone sphere	0	0	3	0	0	0	0	3
Notched net weight	0	0	0	0	0	2	0	2
Plummet net weight	0	0	0	1	0	0	0	1
Anvil	0	0	0	1	0	2	0	3
Hammerstone	1	0	1	1	1	3	1	8
Notched hammerstone	1	0	0	0	0	0	0	1
Polished pebble	0	1	0	0	0	0	0	1
Elongate schist object	0	0	1	0	0	0	0	1
Steatite pendant	0	0	1	0	0	0	0	1
Cobble w/asphaltum	0	0	0	1	0	0	1	2
Subtotal	6	5	8	10	4	28	5	66
Bone awl	1	0	5	3	0	3	0	12
Antler tine	0	0	0	1	0	0	0	1
Bone flaker	0	0	0	1	0	0	0	1
Bone needle	0	0	0	0	0	1	0	1
Bone tube	0	0	0	0	0	1	0	1
Subtotal	1	0	5	5	0	5	0	16
Grand total	12	10	80	23	9	113	50	297

Table 18 Assemblage Summaries: Late, Protohistoric, and Historic Periods (inland sites)

Artifact	CA-MNT-504 Late Period	CA-MNT-507 Late Period	CA-MNT-569B Protohistoric Period	CA-MNT-879 A.D. 1300-1650	CA-MNT-361 Historic Period	Total
Glass bead	0	0	1	0	0	1
Olivella A5	0	0	0	1	0	1
Olivella B1	0	0	0	1	0	1
Olivella B2	0	0	0	8	0	8
Olivella B3	0	0	1	0	0	1
Olivella E1	0	0	0	22	0	22
Olivella E2	0	0	0	6	0	6
Olivella E3	0	0	0	2	0	2
Olivella G1	0	0	1	1	0	2
Olivella G2	0	0	0	1	0	1
Olivella H1	0	0	1	0	0	1
Olivella K1	0	0	0	22	0	22
Olivella K2	0	0	0	1	0	1
Steatite disk	0	0	3	22	0	25
Haliotis epidermis disk	0	0	0	2	0	2
Haliotis nacreous disk	0	0	0	6	0	6
Clam shell disk	0	0	0	1	0	1
Mytilus disk	0	0	0	1	0	1
Bird bone bead	0	0	0	1	0	1
Subtotal	0	0	7	98	0	105
Drilled clam shell tube or pipe	0	0	0	1	0	1
Subtotal	0	0	0	1	0	1
Desert Side-notched	2	0	1	8	0	11
Coastal Cottonwood	1	0	3	4	0	8
Contracting-stemmed	0	1	4	4	0	9
Square-stemmed	0	0	1	0	0	1
Subtotal	3	1	9	16	0	29
Pestle	1	6	2	5	1	15
Bowl mortar	0	0	0	2	0	2
Bedrock mortars	8	14	58	0	4	84
Handstone	0	0	1	6	0	7
Milling slab	0	0	1	0	0	1
Pitted stone	0	0	1	0	0	1
Hammerstone	0	2	1	8	0	1
Notched stone	0	0	1	0	0	1
Cobble w/asphaltum	0	0	1	0	0	1
Subtotal	9	22	66	21	5	123
Bone awl	0	0	1	5	0	6
Bone gorge	0	0	0	1	0	1
Bone whistle	0	0	0	1	0	1
Antler tine	0	0	1	0	0	1
Subtotal	0	0	2	7	0	9
Grand total	12	23	84	143	5	267

Cottonwood arrow points mark the beginning of the Dolan Phase, but the archaic stemmed types may have persisted in very low frequency, as demonstrated by an example found at Mission San Antonio (Hoover and Costello 1985:26), and others from CA-MNT-879 and -1236. The Dolan Phase, identified at CA-MNT-1223, and substantiated by findings from CA-MNT-759/H, -879, -1227, -1235, and -1236, is marked by a co-occurrence of items persisting from the Middle/Late transition--large contracting-stemmed points, the hopper mortar, handstone, and milling slab, circular shell fishhooks, *Olivella* B2, B3, G1, G2, and K1 beads--with a series of new items: Desert Side-notched and Canaliño/Coastal Cottonwood projectile points, finely-made drills, E1 and E2 *Olivella* beads, clam shell disk, steatite beads, and *Haliotis* epidermis disk beads. Both C. King (1982:360) and Bennyhoff and Hughes (1987:127) ascribe lipped *Olivella* beads (Class E) to post-A.D. 1500 contexts, but the possibility of their occurrence earlier has been raised (Arnold 1987). Strict Protohistoric dating may eventually be confirmed, but this type was found at every site with a Late occupation, including two - CA-MNT-759/H and CA-MNT-1235 - where occupation apparently terminated at A.D. 1500. For the time being, E1 beads are considered reliable indicators of the Dolan Phase in Big Sur.

CA-MNT-1277/H, although mixed, was mostly occupied during the Protohistoric Period (i.e., post A.D. 1500). The assemblage is not very different from that of the preceding period, although *Olivella* K2 and K4 beads appear, and B2 and G2 disappear. This assessment is partially based on temporal assignments made by Bennyhoff and Hughes (1987) for the Sacramento Valley, however. *Haliotis* epidermis disks seem to also appear for the first time.

A small but important Dolan Phase component was identified at CA-MNT-1942 (Wolgemuth et al. 2002). The assemblage included a Desert Side-notched point, informal and cylindrical pestles, and a G1 *Olivella* bead. The extensive dating program completed at this site suggests that the Dolan Phase began between A.D.1250 and 1300.

The most important interior site was CA-MNT-879 which confirmed and amplified the Dolan assemblage. This site was not associated with bedrock mortars, but these were well represented at CA-MNT-569B. This component also produced single examples of G1 and B3 beads. Several interior bedrock mortar sites produced crude, unshaped cobble pestles, distinct from the more formal types found in earlier context at CA-MNT-521. Formal, well-made cylindrical pestles were recovered from the Dolan site, however.

Historic Period: Santos Phase

The Historic Period was represented by Feature 1 at CA-MNT-63 and CA-MNT-361. The former, dated by glass trade beads to A.D. 1800-1816, was marked by Desert Side-notched (one made of bottle glass) and Canaliño/Coastal Cottonwood projectile points, *Haliotis* epidermis disk and E2 *Olivella* beads (persisting from the Protohistoric Period), along with H1 *Olivella* beads. Unfortunately, the bedrock mortar outcrop at CA-MNT-361 and associated subsurface features did not yield formal implements. An historic component at CA-MNT-1277/H was not physically discrete.

DISCUSSION

While some consistency through time is apparent in the local cultural sequence, major transitions are also evident ca. 3500 B.C. and A.D. 1250. The Redwood Phase (3500-600 B.C.) marks the first significant change in local assemblages as stemmed points, bowl mortars and pestles appear for the first time along with milling slabs and handstones. The latter persist as hold-overs from the earlier Interpretive Phase, which seems to be a local expression of the California Milling Stone Horizon or Culture. Lanceolate points, marking the Interpretive Phase, disappear during the Redwood Phase. Little typological change is evident through the Early and Middle periods, as projectile point and ground stone tool types show little if any change for 4,500 years. Stemmed points were used throughout this span, although contracting-stemmed variants seem more common during the Middle Period, and square-stemmed types more abundant during the Early Period. Mortars and pestles likewise occur throughout, along with handstones and milling slabs. Only shell beads, which change from rectangular (Class L) to saucer (Class G), and fishing implements, which show initial appearance of circular shell hooks during the Middle Period, changed significantly between 3500 B.C. and A.D. 1000. The Highland Phase, dated to the Middle/Late Transition, also shows retention of many earlier flaked and ground stone types, although small leaf-shaped points, apparent markers of early bow and arrow technology, made their appearance for the first time. Elsewhere (Jones 1993, 2000; Jones and Ferneau 2002), I've used the term, Hunting Culture, as a blanket classification for the uniform assemblages that occur between 3500 B.C. and A.D. 1250 on the central coast. The Dolan Phase marks a more definitive typological and technological shift with some minor continuity suggested by persistence of handstones and milling slabs, circular shell hooks, and occasional contracting-stemmed points.

CHAPTER 8: ARCHAEOLOGICAL/ETHNOHISTORIC FUSION

The radiocarbon record makes it fairly clear that sites linked with ethnohistoric place names date back little earlier than the Middle/Late Transition. Nearly all sites with Late Period components were initially occupied sometime between A.D. 1250 and 1500 (e.g., MNT-504, -507, -569B, -759/H, -879, -1223, -1227, –1236, and -1942). Because of this chronological pattern, Late and Protohistoric components have been combined in this chapter with ethnohistoric information to expand the portrait of settlement and diet introduced in Chapter 3. Historic records, particularly the ethnographic field notes of J. P. Harrington, associate a portion of the archaeological record in the central portion of the study area with places known and used by speakers of Salinan languages. Most of the following discussion pertains directly to those people and that ethnogeographic territory. Three archaeological sites were specifically associated with Salinan place names: CA-MNT-480/H, the village of *Ts'alák'ak'a'*, CA-MNT-1277/H, the village of *Matalcé*, and CA-MNT-1570, the hunting camp, *Tr'acktén*. A fourth, CA-MNT-361, can be tentatively linked with the place known as *Ké* or *Campo de los Piñones* noted by the Portolá expedition in the El Piojo drainage in 1769. Excavation data suggest that CA-MNT-480/H was initially occupied ca. A.D. 1300. CA-MNT-1277/H showed a more complex history of use but was mostly occupied after A.D. 1500. No excavation data are available from CA-MNT-1570, but associated bedrock mortars suggest a Late Period occupation. Radiocarbon dates indicate that CA-MNT-361 was occupied around the time of European contact.

ASSEMBLAGE DIVERSITY, COMPONENT FUNCTION, AND SETTLEMENT

While sites initially occupied after A.D. 1250 showed some variation in size, most were very small, covering less than 2500 m^2 (Table 19). The larger deposits were associated with named villages (CA-MNT-480/H [18,000 m^2] and -1277/H [18,870 m^2]), both of which were located above 550 m elevation, 1.5 km inland. In the case of CA-MNT-1277/H, large size was partially the result of the presence of multiple temporal components. Based on size and presence/absence of constituents, three types of Late Period sites could be recognized among those investigated: large middens (greater than 2500 m^2) associated with village names and/or with evidence of residential structures (e.g. CA-MNT-1227, CA-MNT-1277/H, and CA-MNT-480/H), smaller middens (less than 2500 m^2) (e.g., CA-MNT-569B, -759/H, -879, -1223, -1235, -1236, and 1942), and bedrock mortar outcrops with associated debris (flaked stone, ground stone, faunal or floral remains) (e.g., CA-MNT-361, -504, -507). An additional site type, the bedrock mortar without associated debris, was most likely also a Late Period phenomenon. The largest single-component Late Period deposits were found at CA-MNT-1227 (4135 m^2) and CA-MNT-480/H. The other coastal middens were found in a wider range of locations, between 1 and 866 m elevation, and 0.0-4.2 km inland. In earlier interpretations of the Late Period (e.g., Jones et al 1989; Jones 1995), I emphasized the apparent focus on inland settings, but the recent investigations at CA-MNT-1592 (Hildebrandt and Jones 1998) and es-

Table 19 Summary of Late, Protohistoric, and Contact-era Site Components

Site	Elevation (m)	Area (m^2)	Distance inland (km)	Constituents/ features	Recovery volume (m^3)	No. artifact classes	No. artifacts	Artifacts/ m^3
				LARGE MIDDENS				
CA-MNT-480/H	595	18,000	1.6	Midden	-	-	-	-
CA-MNT-1227	305	4135	0.6	Midden, housefloor, subsurface features	9.0	13	44	4.9
CA-MNT-1277/H	565	18,870	2.0	Midden, BRMs	9.0	16	281	31.3
				SMALL MIDDDENS				
CA-MNT-759/H	350	250	2.4	Midden	2.9	6	12	4.1
CA-MNT-569B	380	360	20.0	BRMs, midden	2.9	16	89	30.7
CA-MNT-879	354	900*	22.0	Midden	14.7	19	206	14.0
CA-MNT-1223	370	1365	0.8	Midden, burials	13.4	16	138	10.3
CA-MNT-1235	125	452	0.4	Midden	2.4	8	15	6.3
CA-MNT-1236	713	981	3.3	Midden	2.0	6	11	5.5
CA-MNT-1571/H	866	2300	4.2	Midden**	-	-	-	-
CA-MNT-1580	872	800	4.3	BRMs**	-	-	-	-
CA-MNT-1942	1	1500	0.0	Midden, burial	8.2	11	22	2.7
				FEATURES WITH ASSOCIATED DEBRIS				
CA-MNT-63	12	2500	0.0	1 subsurface feature	0.4	8	50	125.0
CA-MNT-361	374	2120	21.5	BRMs, subsurface features	2.1	2	5	2.4
CA-MNT-504	459	942	15.0	BRMs, scatter of flaked and stone, faunal remains	3.9	4	13	3.3
CA-MNT-507	445	5105	22.0	BRMs, scatter of flaked and stone	6.2	5	29	4.5
Total					68.9	32	893	12.9

*Midden only.

**These two sites are adjacent to one another and are functionally inter-related.

pecially CA-MNT-1942 (Wolgemuth et al. 2002) show clearly that this early impression was mistaken. Late Period sites do occur along the shoreline of the Big Sur and northern San Luis Obispo coasts (see Hines 1986; Laurie and Jones 2001, among others) although another recent excavation at CA-MNT-1455 produced a Dolan Phase component ca. 2 km inland. The most salient attributes of Late Period sites are their presence as discrete components away from Middle Period sites, and their occurrence, in some instances, far inland at high elevations. The Late Period sites on the coastal flank of the Santa Lucias were the furthest inland and highest elevation (CA-MNT-1236 and CA-MNT-1571/H) of any of the investigated deposits. No pattern could be discerned for Late sites in the interior. All five of the interior Late sites were situated on the edge of the Nacimiento Valley between 374 and 459 m elevation, but their locations did not seem different or unusual relative to other sites in the area although they again tend to occur as discrete single components. All of the interior sites were either small middens or bedrock mortars with associated scatters. Small sites of various kinds in a wide range of settings, including some high in the Santa Lucias, seem to be characteristic of the Late/Contact Period.

Determining the function of individual components and the manner in which they articulated with one another was another matter. The simple assessment of features and constituents used to initially classify sites (Table 19) was supplemented with a statistical evaluation of assemblage diversity to try to isolate possible functional variation. Assemblage diversity was evaluated using the Margalef Index of (Tables 20 and 21) to measure the relative richness of assemblages (i.e., the number of different types of artifacts represented) with some (although not complete) control for sample size (Magurran 1988:11). The underlying assumption in this analysis is that the greater the range of tasks undertaken at a given location, the greater the number of types of tools represented. Higher Margalef scores should reflect greater functional diversity. The Late Period components sorted themselves into three ranges: ≤ 2.00, 2.00-3.00, and > 3.00 (Table 21). Sites in the low range were all features with associated scatters, and the low values are consistent with the limited range of materials present. The highest diversity scores came from both large (CA-MNT-1227) and small (CA-MNT-1223) middens, suggesting that midden size may not be a meaningful index of function.

Given the range of materials recovered from the middens, there can be little doubt that all of them represented residential bases of some type. The diversity scores suggest that the middens could reflect two types of occupations: one where a greater range of tasks was completed (longer-term residential bases) and another where fewer tasks were undertaken (shorter-term residential bases). The small middens probably represent occupations by one or two families (a small band) or a single extended family. Clusters of these small middens may represent village-like communities, in some cases satellites of slightly larger midden/villages where larger groups congregated. In other words, these middens conform with Kroeber's notion of the central California "tribelet" which consisted of:

> ... several settlements -- there might be three or four or five of them --sometimes more or less the same size, but more often one was dominant or permanent, the other more like suburbs of it. They might be situated some miles away. The smaller settlements were likely to be inhabited seasonally, or by certain families only perhaps for a stretch of years, after which their population might drift back to the main settlement (Kroeber 1962:33).

Table 20 Functional Diversity Statistics for Protohistoric, Late and Contact-era Components

Component	Total Artifacts	No. Class	Margalef Index
CA-MNT-879	206	19	3.38
CA-MNT-569B	89	16	3.34
CA-MNT-1942	22	11	3.25
CA-MNT-1227	44	13	3.17
CA-MNT-1223	138	16	3.04
CA-MNT-1235	15	8	2.59
CA-MNT-1277/H	282	16	2.67
CA-MNT-1236	11	6	2.09
CA-MNT-759/H	12	6	2.01
CA-MNT-507	29	6	1.20
CA-MNT-504	13	4	1.17
CA-MNT-63 Feature 1	50	8	1.78
CA-MNT-361	5	2	0.62
Total	634	31*	4.68

*From table 20; not a total; each unique item counted as one class.

Table 21 Late, Protohistoric and Contact-era Tool Assemblages: Functional summary

Artifact	MNT-63	MNT-361	MNT-504	MNT-507	MNT-569B	MNT-879	MNT-759/H	MNT-1223	MNT-1227	MNT-1235	MNT-1236	MNT-1277/H	MNT-1942	Total
Glass beads	30	0	0	0	1	0	0	0	0	0	0	1	0	32
Shell/steatite beads	10	0	0	0	6	129	3	55	4	2	0	87	2	298
Bone beads	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Bead manufacturing detritus	0	0	0	0	0	5	0	0	0	0	0	0	0	5
Projectile points	5	0	3	1	6	24	2	21	0	4	6	17	1	90
Drills	0	0	0	0	1	3	0	8	0	0	0	0	2	14
Bifaces	0	0	1	5	4	5	2	8	5	0	0	88	2	120
Flake tools	0	0	0	1	3	7	1	3	16	0	1	57	2	91
Mortars	1	4	8	14	58	2	0	1	1	1	0	0	1	91
Pestles	1	1	1	6	2	5	0	0	4	2	1	10	5	38
Handstones	0	0	0	0	1	6	3	1	1	0	1	6	2	21
Milling slabs	1	0	0	0	1	0	1	0	0	0	1	1	0	5
Battered cobbls	0	0	0	0	0	0	0	0	0	0	0	0	3	3
Pitted stones	0	0	0	0	1	0	0	0	0	1	0	0	0	2
Steatite pendants	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Anvils	0	0	0	0	0	0	0	0	1	0	0	2	0	3
Stone sphere	0	0	0	0	0	0	0	3	0	0	0	0	0	3
Hammerstones	1	0	0	2	1	8	0	1	1	1	1	2	0	18
Notched stone	0	0	0	0	1	0	0	0	0	0	0	2	0	3
Bone awl s	0	0	0	0	1	5	0	20	5	3	0	4	1	39
Bone tubes	0	0	0	0	0	0	0	0	0	0	0	1	0	1
Bone gorges	0	0	0	0	0	1	0	0	0	0	0	1	0	2
Bone whistles	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Antler tools	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Fishhooks	0	0	0	0	0	0	0	1	3	0	0	1	0	5
Fishhook blanks	0	0	0	0	0	0	0	0	1	0	0	1	0	2
Pendant blanks	0	0	0	0	0	1	0	12	0	0	0	0	0	13
Cut shells	0	0	0	0	0	0	0	1	1	0	0	0	1	3
Shell pendants	0	0	0	0	0	0	0	1	0	0	0	0	0	1
Cobbles w/asphaltum	1	0	0	0	1	0	0	0	1	0	0	0	0	3
Unique	0	0	0	0	0	3	0	1	0	1	0	0	0	5
Total	50	5	13	29	89	206	12	138	44	15	11	281	22	915

Some small middens with lower diversity scores may reflect seasonal encampments by small but diverse social groups (e.g., extended families or bands). CA-MNT-1570, identified as a hunting camp in the Harrington notes, may represent one such residential base. Some of the small middens with mid-range diversity scores (CA-MNT-759/H, -1235, and -1236) may likewise reflect seasonal encampments by diverse groups. Even these apparent encampments showed little, if any, sign of specialized subsistence activities--subsistence residues, discussed in more detail below, showed signs of acquisition of a broad range of resources.

Low diversity scores for the non-midden sites support the inference that their functions were different from those marked by the middens. This is particularly true for the two components that consisted only of features (CA-MNT-63 and CA-MNT-361). The non-midden sites clearly were not occupied intensively or for long periods of time. Nonetheless, most of them produced evidence for a variety of activities, suggesting they functioned as briefly used residential bases. Only CA-MNT-361 produced an assemblage so limited that it seems to reflect non-residential occupation.

FLORAL REMAINS AND PLANT EXPLOITATION

Subsurface features from prehistoric contexts also yielded evidence for plant exploitation. A hearth from CA-MNT-1227 showed evidence for exploitation of acorns and bay nuts, while charred remains from CA-MNT-879 also showed acorn (Table 22). Botanical materials from CA-MNT-1942 were also highlighted by nut remains. The charred remains from both the prehistoric and contact-era features showed a greater representation of nuts over small seeds. From the four features, only seeds of goosefoot (*Chenopodium* sp.) were at all abundant. These findings contrast with those reported by Wolgemuth (1996) from central California where a profusion of small seeds from Late Period contexts was thought to represent an intensified proto-agricultural subsistence mode.

The subsurface hearth features from CA-MNT-361 which yielded evidence for processing and probable on-site consumption of acorns and pine nuts (Table 22) cannot be underestimated in terms of the insights they provide into local settlement systems. This site seems to correlate with the place name of *Ké* or *Campo de los Piñones*, where the Spanish observed a large aggregation of people exploiting pine nuts in September of 1769. The subsurface hearths adjacent to the bedrock mortar outcrop seem to reflect a brief encampment, as pine nuts and acorns were apparently collected, processed and consumed at this spot, rather than being transported to a central village for later consumption. The historic description of a large number of people exploiting pine nuts at this location suggests this site may actually reflect a large aggregation of people for a very short-term encampment. This suggests a more "ad hoc" exploitation of nut crops than is commonly surmised for central California. This less intensive exploitation may reflect the extreme biodiversity of the South Coast Range, in that stands of oaks and pine trees expansive enough to support a large number of people through the winter are nearly non-existent. Oaks in particular are spread out in small numbers across the landscape, intermingled among many different plant communities. Some storage of acorns and other nuts must have taken place, but in this setting, nut crops don't seem to have been concentrated enough to facilitate long-term aggregation of large groups.

In contrast, nut remains from CA-MNT-1942 may reflect a more traditional use of acorns, buckeye nuts, and pine nuts. These remains, meticulously extracted and identified by Wolgemuth et al. (2002), indicate that inhabitants of this shoreline midden were traveling at least 5 km inland to harvest plant foods. Despite its coastal setting, the site seems to have been a base for resource exploitation that was focused inland. Nut crops harvested in the fall were probably stored and used to extend occupation of this site into the winter- at a minimum.

FAUNAL REMAINS, ANIMAL EXPLOITATION, AND DIET

Mammal and bird remains from the Late Period showed a decided emphasis on terrestrial taxa. From a total of 507 identified elements from the coastal sites, 487 (96.1%) represented terrestrial animals (Table 23). The most important resources were deer (399 elements 78.7%) on the coast and cottontail rabbits in the interior (36.4%). Sea otter remains were abundant only at CA-MNT-63 in post-contact context, where they accounted for 25 of 63 (39.6%) identified elements. Remarkably, the coastal sites showed evidence for exploitation of only eight species while fourteen species were exploited in the interior. Not surprisingly, the Margalef diversity score for the coast was very low at 1.16; the score for the interior was only 2.29. The combined score for the coast and interior together was 1.98 (Table 24).

Fish remains showed some variability in diversity and density. Many of the pre-contact sites were marked by light accumulations of fish bone, but several, particularly CA-MNT-1942, produced significant amounts of fish bone. The coastal Late

Table 22 Summary of Charred Plant Remains from Late Period and Contact-era Features

Common name	Taxon	Piece	MNT-63	MNT-361	MNT-879	MNT-1227	Total
Bay	*Umbellularia californica*	Nut shell	21	0	0	13	34
Tan oak	*Lithocarpus densiflora*	Acorn	32	0	0	0	32
Oak	*Quercus* sp.	Acorn shell	78	24	267	54	423
		Acorn kernel	0	2	11	0	13
Oak/tan oak	*Quercus* or *Lithocarpus*	Acorn	73	0	0	0	73
Buckeye	*Aesculus californica*	Nut shell	0	11	0	0	11
Gray pine	*Pinus sabiniana*	Nut shell	0	41	6	0	47
Fescue grass	*Vulpia* or *Festuca*	Seed	0	2	0	0	2
Goosefoot*	*Chenopodium* sp.	Seed	0	3	1	90	94
Small vetch	*Lotus* sp.	Seed	0	1	0	0	1
Farewell-to-spring	*Clarkia* sp.	Seed	0	1	0	0	1
Bentgrass type	*Agrostis* or *Muhlenbergia* sp.	Seed	0	0	1	0	1
Fescue	*Festuca* sp.	Seed	0	0	0	1	1
Grass	Graminae	Seed	0	0	0	1	1
Clover	*Trifolium* sp.	Seed	0	2	1	0	3
Bedstraw*	*Galium* sp.	Seed	1	0	0	0	1
Wild heliotrope	*Phacelia distans*	Seed	3	0	0	0	3
Verbena	*Verbena* sp.	Seed	0	1	0	0	1
Lupine	*Lupinus* sp.	Seed	0	1	0	0	1
Aster tribe	Asterae, Asteraceae	Seed	0	0	1	0	1
Chia	*Salvia* spp.	Seed	0	0	1	0	1
Miner's lettuce	*Claytonia perfoliata*	Seed	0	0	1	0	1
Bean	Leguminosae	Seed	0	0	0	1	1
Large Chenopod-type*	*Chenopodium* cf *berlandieri*	Seed	0	0	3	0	3
Tule/Sedge	*Cyperus* or *Scirpus*	Seed	0	0	1	0	1
Total			208	89	294	160	751
No. non-intrusive species			5	9	8	5	21
Margalef index			0.75	1.79	1.20	0.94	3.08

* Most likely intrusive

Table 23 Bird and Mammal Remains from Late and Contact-era Components

Common name	COASTAL SITES MNT-759/H	MNT-1235	MNT-1236	MNT-1223	MNT-1227	MNT-1277/H	MNT-1942	Sub-total	INTERIOR SITES MNT-504	MNT-569B	MNT-879	Sub-total	Grand total
TERRESTRIAL TAXA													
Deer	9	10	32	105	109	96	38	399	1	9	61	71	470
Cottontail rabbit	0	0	0	10	14	5	36	65	0	2	104	106	171
Jack rabbit	0	0	0	0	0	0	0	0	0	1	11	12	12
Wood rat	0	0	0	0	0	0	0	0	0	0	39	39	39
Coyote/dog	0	0	1	0	0	13	0	14	0	1	51	52	66
Tule elk	0	0	0	0	0	0	0	0	0	1	0	1	1
Badger	0	0	0	0	0	0	2	2	0	0	1	1	3
Bobcat	0	0	0	0	1	0	0	1	0	1	1	2	3
Gray fox	0	0	0	1	0	0	0	1	0	0	0	0	1
Black bear	0	0	0	1	0	3	0	4	0	0	0	0	4
Grizzly bear	0	0	0	0	0	0	0	0	0	0	0	0	0
Skunk	0	0	0	0	0	0	0	0	0	1	0	1	1
Weasel	0	0	0	0	0	0	0	0	0	1	0	1	1
Red-tailed hawk	0	0	0	0	0	0	0	0	0	0	1	1	1
Red-shouldered hawk	0	0	0	0	0	0	0	0	0	1	0	1	1
Band-tailed pidgeon	0	0	0	0	0	0	1	1	0	0	1	1	2
Subtotal	9	10	33	117	124	117	77	487	1	18	270	289	776
MARINE TAXA													
Sea otter	0	0	0	1	1	3	13	18	0	0	2	2	20
Harbor seal	0	0	0	0	0	0	0	0	0	0	0	0	0
Northern fur seal	0	0	0	0	0	1	0	1	0	0	0	0	1
Steller sea lion	0	0	0	0	0	0	0	0	0	0	0	0	0
California sea lion	0	0	0	0	0	0	0	0	0	0	0	0	0
Pelican	0	0	0	0	0	0	1	1	0	0	0	0	1
Subtotal	0	0	0	1	1	4	14	20	0	0	2	2	22
Grand total	9	10	33	118	125	121	91	507	1	18	272	291	798

Table 24 Margalef Index Scores for Late and Protohistoric Mammal and Bird Bone Assemblages

Component	NISP	No. species	Margalef index
CA-MNT-759/H	9	1	0.00
CA-MNT-569B	18	9	2.77
CA-MNT-504	1	1	0.00
CA-MNT-879	272	10	1.61
CA-MNT-1223	118	5	0.83
CA-MNT-1227	125	4	0.62
CA-MNT-1235	10	1	0.00
CA-MNT-1236	33	2	0.28
CA-MNT-1942	91	6	1.10
CA-MNT-1277/H	121	7	1.27
Total	798	14	1.94

Table 25 Summary of Fish Bone from Late Period and Contact-era Components

	COASTAL SITES							INTERIOR SITES			
Common name	MNT-759/H	MNT -1223	MNT -1227	MNT -1235	MNT-1277/H	MNT -1942	Sub-total	MNT-569B	MNT -879	Sub-total	Grand total
MARINE TAXA											
Herring	0	0	0	0	0	1	1	0	0	0	1
Pacific hake	0	0	2	0	1	1	4	0	0	0	4
Surfperches	0	8	35	0	3	19	65	0	0	0	65
Pile perch	0	0	0	0	0	1	1	0	0	0	1
Black or striped surfperch	0	0	5	0	0	0	5	0	0	0	5
Prickleback	1	0	2	0	0	15	18	0	1	1	19
Monkeyface prickleback	0	8	4	0	0	4	16	0	5	5	21
Rock prickleback	0	2	16	0	5	20	43	0	1	1	43
Rockfish	0	94	303	6	144	168	715	1	16	17	731
Sculpins	0	0	0	0	0	2	2	0	0	0	2
Rock or kelp greenling	0	6	28	0	15	9	58	1	0	1	59
Lingcod	0	1	9	0	2	2	14	1	0	1	15
Cabezon	0	10	109	0	48	29	196	0	5	5	201
Clinids	0	0	0	0	0	6	6	0	0	0	6
Subtotal	1	129	513	6	218	277	1144	3	28	31	1175
FRESHWATER TAXA											
Sacramento perch	0	0	0	0	0	0	0	0	1	1	1
Sacramento sucker	0	0	0	0	0	0	0	0	1	1	1
Subtotal	0	0	0	0	0	0	0	0	2	2	2
Grand total	1	129	513	6	218	277	1144	3	30	33	1177

Period components produced a total of 1144 fish elements representing 13 taxonomic categories (Table 25). The dominant taxa were rockfish (NISP=715; 62.5%) and cabezon (NISP=167; 17.1%). Some remains of marine fish were recovered from interior sites but in very low numbers. Remains of freshwater fish were limited to one bone each from a Sacramento sucker and Sacramento perch recovered in the interior. A total of 1177 bones was recovered from the interior and coastal sites combined, representing 16 taxonomic categories. The historic feature at CA-MNT-63 produced a total of 77 elements, dominated by cabezon (NISP=37; 48.1%), with 11 taxonomic categories and a diversity score of 2.30.

At most sites, the fish bone yields were not enhanced by micro-processing with 1.5 mm (1/16 inch) mesh, but fine screening did increase numbers significantly at CA-MNT-1277 and CA-MNT-1942. This increase was particularly marked at the latter. At CA-MNT-1227, the fish bone assemblage increased to a total of 2188 elements when the micro-samples were extrapolated to represent the full recovery volume and combined with other (3 mm) samples. This enlarged sample was dominated by black or striped surfperch (NISP=1480; 67.6%) and rockfish (NISP=412; 18.8%). It showed 10 taxonomic classes for a diversity score of 1.18. At CA-MNT-1942, the combined 3mm and extrapolated 1.5 mm samples represented 3506 elements, dominated by anchovies (NISP=1914; 54.6%), rockfish (NISP=378; 10.8%), and rock or black prickleback (NISP=300; 8.6%). Twenty-one taxonomic classes were represented and this was the most diverse of the fish assemblages with a Margalef score of 2.45. The Margalef score for the combined coastal and interior sites was 2.52 (Table 26). The amount of fish bone recovered from CA-MNT-1942 makes it clear that earlier estimations of the relative unimportance of fish in Late Period diets (e.g., Jones 1995) were exaggerated due to the absence of a shoreline component in the previously available sample.

Shellfish assemblages were consistently dominated by the remains of California mussel-both in the interior and on the coast. While some remains of black and red abalone, turban snails, limpets, and chitons were recovered, the only mollusk that was consistently present at all of the Late/Contact era sites was mussel. All of the pre-contact sites showed mussel shell size profiles that matched a "stripping" curve. The historic feature at CA-MNT-63, however, showed a more selective "plucking" curve, while the Protohistoric component from CA-MNT-1277/H was intermediate between the two (Figure 95).

Table 26 Margalef Index Scores for Late and Protohistoric Fish Bone Assemblages

Component	NISP	No. species	Margalef Index
MNT-759/H	1	1	0.00
MNT-569B	3	3	1.83
MNT-879	30	7	1.76
MNT-1223	129	7	1.23
MNT-1227	2188	10	1.17
MNT-1235	6	1	0.00
MNT-1236	0	0	0.00
MNT-1277/H	218	7	1.11
MNT-1942	3506	21	2.45
Total	6081	23	2.52

Most dietary estimates based on faunal remains from the coastal sites showed an emphasis on terrestrial mammals, with less reliance on fish or shellfish, although a range of variation was also evident (Table 27). Fish bones from the large midden at CA-MNT-1227 represented nearly 50% of the diet at that location. Faunal data from CA-MNT-1942 are not amenable to the type of MNI-based dietary reconstructions that were done at the other sites, but there can be little doubt that the large fish bone recovery from that site indicates a diet in which fish were important. Bone isotope findings from CA-MNT-1227 and CA-MNT-1277/H indicated a generalized diet with no particular emphasis on either terrestrial or marine foods (Table 28, Figure 96). Late Period sites on the interior produced evidence for marine resource exploitation, but quantitative evaluation of these remains showed them to be proportionately unimportant. Before the findings from CA-MNT-1942 were reported by Wolgemuth et al. (2002) I felt that the settlement and subsistence system employed between A.D. 1250 and historic contact included the use of marine foods, but was more focused on terrestrial taxa. The new findings, however, indicate a greater use of fish during the Late and Protohistoric periods than previously suspected. Inhabitants of the Big Sur coast during the Late Period had a generalized diet that included nearly every type of edible food in the area. Sites on the shoreline, however, seem to show a significant interest in terrestrial mammals and plant foods, and their clearly was no intensive maritime focus as there was in the Santa Barbara Channel during the Late Period (Walker and DeNiro 1986).

Patterning among the remains of black-tailed deer, the preferred mammalian prey at nearly all of

Table 27 Dietary Reconstructions from Late, Protohistoric, and Historic Components

	% of edible flesh				
Component	Marine mammals	Terrestrial mammals	Fish	Shellfish	Birds
		COASTAL			
CA-MNT-759/H	0.0	91.5	0.3	8.2	0.0
CA-MNT-1223	1.3	86.6	5.4	6.6	0.0
CA-MNT-1227	0.9	36.8	46.8	15.6	0.0
CA-MNT-1235	0.0	91.3	1.7	7.0	0.0
CA-MNT-1236	0.0	83.7	0.0	16.3	0.0
CA-MNT-1277/H	7.0	68.4	10.0	14.6	0.0
CA-MNT-1942					
		INTERIOR			
CA-MNT-569 B	0.0	98.1	1.5	0.1	0.3
CA-MNT-879	8.7	89.1	4.7*	4.4	0.2
		HISTORIC COASTAL			
CA-MNT-63	60.5	25.8	3.5	9.9	0.2

*Includes 0.1% freshwater species: all other fish are marine.

Table 28 Stable Isotope Ratios from Human Bone

Site	Unit	Depth (cm)	^{13}C apatite	^{13}C gelatin	^{15}N gelatin
CA-MNT-1227	5	80-90	- 11.1	- 15.6	+ 10.2
CA-MNT-1227	6	70-80	- 11.0	- 17.4	+ 8.7
CA-MNT-1228			- 12.1	- 17.7	+ 8.1
CA-MNT-1232/H	4	140-150	- 12.0	- 18.0	+ 6.3
CA-MNT-1233			- 10.8	- 15.3	+11.8
CA-MNT-1277/H			- 13.0	- 17.2	+9.3

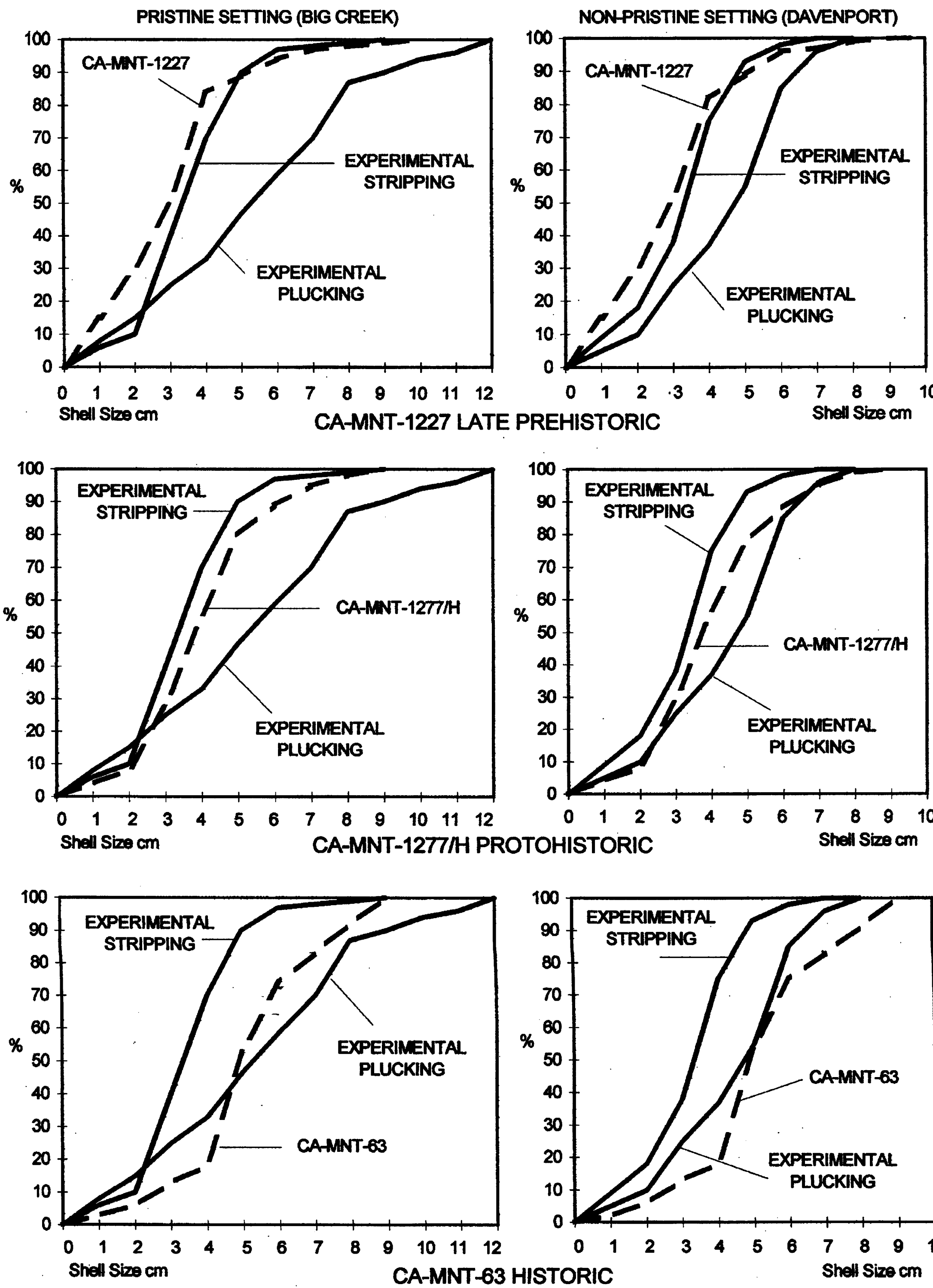


Figure 95 Mussel Shell Size Profiles for the -Late through Contact Periods

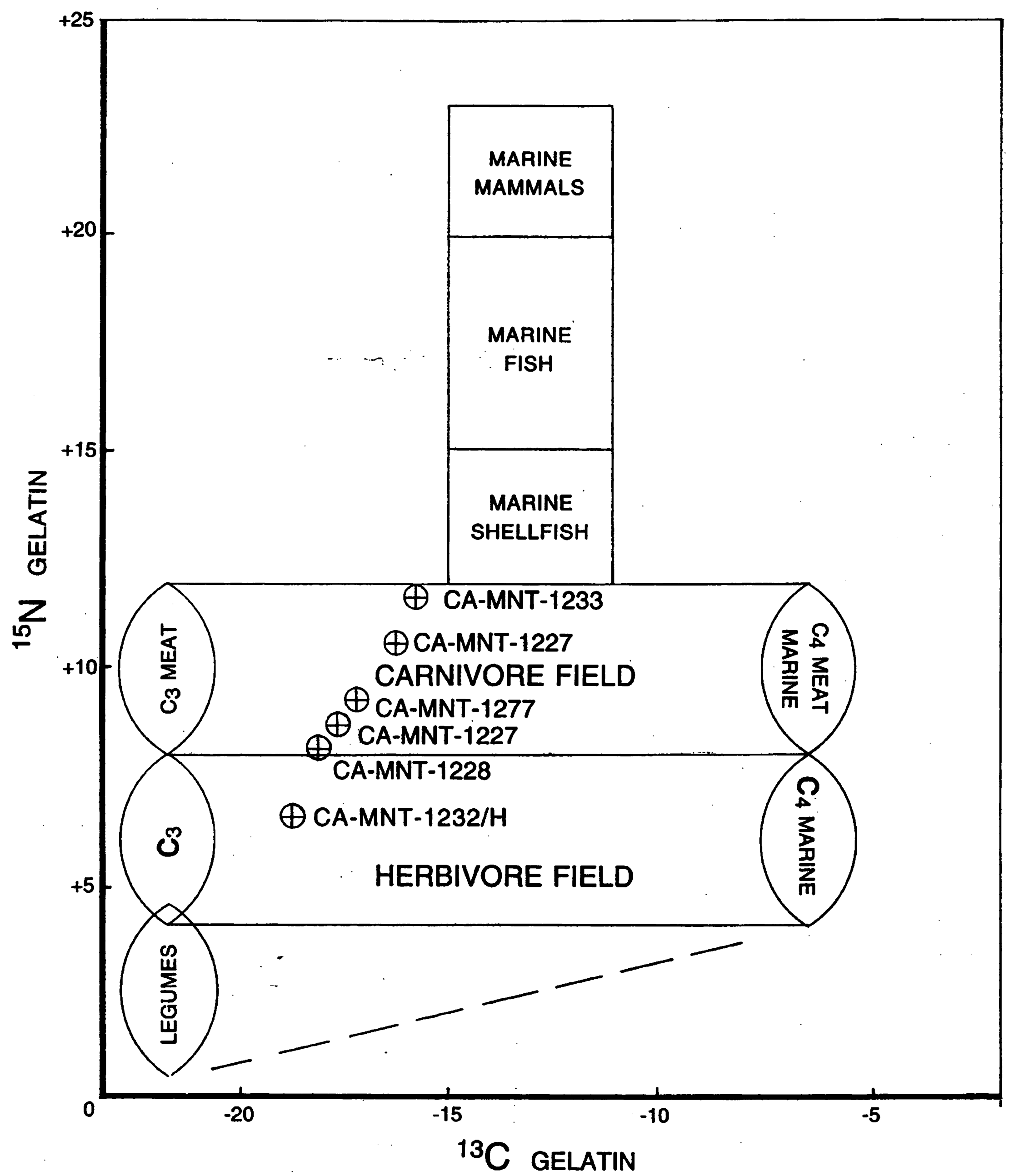


Figure 96 Human Bone Stable Isotope Results

Table 29 Proportional Representation of *Odocoileus hemionus* Skeletal Segments from Late, Protohistoric, and Contact-era Components

Segment	Proportional Representation of elements/ Segment/ Component					
	MNT-759/H	MNT -1223	MNT-1227	MNT-1235	MNT-1236	MNT-1277/H
Cranial	0.000	1.600	1.800	1.200	1.400	0.600
Teeth	0.066	0.429	0.396	0.000	0.000	0.165
Axial	0.018	0.090	0.000	0.000	0.036	0.054
Forelimb	0.000	2.875	1.250	0.000	0.875	2.000
Hindlimb	0.400	3.200	3.400	0.000	0.400	2.800
Metapodial	0.000	4.250	5.000	0.500	6.500	5.500
Forefoot	0.000	1.250	0.250	0.000	0.500	0.500
Hindfoot	0.250	0.625	0.625	0.000	0.125	0.750
Phalanges	0.041	0.492	0.492	0.123	0.738	0.533

Table 30 Rank Coefficients for Skeletal Segment Rankings Compared to Idealized Rankings Based on General Utility, Marrow Value, and Bulk Density

Idealized ranking	r_S Scores per component		
	MNT-1223	MNT-1227	MNT-1277/H
General Utility	0.26	0.15	0.36
Marrow	0.85	0.85	0.98
Bulk density	0.11	0.08	0.00

Score > 0.60 = Significance value of 0.05.
Score > 0.783 = Significance value of 0.01.

Table 31 Late, Protohistoric, and Contact-era Seasonality Based on Deer Teeth Annuli, Oxygen Isotope Determinations from Mussel Shells, and Botanical Remains

```
                                                 Month
Component               J    F      M     A      M     J    J     A     S     O      N     D

                                     COASTAL SITES

CA-MNT-63 Historic                                           ---------------------------------
                      ===========================                       ==================

CA-MNT-376            ----------                                                   ----------
CA-MNT-759/H          ----------                                 -----------------------------
CA-MNT-1223           ----------                                 -----------------------------
                          +++++++++++++                       +++++++++++++++++++++
CA-MNT-1227           -----------                                -----------------------------
                                                                      +++++++++++++++++++
                      =============================                    ===================
CA-MNT-1235           ----------                                                   ----------
CA-MNT-1277/H         ----------                                                   ----------
CA-MNT-1942           ?????????????=====================================================?????

                                     INTERIOR SITES

CA-MNT-361                                                            ==================
CA-MNT-504
CA-MNT-507
CA-MNT-569 B                           ++++++++++++++++++++++++++++++++++++++++
CA-MNT-879            ======================                          ======================

----- Deer Teeth annuli

+++ Oxygen isotope values

=== Botanical Remains
```

the Late/Contact-era sites, was consistent through time. Marrow-bearing elements, particularly metapodials, were always over-represented (Table 29), and there was strong statistical correlation between element profiles and profiles associated with marrow processing (Table 30). This suggests that body portions low in marrow content were disposed of off-site, probably at kill sites. After field butchering, carcasses were transported to the residential base for more intensive processing. This suggests a measure of logistical hunting behavior.

SEASONALITY

Seasonality estimates based on deer teeth annuli, oxygen isotope results and floral remains show two important patterns. First, all of the coastal middens were occupied from fall through late winter/spring. Since acorn collection was a fall activity, it can be assumed that these were the sites of acorn stores relied upon into the winter. Second, nut remains from CA-MNT-361 and -879 indicate that the interior was occupied in the fall as well, indicating the existence of distinct coastal and interior populations, not a single group moving seasonally between the coast and inland valleys. During fall through winter, people seem to have been spread throughout the Santa Lucia Range and interior valleys, occupying residential sites. Middens with high diversity scores may reflect these occupations. Most of the coastal sites showed a seasonal gap during late spring/early summer (Table 31), while CA-MNT-569 in the interior showed evidence of people returning from the coast with mussels during this same period. This suggests some movement the coast and the interior in the late spring/early summer. Because some groups spent fall and winter in the interior, however, there does not seem to have been a wholesale migration by one population between the two environmental zones.

Although plant remains from CA-MNT-1942 suggest the possibility of seasonally extended site use, historic accounts indicate that the local settlement system did not include permanent year-round habitation of single sites. Pedro Fages consistently described people in the Santa Lucias as "wanderers... without house or home" (Priestley 1972:54). These accounts and floral remains from CA-MNT-361, -879, -1227, and -1942 further indicate that acorns were exploited, and the inland emphasis in Late Period subsistence seems to be associated with use of acorns and pine nuts. Stores of these nutcrops may have sustained groups from fall into early winter, but during other seasons, small social units (extended families or bands) apparently took up residence elsewhere. Non-midden sites with bedrock mortars and diverse scatters (short-term residential bases) probably reflect brief encampments by small family groups that dispersed throughout the region especially in the spring/early summer.

DISCUSSION

Clearly, subsistence in the Santa Lucia Range was accomplished by group movement. Exemplified by the location known as "La Hoya de Santa Lucia," residential sites were abandoned for part of the year. The Portolá expedition recorded 60-80 people in September and "not a single heathen" in May of the following year. The gap in archaeological seasonality data between May and August in the coastal middens, compliments these historic accounts, suggesting that coastal groups moved to other sites during this time, probably to the interior. The large congregation of people gathering pine nuts in the interior in September of 1769 probably reflects movement of people in response to a seasonal resource concentration. Periodic aggregation in response to some resources, and dispersal and breakup into smaller social groups may have been an effective method for coping with the extreme biodiversity of the Big Sur coast and the Santa Lucia Range. Resource availability, however, did not follow a strict seasonal schedule, but instead decisions were made on the basis of relative availability of particular foods during any given year. The diversity of the terrestrial environment, year-to-year variability in the abundance of alternative resources, and the potential year-round availability of some marine foods (e.g., fish) would have precluded a highly stable, seasonally-structured food acquisition strategy like the kind that operated in the montane regions of California where people migrated into the highlands during the summer and returned to the lowlands in the fall.

When considered relative to Binford's (1980) settlement classification system, the Late/Contact Period subsistence system of the Santa Lucias conforms poorly with either a forager or collector pattern. Foragers, of course, engage in frequent seasonal movements, and mobility patterns in the Santa Lucias indicate periodic movement from one residential site to another. Foragers differ from collectors, however, in not storing foods. Collectors, tethered to residential sites with stores, send out task groups to exploit specific target resources, process them, and bring them back to the main base in bulk. The preponderance of residential sites in Big Sur suggests forager-like mobility, but ethnohistoric accounts indicate that these people stored food, particularly acorns and/or pine nuts. The residential sites do show variation in range and diversity of constituents suggesting at least four different functional site types: (long-term residential bases marked by middens with high assemblage diversity, short-term residential bases marked by middens with intermediate diversity scores, brief encampments marked by features with associated scatters, and processing stations represented by bedrock mortars without associated debris). This range of site types is more consistent with a collector settlement strategy, but it is also clear that frequent movements (probably within the confines of defined tribelet territories) by residential groups were the norm in this area.

The range of a group's movement was probably constrained by tribelet boundaries. Historic accounts suggest repeatedly that relations between many tribelets were hostile, which may account for the limited extension of trade networks. The establishment of small residential sites in the uplands of these territories may too reflect an increased awareness of hostile social boundaries, as groups turned inward to resolve subsistence problems. A certain fluidity in group movements within tribelets insured that a full spectrum of diverse resources could be taken advantage of.

FLAKED STONE TECHNOLOGY

Flaked stone residues including artifacts, cores, and debitage were represented in significant numbers at most of the Late/Contact sites. These items illuminate a distinctive technology that was employed between A.D. 1250 and 1769 as best represented by materials from CA-MNT-879 and –1223 (Table 32). Stone residues from these sites showed evidence for production of arrow points from small, prepared cores and flake blanks. The cores seem to have been prepared by removing small blade flakes (Figure 97) which allowed for the subsequent removal of flakes suitable for reduction into projectile points or drills. Previously (Jones 1995), I likened this industry to the microblade technology represented in abundance on the northern Channnel Islands (Arnold 1987; Heizer and Kelly 1962), but this similarity was probably overstated. Small cores with distinctive microblade scars were recovered from CA-MNT-879 (Figure 97), but no microblades were found among the debitage-despite a large recovery sample (Haney et al. 2001). Furthermore, drills found with the Late Period materials at CA-MNT-879 and –1223 do not resemble the microblade drills common to the Channel Islands despite the likelihood that they were used to make beads and/or ornaments. Two traits that distinguished Late-Protohistoric flaked stone assemblages were relatively low density of debitage in deposits and a predominance of core-flake debris (Table 32). The bifacial technology, prevalent during earlier periods, probably did not disappear entirely, however, as reflected by the occurrence of biface-derived debitage in low frequencies in Late and Protohistoric assemblages.

On the coast, cores from CA-MNT-1223 and -1227 were very small and heavily worked, in some cases via the bipolar technique. The presence of these small heavily reworked pieces suggests that, in some instances, raw material may have been at a premium. This, in turn, suggests limited access to sources as a possible reflection of inter-group social tension. Hostility between groups was repeatedly described in early historic accounts. The production of a projectile point from abalone shell at CA-MNT-1223 may further reflect scarcity of chert (Jones 1988:103), as does the absence of Franciscan stone from CA-MNT-1227.

INTER-REGIONAL EXCHANGE

The ethnohistoric record suggests that the Salinan engaged in one-for-one trade and also used shell beads as currency (Hester 1978:502). Archaeological evidence for bead and pendant manufacturing, albeit somewhat limited, was recovered from CA-MNT-879, -1223, and -1227, and these finds could reflect manufacture of items for exchange purposes (Figure 97). None of the Late Period components, however, produced much in the way of obvious exotic goods. Obsidian, in particular, one of the only unequivocal exchange items on the central coast, was nearly absent from Late and Contact Period components (Table 33). Steatite objects were also recovered from Late Period middens, but steatite pendants appear to be of local origin, as items representing an apparent production sequence were recovered from CA-MNT-1228 (Jones 1996). Steatite disk beads may have been produced locally or were imports from the central Sierra Nevada. The frequent mention of inter-group hostilities in the ethnohistoric record suggests that inter-regional social relationships may not have been favorable enough to facilitate frequent exchange of commodities over long distances during the Late through Contact eras.

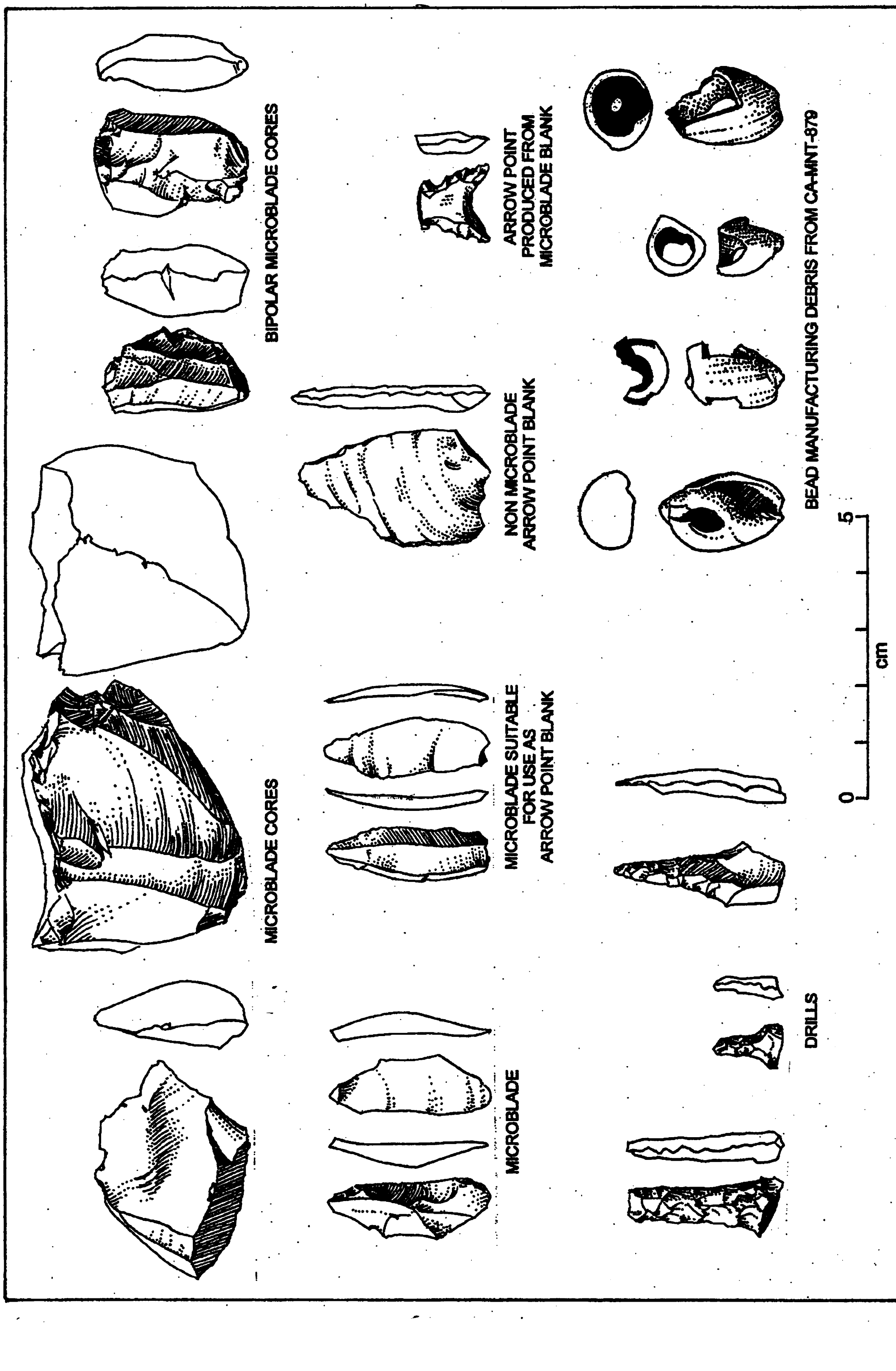


Figure 95 Artifacts representing Late Period Stone Technology and Bead/Ornament Production

Table 32 Characteristics of Flaked Stone Assemblages, Late and Protohistoric Periods

Component	Total flakes	% Monterey chert	Flakes/m^3 (3 mm mesh)	% Core/flake debris	Flake: Biface	Biface: core
			INTERIOR SITES (Chert rich)			
CA-MNT-879	4260	98.9	1358	92.0	182:1	3:1
			COASTAL SITES (Chert poor)			
CA-MNT-759/H	55	89.1	19	53.6	14:1	4:1
CA-MNT-1223	488	97.3	36	80.8	13:1	5:1
CA-MNT-1227	88	99.1	10	79.6	18:1	1:1
CA-MNT-1235	25	80.0	10	*	6:1	4:1
CA-MNT-1236	30	93.3	15	66.7	4:1	1:0
CA-MNT-1277/H	1063	87.2	125	57.8	9:1	10:1
CA-MNT-1942	16	93.8	2	90.0	3:1	5:0

Table 33 Obsidian Frequency from Late Period Components

Site	Total excavation volume (m^3)	Volume screened through 3 mm mesh (m^3)	Contemporaneous obsidian	Obsidian/ m^3 screened through 3 mm mesh
CA-MNT-361	2.1	0.0	0	0.00
CA-MNT-504	3.9	0.0	0	0.00
CA-MNT-507	6.2	0.0	0	0.00
CA-MNT-569 B	2.9	2.1	0	0.00
CA-MNT-759/H	2.9	2.9	0	0.00
CA-MNT-879	14.7	9.5	6	0.60
CA-MNT-1223	13.4	13.4	1	0.07
CA-MNT-1227	9.0	3.8	0	0.00
CA-MNT-1235	2.4	2.4	0	0.00
CA-MNT-1236	2.0	2.0	0	0.00
CA-MNT-1277/H	9.0	5.0	0	0.00
CA-MNT-1942	8.2	8.2	0	0.00
Total	76.7	49.3	7	0.14

CHAPTER 9: ANTECEDENTS

In Chapter 8, archaeological data were combined with ethnohistoric information to characterize Native systems of settlement, subsistence, and trade in the Big Sur region. Archaeological findings from deposits associated with Salinan place names indicated that the ethnohistoric record can be pushed back directly only to approximately A.D. 1250 (i.e., the beginning of the Late Period) at which time there is a distinctive unconformity in the record. In this chapter, the antecedents of the Late and Protohistoric periods (4400 B.C. to A.D. 1250 or Millingstone through the Middle-Late Transition) are described. The chapter begins with a consideration of settlement and culminates with a consideration of flaked stone technology and inter-regional exchange.

LOCATIONAL PATTERNS AND CONTINUITY OF OCCUPATION

The Late Period is distinguished from earlier cultural manifestations largely by a disruption in settlement between the end of the Middle Period (A.D. 1000) and the beginning and the beginning of the Dolan Phase (ca. A.D. 1250). Few sites show continuity in use across this interval (Figure 92). Most occupied during the Middle Period or earlier were abandoned by A.D. 1200. Nearly all of the Late Period sites were initially occupied no earlier than A.D. 1100-most no earlier than A.D. 1250. Also, coastal sites post-dating A.D. 1200 were found in settings further inland and higher in elevation than earlier sites. All sites more than 2 km inland and 600 m in elevation were initially occupied after A.D. 1300-1400. Late sites seemed also to occur in a broader range of elevations and distances inland. Previously I suggested that Late Period sites are not found on the shoreline in the Big Sur area (Jones 1992, 1995; Jones et al. 1989), but recent findings by Wolgemuth et al. (2002) from CA-MNT-1942 and to a lesser extent from CA-MNT-1892 (Hildebrandt and Jones 1998) indicate that shoreline settings were not overlooked during the Late Period. The defining feature of the Late Period in the Big Sur area is the lack of occupational continuity with the Middle Period. Extensive dating of the Dolan Phase component at CA-MNT-1942 confirms this pattern as there was virtually no evidence of occupation at that location prior to A.D. 1150. Coastal sites situated the furthest inland and highest in elevation (CA-MNT-759/H and CA-MNT-1236) were the most recently settled prehistoric locations. They suggest that the settlement transition at A.D. 1250 was later followed by a push into the uplands of the Santa Lucia Range after ca. A.D. 1300-1400.

ASSEMBLAGE DIVERSITY, COMPONENT FUNCTION, AND SETTLEMENT

Owing to a general diversity of materials and inferred activities, all of the midden sites pre-dating the Late Period were interpreted as residential bases. All of these sites yielded fire-altered rock, flaked and ground stone implements, debitage, shell and mammal remains. Most also produced shell beads, bone tools, fish bone, and human remains. Those lacking a particular constituent were generally locations where sample size was small. Most of the non-midden sites in the interior also produced evidence of sufficiently diverse activities to infer that they too served as residential bases of some type (Table 34). The absence of midden, however, and lower diversity of tools suggest they were occupied less intensively and/or for shorter periods of time. When evaluated statistically (Tables 35 and 36), the assemblages fell into the same three classes that were evident for the Late Period: midden residential bases with Margalef indices ≥3.00, less diverse middens with Margalef indices ≥2.00, and non-middens/short-term residential bases with Margolef indices ≤ 2.00 (Table 37). The only midden site with a diversity value less than 2.00 was CA-MNT-282 which was excavated by a previous investigator. Values from it and CA-MNT-281 probably should not be compared with the sites investigated for the current study, because there is a strong likelihood that different classificatory procedures and field methods affected the composition of these assemblages and their resulting diversity scores. Excluding CA-MNT-282, only non-midden sites produced diversity values less than 2.00. Only coastal middens produced values greater than 3.00, and it is clear that assemblage diversity was greater on the coast than on the interior probably as a refection of the added technology needed to exploit marine resources. For the most part, the statistical indices merely confirm inferences that can be drawn based on presence/absence of midden and general evaluation of constituents. Perhaps the most important observation that can be made from these numbers is that at least four different functional site types were used during the Early Period: long-term residential bases (middens with high diversity scores such as CA-MNT-73), short-term residential bases (marked by middens with intermediate diversity scores such as CA-MNT-1228), brief encampments (marked by scatters of flaked and ground stone with low diversity scores such as CA-MNT-1672), and hunting bases (marked by scatters of flaked stone debitage and projectile points, with low diversity scores such as CA-MNT-1657). None of the non-midden sites dated to the Middle Period, so it is difficult to determine whether a similar suite of site types was employed during that period, but one hunting base (CA-MNT-1754) was associated with the Middle/Late Transition. Given the similarities between Early and Middle Period tool kits, it is reasonable to conclude that systems of settlement were similar if not the same for both periods.

The Millingstone component at CA-MNT-1232/H Stratum II produced an intermediate diversity score of 2.63. In itself, a single score is difficult to interpret, but two other recently discovered Millingstone components (CA-SLO-1756 [Fitzgerald 1997] and CA-SLO-1797 [Fitzgerald 2000]) also showed low functional diversity (Table 38). This suggests that a more limited range of site types was employed during the Millingstone Period. Further, it suggests a more technologically limited adaptation, with less technological breadth and perhaps a more narrowly focused or specialized adaptation. Although the size of sample must be kept in mind, the findings from CA-MNT-1232/H could represent a seasonally restricted occupation during which a few tasks were undertaken regularly. Later middens, especially those on the coast, showed increased richness, suggesting that more types of activities were pursued. Middle and Middle/Late Transition components at CA-MNT-63 and 1233 produced the highest diversity scores of any non-mixed site. After the onset of the Early Period, diversity scores for the most part show relative constancy over time.

Table 34 Summary of Millingstone through Middle-Late Transition components

Site	Elevation (m)	Area (m^2)	Distance inland (km)	Constituents/ features	Recovery volume (m^3)	No. artifact classes	No. artifacts	Artifacts/ m^3
				MIDDENS				
CA-MNT-63	12	2500	0.0	Midden	4.6	14	42	9.1
CA-MNT-73	3	2700	0.0	Midden	20.9	15	100	4.8
CA-MNT-281	5	-	-	Midden	-	15	410	-
CA-MNT-282	3	-	-	Midden, human remains	-	6	38	-
CA-MNT-332	440	8679	21.0	Midden, human remains	6.5	10	41	6.3
CA-MNT-519	387	19,550	16.0	Midden	10.5	11	114	10.9
CA-MNT-521	373	30,500	19.0	Midden, human remains	24.9	14	314	12.6
CA-MNT-1232/H	245	3756	1.1	Midden, human remains	5.4	8	23	4.3
CA-MNT-1233	550	2413	1.6	Midden, human remains	10.0	15	73	7.3
CA-MNT-1228	245	548	1.2	Midden, human remains	14.7	11	64	4.4
CA-MNT-569	380	63,774	20.0	Midden	30.1	12	214	7.1
CA-SLO-267	2	37200	0.0	Midden	70.3	19	948	13.5
				NON-MIDDENS				
CA-MNT-861	376	6048	24.0	Flaked and ground stone scatter	5.1	5	11	2.2
CA-MNT-1672	433	4847	20.0	Flaked and ground stone scatter	7.3	3	10	1.4
CA-MNT-1657	453	2356	22.0	Flaked stone scatter	4.4	3	8	1.8
CA-MNT-1754	531	5183	30.5	Flaked stone scatter	4.9	3	9	1.8

Table 35 Millingstone and Early Period Tool Assemblages: Functional summary

Artifact	MNT-1232/H	Subtotal	MNT-1228	MNT-73	MNT-569 A	MNT-861	MNT-1657	MNT-1672	Subtotal	Grand total
Shell beads	3	3	4	1	0	0	0	0	5	8
Projectile points	2	2	13	11	79	4	3	4	114	116
Drills	0	0	0	1	4	0	0	0	5	5
Bifaces	2	2	23	33	77	3	4	5	145	147
Flake tools	3	3	8	13	14	2	1	0	38	41
Core tools	0	0	1	0	4	0	0	0	5	5
Mortars	0	0	1	1	0	0	0	0	2	2
Pestles	0	0	1	5	1	0	0	0	7	7
Handstones	5	5	2	8	19	1	0	1	31	36
Milling slabs	2	2	4	6	1	0	0	0	11	13
Pitted stones	0	0	0	12	5	0	0	0	17	17
Steatite pendants	0	0	2	0	1	0	0	0	3	3
Anvils	0	0	0	1	0	0	0	0	1	1
Stone spheres	0	0	0	0	0	0	0	0	0	0
Net weights	0	0	0	1	0	0	0	0	1	1
Hammerstones	2	2	2	5	1	1	0	0	9	11
Bone awls	0	0	1	1	8	0	0	0	10	10
Bone gorges	0	0	2	0	0	0	0	0	2	2
Antler tines	1	1	1	0	0	0	0	0	1	2
Bone pendant	1	1	0	0	0	0	0	0	0	1
Fishhooks	0	0	0	0	0	0	0	0	0	0
Fishhook blanks	0	0	0	0	0	0	0	0	0	0
Shell scrapers	0	0	0	0	0	0	0	0	0	0
Pendant blank	0	0	0	0	0	0	0	0	0	0
Cut shells	0	0	0	0	0	0	0	0	0	0
Shells w/asphaltum	0	0	0	1	0	0	0	0	1	1
Shell pendants	0	0	0	0	0	0	0	0	0	0
Cobbles w/asphaltum	0	0	0	0	0	0	0	0	0	0
Unique	0	0	0	0	0	0	0	0	0	0
Total	21	21	65	100	214	11	8	10	408	429

Table 36 Middle and Middle-Late Transition Period Tool Assemblages: Functional summary

	Middle Period components							Middle-Late Transition components				
Artifact	MNT-521	MNT-63	MNT-282	MNT-332	MNT-519	SLO-267	Subtotal	MNT-281	MNT-1233	MNT-1754	Subtotal	Grand total
Shell beads	2	17	0	0	1	17	37	6	18	0	24	61
Projectile points	82	4	21	9	50	50	216	4	11	3	18	234
Drills	2	1	0	0	0	0	3	0	0	0	0	3
Bifaces	151	4	0	22	28	478	683	0	11	5	16	699
Flake tools	28	1	0	2	15	24	70	0	6	1	7	77
Core tools	2	0	0	1	2	5	10	0	0	0	0	10
Mortars	4	0	0	1	0	2	7	4	0	0	4	11
Pestles	2	1	0	0	1	15	19	15	2	0	17	36
Handstones	12	1	0	2	5	0	20	0	1	0	1	21
Milling slabs	8	1	0	1	3	0	13	0	1	0	1	14
Pitted stones	6	0	1	1	0	258	266	12	0	0	12	278
Steatite pendants	1	0	0	1	1	10	13	0	0	0	0	13
Steatite pipe	0	0	0	0	0	1	1	0	0	0	0	1
Anvils	0	0	0	0	0	0	0	0	0	0	0	0
Stone spheres	0	0	0	0	0	0	0	0	1	0	1	1
Notched/grooved stone	0	0	6	0	0	11	17	2	2	0	4	21
Hammerstones	3	2	8	1	3	40	57	129	0	0	129	186
Bone awl	11	3	0	0	5	5	24	5	5	0	10	34
Bird bone whistles	0	0	0	0	0	0	0	1	0	0	1	1
Bone gorge	0	0	0	0	0	20	20	0	0	0	0	20
Shell fishhooks	0	1	0	0	0	1	2	1	5	0	6	8
Shell fishhook blanks	0	1	0	0	0	3	4	20	2	0	22	26
Shell scrapers	0	1	0	0	0	0	1	69	1	0	70	71
Pendant blank	0	0	0	0	0	0	0	0	0	0	0	0
Cut shells	0	0	0	0	0	2	2	112	5	0	117	119
Shells w/asphaltum	0	1	0	0	0	0	1	0	0	0	0	1
Shell pendants	0	1	0	0	0	0	1	0	2	0	2	3
Cobbles w/asphaltum (tarring stones)	0	0	1	0	0	5	6	9	0	0	9	15
Unique	0	0	1	0	0	1	2	21	0	0	21	23
Total	314	40	38	41	114	948	1495	410	73	9	492	1987

Table 37 Functional Diversity Statistics for Millingstone through Middle-Late Transition Components

Component	Total Artifacts	No. Classes	Margalef Index
CA-MNT-63	42	14	3.48
CA-MNT-1233	73	15	3.17
CA-MNT-73	100	15	3.04
CA-MNT-1232/H Stratum II	21	8	2.63
CA-SLO-267	948	19	2.62
CA-MNT-332	41	10	2.42
CA-MNT-1228	64	11	2.40
CA-MNT-281	410	15	2.32
CA-MNT-521	314	14	2.26
CA-MNT-569 A	214	12	2.05
CA-MNT-519	114	11	1.86
CA-MNT-861	11	5	1.67
CA-MNT-282	38	6	1.37
CA-MNT-1657	8	3	0.96
CA-MNT-1672	10	3	0.86
CA-MNT-1754	9	3	0.91

Table 38 Functional Diversity Statistics for Millingstone Components from Central Coastal California

Artifact	MNT-1232/H	SLO-1796	SLO-1797	Total
Shell beads	3	0	1	4
Projectile points	2	6	5	13
Bifaces	2	5	2	9
Flake tools	3	39	10	52
Core tools	0	0	24	24
Handstones	5	21	2	28
Milling slabs	2	5	4	11
Anvils	0	0	3	3
Hammerstones	2	1	12	15
Smoothing stones	0	0	2	2
Antler tines	1	0	0	1
Bone pendant	1	0	0	1
Effigy	0	0	1	1
Curvalinear stone	0	0	1	1
Total	21	77	67	165
No. classes	9	6	12	14
Margalef index	2.63	1.15	2.61	2.54

SOURCES: Jones (1995), Fitzgerald (1997, 2000)

Table 39 Bird and Mammal Remains from Millingstone and Early Period Components

Common name	MNT-1232/H	Milling stone subtotal	MNT-1228	MNT-73	Coastal subtotal	MNT-569A (Interior)	Early Period total
			TERRESTRIAL TAXA				
Deer	27	27	75	31	106	15	121
Cottontail rabbit	0	0	0	8	8	2	10
Jack rabbit	0	0	0	0	0	4	4
Coyote/dog	1	1	1	1	2	1	3
Tule elk	0	0	0	0	0	0	0
Bobcat	0	0	1	0	1	0	1
Gray fox	3	3	1	0	1	0	1
Black bear	0	0	0	0	0	0	0
Mountain lion	0	0	0	0		1	1
Grizzly bear	0	0	0	0	0	0	0
Skunk	0	0	0	1	1	0	1
Weasel	0	0	0	1	1	0	1
Red-tailed hawk	0	0	0	0	0	0	0
Red-shouldered hawk	0	0	0	0	0	0	0
Subtotal	31	31	78	42	120	23	143
			MARINE TAXA				
Sea otter	0	0	0	2	2	0	2
Harbor seal	3	3	3	2	5	0	5
Northern fur seal	1	1	0	0	0	0	0
Steller sea lion	0	0	1	1	2	0	2
California sea lion	1	1	0	0	0	0	0
Subtotal	5	5	4	5	9	0	9
Grand total	36	36	82	47	129	23	152

FAUNAL REMAINS, ANIMAL EXPLOITATION, AND DIET

Faunal remains from pre-Late contexts show changes in relative importance of marine versus terrestrial taxa, and mollusks versus fish and mammals. The mammal bone assemblage from CA-MNT-1232/H showed a high proportion of marine species (14%), but the sample from that component was limited to only 36 elements (Table 39). A slightly more robust Early Period sample showed a heavy emphasis on terrestrial species with coastal sites CA-MNT-73 and -1228 producing assemblages with 93% terrestrial animals (Table 39). This proportion increased to 94% when the findings from inland site, CA-MNT-569A, were added. The Middle Period and Middle-Late Transition components showed a slightly higher proportion of marine species (13%). This proportion decreased to 11% when findings from interior sites were added (Table 40). In general, the Early through Middle Period showed a slight increase in marine mammal exploitation.

All but one pre-Late component (CA-MNT-63) had black-tailed deer as the dominant taxon (Table 41). Four species dominated nearly all of the assemblages: deer, sea otter, harbor seals, and rabbits. Large migratory sea mammals (i.e., California sea lion, Steller sea lion, northern and southern fur seal) were represented in very low frequencies throughout the sequence, probably because no rookeries were found in the vicinity of any of the investigated sites. A northern elephant seal rookery present today

Table 40 Bird and Mammal Remains from Middle Period and Middle-Late Transition Components

Common name	MNT-63	SLO-267	MNT-1233	Subtotal	MNT-332	MNT-521	MNT-519	MNT-1754	Subtotal	Grand total
Deer	38	93	203	334	1	44	12	4	61	395
Cottontail rabbit	52	88	21	161	0	16	5	0	21	182
Jack rabbit	0	0	2	2	0	9	2	0	11	13
Coyote/dog	2	51	1	54	0	6	4	0	10	64
Tule elk	0	0	0	0	1	0	0	0	1	1
Badger	0	2	0	2	0	1	0	0	1	3
Bobcat	0	1	1	2	0	2	0	0	2	4
Gray fox	1	1	0	2	0	0	0	0	0	2
Black bear	1	1	0	2	0	0	0	0	0	2
Grizzly bear	0	0	0	0	0	1	0	0	1	1
Raccoon	0	4	0	4	0	1	0	0	1	5
Weasel	1	0	0	1	0	0	0	0	0	1
Red-tailed hawk	0	2	0	2	0	0	0	0	0	2
Subtotal	95	243	228	566	2	80	23	4	109	675
Sea otter	14	12	2	28	0	0	0	0	0	28
Harbor seal	10	1	4	15	0	0	0	0	0	15
Guadalupe fur seal	0	1	0	1	0	0	0	0	0	1
Northern fur seal	15	0	0	15	0	0	0	0	0	15
Steller sea lion	0	5	1	6	0	0	0	0	0	6
California sea lion	6	13	1	20	0	0	0	0	0	20
Cormorant	0	2	0	2	0	0	0	0	0	2
Subtotal	45	34	8	87	0	0	0	0	0	87
Grand total	140	277	236	653	2	80	23	4	109	762

Table 41 Summary of Mammal Findings from pre-Late Components

Component	Deer			Otters			Rabbits			Harbor seals		
	NISP	%	Rank	NISP	%	Ran k	NISP	%	Rank	NISP	%	Rank
CA-MNT-1232/H*	27	75.0	1	0	0.0	0	0	0.0	0	3	8.3	2
CA-MNT-1228	76	90.4	1	0	0.0	0	0	0.0	0	3	3.6	2
CA-MNT-73	29	61.7	1	2	4.2	3	8	17.0	2	2	4.2	3
CA-MNT-569 A	15	65.2	1	0	0.0	0	6	26.1	2	0	0.0	0
CA-MNT-63	38	24.4	2	14	8.9	4	52	33.3	1	10	6.4	5
Middle												
CA-MNT-521	44	54.3	1	0	0.0	0	25	30.9	2	0	0.0	0
CA-SLO-267	93	33.6	1	12	4.3	5	88	31.8	2	1	0.4	10
CA-MNT-519	12	52.2	1	0	0.0	0	5	21.7	2	0	0.0	0
CA-MNT-1233	203	78.4	1	2	0.7	4	21	8.1	2	4	1.5	3

at Point Piedras Blancas was almost certainly not there prehistorically, since no bones from that species were recovered from the archaeological deposit. Large marine mammals were probably taken on an encounter basis from ephemeral haul outs. The greatest number of bones from a migratory sea mammal was 13 representing California sea lion recovered from CA-SLO-267. The most significant marine mammal overall was the sea otter, represented by 28 elements (4.3%) in the Middle Period and Middle-Late Transition components.

The pre-Late components show a distinctive progression toward increased diet breadth through time based on Margalef Index scores (Table 42). The Millingstone component at CA-MNT-1232/H produced a value of 1.39. This increased to 1.82 for the combined Early Period assemblages, and increased still further to 2.87 for the combined Middle and Middle-Late Transition components.

Table 42 Margalef Index Scores for Mammal and Bird Bone Assemblages from Millingstone through Middle-Late Transition Components

Component	NISP	No. species	Margalef index
MILLINGSTONE PERIOD			
CA-MNT-1232/H	36	6	1.39
EARLY PERIOD			
CA-MNT-1228	82	6	1.13
CA-MNT-73	47	8	1.81
CA-MNT-569A	23	5	1.28
Subtotal	152	12	2.19
MIDDLE PERIOD			
CA-MNT-63 Middle	140	10	1.82
CA-SLO-267	277	15	2.49
CA-SLO-1233	236	9	1.46
CA-MNT-521	80	8	1.59
CA-MNT-519	23	4	0.95
Subtotal	756	20	2.87

Fish remains were a highly visible constituent in pre-Late components although there was evidence for change over time in density and diversity. The total pre-Late sample included 3473 elements representing 34 taxonomic categories (Table 43). The overall sample was dominated by rockfish (NISP=1576; 45.4%) followed by cabezon (NISP=422; 12.2%) and prickleback (NISP=363; 10.5%). Fifteen marine fish bones were recovered from CA-MNT-521 in the interior. No freshwater fish bones were recovered from any pre-Late component. Evaluation of fish remains is heavily influenced by sampling strategies, however, and the relative importance of individual species and fish in general changes when sampling techniques are accounted for-particularly when the results of micro-samples (columns and one unit from CA-SLO-267) are taken into account (Table 44). Unlike nearly all of the Late and Protohistoric components, several Early and Middle Period components produced many remains of small fish in residues processed with 1.5 mm (1/16 inch) mesh. Several of the Middle Period deposits, in particular, produced large numbers of fish bones from relatively small samples, indicating very high density of fish bone. Small taxa were absent from the Millingstone component at CA-MNT-1232/H which produced 77 fish bones representing 10 taxonomic classes. Cabezon was the dominant species in this collection, which produced a diversity score of 2.07 (Table 45). Fish bones were present only in a density of 14/m^3, however. The Early Period sample showed some variation with very few fish remains from CA-MNT-1228, and a greater number and density from CA-MNT-73. The number of species exploited showed no increase from the Millingstone Period, but density of fish bone increased to 110.4 elements/m^3. Rock prickleback, rockfish, and cabezon dominate the Early Period assemblages. The Middle Period and Middle-Late Transition show significant increases in all categories. Fish bone density was extremely high at some sites with over 25,000 elements/m^3 at CA-MNT-63. Even inland site, CA-MNT-521, showed a fish bone density of 7.9 elements/m^3. The Middle Period components showed evidence for exploitation of 29 taxa, and greater diet breadth was corroborated by considerably higher Margalef Index scores. The dominant species for the Middle Period were northern anchovies, sardines or herring, prickleback, and rockfish.

A similarly high frequency of anchovy remains was recognized by Fitch (1972:115) at Diablo Canyon. Fitch attributed the high numbers of ancho-

Table 43 Summary of Fish Remains from pre-Late Components

Common name	MNT-1232/H Stratum II	MNT-1228	MNT-73	Early Period sub total	MNT-63 Middle	SLO -267	MNT-521	MNT-1233	Middle Period sub total	Grand total
Requiem shark	0	0	0	0	0	2	0	0	2	2
Shark	4	0	0	0	5	0	0	0	5	9
Shark or ray	0	0	0	0	1	0	0	0	1	1
Sardine or herring	0	0	0	0	0	110	5	0	115	115
Pacific sardine	0	0	0	0	0	17	0	0	17	17
Northern anchovy	0	0	0	0	0	24	0	0	24	24
Smelts	0	0	0	0	0	3	0	0	3	3
Silversides	0	0	0	0	0	33	0	0	33	33
Steelhead	0	0	0	0	5	0	0	0	5	5
Pacific hake	4	0	0	0	0	0	0	9	9	13
Topsmelt or jacksmelt	0	0	0	0	1	0	0	0	1	1
Surfperches	4	0	15	15	26	144	1	68	239	258
Barred surfperch	0	0	0	0	2	1	0	0	3	3
Black or striped surfperch	0	0	0	0	3	4	0	0	7	7
Pile surfperch	0	0	0	0	0	56	0	1	57	57
Señorita	0	0	0	0	0	2	0	0	2	2
Prickleback	3	0	0	0	1	359	0	0	360	363
Monkeyface prickleback	0	0	31	31	65	44	2	1	112	143
Rock prickleback	2	0	20	20	13	102	2	6	123	145
Clinids	0	0	0	0	0	1	0	0	1	1
Striped kelpfish	0	0	0	0	0	6	0	0	6	6
Crevice kelpfish	0	0	0	0	0	1	0	0	1	1
Giant kelpfish	0	0	0	0	0	3	0	0	3	3
Chub mackeral	0	0	0	0	0	4	0	0	4	4
Pacific mackeral	1	0	0	0	0	0	0	0	0	1
Rockfish	17	2	47	49	299	459	5	747	1510	1576
Rock or kelp greenling	1	1	27	28	28	70	0	32	130	159
Lingcod	8	0	19	19	18	3	0	35	56	83
Painted greenling	0	0	0	0	0	2	0	0	2	2
Sculpins	0	0	0	0	0	3	0	0	3	3
Cabezon	33	7	102	109	117	75	0	88	280	422
Wooly sculpin	0	0	0	0	0	1	0	0	1	1
Sand sole	0	0	0	0	0	0	0	1	1	1
Northern clingfish	0	0	0	0	0	9	0	0	9	9
Total	77	10	261	271	584	1538	15	988	3125	3473

Table 44 Summary of Fish Remains from pre-Late Components Weighted to 1.5 mm Mesh

Common name	MNT-1232/H Stratum II	MNT-1228	MNT-73	Early Period Sub-total	MNT-63 Middle	SLO-267	MNT -521	MNT-1233	Middle Period Subtotal	Grand Total
Shark	4	0	0	0	5	0	0	0	5	14
Shark or ray	0	0	0	0	1	0	0	0	1	1
Ray	0	0	0	0	0	0	0	3209	3209	3209
Sardine or herring	0	0	0	0	21,010	31	44	9626	30,711	30711
Pacific sardine	0	0	0	0	0	10	0	0	10	10
Northern anchovy	0	0	0	0	63,000	24	0	0	63,024	63024
Smelts	0	0	0	0	0	2	0	0	2	2
Silversides	0	0	0	0	0	5	0	0	5	5
Steelhead	0	0	0	0	3005	0	0	12	3017	3017
Pacific hake	4	0	0	0	0	0	0	0	0	4
Topsmelt or jacksmelt	0	0	0	0	751	0	0	132	883	883
Surfperches	4	0	15	15	1526	41	22	0	1589	1608
Barred surfperch	0	0	0	0	2	0	0	0	2	2
Black or striped surfperch	0	0	0	0	3	0	0	1	4	4
Pile surfperch	0	0	0	0	0	20	0	0	20	20
Prickleback	3	0	0	0	12,751	94	0	1	12,846	12849
Monkeyface prickleback	0	0	31	31	65	7	44	9	125	156
Rock prickleback	2	0	3155	3155	7	23	44	0	74	3231
Clinids	0	0	0	0	0	1	0	0	1	1
Crevice kelpfish	0	0	0	0	0	1	0	0	1	1
Pacific mackeral	1	0	0	0	0	0	0	2498	2498	2499
Rockfish	17	2	570	572	6299	75	44	71	6489	7078
Rock or kelp greenling	1	1	27	28	3028	10	0	1093	4131	4160
Lingcod	8	0	19	19	18	0	0	115	133	160
Cabezon	33	7	102	109	117	10	0	1	128	270
Threespine stickleback	0	0	0	0	1500	0	0	0	1500	1500
Gobies	0	0	0	0	750	0	0	0	750	750
Sculpins	0	0	0	0	750	1	0	0	751	751
Northern clingfish	0	0	0	0	750	6	0	0	756	756
Clingfish	0	0	0	0	750	6	0	0	756	756
Total	77	10	3919	3929	116,088	367	198	16768	133,421	137,432

vy bones in the Middle Period levels to greater exploitation of marine mammals, and the deposition of their stomach contents (anchovies) into the midden. This explanation is supported by the high frequency of anchovy and otter bones at CA-MNT-63, but not by the low percentage of marine mammals at CA-MNT-1233 (Table 39). A description of anchovy habitat preference and behavior suggests their presence in the coastal middens could be a product of seasonality:

> Anchovies are pelagic schooling fishes...[that] exhibit some seasonal movements. During fall and winter they apparently move offshore and return inshore in spring... anchovies occur well below the surface during the day and move to the upper levels of the ocean at night. During periods of warmer-than-average water temperatures, adult anchovies become less available in the inshore waters (Baxter 1967:110).

If they indeed reflect human diet, and not the stomach contents of marine mammals, these small fish would have required significant expenditures of time to catch and process, particularly if they were available only at night or from considerable depths.

Invertebrate remains at all sites were dominated by the California sea mussel, *Mytilus californianus*. Percentages of mussels ranged from a low of 61.5% at CA-MNT-73 to 98% at CA-MNT-1228 (Jones 1995). The variability between CA-MNT-73 and -1228 reflects differences in habitat, as lower percentages were found only at the mouth of the Big Sur River (CA-MNT-63 and-73) where sandy beach is more expansive than at other locations. There is no significant proportional variation through time at any of the other sites. The Millingstone component at CA-MNT-1232/H yielded 97.3% mussels, the Early Period component at CA-MNT-1228 yielded 98%, and the lowest percentage of 84.9% was obtained from the Middle Period component at CA-SLO-267 (Jones and Ferneau 2001).

Patterns over time in the use of alternative "plucking" versus "stripping" strategies for mussel collection are striking in the lack of variability. With the exception of the bottom of CA-MNT-1232/H Stratum II, which showed a "plucking" profile, all of the pre-Late components showed stripping curves. Apparently, a plucking strategy employed during the Millingstone Period was replaced with stripping at the onset of the Early Period, as evidenced by shell curves from CA-MNT-73 and CA-MNT-1228. This strategy continued to be employed through the Middle/Late Transition (CA-MNT-1233) (Figure 98). Although evidence for taxonomic change was absent, the importance of shellfish varied through time relative to other animal food resources, based on meat:shell and meat:MNI conversions (Table 46). The highest dietary proportion for shellfish was found in the Millingstone component at CA-MNT-1232/H (26.3%). Through time, percentages declined to 16.8% at CA-MNT-1228 during the Early Period, and 0.7% during the Middle Period at CA-MNT-63. They increased slightly during the Middle/Late Transition (4.6% at CA-MNT-1233).

Like shellfish, marine mammals showed greatest dietary importance (30.5%) during the Millingstone Period (Table 46). Proportions declined in the Early Period (24.4% at CA-MNT-1228 and 12.7% at CA-MNT-73), and remained stable through the Middle/Late Transition (10.5% at CA-MNT-1233). This trend is virtually identical to dietary reconstructions reported by Glassow (1992:121) from western Santa Barbara County. Taxonomically, harbor seals were the second most important mammals at CA-MNT-1232/H and CA-MNT-1228, while otters were absent.

Fish also showed proportional changes in overall dietary significance through time. Based on findings from CA-MNT-73, fish became an important dietary item in the Early Period, and continued to be used through the Middle/Late Transition. All of the Middle Period and Middle-Late Transition components showed a high proportion of fish in the diet.

Patterning among remains of black-tailed deer was as consistent through time for the pre-Late components as it was for the Late and Protohistoric periods. Marrow-bearing elements were always over-represented (Table 47), and there are strong statistical correlations between site element profiles and the profile associated with marrow processing (Table 48). This suggests that body portions low in marrow content were disposed of off-site, probably at kill sites. After field butchering, carcasses were transported to the residential base for more intensive processing. This suggests a measure of logistical hunting behavior employed throughout the local sequence. The element representation profiles contrast markedly with findings from Middle and Late period sites in the San Francisco Bay area, where Watts (1984:76-82) found a consistent

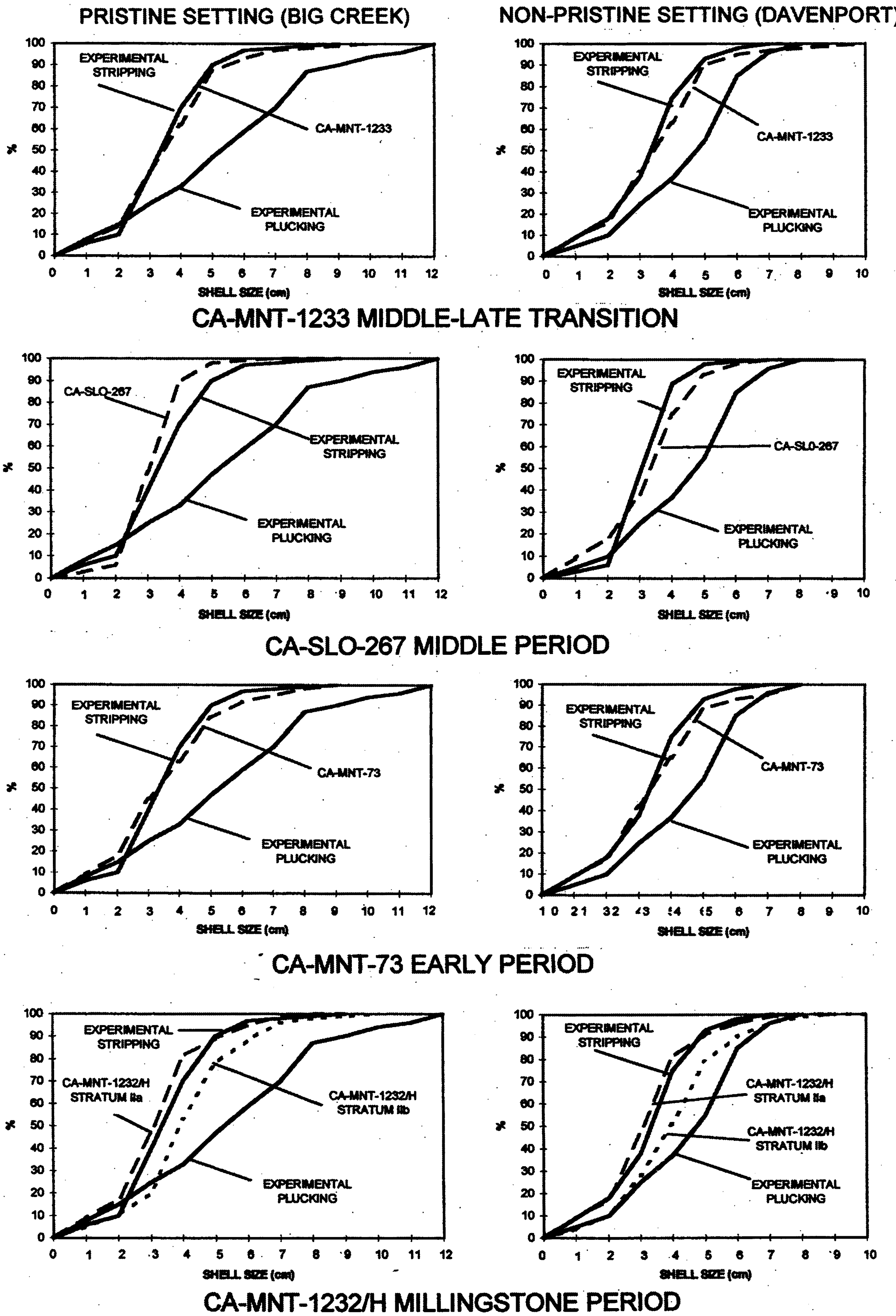


Figure 98 Mussel Shell Size Profiles for the Millingstone through Middle-Late Transition Period

Table 45 Summary of pre-Late Fish Bone Assemblages

Component	NISP	No. species	Margalef Index	Excavation volume (m^3)	NISP/m^3
		MILLINGSTONE PERIOD			
CA-MNT- 1232/H Stratum II	77	10	2.07	5.4	14.3
Subtotal	77	10	2.07	5.4	14.3
		EARLY PERIOD			
CA-MNT- 1228	10	3	0.87	14.7	0.7
CA-MNT-73	3919	7	0.72	20.9	187.5
Subtotal	3929	7	0.72	35.6	110.4
		MIDDLE PERIOD			
CA-MNT-63 Middle	116,088	21	1.71	4.6	25,236.5
CA-SLO-267	367	16	3.02	0.8	459.0
CA-MNT-521	198	5	0.76	24.9	7.9
CA-MNT- 1233	16,768	12	1.48	10.0	1676.8
Subtotal	133,421	29	2.37	40.3	3310.7
Grand total	137,427	30	2.56	81.3	

Table 46 Dietary Reconstructions from pre-Late Components

Component	Marine mammals	Terrestrial mammals	Fish	Shellfish
		MILLINGSTONE PERIOD COASTAL		
CA-MNT-1232/H Stratum II	30.5	32.6	10.6	26.3
		EARLY PERIOD COASTAL		
CA-MNT-1228	24.4	58.5	0.2	16.8
CA-MNT-73	12.7	12.2	74.4	0.6
		EARLY PERIOD INTERIOR		
CA-MNT-569 A	0.0	100.0	0.0	0.0
		MIDDLE PERIOD COASTAL		
CA-MNT-63	13.7	4.2	81.3	0.7
CA-SLO-267	14.9	12.0	69.0	4.0
CA-MNT-1233	10.5	31.2	53.4	4.6
		MIDDLE PERIOD INTERIOR		
CA-MNT-519	0.0	97.8	2.2	0.0
CA-MNT-521	0.0	88.9	10.5	0.5

Table 47 Proportional Representation of *Odocoileus hemionus* Skeletal Segments from Millingstone through Middle-Late Transition

Segment	Proportional Representation of Elements/ Segment/ Component				
	MNT -63	MNT-73	MNT -1228	MNT-1232/H	MNT -1233
Cranial	0.800	0.200	0.800	1.000	1.200
Teeth	0.066	0.033	0.231	0.132	0.165
Axial	0.090	0.054	0.144	0.000	0.756
Forelimb	0.625	0.250	1.000	0.750	2.375
Hindlimb	1.000	1.000	1.800	0.600	2.200
Meta-podial	1.750	11.750	1.250	5.000	0.750
Forefoot	0.500	1.000	1.500	0.250	3.500
Hindfoot	0.125	0.250	0.250	0.125	1.500
Phalanges	0.123	1.476	0.164	3.034	0.041

Table 48 Spearman Rank Coefficients for Skeletal Segment Rankings Compared to Idealized Rankings Based on General Utility, Marrow Value, and Bulk Density for Milingstone through Middle-Late Transition Components

Idealized ranking	r_S Scores per component				
	MNT-63	MNT-73	MNT-1228	MNT-1233	MNT-1232/H
General Utility	0.25	0.44	0.20	0.11	0.11
Marrow	0.80	0.81	0.75	0.63	0.61
Bulk density	0.00	0.22	0.08	0.00	0.28

Score > 0.60 = Significance value of 0.05.
Score > 0.783 = Significance value of 0.01.

overrepresentation of cranial elements, probably as a result of the use of antlers for tools. Crania aside, the rest of the deer assemblages showed fairly equal proportions of all body segments, indicating that animals were brought to the home base whole, without butchering. The profile from CA-MNT-1232/H and other sites may reflect the significantly more rugged character of the Big Sur environment, where field butchering would have been a necessity, and the time-consuming extraction of marrow was saved for the residential base. Regular marrow processing also explains the low frequency of identifiable mammalian elements in the sites (Noe-Nygaard 1977). None of the element rankings correlated well with a bulk density profile, so it is unlikely that post-depositional destruction was at work in the record. There is no correlation with a reverse utility profile, suggesting that the type of logistical hunting recorded by Binford (1978, 1980) among the Nunamiut and used to define his *collector* settlement strategy was not practiced.

The Isotopic Record

The sample of isotope readings from human bone provides an important comparison with the dietary estimates based on faunal remains. One of the most striking revelations from the isotopic data is the lack of correspondence between the Millingstone archaeofauna, which show a heavy marine emphasis, and the stable isotope findings, which suggest a terrestrially-focused herbivorous diet (Figure 95). Identical findings were reported from larger samples in the Santa Barbara Channel, where Walker and DeNiro (1986) found the earliest inhabitants to be heavily dependent on terrestrial plant food, presumably small seeds. Millingstone archaeological deposits from the Channel, however, consistently yield high concentrations of shell (Erlandson 1988a, 1988b, 1991, 1994; Glassow 1992:121), as did the component at CA-MNT-1232/H. It is likely this disparity reflects high mobility during the Millingstone Period, with groups using a variety of inland settings during the course of their seasonal movements, and the coast only for limited periods.

Samples post-dating the Millingstone Period show heavier use of meat and fish, although in the context of a generalized diet. CA-MNT-1228 showed the highest reliance on terrestrial game of any of the samples, matching the estimate based on faunal remains. Shellfish were never an important dietary item, again corroborating the zooarchaeological data. The peak marine focus was at CA-MNT-1233 (Middle/Late Transition), but even here the intensity of maritime resource use was considerably less than in the Santa Barbara Channel. Readings from Late Period contexts at CA-MNT-1277/H and CA-MNT-1227 show a more generalized diet with less marine emphasis. CA-MNT-1227 shows a slight herbivorous focus, consistent with increased use of the acorn. Overall, better correspondence between faunal and isotopic data after 3500 B.C. suggests a decrease in mobility.

SEASONALITY

Seasonality estimates for the Millingstone through Middle/Late Transition were based on deer tooth annuli and oxygen isotope readings from mussel shells. While incomplete, the data are generally consistent and suggest only a modicum of temporal variability. Deer teeth annuli from four sites indicated occupation during the fall/winter (November-February) (Table 49 and Appendix II). This included Middle Period components on the coast (CA-MNT-63, CA-SLO-267) and in the interior (CA-MNT-521). This is an important finding, indicating separate interior and coastal populations, at least during the Middle Period (the same pattern evident for the Late Period). Most coastal sites (CA-MNT-63, -1228, and –1232/H), however, also showed a seasonal gap during spring and early summer. This gap was less pronounced at CA-MNT-1233, where shellfish were collected between April and August. Seasonal data from the Middle Period interior component at CA-MNT-521 show evidence for people returning from the coast with mussels in the spring--during the gap in coastal occupation. It would appear that coastal inhabitants moved inland during the spring, possibly to take advantage of the seasonal bloom in grasses and herbs that would follow winter rains. Based on the findings from CA-SLO-267, it further appears that coastal inhabitants returned to the shoreline in the summer or fall, while interior peoples remained in the interior. Overall, there seems to have been seasonal movement between the interior and the coast in the spring. Whether this was a bipolar system with one group moving between the shore and the interior is unclear, although I have suggested this elsewhere (Jones and Ferneau 2002). Some data also suggest separate occupations of both areas during the fall and winter. Tentatively, occupations seem to have been more seasonally extended during the Middle-Late Transition. Overall, the seasonality profiles show general continuity over time, which may be partially related to a small sample.

The consistency in seasonality, particularly the redundant evidence of fall/winter deer hunting, could be related to nutrient availability. Speth (1990) and Speth and Spielmann (1983) noted that spring was an interval of resource stress among many hunter-gatherers in temperate climates, including California.

Table 49 Millingstone-Middle/Late Transition Seasonality based on Deer Teeth Annuli, and Oxygen Isotope Values from Mussel Shells

Component	J	F	M	A	M	J	J	A	S	O	N	D
COASTAL SITES												
CA-MNT-1232/H Stratum II	-----	-----									-----	-----
CA-MNT-1228								-----	-----			
CA-MNT-63 Middle	-----	-----									-----	-----
CA-MNT-1233				+++++	+++++	+++++	+++++	+++++				
									-----	-----	-----	-----
CA-SLO-267	+++++	+++++				+++++	+++++	+++++	+++++	+++++	+++++	+++++
	-----	-----									-----	-----
INTERIOR SITE												
CA-MNT-521	-----	-----								-----	-----	
				+++++	+++++	+++++	+++++					

----- Deer Teeth annuli

+++ Oygen isotope values

Contributing to this problem was the lean state of game animals. Hunting and consumption of lean game, in the absence of other sources of fat and/or calories, makes for very meager subsistence, that in extreme cases, is dangerously low in calories. Many discussions of prehistoric diet in California emphasize protein (Erlandson 1988a, 1988b; Glassow and Wilcoxon 1988), but the high protein content of many foods available on the Big Sur coast (e.g., shellfish, fish, deer) could actually have been problematic, particularly in the spring. In the fall and winter when acorns were available, and deer were fat, it would have been cost-effective to hunt. By late winter/spring when acorn stores were exhausted and game became lean, it would have been unprofitable to hunt terrestrial animals and could have been more prudent to pursue either marine mammals or terrestrial sources of carbohydrates (e.g., plant foods). Marine mammals migrate past the Big Sur coast seasonally, but their appearance on shore is limited to unpredictable haul-outs. The spring/summer gap in occupation of the coast may reflect migration to the interior to exploit more expansive, richer sources of terrestrial plant foods. Acorn stores may too have lasted longer in the interior, where oak groves were larger and the dominant species are superior to coastal oaks in acorn production (McCarthy 1993). The oxygen isotope findings from the interior corroborate movement of people from the coast to the interior in spring/early summer.

FLAKED STONE TECHNOLOGY

Flaked stone cores, debitage, and tools made up a significant portion of the archaeological record at the investigated sites, and considerable energy was devoted to washing, cataloging, and classifying these materials, and completing of replication experiments to aid in their interpretation. While the stone-working residues showed marked spatial and temporal variability, with some important exceptions, they seemed more than anything else to reflect raw material distribution and technology. The degree to which they reflected mobility and settlement seem more limited. Nonetheless, temporal and spatial patterns in the flaked stone residues have been described, if for no other reason than to establish a seminal datum point for lithic studies in the region.

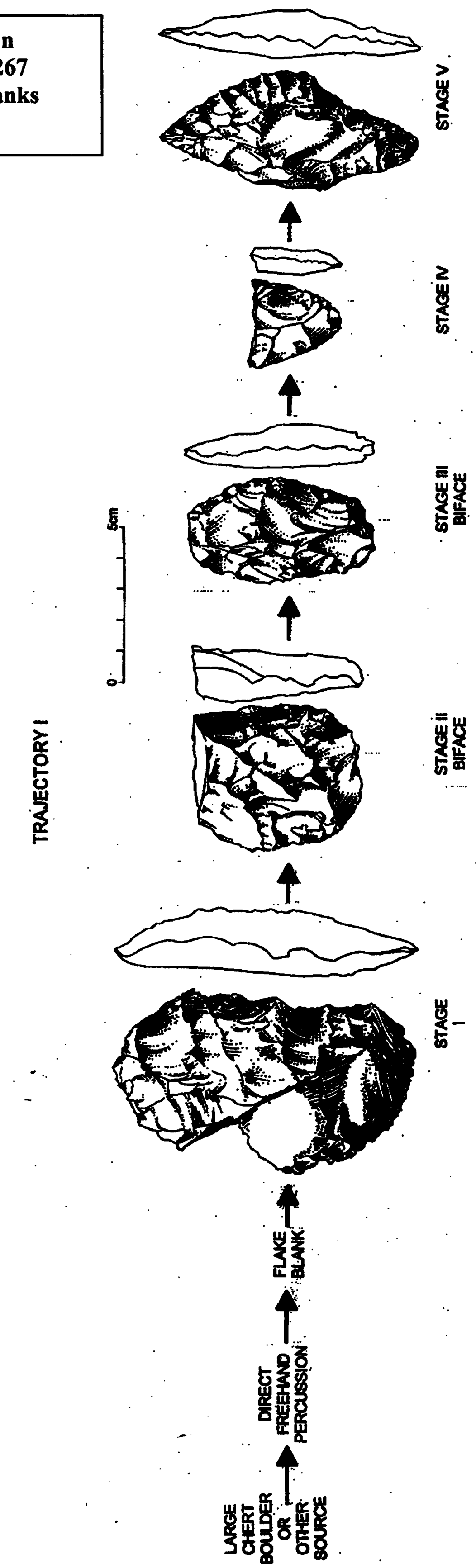
Two types of stone dominated the study site assemblages: Monterey chert found in the interior of the Santa Lucia Range and as a source adjacent to CA-SLO-267, and Franciscan chert found on the coast at outcrops and as cobbles. One source of Franciscan chert cobbles is located at the mouth of the Big Sur River, adjacent to CA-MNT-63 and –73. This source does not appear to have been particularly rich, however. A more visible and productive source of Monterey chert is located at Point Piedras Blancas where cobbles, pebbles, and boulders of relatively high-quality stone are found. All of the other coastal sites investigated for the study (i.e., those in the Big Creek drainage) were situated at least 15 km from sources of either Franciscan or Monterey chert. The interior sites within Fort Hunter Liggett were all relatively close to sources of Monterey chert, although exact distances between sites and sources could not be defined, due to lack of complete information on the quarry locations. Proximity to stone explains many characteristics of the archaeological assemblages, irrespective of time or technology. Sites in the chert-rich areas showed high debitage densities, high flake:tool ratios, high proportions of core/flake-derived debitage, and high core:biface ratios (Table 50). The local Franciscan chert was the dominant raw material at the Big Sur River sites (CA-MNT-63 and CA-MNT-73), whereas Monterey chert dominated at all other coastal and inland areas.

With respect to technology, the Millingstone through Middle-Late Transition components distinguished themselves from the Late and Protohistoric periods by an industry focused on large bifacial implements suitable for use as knives, spear, and/or dart points. This technology was well represented at both CA-MNT-73 and CA-SLO-267. At least three different reduction sequences were associated with this industry. As represented by production failures at CA-MNT-73, large bifaces were in some cases produced from Franciscan chert by splitting the cobbles either with the bipolar technique or direct freehand percussion to produce large flake blanks that could, in turn, be reduced into bifacial preforms (Figure 10). The preforms were reduced through a series of stages from crude stage 1 bifacial cores into finished, pressure-flaked tools (Stage 5). Two other reduction trajectories were suggested at CA-SLO-267. The first involved large flakes obtained from boulders or other massive sources which served as flake blanks (Figure 99). These were in turn reduced through the same bifacial stages. Points and other tools produced in this manner were distinguished by a lack of cobble cortex on the finished implement. Bifaces produced from cobble-derived flake blanks inevitably showed some remnant of the original cobble on at least one surface. The other reduction technique, represented at CA-SLO-267, involved small tabular pebbles and cobbles of Monterey chert (Figure 100). For Franciscan chert cobbles, experimental replication

Table 50 Characteristics of Flaked Stone Assemblages, Millingstone through Middle-Late Transition

Component	Total flakes	% Monterey chert	Flakes/ m^3 3 mm mesh	Flakes/ m^3 6 mm mesh	Flake: biface 3 mm mesh	Flake: biface 6 mm mesh	% Core/ flake debris 3 mm	% Core/ flake debris	Biface: core
CHERT POOR COASTAL SITES									
CA-MNT-1232/H	19	92.9	4	-	5:1	-	23	-	1:1
CA-MNT-1228	337	90.2	23	-	9:1	-	30	-	36:1
CA-MNT-1233	171	95.3	17	-	9:1	-	40	-	2:1
CHERT SOURCES									
CA-MNT-73	11232	12.3	537	-	250:1	-	56	-	0.4:1
CA-MNT-63	301	14.3	145	-	107:1	-	35	-	1:1
CA-SLO-267	173,548	99.8	16,563	-	2303:1	-	95	-	2:1
NEAR SOURCE SITES									
CA-MNT-861	1117	99.5	-	179	-	183:1	-	76	7:1
CA-MNT-1657	1214	99.0	-	44	-	173:1	(57)	67	4:1
CA-MNT-1672	709	99.6	320	72	192:0	54:1	57	68	3:1
CA-MNT-569 A	15253	99.1	8290	1253	822:1	-	85	-	2:1
CA-MNT-332	10082	99.6	5963	1020	4180:1	281:1	84	(94)	2:1
CA-MNT-521	39929	99.2	4478	1568	443:1	-	84	-	2:1
CA-MNT-1754	1157	98.9	-	210	-	172:1	-	86	1:1
CA-MNT-504	132	99.2	-	29	-	29:1		79	2:1
CA-MNT-507	761	99.0	-	195	-	94:1	-	75	6:0
CA-MNT-519	7720	99.6	1428	-	203:1	-	83	-	3:1

Figure 99 Biface Reduction Sequence from CA-SLO-267 Involving Large Flake Blanks



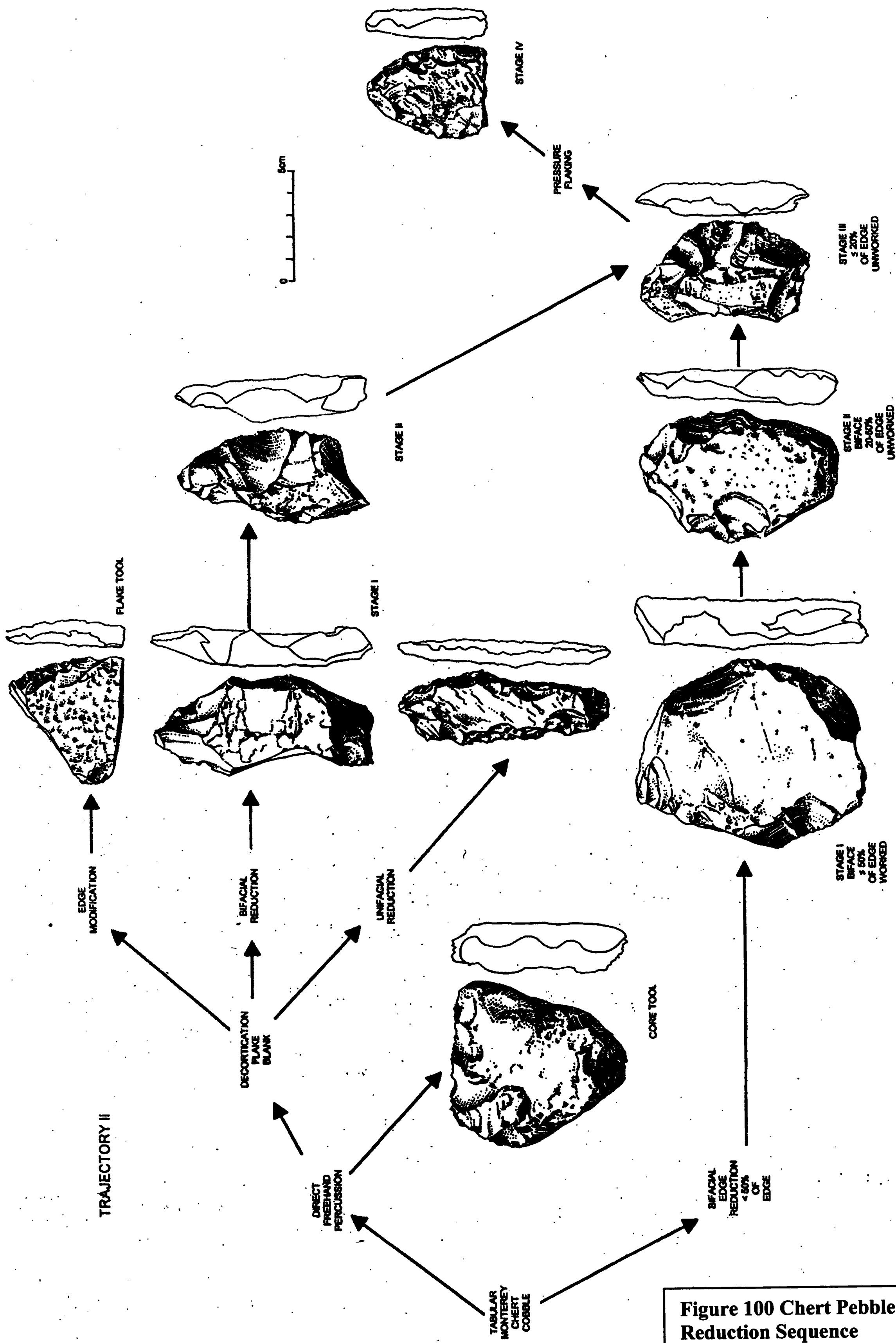


Figure 100 Chert Pebble Reduction Sequence Identified at CA-SLO-267

showed that initial reduction (manufacture of a Stage 1 biface from a cobble) produces debitage that is ca. 73% core/flake derived. Reduction of stage 1 bifacial preforms into tools produced debitage dominated (ca. 74%) by biface-derived flakes (Table 6). When the full reduction sequence is carried out in one location, biface-derived flakes make up 62% of the debitage, and core-flake debris, 38%.

Experimentation also showed that patterns in debitage frequency were very different for Monterey chert which occurs in more massive blocks at sources in the interior and at CA-SLO-267. At quarry site CA-MNT-1813 within Fort Hunter Liggett material was available in large (10-25 cm diameter) angular blocks, most of which were of relatively poor quality due to linear fracture planes. For this reason, reduction of Monterey chert from Fort Hunter Liggett quarries required much more primary reduction, which led to the production of more core/flake debitage. Production of a large flake blank from an angular chunk and subsequent reduction of the blank into a stage 1 biface resulted in 1215 pieces of debitage (3 mm mesh) for a flake-biface ratio of 1215:1. This reduction was associated with 97.6% core/flake debitage. Reduction of a Stage 1 bifacial preform to a Stage 5 projectile point was still dominated by core/flake debris (74.5%). The full reduction sequence from chunk to finished bifacial tool yielded 89.6% core/flake debitage.

In general, the vast majority of variability in the pre-Late flaked stone assemblages can be equated with technology, distance from source, and site function. CA-SLO-267 represents a chert source/workshop where relatively good quality stone was abundant in a variety of forms (cobble, pebble, boulder). The site produced a profusion of debitage with an average of over 16,000 flakes/m^3 (Table 50). Nearly all of this waste material represented the local stone (99.8%). While the site was clearly associated with biface technology, producing over 500 bifaces and projectile points, debitage was dominated by core/flake debris (95%), reflecting primary reduction from the source. The flake-biface ratio was extremely high (2303:1) as a result of the transport of some bifaces to other locations for further reduction and use. Perhaps most significantly, this deposit showed a predominance of bifaces over cores by a ratio of 2:1, even with the very liberal definition of core used for the current project (cf., Bouey and Basgall 1991).

The less abundant secondary chert sources at CA-MNT-63 and CA-MNT-73 showed different patterns. Debitage density was much lower (only 145 flakes/m^3 at CA-MNT-63), and the stone available at the source (Franciscan chert) accounted for no more than 88% of the debitage. Flake-biface and biface-core ratios were lower, considerably so for the former. Core/flake debris was also much less dominant among the waste. These figures all seem to reflect the form in which chert occurred at this site. In contrast with the Monterey chert, experimental reduction of small Franciscan chert cobbles like those found near CA-MNT-63 and -73 shows a dominance of bifacial flake types over core flake debris for a full reduction sequence (see Table 5). The high frequencies of biface-derived debitage at CA-MNT-63 and –73 probably reflect a full reduction sequence. More importantly, the form of the raw material at this location fostered a quantitative profile completely different from those associated with Monterey chert sources.

The remaining pre-Late assemblages represent sites situated at various distances from toolstone sources, including those in the Big Creek drainage on the coast where the nearest quarry for Monterey chert was at least 15 km distant, and sites in the interior within Fort Hunter-Liggett where raw material was generally rather close at hand. The actual locations of all of the Fort Hunter-Liggett sources are unknown, however, due to incomplete survey coverage. Sites in the chert-poor coastal areas showed remarkably low flake densities ($\leq$36 flakes/m^3) and extremely low flake-biface ratios ($\leq$9:1). All of these assemblages were also heavily dominated by biface-derived debitage. Biface-core ratios also varied from source locations, with CA-MNT-1228 at Big Creek showing a value of 36:1. There can be little doubt, that with the possible exception of CA-MNT-1232/H, these assemblages represent bifaces that were produced elsewhere and then transported into the chert-poor areas where they were further reduced.

Sites within Fort Hunter-Liggett showed attributes intermediate between chert sources and chert-poor areas. All of the interior sites were dominated by Monterey chert (>99%). All of these sites showed a predominance of core-flake debris, despite the heavy representation of bifaces in the tool assemblages. All of the midden sites (CA-MNT-332, -519, -521, -569A) showed nearly identical proportions of core-flake debris (between 83 and 85%). These sites also showed fairly high flake densities with a range between ca. 8300/m^3 at CA-MNT-569A and 1400/m^3 at CA-MNT-519. A range of flake-biface ratios was also apparent with a maximum of 4180:1 at CA-MNT-332 and a minimum of ca. 200:1 at CA-MNT-519. The profusion of flakes and the high flake-biface ratios at CA-MNT-569A and CA-MNT-332 suggest these sites were situated relatively close to sources of Monterey chert. The inordinately high flake:biface ratio at CA-MNT-332 is particularly suggestive of a near-source situation with bifaces being produced for transport and use elsewhere. Cores, flake blanks and early stage bifaces were probably brought to these locations and reduced into later stage bifacial tools. CA-MNT-519 with a considerably lower flake density and flake-biface ratio was probably a location where early stage bifaces were reduced. Consistent with this observation was a biface-core ratio of 3:1. The other midden sites all had biface-core ratios of 2:1. Perhaps not surprisingly, all of the non-midden sites (CA-MNT-504, -507, 861, -1657, -1672, -1754) also had lower debitage densities, lower flake-biface ratios, and higher biface-core ratios. These traits seem consistent with locations that were not major production loci, but rather places where a limited array of tasks was accomplished using later stage bifaces. Later stage preforms were probably reduced into tools. In the interior within Fort Hunter-Liggett, midden sites were clearly major stone reduction loci where all stages of reduction were completed. The non-midden sites represent places where preforms were reduced.

As a general rule, preforms and finished tools manufactured at sources were transported to sites in chert-poor settings, where they were further reduced (i.e., preforms were converted into tools and tools were reworked). In this regard, the Monterey chert-dominated assemblages on the coast at Big Creek testify to the movement of people between the interior and the coast. Debitage from pre-arrow sites where raw material was absent, such as CA-MNT-1228, show biface thinning debris in a proportion (73.2%) similar to the experimentally-derived figure (73.5%) associated with preform reduction. The heavily resharpened blades on several points from CA-MNT-1228 (Figures 16 and 17) also indicate reworking.

Clearly most of the variability in the Big Sur assemblages can be attributed to the the distribution and quality of toolstone and the form in which it occurs. This observation is consistent with views advanced by Andrefsky (1994) who emphasized the significant influence of raw material availability on the organization of stone technology. Nonetheless, some aspects of the flaked stone assemblages may speak to aspects of Big Sur prehistory beyond the specifics of simple tool manufacture and distribution. Seminal papers in the 1980s by Parry and Kelly (1987) and Kelly (1988) demonstrated that mobile hunter-gatherers tend to rely on bifaces as cores. The premise here is that bifacial cores would benefit mobile populations in being readily modifiable, multi-functional, and portable (Andrefsky 1998:150). Some (e.g., Kuhn 1994) have argued for a different optimal mobile tool kit, but Parry and Kelly (1987) also showed that biface-core ratios tend to decrease as people settle down and become less mobile. If this obserevation is accurate, the biface-oriented technology marking the Early and Middle Period on the Big Sur coast would seem generally consistent with some measure of mobility. Most of the variability in biface-core ratios, however, seems to reflect distance from source. The highest biface:core ratio (36:1) was manifested at CA-MNT-1228 in the Big Creek drainage, far from any source of toolstone while lower values (2:1 at CA-MNT-521, -332, 569A and CA-SLO-267) were evident at sites closer to sources of stone. No clear temporal trend can be discerned among the biface:core ratios. If this computation does reflect mobility at some level, the data from the Millingstone through Middle-Late Transition do not show any obvious trend toward increasing sedentism.

A hint of a meaningful shift in the organization of technology was afforded by the findings from the Millingstone Period component at CA-MNT-1232/H, where an inordinately low frequency of debitage (4 flakes/m^3) and flake:biface ratio (4.8:1) suggested a minimal emphasis on flaked stone tool production. A low incidence of flaked stone is characteristic of Millingstone sites throughout California (Meighan 1978:236). Furthermore, one of the largest cores of any of the investigated sites, a chunk of Monterey chert weighing 461 g, was also found as part of this component. Larger than any of the cores found at either the Big Sur River chert source or the interior, this specimen was one of three cores recovered from Stratum II, equaling the number of bifaces. These traits suggest a low rate of tool production and a high rate of curation, as raw material was transported into chert-poor settings in the form of flake blanks, and cores more frequently than preforms.

The Early Period shows a departure from Millingstone tool manufacturing strategies. Early Period components in both chert-rich and chert-poor settings show greater densities of flaked stone debris and increased flake:biface values (Table 50). CA-MNT-1228, situated near CA-MNT-1232/H but occupied after CA-MNT-1232/H Stratum II was abandoned, showed a markedly increased ratio of 36:1, signaling a new emphasis on biface technology, with preforms (Stage 1-4 bifaces) emphasized over cores. It is unclear whether the shift in ratios reflects a general disinterest in bifaces by Millingstone peoples or a shift in mobility. If it is the latter, the trend would be toward increased mobility not a decrease. After this shift, stone residues in the Big Creek area show continuity through the Middle/Late Transition as suggested by the findings from CA-MNT-1233 where the flake:biface ratio (9:1) and debitage density (17 flakes/m^3) are similar to CA-MNT-1228. A lower biface:core ratio may reflect the presence of an incipient arrow point industry reflected by the presence of small leaf-shaped projectile points.

It is significant that stone sources seem not to have been exploited through the use of specialized quarry sites, but by combined residential/workshop sites, exemplified by CA-MNT-63, CA-MNT-73, and CA-SLO-267. Flaked stone tool manufacture and use appears to have been firmly embedded within the larger settlement and site use strategy. Use of these sites changed slightly through time, however, as Early Period occupation at CA-MNT-73 showed more emphasis on stone-working (flake density of 537/m^3 and flake:tool ratio of 249.6:1) than the Middle Period component at CA-MNT-63 (flake density of 145/m^3 and flake:tool ratio of 107:1). Apparently, Middle Period site use was more generalized. Changes accompanying the onset of the Late Period reflect the greater production of arrow points. Although arrows seem to have been introduced during the Middle/Late Transition, arrow points did not dominate tool assemblages until the Late Period.

INTER-REGIONAL EXCHANGE

Obsidian is perhaps the only clear marker of inter-regional exchange during the Millingstone through Middle-Late Transition periods. Imported as finished bifaces that were often heavily re-worked, obsidian was found at Big Sur sites in the form of biface fragments and small broken pressure flakes. Eight different source locations have been identified to date: Annadel, Bodie, Casa Diablo, Coso, Hicks/Queen, Mono, Napa, and Queen (Figure 101), but only Casa Diablo, Coso, and Napa were numerically significant. In general, obsidian from the Casa Diablo source was most abundant, followed by Coso and Napa. Coso obsidian, however, did not appear in significant quantities until the Middle Period, as indicated by its near absence from the Early Period component at CA-MNT-73. No other significant source variability is apparent.

When recovery bias was accounted for, obsidian showed change in frequency through time. Because it was most commonly found in the form of small pressure flakes, obsidian samples from 6 mm mesh recovery were inevitably lower than those from 3 mm mesh. Previous claims for the chronology of obsidian arrival on the central coast (cf. Breschini and Haversat 1989; Cartier 1993a) ignore this type of recovery bias. Obsidian from the sites investigated for this project were evaluated by considering the density/m^3 from 3 mm mesh samples only. Calculations of density also took into account hydration results, which in some instances (e.g., CA-MNT-1277/H) indicated that the obsidian was not contemporaneous with the rest of a deposit. When these variables were controlled, the Big Sur data show definitive trends through time (Table 51). No obsidian whatsoever was recovered from the Millingstone component at CA-MNT-1232/H, and a similar absence or near-absence has been noted at other Millingstone components on the central coast, including CA-MNT-229 (Dietz et al. 1988; Jones and Jones 1992), CA-MNT-228 (Jones et al. 1996), CA-SLO-1796 (Fitzgerald 1997), and CA-SLO-1797 (Fitzgerald 2000; Jones et al. 2002).

Obsidian appeared initially during the Early Period, first at CA-MNT-1228, in a small quantity, and later at CA-MNT-73, in abundance. Quantities comparable to the yield from CA-MNT-73 were reported by Breschini and Haversat (1989) from CA-MNT-108 on the Monterey Peninsula in a nearly identical temporal context. Obsidian density increases through the Middle Period, as shown at CA-MNT-63 and CA-MNT-521, but disappeared from the record during the Middle/Late Transition at CA-MNT-1233. As discussed in Chapter 8, it was also missing from most of the Late and Protohistoric Period components. A cumulative hydration profile depicting all hydration readings from Big Sur likewise shows the greatest number of readings in the Early and Middle Period micron spans, with very few in earlier or later periods (Figure 102).

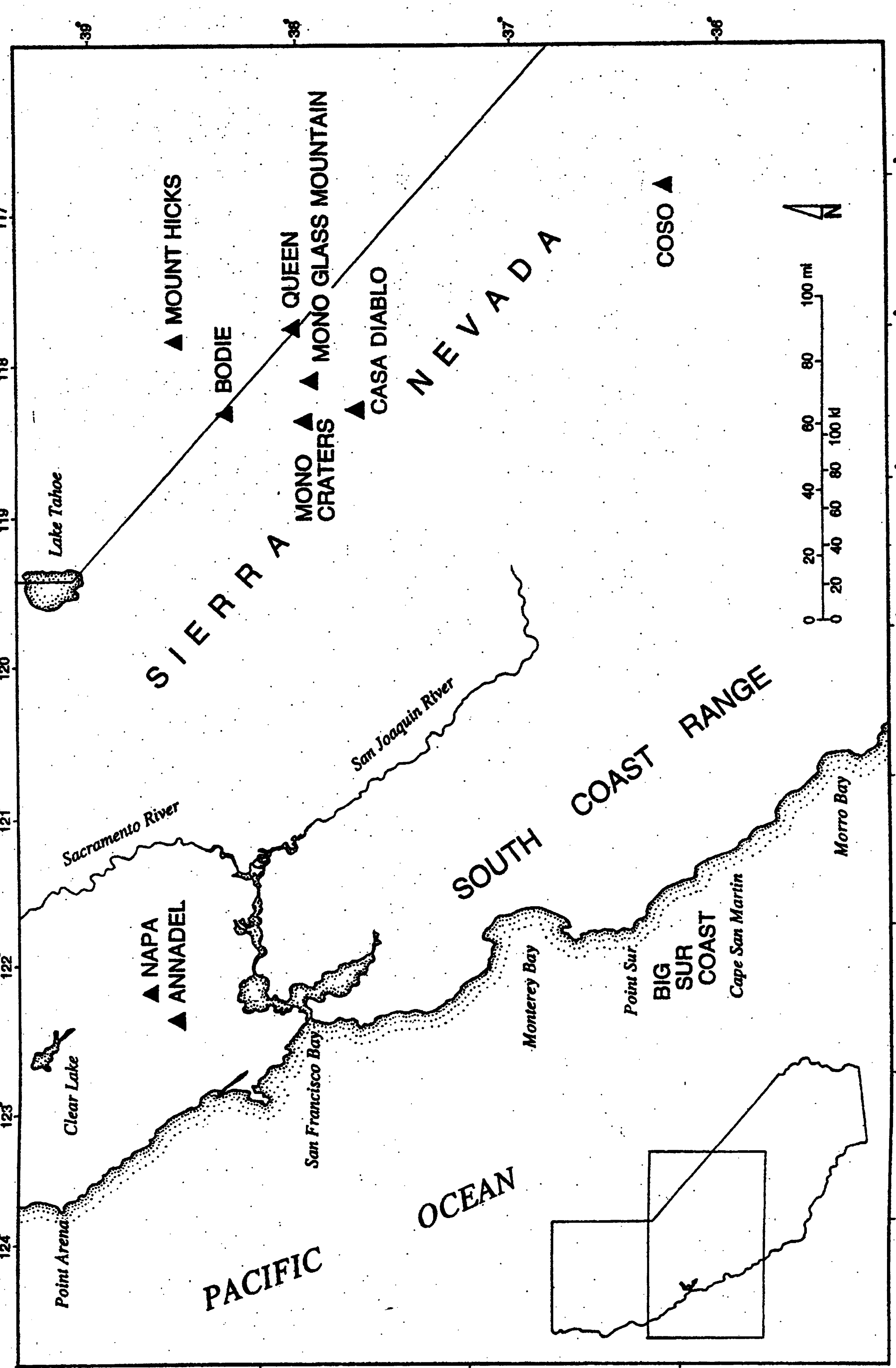


Figure 99 Obsidian Sources represented at Archaeological Sites on the Big Sur Coast

Figure 102 Cumulative Hydration Profile for Casa Diablo, Napa, and Coso Obisidian from Big Sur Archaeological Sites

Table 51 Summary of Obsidian Recovery, Millingstone through Middle-Late Transition

Site	Total excavation volume (m^3)	Volume screened through 3 mm mesh (m^3)	Contemporaneous obsidian	Obsidian/ m^3 screened through 3 mm mesh
CA-MNT-1232/H	5.4	2.6	0	0.00
Subtotal	5.4	2.6	0	0.00
CA-MNT-1228	14.7	1.6	1	0.40
CA-MNT-73	20.9	20.9	94	4.49
CA-MNT-569 A	30.1	1.9	4	2.11
Subtotal	65.7	24.4	99	4.06
CA-MNT-63	4.6	3.2	19	5.93
CA-MNT-332	6.5	0.7	5	7.01
CA-MNT-521	25.0	3.2	32	10.00
CA-MNT-519	10.0	1.0	2	2.00
CA-SLO-267	70.3	7.0	6	0.86
Subtotal	116.4	15.1	64	4.24
CA-MNT-1233	10.0	3.4	0	0.00
Subtotal	10.0	3.4	0	0.00
Grand total	197.5	45.5	163	3.58

Pendants of talc schist were also apparently employed in exchange networks. Absent from Stratum II at CA-MNT-1232/H, these artifacts appear for the first time during the Early Period at CA-MNT-1228 when obsidian also first appeared. Partially complete specimens were recovered from both this site and Stratum I at CA-MNT-1232/H, demonstrating their local manufacture.

Evidence for local shell bead and/or pendant manufacture is relatively modest among the investigated sites. Possible pendant blanks were found at CA-MNT-1223, -1227, and -1233. Several bead blanks were recovered from CA-MNT-1277/H. The most substantive inventory was obtained from CA-MNT-1223, where pendant blanks were found along with drills and a few small blades. These items apparently represent a small-scale manufacturing industry. All of the evidence for shell bead and/or pendant manufacture dates from the Middle/Late Transition and later, and may indicate continuation of trade. The absence of obsidian and otter bones from the Late Period sites, however, suggests that exchange networks were less extensive than they had been previously.

CHAPTER 10: SUMMARY AND CONCLUSIONS

Sites investigated for this project revealed a complex pattern of human occupation spanning from 4400 B.C. to A.D. 1830. This sequence was divided into seven periods, each represented by a local phase: Millingstone (Interpretive Phase; 4400-3500 B.C.), Early (Redwood Phase; 3500-600 B.C.), Middle (Willow Creek Phase; 600 B.C.-A.D. 1000), Middle-Late Transition (Highland Phase A.D. 1000-1300), Late and Protohistoric (Dolan Phase; A.D. 1300-1769), and Historic (Santos Phase; A.D. 1769-1830). In an effort to develop the most effective interpretation for patterns in this sequence, salient characteristics of each period are reviewed in this chapter, and intervals of transition are evaluated relative to the predicted outcomes from alternative theories discussed in Chapter 1. Four intervals of significant change were considered: Millingstone-Early (ca. 3500 B.C.), Early-Middle (600 B.C.), the Middle-Late (A.D. 1000-1300), and the Proto-historic-Historic (A.D. 1769). To evaluate possible links between apparent cultural changes and events in the natural environment, paleo-environmental trends were reviewed, and cases for or against environmental causality were evaluated. In light of the paleoenvironmental record, the directions of cultural changes were then evaluated relative to the outcomes anticipated from theories of cultural evolution, cultural ecology, resource stewardship, and optimal foraging. While population-induced subsistence intensification explains much of the record, rapidly transpiring, high-intensity environmental deterioration between A.D. 1000 and 1300 appears to have caused unique changes in settlement, diet, exchange, and social relationships.

MILLINGSTONE PERIOD

Other than a single, unassociated radiocarbon date from CA-MNT-521, the Millingstone Period was represented only by Stratum II at CA-MNT-1232/H, and the interpretive limitations of such a small sample must be acknowledged. Indeed, the term "Interpretive" was applied to the phase defined from this component in part to acknowledge the challenges presented by such a small but unique component, and in part to recognize the site's location along the Big Creek Reserve Interpretive Trail. Dating ca. 4400-3300 B.C., Stratum II yielded a small, but distinctive assemblage similar to those from Millingstone sites in southern California (Meighan 1978:234-236; Rogers 1929; Wallace 1955). Typical Millingstone traits represented in Stratum II included a low frequency of flaked stone debitage and tools, particularly projectile points, and absence of mortars and pestles. Overall, this component fits comfortably within widely accepted characterizations of the Millingstone culture or horizon (Wallace 1955, 1978; Meighan 1978:234-236; Fitzgerald and Jones 1999).

The dietary proclivities of Millingstone peoples have been a subject of different views over the years. Marine foods, in particular, have not always been linked with the Millingstone Horizon (see Wallace 1978:28), but recent investigations have documented dense accumulations of shell in Millingstone contexts (Greenwood 1972; Erlandson 1988a, 1988b, 1991, 1994; Glassow 1991:119, 1992; Warren 1964). In keeping with this pattern, CA-MNT-1232/H showed a dense concentration of mussel shells, although the rest of the faunal assemblage suggested a somewhat diverse diet composed of nearly equal proportions of shellfish, marine mammals, and terrestrial mammals. While fish were insignificant as a dietary item, shellfish and marine mammals were more important than during any other period prior to historic contact. Overall, diet breadth was fairly low, however, with a Margalef score of only 1.39 for the mammal and bird assemblage (Figure 103). A human bone isotope reading suggesting an herbivorous, terrestrially-focused diet is at odds with the findings from the faunal remains. Although this discrepancy could reflect the limited sample, it is consistent with the Santa Barbara Channel, where faunal residues show high frequencies of shellfish (Erlandson 1988a, 1988b, 1991), but human bone studies suggest a vegetable-based diet (Walker and DeNiro 1986). It is further consistent with a millingstone-dominated tool assemblage, commonly linked to small seed processing (see Meighan 1978; Wallace 1978; Erlandson 1991, 1994 among others). The discrepancy between the faunal and isotope findings from CA-MNT-1232/H, suggests this was only one location used for subsistence, indicating that Millingstone peoples in Big Sur were relatively mobile. The mussel harvesting strategy represented in Stratum II was one of only four that showed any degree of selectivity. This further suggests non-sedentary occupation and relatively low population levels, as selective harvest could only be sustained at mussel beds that were not harvested regularly (White 1989). Mobility was probably residential in nature, since Stratum II clearly represented a residential base. The distribution profile of deer elements, however, suggested a logistical hunting strategy in which carcasses were butchered in the field and then were transferred to the residential base for marrow processing. A dominance of Monterey chert among the debitage and tools suggests movement between the coast and the interior, as does the shell-derived radiocarbon date from the interior at CA-MNT-521. At a minimum, the coast was apparently used in the fall/winter, based on deer teeth annuli.

Flaked stone from CA-MNT-1232/H showed a very low debitage density and a very low flake:biface ratio (5:1). These characteristics suggest that flaked stone tool manufacture was relatively unimportant which is consistent with a diet emphasizing shellfish and small seeds. There was also a hint of variation in the use of toolstone as suggested by a large block of Monterey chert. This large piece of toolstone suggested an *ad hoc* strategy in which stone was occasionally transported into chert-poor areas in the form of cores and flake blanks that were apparently cached in anticipation of a range of future needs. Stratum II yielded no obsidian, which is consistent with other early sites on the central California coast (Jones and Waugh 1995). Inter-regional exchange appears to have been very poorly developed during the Millingstone Period.

EARLY PERIOD

The Early Period was represented by a more robust sample including findings from CA-MNT-1228 (3700-2900 B.C.) and CA-MNT-73 (2300-1700 B.C.) on the coast and CA-MNT-569A, -861, -1672, and -1657 in the interior. Collectively, these sites defined the Redwood Phase. They show continued use of milling slabs and handstones, along with the initial appearance of mortars and pestles, and stemmed projectile points. These additions conform with patterns in the Santa Barbara Channel and the Monterey Bay Area. Other changes in diet, mussel collection strategies, and exchange suggest that Early Period people were less mobile then during the Millingstone Period but still not fully sedentary.

Faunal residues show significant change, as fish and terrestrial game became more significant in the diet (Figure 104). At CA-MNT-1228, terrestrial mammals were dominant, while at CA-MNT-73, fish were most important. Shellfish decreased in dietary importance at both sites. Human bone isotope data were consistent with the faunal indices, indicating a greater carnivorous focus. Mussels were collected by the more labor-intensive stripping technique for the first time, causing a decrease in the mean size of shells.

Early Period stone working reflected greater use of flaked stone tools, and more calculated use of bifacial preforms. CA-MNT-1228 showed significant increases in debitage density (23 flakes/m^3), flake:biface ratio (9:1), and biface:core ratio (36:1). Continued dominance of Monterey chert (CA-MNT-1228) suggested ongoing ties between the coast and the interior. Sites in the interior showed a range of functional types, indicating that local settlement systems more closely approximated a collector type settlement strategy.

Inter-regional trade apparently began in earnest during the Early Period based on the appearance of obsidian, first in small amounts at CA-MNT-1228, and later in abundance at CA-MNT-73 and CA-MNT-569 A. Locally-made talc schist pendants might have been probably offered in trade, since the pendants appear in the record for the first time coeval with the appearance of obsidian.

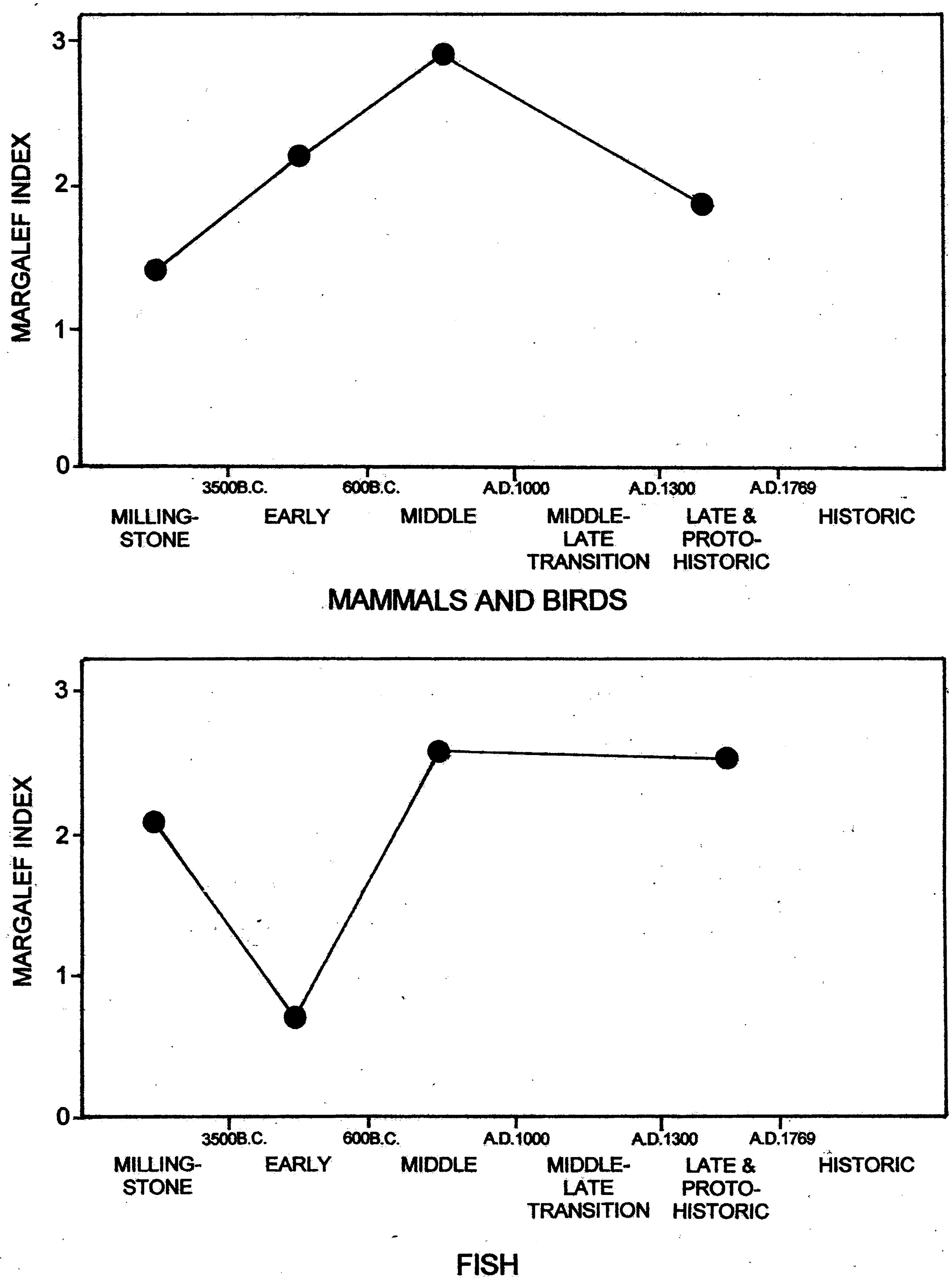


Figure 103 Diet Breadth through Time for Mammals, Birds, and Fish Based on Margalef Index Scores

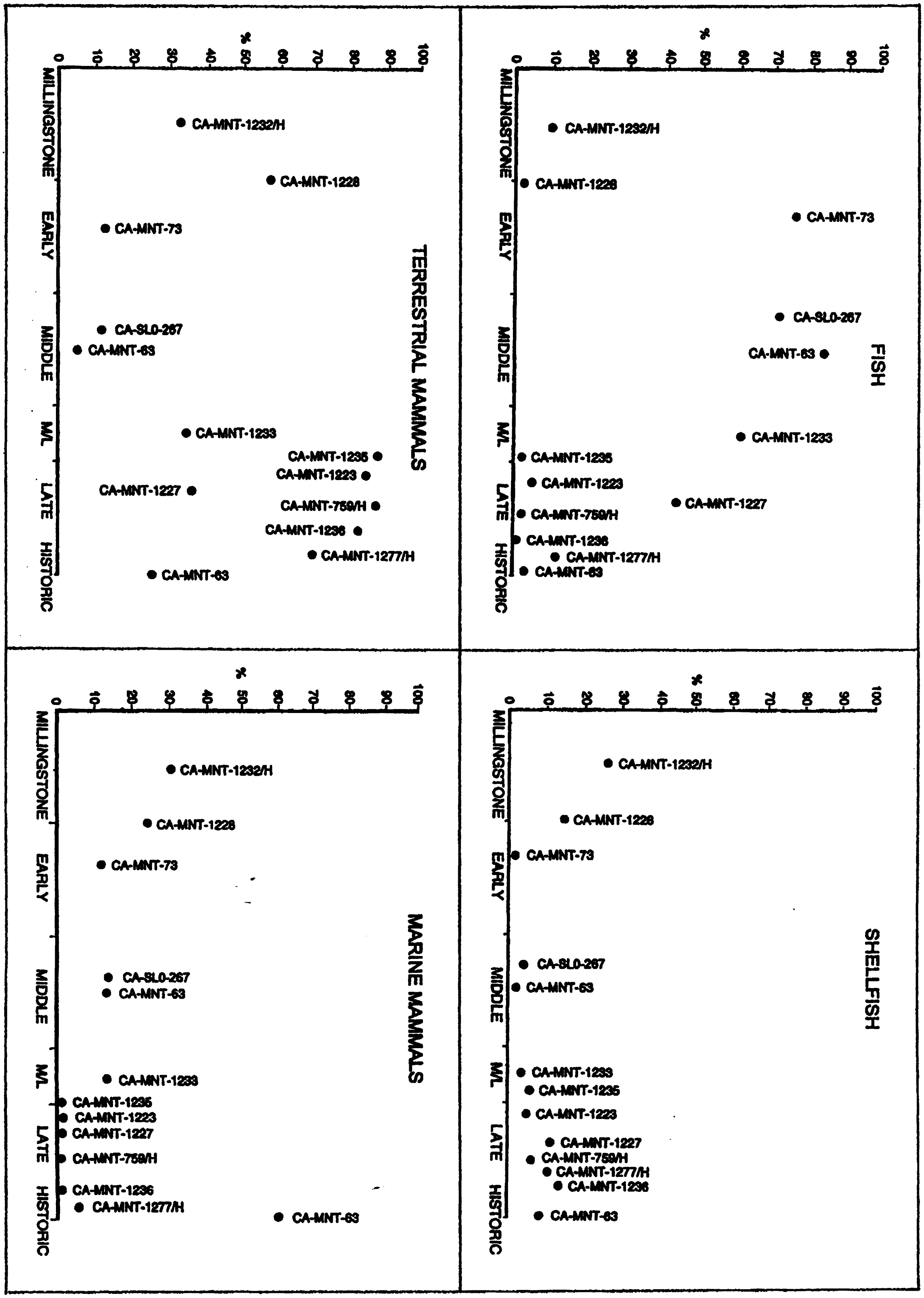


Figure 104 Summary of Dietary Trends through Time for the Big Sur Coast

MIDDLE PERIOD

The Middle Period was represented by materials from CA-MNT-63, -332, and -521, supplemented with data reported previously from CA-MNT-282 (Pohorecky 1976). These sites show strong stylistic continuity from the Early Period. Earlier projectile point and ground stone types persisted, along with circular shell fishhooks that were a significant innovation at the onset of the Middle Period, supplementing or possibly replacing bone gorge hooks. Faunal residues show the appearance of hooks to be coeval with an increase in fishing, as seen elsewhere on the California coast (Fitch 1972). Rabbits and otters were slightly more important in the diet than they had been previously, although the latter may have been exploited more for their pelts than for their meat. Diet breadth among both fish and mammals was higher than at any other point in the sequence (Figure 104).

There was only modest evidence for change in stone tool manufacturing from the Early Period to the Middle Period. The chert source at the mouth of the Big Sur River was exploited as part of generalized residential occupation, with less emphasis on stone-working than during the Early Period. Sites near sources of Monterey chert showed occupations that combined heavy stone working with residential use. Sites closest to sources showed the full range of reduction, while sites further away showed a focus on preform reduction. These types of uses seem little changed from the Early Period. Both the coast and the interior were occupied during the fall/winter, indicating two distinct populations, not one moving between two environments. Seasonal movements were undertaken in the spring when coastal inhabitants migrated inland, only to return to the coast in the late summer or fall. A combination of residential mobility combined with logistical hunting suggests a continued collector-like settlement strategy.

Inter-regional exchange peaked during the Middle Period as obsidian density was higher at CA-MNT-521 than at any other site, although combined obsidian density for the Middle Period was very similar to the Early Period. Volcanic glass from the Coso source reached Big Sur for the first time. Otter pelts apparently reached their peak utility as trade items during this time.

MIDDLE-LATE TRANSITION PERIOD

The Middle-Late Transition was represented at CA-MNT-1233 and CA-MNT-281 on the coast and CA-MNT-1754 in the interior. These assemblages again showed continuity in point types and ground stone from the Middle Period, although small leaf-shaped points and hopper mortars appeared for the first time alongside the persisting large stemmed types. The larger points were more abundant in the assemblages than the smaller types, however. The latter are commonly interpreted as arrow points. Faunal remains showed continued emphasis on fishing, including pursuit of some small taxa like anchovies. A bone isotope reading suggests more generalized subsistence, slightly more marine-focused than at other sites. Mussels continued to be collected by stripping entire colonies.

Stone use showed strong continuity from the Early Period in the Big Creek drainage. The settlement system continued to approximate a "collector" pattern based on the hunting-focused assemblage at CA-MNT-1754 and on patterns in the skeletal element profile from CA-MNT-1233. Seasonality findings suggest that coastal sites might have been occupied longer than they were previously, but were still probably not fully permanent. No obsidian was recovered from the Middle-Late Transition sites, and otter bones show a significant proportional decrease from the Middle Period, suggesting that inter-regional exchange networks may have broken down.

LATE AND PROTOHISTORIC PERIODS

The Late and Protohistoric Periods were well-represented in the excavation sample. Thirteen sites yielded evidence for Late/Protohistoric occupation, and ten produced substantive, temporally discrete components. Most of these showed little evidence for occupation earlier than A.D. 1100. All were marked by Desert Side-notched and Canaliño/Coastal Cottonwood projectile points, hopper mortars and/or bedrock mortars, small well-made drills, and class E *Olivella* and steatite disk beads. Circular shell fishhooks were still used, and contracting-stemmed points may have persisted in very low quantities, along with handstones and milling slabs.

In my earlier writing (Jones 1995), I suggested that the Late Period showed a decided emphasis on terrestrial foods, particularly black-tailed deer. The excavation sample available in 1995 suggested a lack marine mammals in the diet, and a decrease in the importance of fish. The findings from CA-MNT-1942 reported by Wolgemuth et al. (2002), however, show that fish, including small taxa such as herring and anchovies, continued to be caught during the Late Period. Margalef scores show no evidence for increased diet breadth among piscine resources, however, from the Middle Period into the Late Period (Figure 103). Human bone isotope results suggest a generalized diet. Margalef Index scores for mammals and birds suggest a decrease in diet breath. Mussels were collected by stripping, although the Protohistoric components at CA-MNT-1277/H and CA-MNT-569B suggest a return to "plucking" and an increase in mean shell size. The latter, however, could also reflect slightly cooler sea temperatures during the Little Ice Age.

The Late Period was marked by a new stone technology, in which flake blanks from carefully prepared cores were pressure-flaked into preforms, and arrow points. Large bifacial implements were very uncommon among Late Period assemblages, and staged reduction of large preforms into bifacial tools (a process that dominated Early and Middle Period stone working activities) was not common during the Late Period. As a result, debitage at Late components was dominated by core/flake debris. Blade flakes were found occasionally reflecting careful core preparation, and the use of blade blanks for projectile points. Late Period cores on the coast were very small and heavily worked.

Four types of sites were associated with the Late/Protohistoric Period: large middens associated with village names, smaller middens, bedrock mortars with associated, diverse scatters, and bedrock mortars with minimal associated debris (CA-MNT-361). All four of these site types seem to represent residential encampments, occupied for varied amounts of time although bedrock mortars with little or no associated debris must have functioned as non-residential processing stations in some instances. No example of a fifth site type--the rockshelter with midden and/or pictographs--was investigated for the current study. The bedrock mortar and associated subsurface feature at CA-MNT-361 seemed to represent a fairly ephemeral encampment, while the middens were occupied longer. In general, the the two site types that dominate the Late Period landscape are small, discrete middens and bedrock mortars. The size of the deposits seems to reflect their almost inevitable occurrence as single temporal components post-dating A.D. 1250.

During the early phases of this study, it appeared that Late Period middens were rarely found along the shoreline (Jones 1992, 1995), but discovery of the buried Late Period component at CA-MNT-1942 at the mouth of Big Creek and other findings (Hildebrandt and Jones 1998; Hines 1986; Laurie and Jones 2002) show that Late Period sites indeed occur on the shore of southern Monterey and northern San Luis Obispo counties-- generally as single components. The earlier estimation was a product of limited sampling. Sites situated the furthest inland and at the highest elevations (CA-MNT-759/H and CA-MNT-1236) were among the most recently occupied, and it appears that there was a push higher into the Santa Lucia Range after ca. A.D.1400.

Skeletal profiles from black-tailed deer showed the same patterning as earlier periods suggesting the same logistical hunting. The only site to show a more specialized focus was CA-MNT-361 where the mortars and associated features suggested a focus on terrestrial plant foods. Non-residential sites from earlier periods showed a focus on hunting.

Seasonal indicators including deer teeth annuli and botanical remains from features indicate separate coastal and interior populations that resided in residential bases from fall through winter. Oxygen isotope findings from CA-MNT-569 suggest that people returned to the interior with mussels in the spring/summer. These spring/summer readings from this interior site correspond with a gap in the coastal seasonality profiles, suggesting some movement of people from the shore to the interior valleys in the spring/summer. It seems reasonable to conclude that spring was the period of movement for both interior and coastal populations, with some focus on interior resources. Overall, the scheduling and direction of residential movements was probably very flexible, and the size of the migrating group probably varied from year to year, as the highly diverse Big Sur resource base demanded a fluid approach to settlement. This system was by no means fully sedentary, but might best be characterized as semi-sedentary. Late Period deposits were also marked by a striking lack of obsidian, suggesting that inter-regional exchange was not common.

HISTORIC PERIOD

The Historic Period was best represented by a subsurface feature at CA-MNT-63, although CA-MNT-361 may have been occupied around the time of contact. CA-MNT-63 provided a more complete assemblage, however, as findings from –361 were limited to botanical remains. Feature 1, Unit 3 at CA-MNT-63 was dated on the basis of glass beads to A.D.1800-1816. The faunal assemblage was dominated by otter bones, while a sample of mussel shells showed evidence for selective harvest and a large mean shell size. Seasonality indicators suggest nearly year-round occupation. The deposit apparently represents a small refugee group, partially dependent on the Euro-American market, and exploiting an environment from which exploitative pressure had been lessened by the decline of the overall Native population.

CULTURAL TRANSITIONS 4400 B.C. - A.D. 1800

Continuity through time in some aspects of the material record from Big Sur was very apparent, particularly the character of site use, mobility strategies, and hunting patterns. The majority of investigated sites were residential bases; most were occupied in the fall/winter, and a majority showed logistical deer hunting. While there was evidence for a disruption in settlement at the onset of the Late Period, the overall settlement/subsistence strategy did not show major shifts. The prevailing system was not wholly concordant with either a forager or collector system, but more closely approximated the latter. The diverse resource base of Big Sur and the Santa Lucia Range apparently promoted fairly flexible mobility, in which people congregated in larger groups for parts of the year, and dispersed into smaller residential associations during others. Year-round use of single sites was evident only during the Historic Period under conditions of refuge and Euroamerican trade in otter pelts. Residential sites on the coast might have been partially unoccupied between late winter and summer, when many people traveled to the interior. Groups from the interior apparently made forays to the coast in spring/summer, although seaonality data are incomplete for the full 6400-year occupational sequence. There was probably no strict seasonal schedule for resource exploitation, however, as many coastal foods, particularly fish and shellfish were available year-round, and the timing of their pursuit may have depended more on the year-to-year vitality of other resources. The leanness of game in late winter/spring (Speth 1990) and the low availability of high-fat, high-calorie foods may have encouraged exploitation of inland plant foods in the spring.

Patterns in diet, site location, and trade show more distinctive changes through time, with at least four intervals of transition: Millingstone-Early (ca. 3500 B.C.), Early-Middle (ca. 600 B.C.), Middle-Late (ca. A.D. 1300), Protohistoric/Historic (A.D. 1769). Of varied intensity, these periods of change generally correspond with transitions defined in adjoining areas. In the following discussion, these transitions are placed in ecological context by evaluating the direction of change at each juncture relative to alternative predictions based on concepts of cultural evolution, cultural ecology, resource stewardship, and economic optimization/intensification. The paleoenvironmental context of each transition has been reviewed in order to evaluate the possible role of environmental flux in influencing or forcing cultural adjustments.

Millingstone-Early (3500 B.C.)

Cultural changes at 3500 B.C. conformed with the appearance of what is sometimes referred to as the Hunting Culture in the Santa Barbara Channel, replacing Oak Grove, a local manifestation of the Millingstone Horizon. Although all of the Big Sur sites occupied before and after this transition were residential bases, there are strong indications of a change in mobility ca. 3500 B.C. Most indicators suggest a shift toward a more sedentary lifeway, but some ambiguity is also apparent in the record, and may only be clarified with the discovery of additional components. First, the disparity between the faunal data and the bone isotope results, also seen in the Santa Barbara Channel (Erlandson 1988b; Walker and DeNiro 1986) suggests the Millingstone Period was a time of high mobility, with exploitation of multiple interior and coastal settings. Early Period and later sites show a stronger correlation between faunal residues and the isotopic results, suggesting a more constrained system of transhumance. Early Period faunal reconstructions suggest a decreased importance of shellfish and marine mammals, and an increased reliance on fish and terrestrial mammals. Since there is no evidence for a marine mammal rookery in the vicinity of any of the Millingstone or Early sites prehistorically, seal exploitation probably involved the pursuit of animals at haulouts. Hunters ranging over a wide area would be able to exploit these sporadically-occurring resources, but those operating within more restricted radii would have had less access. Decrease in proportional significance of marine mammals across the Millingstone/Early transition therefore is consistent with a decrease in foraging radii. Margalef Index scores suggest that diet breadth decreased which is consistent with economic intensification, and the imposition of boundaries in what had previously been unlimited hunting areas.

Comparison between experimentally derived cumulative frequency curves for mussel exploitation and curves generated from the archaeological collections suggest a change in exploitation strategy across this transition, coincident with decrease in mean shell size. The selective strategy evident in the lower portion of the Millingstone component was superseded by stripping in the Early Period. Mussels continued to be stripped until the Protohistoric Period. The experimental data also indicated that plucking is the more efficient strategy, even in mussel beds that are regularly harvested. The superiority of plucking over stripping is greatest in settings subjected to infrequent human harvest, however. Intensity of human collection, therefore, influences the value of the resource through time.

Mussels can grow up to 86 mm in a single year, but only in cases where they are not totally recolonizing. Mussel collection that was either too frequent or too intensive will impact the mussel population and deflate the value of subsequent harvests. Any degree of exploitation could potentially reduce the population's recovery rate, although Yamada and Peters (1988) demonstrated that limited harvesting is beneficial to the growth curve of *Mytilus californianus*. Limited harvesting, which allows the mussel to grow instead of competing for space, can actually be beneficial to marine populations (Hockey and Bosman 1986). The Millingstone/Early transition, therefore, represents the adoption of a less efficient bivalve collection strategy that could yield higher total calories with the expenditure of more processing labor, particularly in locations where humans had previously collected. The high frequency of mussel shells in Stratum II at CA-MNT-1232/H is most likely a product of mobile groups who were foraging optimally and moving on. It is reasonable to assume that the subsequent adoption of a less efficient strategy was not voluntary, but rather a forced transition associated with longer occupation of coastal residential bases and concomitant human impact on intertidal fauna. The other major change marking the Millingstone/Early transition involved exchange commodities, as obsidian seems to have arrived for the first time in significant quantities during the Early Period.

In concert, diachronic trends in tool assemblages, dietary remains, mussel collection strategies, and exchange suggest population circumscription, as a selective use of the coast was replaced by a less diverse, more intensive exploitation strategy that involved extended, but not permanent, occupation of residential bases. These changes, equating to what Beaton (1991) described as a shift from extensification to intensification may reflect the success of an earlier, mobile, more selective adaptive strategy. Trends in diet breadth and diversity are somewhat unclear due to the small size of the available Millingstone sample, but foraging radii probably shrank in response to the presence of groups in adjoining areas. Mussels became less important in the diet as longer use of individual sites depleted beds. More time was spent processing mussels to capture more calories, but net returns were lower. Compared to acorns and fish, mussels are more limited in their potential for intensification (Jones and Richman 1995:52), and their decrease in dietary significance relative to other foods is consistent with their economic value. The mortar and pestle, minor additions to the equipment inventory in the Early Period, support conclusions from the mussel profiles that processing was becoming increasingly important, concomitant with a reduction in mobility and decreased subsistence efficiency.

These dietary and exchange shifts may also signal a change in social organization and division of labor along gender lines. Based on faunal remains and human isotope findings both from this study and the Santa Barbara Channel, there are indications that gathered foods contributed a large portion of the diet during the Millingstone Period. Flaked stone tools are uncommon relative to milling slabs and handstones, and shellfish remains occur in dense deposits. Human bone isotope readings suggest a heavy reliance on terrestrial vegetable foods. Such a diet suggests that gathering was undertaken by all group members, and that a less rigid division of gender-defined tasks existed (Erlandson 1994; Jones 1996; Mcguire and Hildebrandt 1994)). During the Millingstone Period, men must have participated in gathering more frequently than they did at the time of historic contact. At the inception of the Early Period, as economies became more intensive, men began to spend more time hunting and fishing, and less time gathering. The suggestion by Hill et al. (1987) that men could provide more calories to a group by gathering than by hunting may be supported by the behavior of men during the Millingstone Period in California, who apparently gathered more than they did at contact. A strategy in which shellfish collection was used as a contingency to a failed hunt may have provided an exceptionally high and reliable caloric contribution to the group, particularly when mussels were harvested selectively by mobile populations.

As hunting became more important, a concurrent increase in processing time is seen in the mussel profiles, and by the appearance of a technology suggestive of processing intensification--the mortar and pestle-- and an increased reliance on fish. Women's processing labor must have been critical to this newly intensified economy which was also marked by a dramatic increase in inter-regional exchange, shown by obsidian profiles. It is interesting to speculate on the possibility that these two developments reflect marriage-related exchanges and the formation of marriage alliances based on the exchange of women between groups, as a result of the increased value of, indeed the need for, processing labor. Equally speculative is the possibility that these developments approximate the system of marriage-related exchange identified at the time of historic contact by J. P. Harrington (1942:30), and that they further reflect the emergence of a system of lineal kin organization, as kin-based groups became more closely associated with particular geographic localities, and trade goods and mates were exchanged between groups. Production of steatite pendants and the first exploitation of otters during the Early Period at the same time when obsidian first appeared in significant quantities may represent the beginning of commoditization (i.e., the "process of becoming involved in producing things for exchange" [Peterson 1991:2]). Evidence for increased resource processing and inter-regional exchange conforms well with expectations advanced of Kelly (1991) concerning the possible gender implications of subsistence intensification. He suggested that reliance on smaller foraging radii would encourages development of social alliances through inter-lineage marriage. At Big Sur, inter-regional exchange began abruptly and may signal the exchange of women and women's processing labor. Exchange might have also served as a substitute for direct resource acquisition, as population circumscription resulted in decreased access to some commodities. These trends are consistent with observations about exchange in foraging societies made by Peterson (1991:3), who stated that, "commoditization has its origins in things produced for use, subsequently these come to be alienated through gift and barter, which leads to an intensification of the division of labor and circulation by means of exchange." Among California foragers, division of labor was based primarily on gender and age. At the Millingstone/Early transition, gender roles became more clearly delineated in response to population circumscription and intensification. This is contrary to a proposal made by Hollimon (1990) that division of labor became less gender-based in Native California through time.

Whether or not the mortar and pestle, which also appeared at this juncture, represent initial use of the acorn is less significant than the importance of these tools for processing. The co-occurrence of their initial appearance and the initiation of inter-regional exchange seems to signify population circumscription, economic intensification, and perhaps, more speculatively, the commoditization of women.

Environment Conditions and the Case Against Environmental Causality

A major cultural transition is also recognized in the Santa Barbara Channel ca. 3500-3400 B.C., where it has been linked with a decline in ocean temperatures. Identified originally by Pisias (1978, 1979), and subsequently confirmed by Glassow et al. (1994), this decline was associated by Glassow et al. (1988:75) and Glassow (1997) with increased rainfall and greater marine productivity, which is argued to have promoted growth of marine mammal populations, encouraging their pursuit by humans. The advent of the mortar and pestle is attributed to a loss of grassland caused by sea level rise.

In point of fact, some ambiguity is apparent concerning the direction of environmental change at ca. 3500 B.C. along the California coast, particularly conditions in the terrestrial biome. Most data indeed suggest an improvement from earlier, drier and warmer conditions of the mid-Holocene warm period, but some findings suggest that such conditions persisted much later into the Early Period. (Heusser 1978; Moratto 1984:548). Pollen data from Elkhorn Slough in Monterey Bay show high frequencies of redwood pollen in the Early Period levels suggesting that the interval was not marked by prolonged dry and/or warm climate. Conditions in the marine environment are better documented, at least in the Santa Barbara Channel, where there is evidence for decline in sea temperature and enhanced marine productivity. The Big Sur coast must have experienced this lowering of sea temperatures, but decrease in mean size of mussel shells is the opposite of what would be caused by colder ocean temperatures, as mussels grow fastest in cold water. A shift from selective mussel harvest to stripping was apparently responsible for this decrease, indicating that human behavior and population, not large-scale environmental change, were influential on the character of this resource. Furthermore, the transition toward intensified mussel collection (stripping) represents a step away from resource stewardship, as high yields could only be perpetuated through the use of a more selective harvesting strategy.

For the time being, it is suggested that *in situ* intensification related to population growth and circumscription best explains varriability in the record across this transition at Big Sur. The cultural changes that mark the onset of the Early Period in this region, however, are very striking, particularly in regard to formal artifacts and increased evidence for inter-regional exchange. Mikkelsen et al (2000) have suggested that similar changes recognized at CA-SLO-165 at Morro Bay in San Luis Obispo County could reflect intrusion of people to the coast from the interior during the mid-Holocene warm period. This must also be considered a viable possibility.

Early-Middle (600 B.C.)

Cultural changes marking the transition from the Early to the Middle Period are generally not strong, and it is not surprising that earlier archaeologists working in adjoining areas (e.g., Greenwood 1972; Rogers 1929) did not recognize a significant cultural break at this juncture. Among the sites investigated for this study, this transition is not well dated. The Middle Period, represented by findings from CA-MNT-63, -282, -332, -521 and CA-SLO-267, shows only minor changes in assemblage from the Early

Period as stemmed projectile points, hand stones, milling slabs, mortars, and pestles all persisted. The main changes marking the onset of the Middle Period are limited to bead types (i.e., saucers replace rectangles and clam shell disks) and the initial appearance of circular shell fishhooks. In the interior, where fishhooks are rarely found, it is particularly difficult to distinguish Middle from Early Period assemblages. Findings from CA-MNT-282 and CA-SLO-267 suggest that square-stemmed points became much less common during the Middle Period, and probably disappeared entirely. King (1982, 1990) argued that the stylistic shift from rectangular to circular beads that marks the Early-Middle transition in both the Santa Barbara Channel and Big Sur was symbolic of major economic and sociopolitical changes. At least in Big Sur, the modest stylistic shifts that mark the transition from Early to Middle seem more consistent with cultural and adaptive continuity.

Diet and exchange, in particular, showed little change from the Early Period. Diet breadth in mammals, birds, and fish showed marked increases from the Early Period, reaching their highest post-Millingstone levels (Figure 103). Fish, which first became important in the Early Period at CA-MNT-73, were even more significant during the Middle Period. Even in the interior, marine fish represented 10% of the animal diet. Shellfish continued to decrease in dietary importance. Herring and northern anchovies appeared in the record for the first time. Sea otters and rabbits were more important than they had been previously, complementing a trend toward increased use of smaller, more elusive taxa.

Obsidian showed continued increase, arriving from the Coso source in larger quantities. A high frequency of otter bones suggested that otter pelts may have been used in exchange, along with locally-produced steatite or talc schist pendants. Inter-regional exchange relationships apparently were well-developed, representing continuation of a trend that began during the Millingstone Period. It is not unreasonable to speculate that inter-group alliances remained strong and perhaps solidified during this period.

Dietary patterns, particularly the increase in diet breadth, seem most consistent with simple optimization, as a slowly increasing population added more items to the diet. They further suggest intensification as a consequence of increasing demographic pressure, with smaller, more labor-intensive taxa, particularly fish, exploited more heavily. Increased exploitation of fish clearly marks an intensifying economy in which processing labor was important. Like acorns, fish can provide higher caloric yields with increased labor inputs, but this equates to a decrease in dietary efficiency. Development of the shell fishhook suggests increased line and hook fishing which is a potentially low-yield pursuit strategy.

Environmental Conditions and the Case Against Environmental Causality

While incompleteness of the paleoenvironmental record must be acknowledged, there is little reason to attribute patterns in the Early-Middle transition to environmental change. Limited oxygen isotope data, available for the Middle Period onward (Jones and Kennett 1999), show that sea temperatures were slightly cooler than present and relatively stable between ca. A.D. 1 and 1300, but there is nothing in the available record that shows incremental directional change from the Early Period through the Middle Period. Trends in diet and exchange seem most readily explained by slow population growth, simple intensification, and increased diet breadth.

Middle-Late (A.D. 1000-1250)

Unlike previous transitions, the Middle-Late juncture was a period marked by distinct archaeological components (CA-MNT-1233 and CA-MNT-1754) spanning the interval of transition. Of these, most important was CA-MNT-1233 which showed continuity from the Middle Period, as well as change. Artifact types that first appeared ca. 3500 B.C. (e.g., large stemmed points, bowl mortars, pestles, handstones and milling slabs) persisted along with the first appearance of hopper mortars and an occasional small leaf-shaped point. Settlement and subsistence showed continuity from the Middle Period, consistent with slow, ongoing intensification. Fish continued as an important dietary item, while shellfish were insignificant. Faunal and isotope data suggested that marine resources reached their peak importance, but the isotope data also indicate that diets were more generalized than in the Santa Barbara Channel. Mussel collection continued to emphasize "stripping" over "plucking," as mean shell size reached a low point (Figure 105).

The seasonality profile from CA-MNT-1233, however, was one of the few that suggested occupation during the spring/summer on the coast. Although there is little evidence for significant change in the character of site use, this finding suggests that individual residential sites may have been used for more of the year during the Middle-Late Transition than they were before or after. Continually growing populations apparently led to increasingly intensified subsistence during the initial

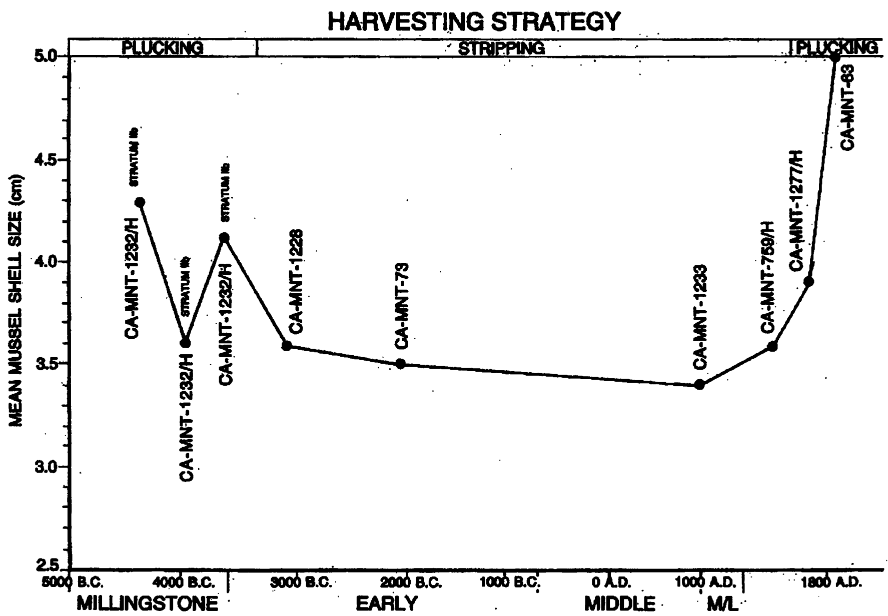


Figure 105 Mean Size of *Mytilus californianus* Shells and Collecting Strategies through Time on the Big Sur Coast

part of the Middle-Late Transition, as diet and mobility progressed along previously established trajectories.

Sites first occupied during the latter portion of the Middle-Late Transition show evidence for more substantial changes. Most significant is an apparent settlement disruption. Late and Contact Period sites showed a marked unconformity with earlier deposits, many of which were abandoned between A.D. 1100 and 1300. The Late Period settlement landscape was marked by a profusion of small residential sites located in a wide variety of locations, along with bedrock mortars. This seems to contrasdt with the larger interior and coastal middens that mark the Middle Period. Diet breadth, however, shows no evidence for increase among fish, mammals, or birds, with a noticeable decrease among mammals. During the Protohistoric Period, sites were established further inland at higher elevations, and residential sites may have been slightly more common away from the shoreline at elevations in excess of 550 m., while shoreline encampments were used less frequently. Obsidian disappeared from the record, reflecting continued deterioration of exchange relationships. These patterns are very different from the Santa Barbara Channel, where a progressive maritime intensification continues into the Late Period, as fish were exploited intensively with redwood plank canoes.

The Paleoenvironmental Record A.D. 800-1350 and the Case for Environmental Complicity

From one perspective, cultural changes accompanying the onset of the Late Period might be interpreted as the logical outcome of population growth and resource overexploitation, as Native populations reached a demographic threshold where periodic lows in resource availability forced inter-group competition. In several early papers (T. Jones 1992:16; Hildebrandt and Jones 1992), I argued that point, attributing the terrestrial economy of the Late Period on the central coast to limitations of the marine environment, particularly in contrast with theSanta Barbara Channel. Without the rich pelagic fisheries of the Channel, central coast populations may have been forced to direct their intensification efforts inland after overexploiting key marine resources (e.g., shellfish and migratory marine mammals). Shoreline sites were used less often in order to focus more heavily on interior resources (e.g., acorns), which can provide more calories with increased labor expenditures (Basgall 1987). Late Period features from the Big Sur coast all produced remains of acorns and other nuts. Furthermore, the mean shell size profile from Big Sur suggests that regular harvest of mussels between 3500 B.C. and the Middle-Late Transition may have effected an overall diminution in the shell beds, although Claassen (1998) suggested that human harvest is a much less significant influence on mussel beds than are the impacts of non-human predators and disruptive natural events like large winter storms. Marine mammals, although never found in high frequencies at Big Sur, declined in importance along the entire coast by the end of the Middle Period (Hildebrandt and Jones 1992). Simple population growth and economic intensification seem to provide adequate explanation for some changes that transpired by the end of the Middle Period, but there are also reasons to suspect that environmental problems may have contributed to the cultural shifts.

Intensification does not readily explain dietary trends after ca. A.D. 1300. Simple optimization theory would suggest continued expansion of the number of species exploited over time, but the Margalef diversity indices show trends in the opposite direction, in that the number of species exploited dropped among both mammals and fish. While human predation may have lessened the availability and/or value of marine mammals and shellfish, there is no reason to suspect that Big Sur fisheries were affected by the intensity of prehistoric fishing. Elsewhere in California, some researchers (e.g., Broughton 1994, 1999; Salls 1992) have argued that Native fisheries were depressed as a consequence of sustained, overly intensive prehistoric harvest, but these arguments are based on suspect faunal samples that did not take into account fish bone recovery strategies. While humans could have overhunted megafauna at the end of the Pleistocene and may have decimated highly vulnerable marine mammal rookeries, there is little empirical evidence to suggest significant human impact on prehistoric California fisheries. This resource base was simply too large, too abundant, and too invisible to be depressed by means of prehistoric technology. Nonetheless, people inhabiting the Big Sur coast after ca. A.D. 1250 did not increase their fish catches which seems inconsistent with relentless economic intensification. Inter-regional exchange, which increased in regularity from the Early through Middle periods at the same time that diets were apparently broadening, came to a halt during the Middle-Late Transition. Simple intensification cannot simultaneously explain increased trade and broadening of diets on the one hand and decline in diet breadth and deterioration of exchange relationships on the other.

There is, however, ample evidence for serious environmental problems between ca. A.D. 800 and 1350, associated with the Medieval Climatic Anomaly (Graumlich 1993; Stine 1994; although see Mensing 1993; Roos 2002). Prolonged droughts during this interval came at a time when human populations were probably very high and were approaching a significant demographic threshold. Many changes in the archaeological record ca. A.D. 1000-1400 may reflect subsistence problems, decrease in human population, and a reversal of the previous trends of economic intensification. The Medieval Warm Period or the Little Climatic Optimum has been recognized for decades in Europe, but its effects in North America have only recently been discussed (Jones et al. 1999).

Characterization of the Medieval Climatic Anomaly in western North American has evolved considerably over the last decade. Researchers have identified three different environmental trends during this period: changing sea temperatures (Arnold 1992a, 1992b; Kennett 1998; Kennett and Kennett 2000; Pisias 1978), decreased precipitation (Stine 1990, 1994), and warmer summer temperatures (Graumlich 1993). Based on the provisional paleo-sea temperature record for the Santa Barbara Channel developed by Pisias (1978, 1979), Arnold (1992a, 1992b) argued for a causal link between high sea water temperatures, marine deterioration, and abrupt cultural change in the Santa Barbara Channel. She focused on an interval of apparently warm seas dating ca. 1150-1250, likening its effects to a 100-year El Niño event. Raab (1994) and Raab et al. (1995) countered that there are no data which firmly support a holocaust in the marine environment ca. A.D. 1150-1250. Subsequently, Kennett and Kennett (2000) reported an enhanced sea temperature record for the Channel that shows the A.D. 1150-1250 period as a time of cold but variable sea temperatures. Isotopic results from the Big Sur coast show trends less dramatic than those of the Channel, with temperatures more variable than today between A.D. 1300 and 1500, and colder than present during the Little Ice Age (A.D. 1500-1800) (Jones and Kennett 1999). During the Medieval Climatic Anomaly, the California coast must have experienced changes in ocean temperatures and/or circulation patterns, but their correlation with inland weather patterns may be more important than their impact on marine ecosystems. Events of the last decade further show that in California warm seas associated with the El Niño Southern Oscillation decrease marine productivity (Dayton and Tegner 1990), but also cause increased rainfall and enhanced terrestrial productivity as is the case in Peru where the El Niño phenomenon was first recognized (Philander 1990).

Graumlich (1993) and Stine (1990, 1994) discussed climate during the Medieval Warm Period in California in slightly different terms. Based on tree rings from the southern Sierra Nevada, Graumlich argued that the period between A.D. 1100 and 1375 was unusual for its inordinately high summer temperatures, which peaked ca. A.D. 1150. Droughts occurred from A.D. 1020-1070, 1197-1217, and 1249-1365 (Figure 106), but were less anomalous

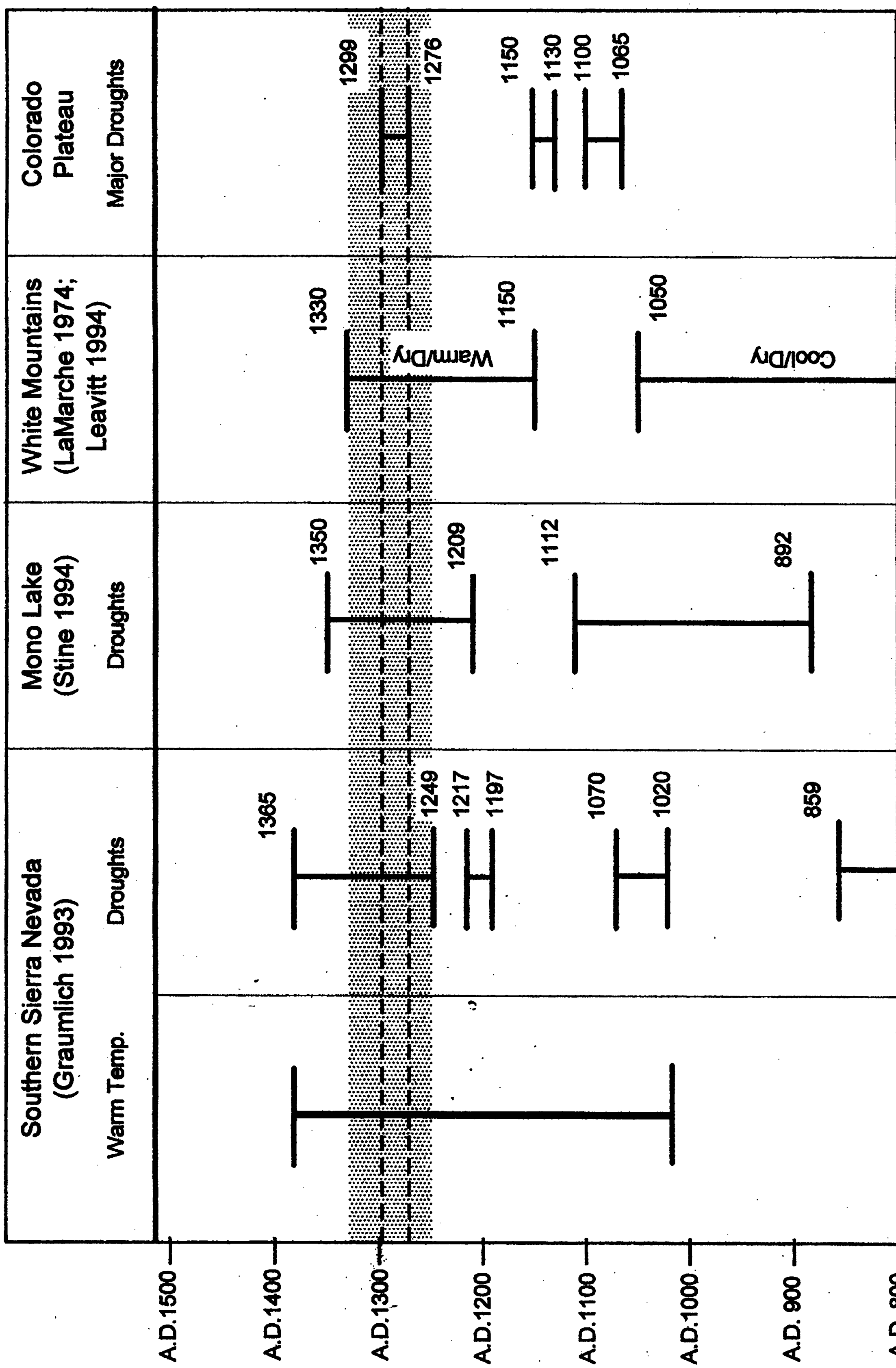


Figure 105 Summary of Paleoenvironmental Trends for Medieval Climatic Anomaly in western North America

relative to the precipitation cycle of the last millennium than were the summer temperatures. She argued that the anomalous temperatures were a product of the convergence of external climatic factors (e.g., volcanic ash, solar events) with internal oscillations (ocean circulation patterns) (Graumlich 1993:254). Stine (1994:549) suggested that major droughts ca. A.D. 892-1112 and 1209-1350 at Mono Lake were part of a global phenomenon in which ocean circulation patterns shifted to positions completely unlike those of today. Clearly these studies provide significant evidence from areas adjacent the central California coast for severe droughts between A.D. 1000 and 1400. Whether these events were somehow linked with variation in sea temperatures is unclear, but environmental problems in the terrestrial arena seem more substantiated and severe than possible deterioration of marine systems.

Archaeological and paleoenvironmental data from Big Sur seem consistent with anomalous climate during the Medieval Period. Oxygen isotope readings from CA-MNT-1233 indicate that mean monthly water temperatures were significantly higher than at present off the Big Sur Coast between A.D. 1300 and A.D. 1500, but temperature ranges in the shell samples also show much wider variability than at present. Maximum temperatures were higher than those recorded during the 1982/83 El Niño, but yearly minimums were also lower. This seasonal profile does not conform well with an El Niño event in that the critical characteristic of an El Niño is elevated sea temperatures throughout the year (Figure 107). Warm seas in the winter months contribute to high rainfall. Marine productivity may have been negatively affected by warm water during the Medieval Climatic Anomaly, but the high frequency of fish bone at CA-MNT-1233, CA-MNT-1942, and other sites (Jones and Kennett 1999) indicates that fisheries were not decimated by the changes in the seasonal water temperature profile. Similar findings were reported by Erlandson and Gerber (1993) from a site on the mainland of the Santa Barbara Channel (CA-SBA-1731). The unusual sea temperature profile from CA-MNT-1233 may reflect not an extended El Niño, but rather altered climatic conditions related to drought and extremely high terrestrial temperatures in adjoining areas. This supports Stine's (1994) and Graumlich's (1993) characterization of climate during the Medieval Climatic Anomaly as unusual. Off the Big Sur coast, seas seem to have been warmer than at present during part of the year, but they also plummeted to temperatures lower than today during other months. Since warm winter sea temperatures today correlate with high precipitation, the pattern at CA-MNT-1233 could represent co-occurrence of warm atmospheric conditions and low rainfall. Together, long, hot summers and decreased rainfall would have reduced the productivity of terrestrial habitats, contributing to resource stress among resident hunter-gatherers.

The co-occurrence of climatic problems, particularly drought, and major changes in diet, exchange, and site location ca. A.D. 1000 and 1400 is simply difficult to overlook. The following Salinan myth provided by Maria Ocarpia, an elderly Salinan speaker, to J. Alden Mason in 1916 provides a hint of what may have transpired during the early centuries of the second millennium A.D.:

> *Once there was a famine....there was no rain and no food. They ate bleached bones pounded in the mortar, and acorn mush made of manzanitas. There were no deer and no meat; it was a great famine. The poor people ate alfilerillo seeds. One old woman killed and roasted and ate her son; [sic] was very hungry. Then her brother came and killed her with three arrows because she had eaten her child. They did not bury her, but left her to be eaten by the coyotes. It was a great famine. But the people who lived on the shore did not die because they ate abalones. But even they were thin because they had nothing but seaweed to eat* (Mason 1918:120).

While such sources must be regarded with caution, the possibility exists that this myth describes drought conditions between A.D. 1000 and 1350. At the least, it could represent an analog for effect of catastrophic droughts in the prehistoric past. Alfilerillo seeds are filaree (*Erodium* spp.), most of which are non-natives introduced from Europe. This analog also provides an interesting assessment of the relative impact of drought on marine and terrestrial resources, and the degree of human stress that could result from such an event. Similar myths are known from the Chumash (Walker et al. 1989:351), Pomo (Kniffen 1939:366), and Shoshone (Steward 1938:20). The abrupt transitions in the archaeological record ca. A.D. 1100-1300 are consistent with resource stress and possibly a brief, rapid decrease in human population. In the face of extreme drought, the already intensified, partially marine-focused economy may not have been able to continue to provide an ample resource base. Groups escaping the intolerable conditions of the interior may have fled to

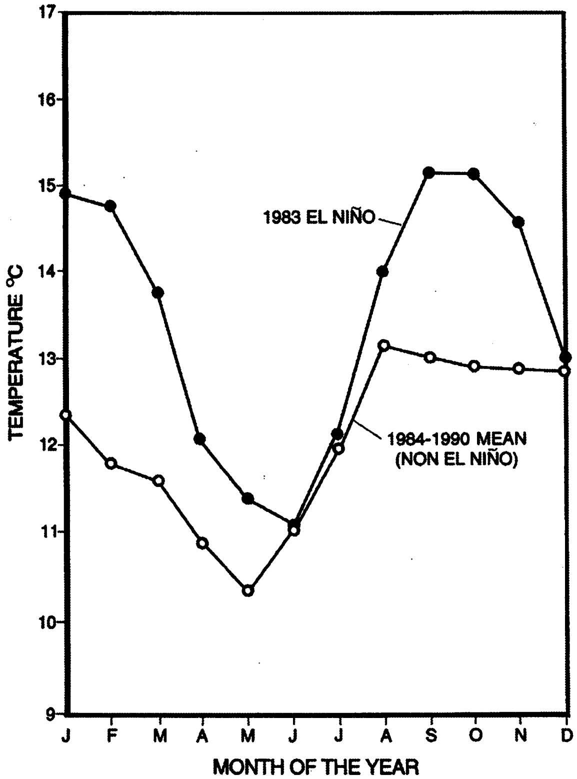


Figure 107 El Niño Versus Non-El Niño Sea Temperatures on the Big Sur Coast

the Big Sur coast, evidenced by the first appearance of many sites on the coastal flank of the Santa Lucias between A.D. 1100 and 1400. In both the interior and on the coast, famine may have contributed to increased death rates, decreased birth rates, competition for resources, and a decline in population.

Linguistic and kinship data both suggest that Salinan speakers resided farther inland in the past. Turner (1987:194) identified many similarities between Salinan and the Uto-Aztecan languages, even though there were no common boundaries between these languages at contact. Kroeber (1917:379, 380) felt the Salinan system of kinship was most similar to that of the Uto-Aztecan speakers of the Great Basin. Prior to the droughts of A.D. 1000-1400, Salinan speakers may have occupied some area west of the territory they occupied at contact, closer to or within the Great Basin, or a portion of the southern San Joaquin Valley where they had direct contact with speakers of Uto-Aztecan languages. Moratto et al. (1978) reported evidence for violence and settlement disruption in the foothills of the southern San Joaquin Valley between A.D. 600 and 1400 due to warm climate, and these events could be related to movement of peoples--including Salinan speakers. Linguistic data reported by Turner (1987) suggests continuous and long-term occupation of the area inhabited by the Salinan-speakers at the time of historic contact, however. The coastal intrusion during the Medieval Climatic Anomaly may not have been a linguistic replacement, but rather a concentration of people speaking related dialects.

The terrestrially-focused economy of the Protohistoric Period seems to represent an adaptation to ameliorated environmental conditions following the Medieval droughts during the little Ice Age when terrestrial productivity rebounded. Reduced human numbers and an improved resource base may have eliminated stress in the subsistence system. Fish, which had been the focus of increasingly labor-intensive subsistence activities into Middle-Late Transition, seem to have become less important as the subsistence economy de-intensified. The rebound in mean mussel shellsize after the Middle-Late occupation at CA-MNT-1233 may further signify reduction of stress on human populations, as does the renewal of more selective mussel harvesting strategies at the Salinan village of CA-MNT-1277/H and at CA-MNT-569B. Slightly colder sea temperatures during the Little Ice Age, however, could also account for the apparent increase in mussel size.

The tribelet form of sociopolitical organization employed in Big Sur and elsewhere in central California at the time of historic contact may also have its origin in the climatic oscillations of the Medieval Climatic Anomaly. One of the defining traits of autonomous tribelets was the congregation of multiple lineages, sometimes within single villages. The crowding together of multiple groups could be a product of the coastal intrusion that began during the Middle-Late Transition. The earlier and more structured lineal descent system was probably characterized by more orderly spatial organization of kin groups. Regularized inter-group exchange of obsidian and otter pelts during the Middle Period deteriorated under stress, as the less cohesive, less organized tribelet system evolved as an *ad hoc* response to crisis. Trade became limited, and inter-group competition became more common. Inter-regional exchange never regained the intensity that it had achieved during the Middle Period, suggesting that social relationships never fully rebounded from the changes that transpired ca. A.D. 1300.

Evidence for environmental stress and abrupt cultural change between A.D. 1000 and 1400, not readily accommodated by simple optimization or gradualist adaptive models is also apparent away from the Big Sur coast. Walker et al. (1989:351), Lambert (1993) and Walker and Lambert (1989) documented a peak in osteological signs of poor health during the late Middle Period (ca. A.D. 900-

1150) in the Santa Barbara Channel. Arnold (1992b:134) discussed the abandonment of many sites on the northern Channel Islands between A.D. 1200 and 1300. Salls (1992:166) identified a sea urchin barren on San Clemente Island, dating ca. A..D.1050, apparently resulting from extensive over-exploitation of littoral and nearshore habitats. Raab et al. (1994) reported an apparent abandonment of San Clemente Island ca. A.D. 1200. In San Diego County, a formerly productive marine-focused economy was replaced by a terrestrial one sometime ca. A.D. 1000 (Gallegos 1992; Christenson 1992), suggesting that San Diego may have also served as a refugium for groups from the interior. In the Sacramento/San Joaquin Delta, the Meganos Intrusion into San Francisco Bay was terminated by the expansion of Bay Miwok (Bennyhoff 1994a:83) ca. A.D. 1000. Intrusive movements by the Wappo and the Patwin are evident in the southern north Coast Ranges (Bennyhoff 1994b:56). In short, there is evidence for population movements and cultural stress throughout much of central and southern California during this time, including signs of declining health, famine, social disintegration, deteriorating exchange relationships, increasing boundary hostilities, and group movements.

In short, the Middle-Late Transition on the Big Sur coast and elsewhere cannot be adequately portrayed in terms of simple intensification or cultural evolution, as diets did not broaden and exchange relationships did not expand. In the White Mountains of eastern California, Bettinger (1994) discussed a cultural transition in which dietary diversity also decreased. In that case, however, dietary richness remained the same while diversity declined, reflecting greater use of a few lower-ranked, abundant taxa. At Big Sur, diets seem to have been narrower during the Late Period than they were during the Middle and Middle-Late periods.

In the Santa Barbara Channel, cultural ecology has been used to explain subsistence stress and health problems at the end of the Middle Period (Walker et al. 1989). Some aspects of this model are consistent with events in Big Sur, but the non-specilized economy that emerged at Big Sur after A.D. 1250 differs markedly from the intensive maritime culture of the Channel. While better temporal resolution is needed, the Big Sur record seems to reflect changes that transpired more rapidly beginning ca. A.D. 1100, when obsidian disappeared from the record. Before that time, population pressure seems to have been effecting subsistence change, as diets broadened and fish became more important as a food resource. Big Sur populations may indeed have reached a population threshold of previously unmatched demographic pressure during the Middle-Late Transition, and serious droughts after A.D.1000 caused such rapid, severe deterioration of the resource base, that major subsistence problems developed, causing widespread settlement shifts and resource competition. Unlike the gradual environmental changes of the early and mid-Holocene, the climatic problems of the Medieval Climatic Anomaly may have developed so rapidly that it would not have been possible to develop new innovations to mitigate difficulties. Aspects of Late Period culture at Big Sur that may reflect these events include the non-diverse, narrow diet, lack of inter-regional exchange, and possibly the tribelet system of socio-political organization. All of these may be products of the chaos and disharmony of the Medieval Climatic Anomaly rather than the end-product of gradual intensification and incremental social evolution.

Protohistoric-Post Contact (A.D. 1769)

This transition was best distinguished by the findings from Feature 1 at CA-MNT-63 which contrast with the Late and Protohistoric components. This feature which produced a dense concentration of household and/or dietary debris seems to reflect the historically-documented decimation of Native populations, their retreat to refugee encampments, and participation in European markets. Mussel shells from this feature showed a "plucking" cumulative proportion curve and a large mean shell size. Selective harvest was identified at only three other sites, including the Late/Protohistoric component at CA-MNT-1277/H. Apparently, as human numbers dwindled beginning in the Protohistoric Period (caused by rapidly moving diseases [Erlandson and Bartoy 1995; Preston 1996, 1997]) and continuing after contact, selective harvest was accommodated and mussel beds rebounded after thousands of years of more intensive use. Throughout the occupation of Big Sur, the size of mussels harvested seems to have been influenced by the character and intensity of human harvest as well as changing water temperatures. More components from this little-understood period at the interface of history and prehistory need to be investigated in order to truly understand and to document lifeways of the indigenous groups and evaluate alternative explanations.

DISCUSSION: THE ECOLOGICAL PLACE OF PREHISTORIC HUNTER-GATHERERS ON THE BIG SUR COAST

On some levels, tool assemblages, diet, and mobility show continuity through time at Big Sur as non-sedenrtary hunting and gathering was pursued throughout the sequence. A settlement strategy emphasizing residential mobility and logistical hunting was employed during all but post-Contact times. The coast was always occupied during the fall and winter. In comparison with the Santa Barbara Channel, diet was always somewhat generalized. Deer hunting was perennially important, and carcasses were butchered in the field with elements of high marrow value transported to residential bases. The archaeological record also illuminates periods of transition. Two of these are significant: the first at 3500 B.C. and a second ca. A.D. 1300. These interludes are also apparent in adjoining regions, where they have frequently been associated with broad scale environmental change (e.g., ocean temperature change, rising sea level, and Holocene climatic fluctuations), but most of the record at Big Sur can be readily attributed to population pressure and economic intensification. Changes at 3500 B.C. seem to reflect population circumscription, a logical juncture in the demographic history of California when the presence of people in surrounding areas, forced groups to turn their subsistence foci inward. Economic intensification theory also helps to explain changes in the record ca. A.D. 1300, in that signs of settlement disruption, decreasing diet breadth, and deterioration of exchange relationships do not conform with the predicted outcomes of continued incremental population growth and optimal subsistence adjustment. Rather, demographic pressures that fostered the intensive economies of the terminal Middle Period also left populations vulnerable to severe and rapid environmental change. Subsistence intensification explains dietary changes between 3500 B.C. and A.D. 1000, but not the environmentally exacerbated narrowing of diet breadth and deterioration of trade relations that occurred at the hands of droughts during the Medieval Climatic Anomaly.

Human beings on the prehistoric Big Sur coast seem to have been more than capable of dealing with large-scale/low intensity environmental flux during the mid-Holocene. However, in the face of population pressure, they abandoned a subsistence practice that was compatible with resource stewardship (mussel plucking), adopting instead one that provided more calories, but impacted natural productivity and required greater amounts of human labor. While in some instances, environmental flux could be accommodated, culturally-induced demographic conditions shaped necessary cultural responses. These responses were not necessarily compatible with stewardship of the natural environment.

Changes in diet and exchange ca. A.D. 1000-1400, however, seem to reflect a time when prehistoric cultures of the California coast were more seriously impacted by environmental change. Severe declines in environmental productivity seem to have had widespread affects on human populations. At Big Sur, incremental population growth and subsistence intensification between 3500 B.C. and A.D. 1000 created a situation in which populations were susceptible to rapid, severe environmental flux. Droughts of similar intensity may have occurred earlier in the Holocene (Raab et al. 1995), but population density ca. A.D. 1000-1400 was probably higher, following 4500 years of steady, incremental growth among people with already-intensified economies. In this case, human populations were unable to cope with environmental stress, and disastrous population declines may have followed, only to be amplified by the appearance of new diseases during the Protohistoric and Historic periods (Erlandson and Bartoy 1995; Preston 1996). Under these circumstances, environment caused changes in diet, settlement, exchange, and possibly social organization. Resource stewardship could not have been a major factor in this crisis situation, as victims of environment cannot simultaneously serve as managers.

Above all else, the prehistoric inhabitants of Big Sur were human. They had exceptional technological capabilities, which allowed them to cope with an inordinate number and variety of environments. Their mere presence in North America bears testimony to their ability to transcend most environmental variability through technological innovation. They also represented a uniquely human component in ecosystems that had evolved for millions of years without them. Their technological and biological capabilities allowed their populations to grow, putting them at odds with their natural surroundings, and ultimately making them highly vulnerable to the abrupt, severe, environmental changes of the Medieval Climatic Anomaly. The environment of California was unequivocally richer and more luxuriant at the time of European contact than it is now, but this verdant landscape was the end product of a long history of complex human/environmental relationships that included resource manipulation, intensive resource use, and periods of extreme stress. Much of its apparent luxuriance during the earliest historic era may reflect decline in human population during the immediately preceding centuries. Arguments to the contrary (c.f., Blackburn and Anderson 1993), the ability of people who alternately impacted natural resource situations and were victimized by them to serve as effective environmental managers or resource stewards seems unlikely and is at best a matter of opinion.

REFERENCES CITED

Abrams, D. M.
1968a Salvage Investigations at the Little Pico Creek Site: 4-SLO-175. In *Archaeological Salvage at the Pico Creek and Little Pico Creek Sites*, edited by N. N. Leonard III. Report on file, California Department of Parks and Recreation, Sacramento.

1968b Part 2: Salvage Investigations at the Little Pico Creek Site 4-SLO-175. In *Archaeological Salvage of the Pico Creek And Little Pico Creek Sites*, San Luis Obispo County, California. Robert E. Schenk Archives of California Archaeology, No. 4: 1-40. San Francisco State University.

1968c Little Pico Creek: Beach Salinan, Barnacles and Burials. Unpublished Master's thesis, Department of Anthropology, University of California, Davis.

Adam, D. P., R. Byrne, and E. Luther
1981 A Late Pleistocene and Holocene Pollen Record from Laguna de las Trancas, Northern Coastal Santa Cruz County, California. *Madroño* 28:255-272.

Anderson, R.Y.
1994 Long-term Changes in the Frequency of Occurrence of El Niño Events. In *El Niño Historical and Paleoclimatic Aspects of the Southern Oscillation*, edited by H. F. Diaz and V. Markgraf, pp. 193-200. Cambridge University Press, Cambridge.

Andrefsky, W.
1994 Raw Material Availability and the Organization of Technology. *American Antiquity* 59:21-34.

1998 *Lithics*. Cambridge University Press, Cambridge.

Antevs, E.
1948 Climatic Changes and Pre-white Man. *University of Utah Bulletin* 38:168-191.

1952 Climatic History and the Antiquity of Man in California. *University of California Archaeological Survey Reports* 16:23-31.

Arnold, J. E.
1987 *Craft Specialization in the Prehistoric Channel Islands, California.* University of California Publications in Anthropology. Vol. 18. Berkeley.

1991 Transformation of a Regional Economy: Sociopolitical Evolution and Production of Valuables in Southern California. *Antiquity* 65: 953-962.

1992a Complex Hunter-Gatherer-Fishers of Prehistoric California: Chiefs, Specialists, and Maritime Adaptations of the Channel Islands. *American Antiquity* 57: 60-84.

1992b Cultural Disruption and the Political Economy in Channel Islands Prehistory. In *Essays on the Prehistory of Maritime*

California, edited by T. L. Jones, pp. 129-144. Center for Archaeological Research at Davis, Publication No. 10, University of California, Davis.

Arnold, J. E., R. H. Colten, and S. Pletka.
1997 Contexts of Cultural Change in Insular California. *American Antiquity* 62:300-318.

Arnold, J. E., and B. N. Tissot
1993 Measurement of Significant Marine Paleotemperature Variation Using Black Abalone Shells from Prehistoric Middens. *Quaternary Research* 39:390-394.

Axelrod, D. I.
1981 Holocene Climatic Changes in Relation to Vegetation Disjunction and Speciation. *American Naturalist* 117:847-870.

Baldwin, M. A.
1971 *Archaeological Evidence of Culture Continuity from Chumash to Salinan Indians in California*. San Luis Obispo County Archaeological Society Occasional Papers No. 6. San Luis Obispo CountyArchaeological Society, San Luis Obispo.

Bamforth, D.
1991 Technological Organization and Hunter-Gatherer Land Use: A California Example. *American Antiquity* 56:216-234.

Barbour, M. G., and J. Major
1988 *Terrestrial Vegetation of California.* California Native Plant Society, Special Publication No. 9, Sacramento.

Barry, J. P., Baxter, C., Sagarin, R. D., and S. E. Gilman
1995 Climate-related Long-term Faunal Changes in a California Rocky Intertidal Community. *Science* 267:672-675.

Basgall, M. E.
1982 Archaeology and Linguistics: Pomoan Prehistory as viewed from northern Sonoma County. *Journal of California and Great Basin Anthropology* 4:3-22.

1987 Resource Intensification Among Hunter-Gatherers: Acorn Economies in Prehistoric California. *Research in Economic Anthropology* 9:21-52.

Basgall, M. E., and M. C. Hall
1992 Fort Irwin Archaeology: Emerging Perspectives on Mojave Desert Prehistory. *Society for California Archaeology Newsletter* 26:1-7.

Baumhoff, M. A.
1962 Ecological Determinants of Aboriginal California Indian Populations. *University of CaliforniaPublications in American Archaeology and Ethnology* 49:155-236.

Baumhoff, M. A., and D. L. Olmsted
1963 Palaihnihan: Radiocarbon Support for Glottochronology. *American Anthropologist* 65:278-284.

Baumhoff, M. A., and R. F. Heizer
1965 Postglacial Climate and Archaeology in the Desert West. In *The Quaternary of the United States*, edited by H. E. Wright and D.G. Frey, pp. 697-708. 7th Congress of the International Association for Quaternary Research, Princeton University Press, Princeton.

Baxter, J. L.
1967 Summary of Biological Information on the Northern Anchovy, *Engraulis mordax*. *California Cooperative Oceanic Fisheries Investigations Report* 11:110-116.

Bean, L. J.
1978 Social Organization. In *California*, edited by R. F. Heizer, pp. 673-682. Handbook of North American Indians, vol. 8, W. G. Sturtevant, general editor, Smithsonian Institution, Washington, D.C.

Bean, L. J., and T. C. Blackburn
1976 *Native Californians: A Theoretical Retrospective*. Ballena Press, Menlo Park.

Beaton, J.
1991 Extensification and Intensification in Central California Prehistory. *Antiquity* 65:946-952.

Beeler, M.
1978 Esselen. *Journal of California Anthropology Papers in Linguistics* 1:3-38.

Bell. D., and S. Song
1994 Explaining the Level of Bridewealth. *Current Anthropology* 35:311-316.

Bender, Barbara
1985 Emergent Tribal Formation in the American Mid-continent. *American Antiquity* 50:52-62.

Bennyhoff, J. A.
1994a Variation within the Meganos Culture. In *Toward a New Taxonomic Framework for Central California Archaeology*, edited by R. E. Hughes, pp. 81-89. Contributions of the University of California Archaeological Research Facility No. 52, Berkeley.

1994b The Napa District and Wappo Prehistorry. In *Toward a New Taxonomic Framework for Central California Archaeology*, edited by R. E. Hughes, pp. 49-56. Contributions of the University of California Archaeological Research Facility No. 52, Berkeley.

Bennyhoff, J. A., and D. A. Fredrickson
1967 A Typology of Shell and Stone Beads from Central California. Manuscript on file, Department of Anthropology, Sonoma State University, Rohnert Park, California.

Bennyhoff, J. A., and R. E. Hughes
1987 Shell Bead and Ornament Exchange Networks Between California and the Western Great Basin. *American Museum of Natural History Anthropological Papers* 64(2).

Bettinger, R. L.
1991 *Hunters-Gatherers, Archaeological and Evolutionary Theory.* Plenum Press, New York.

1994 How, When, and Why Numic Spread. In *Across the West: Human Population Movement and the Expansion of the Numa*, edited by D. B. Madsen and D. Rhode, pp. 44-55. University of Utah Press, Salt Lake City.

Bettinger R. L., and M. A. Baumhoff
1982 The Numic Spread: Great Basin Cultures in Competition. *American Antiquity* 47:485-503.

Bickel, P.
1978 Changing Sea Levels along the California Coast: Anthropological Implications. *The Journal of California Anthropology* 5:6-20.

Bickford, C, and P. Rich
1984 *Vegetation and Flora of the Landels-Hill Big Creek Reserve.* University of California Santa Cruz Environmental Field Program No. 15.

Binford, L.
1978 *Nunamiut Ethnoarchaeology.* Academic Press, New York.

1980 Willow Smoke and Dog's Tails: Hunter-Gatherer Settlement Systems and Archaeological Site Formation. *American Antiquity* 45:4-20.

Blackburn, T. C., and K. Anderson
1993 *Before the Wilderness: Environmental Management by Native Californians.* Ballena Press, Menlo Park, California.

Bloom, A. L.
1983 Sea Level and Coastal Changes. In *Late Quaternary Environments of the United States*, vol. III, edited by H. E. Wright Jr., pp. 42-51. University of Minnesota Press, Minneapolis.

Bolton, H. E.
1927 [1971] *Fray Juan Crespí, Missionary Explorer on the Pacific Coast, 1769-1774.* AMS Press, New York.

Boneu Companys, F.
1983 *Gaspar de Portolá, Explorer and Founder of California.* Translated by Alan K. Brown. Instituto de Estudias, Ilerdenses, Spain.

Botkin, S.
1980 Effects of Human Exploitation on Shellfish Populations at Malibu Creek. In *Modeling Change in Prehistoric Subsistence Economies*, edited by T. K. Earle and A. L. Christenson, pp. 121-139. Academic Press, New York.

Bouey, P. D.
1987 The Intensification of the Hunter-gatherer Economies in the Southern North Coastal Ranges of California. *Research in Economic Anthropology* 9:53-101.

Bouey, P. D., and M. E. Basgall
1991 *Archaeological Patterns along the South Coast, Point Piedras Blancas, San Luis Obispo, California: Archaeological Test Evaluations of Sites CA-SLO-264, SLO-266,*

SLO-267, SLO-268, SLO-1226, and SLO-1227. Submitted to the California Department of Transportation, Contract No. SA05B86100. Copies available from California Department of Transportation, Environmental Branch, San Luis Obispo, California.

Breschini, G. S.
1983 Models of Population Movements in Central California Prehistory. Unpublished Ph.D. disertation, Department of Anthropology, Washington State University.

Breschini, G. S., and T. Haversat
1980 *Preliminary Archaeological Report and Archaeological Management Recommendations for CA-MNT-170, on Pescadero Point, Monterey County, California*. Archaeological Consulting. Copies available from the Northwest Information Center, Department of Anthropology, Sonoma State
University, Rohnert Park.

1989 *Archaeological Investigations at CA-MNT-108 at Fisherman's Wharf, Monterey, Monterey County, California.* Coyote Press Archives of California Prehistory No. 29.

1993 *An Overview of the Esselen Indians of central Monterey County, California*. Coyote Press, Salinas.

Breschini, G. S., T. Haversat, J. Flenniken, and R. L. Edwards
1984 Archaeological Investigations at CA-MNT-1215, an Esselen Quarry Site on the Big Sur Coast. Copies available from the Northwest Information Center, Department of Anthropology, Sonoma State University, Rohnert Park.

Breschini, G. S., T. Haversat, and R. P. Hampson
1983 *A Cultural Resources Overview of the Coast and Coast Valley Study Areas*. Coyote Press, Salinas.

Brewer, D.
1992 Zooarchaeology, Method, Theory, and Goals. In *Archaeological Method and Theory*, Vol. 4, edited by M. B. Schiffer, pp. 1-35, University of Arizona Press, Tucson.

Broughton, J. M.
1994 Late Holocene Resource Intensification in the Sacramento Valley, California: The Vertebrate Evidence. *Journal of Archaeological Science* 21:501-514.

1999 *Resource Depression and Intensification during the Late Holocene, San Francisco Bay.* University of California Publications: Anthropological Records No. 32. pp. 1-150.

Brown, A. K.
1991 The Missionary Explorer Juan Crespi and his Journals of Discovery: New Findings. Paper presented at the International Symposium of the Spanish Beginnings in California 1542-1822, Santa Barbara.

Brumfiel, E. M.
1992 Distinguished Lecture in Archaeology: Breaking and Entering the Ecosystem – Gender, Class, and Faction Steal the Show. *American Anthropologist* 94:551-567.

Burton, R.
2000 Ecology of the Northern Fur Seal (*Callorhinus ursinus*) from the Middle and Late Holocene of California. Unpublished Ph.D. dissertation, Department of Anthropology, University of California, Santa Cruz.

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

Cartier, R.
1993a *The Saunders Site: Mnt-391, A Littoral Site of the Early Period.* Scotts Valley Historical Society Monograph No. 1. Scotts Valley, California.

1993b *The Scotts Valley Site: CA-SCr-177*. Santa Cruz Archaeological Society Monograph No. 1, Santa Cruz.

1995 *Cultural Resource Evaluation of the Tashmarkan Project in the County of Monterey.* Copies available from the Northwest Information Center, Department of Anthropology, Sonoma State University, Rohnert Park.

Chartkoff, J. L.
1989 Exchange Systems in the Archaic of Coastal Southern California. *Proceedings of the Society for California Archaeology* 2:167-186.

Chartkoff, J. L., and K. K. Chartkoff
1984 *The Archaeology of California*. Stanford University Press, Stanford.

Christenson, L. E.
1992 The Late Prehistoric Yuman Settlement and Subsistence System: Coastal Adaptation. In *Essays on the Prehistory Of Maritime California*, edited by T. L. Jones, pp. 217-230. Center for Archaeological Research at Davis, Publication No. 10, University of California, Davis.

Claassen, C.
1986 Temporal Patterns in Marine Shellfish-Species Use along the Atlantic Coast of the Southeastern United States. *Southeastern Archaeology* 5:120-137.

1998 *Shells*. Cambridge University Press, New York.

Coe, W. R., and D. L. Fox
1942 Biology of the California Sea Mussel: Influence of Temperature, Food Supply, Sex and Age on the Rate of Growth. *Journal of Experimental Zoology* 90:1-30.

Cohen, M.
1977 *The Food Crisis in Prehistory*. Yale University Press, New Haven.

Colten, R. H.
1993 Prehistoric Subsistence, Specialization, and Economy in a Southern California Chiefdom. Unpublished Ph.D. dissertation, Department of Anthropology, Institute of Archaeology, University of California, Los Angeles.

Colten, R. H., and J. E. Arnold
1998 Prehistoric Marine Mammal Hunting on California's Northern Channel Islands. *American Antiquity* 63:679-701.

Cook, S. F.
1974 The Esselen: Territory, Villages, and Population. *Monterey County Archaeological Society Quarterly* 3(2).

Cope, C. R.
1985 The Mammalian Fauna of the Emeryville Shellmound, CA-ALA-309. Unpublished Master's thesis, Department of Anthropology, Sonoma State University, Rohnert Park.

Cowgill, G.
1975 Population Pressure as a Non-Explanation. *Society for American Archaeology Memoirs* 30:127-131.

Crabtree, D. E.
1972 *An Introduction to Flintworking*. Occasional Papers of the Idaho State University Museum No. 28. Pocatello.

Culleton, J. G.
1950 *Indians and Pioneers of Old Monterey*. Academy of California Church History, Fresno.

Currey, D. R., and S. R. James
1982 Paleoenvironments of the Northeastern Great Basin and Northeastern Basin Rim Region: A Review of Geological and Biological Evidence. In *Man and Environment in the Great Basin*, edited by D. B. Madsen and J. F. O'Connell, Society for American Archaeology Papers 2. Washington, D.C.

Curry, R. R.
1969 Holocene Climatic and Glacial History of the Central Sierra Nevada, California. *Geological Society of America Special Papers* 123:1-47.

Davenport, D., J. R. Johnson, and J. Timbrook
1993 The Chumash and the Swordfish. *Antiquity* 67:257-272.

Davis, O. K., and M. J. Moratto
1988 Evidence for a Warm Dry Early Holocene in the Western Sierra Nevada of California: Pollen and Plant Macrofossil Analysis of Dinkey and Exchequer Meadows. *Madroño* 35:132-149.

Dayton, P. K., and M. J. Tegner
1990 Bottoms Beneath Troubled Waters: Benthic Impacts of the 1982-1984 El Niño in theTemperate Zone. In *Global Ecological*

Consequences of the 1982-83 El Niño-Southern Oscillation, edited by P. W. Glynn, pp. 433-472. Elsevier Oceanography Series, Amsterdam.

Dietz, S. A.
1991 *Final Report of Archaeological Investigations at Pescadero Point, Data Recovery Excavations and Monitoring of CA-MNT-170*. Archaeological Consulting and Research Services. Copies available from the Northwest Information Center, Department of Anthropology, Sonoma State University, Rohnert Park.

Dietz, S. A., W. R. Hildebrandt, and T. L. Jones
1988 *Archaeological Investigations at Elkhorn Slough: CA-MNT-229, A Middle Period Site on the California Coast.* Papers in Northern California Anthropology No. 3. Rohnert Park, California.

Dietz, S. A., and T. L. Jackson
1981 *Report of Archaeological Excavations at Nineteen Archaeological Sites for the Stage 1 Pacific Grove-Monterey Consolidation Project of the Regional Sewerage System*. Archaeological Consulting and Research Services. Submitted to Engineering-Science, Berkeley. Copies available from the Northwest Information Center, Department of Anthropology, Sonoma State University, Rohnert Park.

Dixon, R., and A. L. Kroeber
1913 New Linguistic Families in California. *American Anthropologist* 15:647-655.

Dunbar, R.
1983 Stable Isotope Record of Upwelling and Climate from the Santa Barbara Basin. In *Coastal Upwelling: Its Sedimentary History Part B: Sedimentary Records of Ancient Coastal Upwelling*, edited by J. Thide and E. Suess, pp. 217-242. NATO Conference Series 4: Marine Sciences, Plenum Press, New York.

Edwards, R. L.
1975 *Prehistoric Cultural Resources at Hunter Liggett Military Reservation*. Submitted to the Advisory Council on Historic Preservation, Washington, D.C. Copies available from the Northwest Information Center, Department of Anthropology, Sonoma State University, Rohnert Park.

Edwards, R. L., G. S. Breschini, T. Haversat, and C. Simpson-Smith
2000 Archaeological Evaluation of Sites CA-MNT-798, CA-MNT-799 and CA-MNT-800, in the Pfeiffer Beach Day Use Area, Big Sur, Monterey County, California. *Coyote Press Archives of California Prehistory* No. 48.

Eidsness, J., and T. L. Jackson
1994 *Historic Preservation Plan Fort Hunter Liggett Military Installation, California..* Biosystems, Santa Cruz. Copies available from the Northwest Information Center, Department of Anthropology, Sonoma State University, Rohnert Park.

Engelhardt, Z.
1972[1934] *Mission San Antonio de Padua, the Mission in the Sierras*. Ballena Press, Ramona.

Engles, E. (editor)
1984 *The Natural Features of the Gamboa Point Property*. Environmental Field Program Publication No. 13. University of California, Santa Cruz.

Ericson, J. E., M. West, C. H. Sullivan, and H. W. Krueger
1989 The Development of Maize Agriculture in the Viru Valley, Peru. In *The Chemistry of Prehistoric Human Bone*, edited by T. D. Price, pp. 68-104. Cambridge University Press, Cambridge.

Erlandson, J. M.
1988a Of Millingstones and Molluscs: Cultural Ecology of Early Holocene Hunter-Gatherers on the California Coast. Unpublished Ph.D. dissertation, Department of Anthropology, University of California, Santa Barbara.

1988b The Role of Shellfish in Prehistoric Economies: A Protein Perspective. *American Antiquity* 53:102-109.

1991 Shellfish and Seeds as Optimal Resources: Early Holocene Subsistence on the Santa Barbara Coast. In *Hunter-Gatherers of Early Holocene Coastal California*, edited by J. M. Erlandson and R. H. Colten, pp. 89-100. Perspectives in California Archaeology No. 1, Institute of Archaeology, University of California, Los Angeles.

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

Erlandson, J. M., and K. Bartoy
1995 Cabrillo, the Chumash and Old World Diseases. *Journal of California and Great Basin Anthropology* 17:153-173.

Erlandson, J. M., and J. L. Gerber
1993 *Archaeological Investigations at CA-SBA-1731: A Middle-to-Late Period Site on the Santa Barbara Channel*. Dames and Moore, Santa Barbara. Prepared for Exxon Company USA. Copies available from the Central Coast Information Center, Department of Anthropology, University of California, Santa Barbara.

Erlandson J. M., D. J. Kennett, B. L. Ingram, D. A. Guthrie, D. P. Morris, M. A. Tveskov, G. J. West, and P. L. Walker
1996 An Archaeological and Paleontological Chronology for Daisy Cave (CA-SMI-261), San Miguel Island, California. *Radiocarbon* 38:361-373.

Estioko-Griffin, A., and P. B. Griffin
1981 Woman the Hunter: The Agta. In *Woman the Gatherer*, edited by F. Dahlberg, pp. 121-151. Yale University Press, New Haven.

Fagan, B. M.
2000 *The Little Ice Age: The Prelude to Global Warming, 1300-1850*. Basic Books: New York.

Fairbanks, R. G.
1989 A 17,000-year Gacio-eustatic Sea Level Record: Influence of Glacial Melting Rates on the Younger Dryas Event and Deep Ocean Circulation. *Nature* 342:637-641.

Ferguson, A. F. (editor)
1984 *Intertidal Plants and Animals of the Landels-Hill Big Creek Reserve*. Environmental Field Program Publication No. 14. University of California, Santa Cruz.

Fiedler, P. C.
1984 Satellite Observations of the 1982-83 El Niño along the U.S. Pacific Coast. *Science* 224:1251-1254.

Fitch, J.
1972 Fish Remains, Primarily Otoliths, from a Coastal Indian Midden (SLO-2) at Diablo Cove, San Luis Obispo County, California. In *9000 Years of Prehistory at Diablo Canyon, San Luis Obispo County*. San Luis Obispo County Archaeological Society Papers No. 7:101-120.

Fitzgerald, R. T.
1992 Archaic Milling Cultures of the Southern San Francisco Bay Region. Coyote Press Archives of California Prehistory 35. Salinas.

1997 *Archaeological Data Recovery at the Salinas River Crossing Site (CA-SLO-1756), San Luis Obispo County, California, Coastal Branch Phase II Project*. Garcia and Associates, San Anselmo, California. Submitted to California Department of Water Resources, Sacramento. Copies available from California Department of Water Resources, Sacramento.

1998 *Archaeological Data Recovery at CA-SLO-1797, the Cross Creek Site, San Luis Obispo County, California, Coastal Branch Phase II Project*. Garcia and Associates, San Anselmo, California. Submitted to California Department of Water Resources, Sacramento. Copies available from California Department of Water Resources, Sacramento.

2000 *Cross Creek: An Early Holocene Millingstone Site*. The California State Water Project, Coastal Branch Series Paper No. 12. San Luis Obispo County Archaeological Society, San Luis Obispo, California.

Fitzgerald, R. T., and T. L. Jones
1999 The Milling Stone Horizon Revisited: New Perspectives from Northern and Central California. *Journal of California and Great Basin Anthropology* 21:65-93.

Flannery, K. V.
1972 The Cultural Evolution of Civilizations. *Annual Review of Ecology and Systematics* 3:399-426.

Flenniken, J. J.
1980 Replicative Systems Analysis: a Model Applied to the Vein Quartz Artifacts from the Hoko River Site. Unpublished Ph. D. dissertation, Department of Anthropology, Washington State University, Pullman.

Fredrickson, D. A.
1973 Early Cultures of the North Coast Range, California. Unpublished Ph.D. dissertation, Department of Anthropology, University of California, Davis.

1974 Cultural Diversity in Early Central California: A View from the North Coast Ranges. *The Journal of California Anthropology* 1:41-54.

1994 Spatial and Cultural Units in Central California Archaeology. In *Toward a New Taxonomic Framework for Central California Archaeology*, edited by R. E. Hughes, pp. 25-47. Contributions of the University of California Archaeological Research Facility No. 52, Berkeley.

Gallegos, D.
1992 Patterns And Implications of Coastal Settlement In San Diego County: 9000 To 1300 Years Ago. In *Essays on the Prehistory Of Maritime California*, edited by T. L. Jones, pp. 205-216. Center For Archaeological Research At Davis, Publication No. 10, University of California, Davis.

Gibson, R. O.
1983 Ethnogeography of the Salinan Peoples: A Systems Approach. Unpublished Master's thesis, Department of Anthropology, California State University, Hayward.

1985 Ethnogeography of the Northern Salinan. In *Excavation at Mission San Antonio 1976-1978*, edited by R. L. Hoover and J. G. Costello, pp. 152-221. Institute of Archaeology Monograph 26, University of California, Los Angeles.

Gibson, R. O., A. Lonnberg, J. Morris, and W. Roop
1976 Report on the Excavations at the Kirk Creek Project (CA-MNT-238) Monterey County, California. Manuscript on file, Department of Transportation, San Luis Obispo.

Gifford, D. P.
1981 Taphonomy and Paleoecology: A Critical Review of Archaeology's Sister Disciplines. *Advances in Archaeological Method and Theory* 4:365-438.

Gifford, E. W.
1916 Composition of California Shellmounds. *University of California Publications in American Archaeology and Ethnology* 11:291-296.

1940 Californian Bone Artifacts. *University of California Anthropological Records* No. 3.

Gilliland, L. E.
1985 Proximate Analysis and Mineral Composition of Traditional California Native American Foods. Unpublished Master's thesis, Department of Nutrition Science, University of California, Davis.

Gilreath, A.
1989 Flaked Stone Analysis. In *Prehistory of the Sacramento River Canyon, Shasta County, California.* edited by M. E. Basgall and W. R. Hildebrandt, pp. A1-A85. Center for Archaeological Research at Davis Publications No. 9.

Glassow, M. A.
1990 *Archaeological Investigations at Vandenberg Air Force Base in Connection with the Development of Space Transportation System Facilities.* Submitted to the U. S. Department of Interior, National Parks Service, Western Region, Interagency Archaeological Services Branch, Contract no. CX 8099-2-0004. Copies available from National Technical Information Service.

1991 Early Holocene Adaptations on Vandenberg Air Force Base, Santa Barbara County. In *Hunter-Gatherers of Early Holocene Coastal California*, edited by J. M. Erlandson and R. H. Colten, pp. 113-124. Perspectives in California No. 1, Institute of Archaeology, University of California, Los Angeles.

1992 The Relative Dietary Importance of Marine Foods Through Time in Western Santa Barbara County. In *Essays on the Prehistory of Maritime California*, edited by T. L. Jones, pp. 115-128. Center for Archaeological

Research at Davis, Publication No. 10, University of California, Davis.

1995 *Purisimeño Chumash Prehistory*. Harcourt Brace, San Diego.

1997 Middle Holocene Cultural Development in the the Central Santa Barbara Channel Region. In *Archaeology of the California Coast during the mid-Holocene*, edited by J. M. Erlandson and M. A. Glassow, pp. 73-90. Perspectives in California Archaeology No. 4 Institute of Archaeology, University of California, Los Angeles.

Glassow, M. A., D. J. Kennett, J. P. Kennett, and L. R. Wilcoxon
1994 Confirmation of Middle Holocene Ocean Cooling Inferred from Stable Isotopic Analysis of Prehistoric Shells from Santa Cruz Island, California. In *The Fourth California Islands Symposium: Update on Status of Resources,* edited by W. L. Halvorson and G. J. Maender, 223-234. Santa Barbara Museum of Natural History, Santa Barbara.

Glassow, M. A., and L. Wilcoxon
1988 Coastal Adaptation Near Point Conception, California, with Particular Regard to Shellfish Exploitation. *American Antiquity* 53:36-51.

Glassow, M. A., L. R. 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 Geoff Bailey and John Parkington, pp. 64-77. Cambridge University Press, Cambridge

Goldschmidt, W.
1948 Social Organization in Native California and the Origin of Clans. *American Anthropologist* 50:444-456.

Goody, J., and S. Tambiah
1973 *Bridewealth and Dowry*. Cambridge University Press, Cambridge.

Gordon, E. A.
1993 Screen Size and Differential Faunal Recovery: A Hawaiian Example. *Journal of Field Archaeology*. 20:453-460.

Gould, R. A.
1982 To Have and Have Not: The Ecology of Sharing among Hunter-Gatherers. In *Resource Managers: North American and Australian Hunter-Gatherers*, edited by N. M. Williams and E. S. Hunn, pp. 69-92. Westview Press, Boulder, Colorado.

Graumlich, L. J.
1993 A 1000-Year Record of Temperature and Precipitation in the Sierra Nevada. *Quaternary Research* 39:249-255.

Grayson, D. K.
1988 Danger Cave, Last Supper Cave, and Hanging Rock Shelter: The Faunas. *Anthropological Papers* Vol. 66, Pt. 1. American Museum of Natural History, New York.

Greengo, R.
1948 Aboriginal Use of Shellfish as Food in California. Unpublished Master's thesis, Department of Anthropology, University of California, Berkeley.

Greenwood, R. S.
1972 *9000 Years of Prehistory at Diablo Canyon, San Luis Obispo County, California.* San Luis Obispo County Archaeological Society Occasional Paper No. 7:1-97.

Haney, J. W., and T. L. Jones
1997 *Programmatic Treatment of Low Density, Low Variability Flaked Stone Artifact Scatters and Isolated Bedrock Mortar Sites at Fort Hunter Liggett, Monterey County, California: 1993-1995.* Garcia and Associates, San Anselmo. Copies available from the Northwest Information Center, Department of Anthropology, Sonoma State University, Rohnert Park.

Haney, J. W., T. L. Jones, and J. M. Farquhar
2001 Phase II *Archaeological Investigation of CA-MNT-879, Fort Hunter Liggett, Monterey County, California.* Albion Environmental, Santa Cruz. Copies available from the Northwest Information Center, Department of Anthropology, Sonoma State University, Rohnert Park.

Harrington, J. P.
1942 Cultural Element Distributions, XIX: Central California. *University of California Anthropological Records* 7:1-146.

1985 *John P. Harrington Papers*, vol. 2. Smithsonian Institution, National Anthropological Archives, Washington D.C.

Haston, L., and Michaelsen, J.
1994 Long-term Central Coastal California Precipitation Variability and Relationships to El Niño. *Journal of Climate* 7:1373-1387.

Hayden, B., M. Deal, A. Cannon, and J. Casey
1986 Ecological Determinants of Woman's Status among Hunter-Gatherers. *Human Evolution* 1:449-474.

Heizer, R. F., and H. Kelly
1962 Burins and Bladelets in the Cessac Collection from Santa Cruz Island, California. *Proceedings of the American Philosophical Society* 106:92-105.

Hensen, P., and D. J. Usner
1993 *The Natural History of Big Sur*. University of California Press, Berkeley.

Heusser, L.
1978 Pollen in Santa Barbara, California: A 12,000 Year Record. *Geological Society of America Bulletin* 89:673-678.

Hildebrandt, W. R.
1981 Native Hunting Adaptations on the North Coast of California. Unpublished Ph.D. dissertation, Department of Anthropology, University of California, Davis.

1984 Late Period Hunting Adaptations on the North Coast of California. *Journal of California and Great Basin Anthropology* 6:189-206.

Hildebrandt, W. R., and D. A. Jones
1998 *Archaeological Investigations at CA-MNT-1892: A Late Period Occupation Site at the Mouth of Limekiln Creek, Monterey County, California*. Far Western Anthropological Research Group, Davis, California. Copies available from the Northwest Information Center, Department of Anthropology, Sonoma State University, Rohnert Park.

Hildebrandt, W. R., and T. L. Jones
1992 Evolution of Marine Mammal Hunting: a View from the California and Oregon Coasts. *Journal of Anthropological Archaeology* 11:360-401.

Hill, K., H. Kaplan, K. Hawkes, and M. Hurtado
1987 Foraging Decisions Among Ache Hunting-Gatherers: New Data and Implications for Optimal Foraging Models. *Ethnology and Sociobiology* 8:1-36.

Hines, P.,
1986 *The Prehistory of San Simeon Creek: 5800 B.P. to Missionization.* California Department of Parks and Recreation, Sacramento.

Hockey, P. A. R., and A. L. Bosman
1986 Man as an Intertidal Predator in Transkei: Disturbance, Community Convergence, and Management of a Natural Food Resource. *Oikos* 64:3-14.

Hollimon, S. E.
1990 *Division of Labor and Gender Roles in Santa Barbara Channel Prehistory*. Ph.D. dissertation, Department of Anthropology, University of California, Santa Barbara. University Microfilms, Ann Arbor.

Hoover, R. L., and J. G. Costello (editors)
1985 *Excavation at Mission San Antonio 1976-1978*. Institute of Archaeology Monographs No. 26, University of California, Los Angeles.

Howard, D. M.
1973 The Gamboa Site (MNT-48O)--An Esselen Village, with a Review of Esselen Ethnography. *The Monterey County Archaeological Society Quarterly* 3:1-10.

Huddleson, J., and T. L. Jones
1992 An Archaeological Survey in Southern Monterey County by the 1990 University of California, Davis Field School. Copies available from the Northwest Information Center, Department of Anthropology, Sonoma State University, Rohnert Park.

Hughes, M. K., and H. F. Diaz

1994 Was There a Medieval Warm Period, and if so, Where and When? *Climate Change* 26:109-142.

Hughes, R. E.
1992 California Archaeology and Linguistic Prehistory. *Journal of Anthropological Research* 48:317-338.

Hunn, E. S., and N. M. Williams
1982 Introduction. In *Resource Managers: North American and Australian Hunter-Gatherers*, edited by N. M. Williams and E. S. Hunn, pp.1-16. Westview Press, Boulder, Colorado.

Ingram, B. L., and D. J. DePaolo
1993 A 4300-year Strontium Isotope Record of Estuarine Paleosalinity in San Francisco Bay, California. *Earth and Planetary Science Letters* 119:103-119.

Ingram, B. L., and J. R. Southon
1996 Reservoir Ages in Eastern Pacific Coastal and Estuarine Waters. *Radiocarbon* 38:573-582.

Ingram, M. J., G. Farmer, and T. M. L. Wigley
1981 Past Climates and their Impact on Man: A Review. In *Climate and History: Studies in Past Climates and their Impact on Man*, edited by T. M. L. Wigley, M. J. Ingram, and G. Farmer, pp. 3-50. Cambridge University Press, Cambridge.

Jackson, T. L.
1991 Pounding Acorn: Women's Production as Social and Economic Focus. In *Engendering Archaeology: Women and Prehistory*, edited by J. M. Gero and M. W. Conkey, pp. 301-325. Basil Blackwell, Cambridge.

Jochim, M.
1988 Optimal Foraging and the Division of Labor. *American Anthropologist* 90:130-135.

Johnson, D. L.
1977 The Late Quaternary Climate of Coastal California: Evidence for an Ice Age Refugium. *Quaternary Research* 8:154-178.

Jones, D.
1992 The Forager-Collector Model and Monterey Bay Prehistory. In *Essays on the Prehistory of Maritime California*, edited by T. L. Jones, pp. 105-113. Center for Archaeological Research at Davis, Publication No. 10. University of California, Davis, California.

Jones, G. T., D. K. Grayson, and C. Beck
1983 Artifact Class Richness and Sample Size in Archaeological Surface Assemblages. In *Lulu Linear Punctuated: Essays in Honor of George Irving Quimby*, edited by R. C. Dunnell and D. K. Grayson, pp. 55-73. University of Michigan Anthropological Papers No. 72, Detroit.

Jones, T. L.
1988 A Shell Projectile Point from the Big Sur Coast. *Journal of California and Great Basin Anthropology* 10:100-103.

1991 Marine-Resource Value and the Priority of Coastal Settlement: A California Perspective. *American Antiquity* 56:419-443.

1992 Settlement Trends along the California Coast. In *Essays on the Prehistory of Maritime California*, edited by T.L. Jones, pp. 1-37. Center for Archaeological Research at Davis, Publication No. 10.

1993 Big Sur: A Keystone in Central California Cultural History. *Pacific Coast Archaeological Society Quarterly* 29:1-78.

1994 Archaeological Testing and Salvage at CA-MNT-63, CA-MNT-73, and CA-MNT-376, on the Big Sur Coast, Monterey County, California. Copies available from the Northwest Information Center, Department of Anthropology, Sonoma State University, Rohnert Park.

1995 Transitions in Prehistoric Diet, Mobility, Exchange, and Social Organization along California's Big Sur Coast. Unpublished Ph.D. dissertation, Department of Anthropology, University of California, Davis.

1995 Mortars, Pestles, and Division of Labor in Prehistoric California: A View From Big Sur. *American Antiquity,* 61: 243-264.

2000 Archaeological Evaluations at CA-MNT-237 and CA-MNT-519, Fort Hunter Liggett, Monterey County, California. Albion Environmental, Santa Cruz. Copies available from the Northwest Information Center, Department of Anthropology, Sonoma State University, Rohnert Park.

Jones, T. L., S. Anderson, M. Brown, A. Garsia, K. Hildebrand, and A. York
1989 *Surface Archaeology at Landels-Hill Big Creek Reserve and the Gamboa Point Properties*. University of California Santa Cruz Environmental Field Program No. 18.

Jones, T. L., G. Brown, L. M. Raab, J. McVickar, G. Spaulding, D. J. Kennett, A. York, and P. L. Walker
1999 Environmental Imperatives Reconsidered: Demographic Crises in Western North America during the Medieval Climatic Anomaly. *Current Anthropology* 40:137-156.

Jones, T. L., and J. A. Ferneau
2002 *Prehistory at San Simeon Reef: Archaeological Data Recovery at CA-SLO-179 and -267, San Luis Obispo County, California*. San Luis Obispo County Archaeological Society Publication 16.

Jones, T. L., R. T. Fitzgerald, D. J. Kennett, C. H. Miksicek, J. L. Fagan, J. Sharp, and J. M. Erlandson
2002 The Cross Creek Site (CA-SLO-1797) and its Implications for New World Colonization. *American Antiquity* 67:213-230.

Jones, T. L., and J. W. Haney
1992 *Excavation and Conservation of Six Archaeological Sites at Landels-Hill Big Creek Reserve, Monterey County*. Anthropological Studies Center, Sonoma State University. Copies available from the Northwest Information Center, Department of Anthropology, Sonoma State University, Rohnert Park.

1997a *Archaeological Evaluation of CA-MNT-521, Fort Hunter Liggett, Monterey County, California*. Garcia and Associates, San Anselmo, California. Copies available from the Northwest Information Center, Department of Anthropology, Sonoma State University, Rohnert Park.

1997b *Archaeological Evaluation and Data Recovery at CA-MNT-569, Fort Hunter Liggett, Monterey County, California*. Garcia and Associates, San Anselmo, California. Copies available from the Northwest Information Center, Department of Anthropology, Sonoma State University, Rohnert Park.

Jones, T. L., and W. R. Hildebrandt
1995 Reasserting a prehistoric tragedy of the commons: Reply to Lyman. *Journal of Anthropological Archaeology* 14:78-98.

Jones, T. L., and M. Hylkema
1988 Two Proposed Projectile Point Types for the Monterey Bay Area: The Rossi Squarestemmed and Año Nuevo Long-stemmed. *Journal of California and Great Basin Anthropology* 10:163-186.

Jones, T. L., and D. Jones
1992 Elkhorn Slough Revisited: Reassessing the Chronology of CA-MNT-229. *Journal of California and Great Basin Anthropology* 14:159-179.

Jones, T. L., and D. J. Kennett
1999 Late Holocene Sea Temperatures along the Central California Coast. *Quaternary Research* 51:74-82.

Jones, T. L., and J. R. Richman
1995 On Mussels: *Mytilus californianus* as a Prehistoric Resource. *North American Archaeologist* 16:33-58.

Jones, T. L., B. Rivers, T. L. Joslin, A. Maliarik, and D. Alger
2000 An Addendum to Harrington's Northern Salinan Place Names. *Journal of California and Great Basin Anthropology* 22:3-11.

Jones, T. L., T. Van Bueren, S. Grantham, J. Huddleson, and T. Fung
1996 *Archaeological Investigations for the Castroville Bypass Project, Monterey County, California*. California Department of Transportation, Sacramento. Copies available from the Northwest Information Center, Department of Anthropology, Sonoma State University, Rohnert Park.

Jones, T. L., and G. Waugh
1995 *Central California Coastal Prehistory: A View from Little Pico Creek*. Perspectives in California Archaeology No. 3, Institute of Archaeology, University of California, Los Angeles.

Kay, C.
1990 Yellowstone's Northern Elk Herd: A Critical Evaluation of the "Natural Regulation Paradigm." Unpublished Ph.D. dissertation, Department of Biology, Utah State University.

1994 Aboriginal Overkill: The Role of Native Americans in Structuring Western Ecosystems. *Human Nature* 5: 359-398.

Kelly, R. L.
1983 Hunter-Gatherer Mobility Strategies. *Journal of Anthropological Research* 39:277-306.

1988 The Three Sides of a Biface. *American Antiquity* 53:717-734.

1991 Sedentism, Sociopolitical Inequality, and Resource Fluctuations. In *Between Bands and States*, edited by S. A. Gregg, pp. 135-158. Center for Archaeological Investigations, Occasional Paper No. 9. Southern Illinois University at Carbondale.

1992 Mobility/Sedentism: Concepts, Archaeological Measures, and Effects. *Annual Review of Anthropology* 21:43-66.

Kennett, D. J.
1998 Behavioral Ecology and the Evolution of Hunter-Gatherer Societies on the Northern Channel Islands, California. Unpublished Ph.D. dissertation, University of Anthopology University of California, Santa Barbara.

Kennett, D. J., B. L. Ingram, J. Erlandson, and P. Walker
1997 Evidence for Temporal Fluctuations of Marine Radiocarbon Reservoir Ages in the Santa Barbara Channel Region, California. *Journal of Archaeological Science* 24:1051-1059.

Kennett, D. J., and J. P. Kennett
2000 Competitive and Cooperative Responses to Climatic Instability in Coastal Southern California. *American Antiquity* 65:379-395.

Kidd, K. E., and M. A. Kidd
1970 A Classification System for Glass Beads for the Use of Field Archaeologists. *Canadian Historic Sites Occasional Papers in Archaeology and History* No. 1.

King, C. D.
1982 The Evolution of Chumash Society: A Comparative Study of Artifacts Used in Social System Maintenance in the Santa Barbara Channel Region before A.D. 1804. Unpublished Ph.D. dissertation, University of California, Davis.

1990 *The Evolution of Chumash Society: A Comparative Study of Artifacts Used in Social System Maintenance in the Santa Barbara Channel Region before A.D. 1804.* Garland Publishing, New York.

King, L. B.
1982 Medea Creek Cemetery: Late Inland Chumash Patterns of Social Organization, Exchange and Warfare. Unpublished Ph.D. dissertation, Department of Anthropology, University of California, Los Angeles.

Kintigh, K. W.
1993 *Tools for Quantitative Archaeology: Programs for Quantitative Analysis in Archaeology.* Computer program manual, privately printed. Copies available from K. Kintigh, 2014 East Alameda Drive, Tempe, Arizona.

Klar, K. A.
1977 Topics in Historical Chumash Grammar. Unpublished Ph.D. dissertation, Department of Linguistics, University of California, Berkeley.

Klevezal, G. A., and S. E. Kleinenberg
1967 Age Determination of Mammals from Annual Layers in Teeth and Bones. *Fisheries Research Board of Canada Translation Series* No. 1024.

Koerper, H. C., J. S. Killingley, and R. E. Taylor
1985 The Little Ice Age and Coastal Southern California Human Economy. *Journal of California and Great Basin Anthropology* 7:99-103.

Koerper, H. C., P. Langenwalter II, and A. Schroth
1991 Early Holocene Adaptations and the Transition Phase Problem. Evidence from the Allan O. Kelly Site, Aqua Hedionda Lagoon. In *Hunter-Gatherers of Early Holocene Coastal California,* edited by J. M. Erlandson and R. H. Colten, Institute of Archaeology, University of California, Los Angeles.

Koloseike, A.
1969 On Calculating the Prehistoric Food Resource Value of Mollusks. *University of California Los Angeles Archaeological Survey Annual Report* 11:143-162.

Kniffen, F. B.
1939 Pomo Geography. *University of California Publications in American Archaeology and Ethnology* 36:353-400.

Kroeber, A. L.
1904 The Languages of the Coast of California South of San Francisco. *University of California Publications in American Archaeology and Ethnology* 2:29-80.

1917 California Kinship Systems. *University of California Publications in American Archaeology and Ethnology* 12:339-396.

1925 *Handbook of the Indians of California.* Bureau of American Ethnology Bulletin 78. Washington D.C.

1955a Linguistic Time Depth Results so far and their Meaning. *International Journal of American Linguistics* 21:91-104.

1955b Nature of the Land-holding Group. *Ethnohistory* 2:303-314.

1962 The Nature of Land Holding Groups in Aboriginal California. In *Two Papers On The Aboriginal Ethnography of California*, edited by D. H. Hymes and R. F. Heizer, pp. 19-58. University of California Archaeological Survey Reports 56. Berkeley.

Kroeber, A. L., and S. Barrett
1960 Fishing among the Indians of Northwestern California. *University of California Anthropological Records* 21:1-210.

Krueger, H. W.
1985 Models for Carbon and Nitrogen Isotopes in Bone. Paper presented at Biomineralization Conference, Airlie House, Warrenton, Virginia.

Kuhn, S. L.
1994 A Formal Approach to the Design and Assembly of Mobile Toolkits. *American Antiquity* 59:426-442.

LaMarche, V. C.
1974 Paleoclimatic Inferences from Long Tree - Ring Records. *Science* 183:1043-1048.

Lambert, P. M.
1993 Health in Prehistoric Populations of the Santa Barbara Channel Islands. *American Antiquity* 58:509-522.

Larson, D. O., and J. Michaelsen
1989 Climatic Variability: A Compounding Factor Causing Culture Change among Prehistoric Coastal Populations. Manuscript on file, Department of Anthropology, California State University, Long Beach.

Laurie, L. T., and T. L. Jones
2002 San Simeon State Park Site Assessment: 2001. Department of Social Sciences, California Polytechnic State University, San Luis Obispo. Prepared for California Department of Parks and Recreation, San Luis Obispo. Copies available from the Central Coastal Information Center of the California Historical Resources System, Department of Anthropology, University of California, Santa Barbara.

Leavitt, S. W.
1994 Major Wet Interval in White Mountains Medieval Warm Period Evidenced in ^{13}C Bristlecone Pine Tree Rings. *Climate Change* 26:299-308.

LeBoeuf, B. J.
1981 Mammals. In *The Natural History of Año Nuevo*, edited by B. J. LeBoeuf, and S. Kaza, pp. 287-325. Boxwood Press, Pacific Grove, California.

Lee, R. B., and I. Devore (Editors)
1968 *Man the Hunter.* Aldine, Chicago.

Lewis, H. T.
1973 Patterns of Indian Burning in California: Ecology and Ethnohistory. *Anthropological Papers* No. 1. Ballena Press, Ramona.

Lyman, R. L.
1979 Available Meat from Faunal Remains: A Consideration of Techniques. *American Antiquity* 44:536-546.

1985 Bone Frequencies: Differential Transport, *In Situ* Destruction and the MGUI. *Journal of Archaeological Science* 12:221-236.

Magurran, A. E.
1988 *Ecological Diversity and its Measurement*. Princeton University Press, Princeton, New Jersey.

Margolin, M. (editor)
1989 *Monterey in 1786: The Journals of Jean Francois de La Perouse*. Heyday Books, Berkeley.

Martin, P. S.
1967 Prehistoric Overkill. In *Pleistocene Extinctions: The Search for a Cause*, edited by P. S. Martin and H. E. Wright, pp. 75-120. Yale University Press, New Haven, Connecticut.

Martz, P. C.
1992 Status Distinctions Reflected in Chumash Mortuary Populations in the Santa Monica Mountains Region. In *Essays on the Prehistory Of Maritime California*, edited by T. L. Jones, pp.145-156. Center For Archaeological Research at Davis, Publication No. 10, University of California, Davis.

Mason, J. A.
1912 The Ethnography of the Salinan Indians. *University of California Publications in American Archaeology and Ethnology* 10:97-240.

1918 The Language of the Salinan Indians. *University of California Publications in Archaeology and Ethnology* 14:1-154.

McCarthy, H.
1993 A Political Economy of Western Mono Acorn Production. Unpublished Ph.D. dissertation, Department of Anthropology, University of California, Davis.

McGrew, W.C.
1981 The Female Chimpanzee as a Human Evolutionary Prototype. *Woman the Gatherer*, edited by F. Dahlberg, pp. 35-73. Yale University Press, New Haven Connecticut.

McGuire, K. R.
1995 Test Excavations at CA-FRE-61, Fresno County, California. *Occasional Papers in Anthropology* No. 5. Museum of Anthropology, California State University, Bakersfield.

McGuire, K. R., and W. R. Hildebrandt
1994 The Possibilities of Women and Men: Gender and the California Milling Stone Horizon. *Journal of California and Great Basin Anthropology* 16:41-59.

Meighan, C.
1955 Excavation of the Isabella Meadows Cave CA-MNT-250. *University of California Archaeological Survey 29*. Berkeley.

1978 California. In *Chronologies in New World Archaeology*, edited by R. E. Taylor and Clement W. Meighan, pp.223-240. Academic Press, San Francisco.

1979 Glass Trade Beads in California. Manuscript on file, Lowie Museum of Anthropology, University of California, Berkeley.

Mensing, S. A.
1993 The Impact of European Settlement on Oak Woodlands and Fire: Pollen and Charcoal Evidence from the Transverse Ranges, California. Unpublished Ph.D. dissertation, Department of Geography, University of California, Berkeley.

Merriam, C. H.
1955 *Studies of California Indians*. University of California Press, Berkeley.

1968 Village Names in Twelve California Indian Mission Records. Assembled and edited by Robert F. Heizer. *University of California Archaeological Survey Reports* 74:1-175.

Michaelsen, J., and J. T. Dailey
1983 Long Period Modulation of El Niño. *Proceedings of the Eighth Annual Climate Diagnostic Workshop,* California Department of Water Resources:104-147.

Mikkelsen, P., W. R. Hildebrandt, and D. A. Jones
2000 *Prehistoric Adaptations on the Shores of Morro Bay Estuary, San Luis Obispo County, California.*. San Luis Obispo County Archaeological Society Occasional Paper 14.

Milliken, R. T.
1981 Ethnohistory of the Rumsen: The Mission Period. In *Report of Archaeological Excavations at Nineteen Archaeological Sites*

for the Stage 1 Pacific Grove-Monterey Consolidation Project of the Regional Sewerage System. Archaeological Consulting and Research Services. Submitted to Engineering-Science, Berkeley. Copies available from the Northwest Information Center, Department of Anthropology, Sonoma State University, Rohnert Park.

1990 Ethnographic and Ethnohistory of the Big Sur District, California State Parks System During the 1770-1810 Time Period. Manuscript on file, California Department of Parks and Recreation, Sacramento.

Mills, E. L. (editor)
1985 The Papers of John Peabody Harrington in the Smithsonian Institution, Vol. 2, Northern and Central California National Anthropological Archives, Smithsonian Institution, Washington D.C. [Microfilm Edition. Millwood, NY: Kraus International Publications].

Mitchell, B.
1969 Growth Layers in Dental Cement for Determining the Age of Red Deer (*Cervus elaphus l.*) *Journal of Animal Ecology* 36:279-293.

Mitchell, D.
1988 Changing Patterns of Resource Use in the Prehistory of Queen Charlotte Strait, British Columbia. In *Prehistoric Economies of the Pacific Northwest Coast*, edited by B. L. Isaac, pp. 245-290. Research in Economic Anthropology Supplement 3, JAI Press, Greenwich, Connecticut.

Moratto, M. J.
1984 *California Archaeology*. Academic Press, Orlando.

Moratto, M. J., T. F. King, and W. B. Woolfenden
1978 Archaeology and California's Climate. *The Journal of California Anthropology* 5:147-161.

Morgan, A., L. S. Cummings, and J. C. Rudolph
1991 Paleoenvironmental Change. In *Western Chumash Prehistory: Resource Use and Settlement in the Santa Ynez River Valley*, edited by C. F. Woodman, J. C. Rudolph, and T. P. Rudolph, pp. 65-101. Scientific Applications International. . Copies available from the Central Coast Information Center, Department of Anthropology, University of California, Santa Barbara.

Munz, P. A., with D. Keck
1968 *A California Flora*. University of California Press, Berkeley.

Muto, G.
1971 A Technological Analysis of the Early Stages in the Manufacture of Lithic Artifacts. Unpublished Master's thesis, Department of Anthropology, Washington State University.

Noe-Nygaard, N.
1977 Butchering and Marrow Fracturing as a Taphonomic Factor in Archaeological Deposits. *Paleobiology* 3:218-237.

Nelson, N.
1910 The Ellis Landing Shellmound. *University of California Publications in American Archaeology and Ethnology* 7:309-356.

Oliver-Smith, A.
1996 Anthropological Research on Hazards and Disasters. *Annual Review of Anthropology* 25:303-328.

Osborne, M. A.
1997 Integrated Training Area Management (ITAM) Program, Fort Hunter Liggett, California: Land Condition Trend (LCTA) Component, Annual Report 1997. Center for Ecological Management of Military Lands, Colorado State University. Manuscript on file, Fort Hunter Liggett Environmental Office.

Owen, R. C.
1964 Early Millingstone Horizon (Oak Grove), Santa Barbara County, California: Radiocarbon Dates. *American Antiquity* 30:210-213.

Parry, W. J., and R. L. Kelly
1987 Expedient Core Technology and Sedentism. In *The Organization of Core Technology*, edited by J. K. Johnson and C. A. Morrow, pp. 285-304. Westview Press, Boulder, Colorado.

Parsons, G. A.
1987 Thermal Alteration of Monterey Banded Chert: An Analytical Study with Emphasis on Archaeological Sites of the central California Coast. *Coyote Press Archives of California Prehistory* 11:1-40.

1990 Sourcing Monterey Banded Chert, A Cryptocrystalline Hydrosilicate: With Emphasis on its Physical and Thermal Traits as Applied to central California Archaeology. Unpublished Master's thesis, Department of Anthropology, California State University, San Jose.

Perlman, S. M.
1980 An Optimum Diet Model, Coastal Variability, and Hunter-gatherer Behavior. In *Advances in Archaeological Method and Theory, vol. 3,* edited by Michael B. Schiffer, pp. 257-310. Academic Press, New York.

Peterson, N.
1991 Introduction. In *Cash, Commoditization, and Changing Foragers*, edited by N. Peterson and Toshio Matsuyama, pp. 1-16. Senri Ethnological Studies vol. 30, National Museum of Ethnology, Osaka, Japan.

Philander, S. G.
1990 *El Niño, La Niña, and the Southern Oscillation.* Academic Press, San Diego.

Piette, J. G.
1947 An Unpublished Diary of Fray Juan Crespi, O.F.M., 1770. *The Americas: Quarterly Review of Inter-American Cultural History* 3(3).

Pilling, A.
1948 Site record for CA-MNT-63. Manuscript on file at the Northwest Information Center, Department of Anthropology, Sonoma State University, Rohnert Park.

Pisias, N. G.
1978 Paleoceanography of the Santa Barbara Basin During the Last 8000 Years. *Quaternary Research* 10:366-384.

1979 Model for Paleoceanographic Reconstructions of the California Current During the Last 8000 Years. *Quaternary Research* 11:373-386.

Pohorecky, Z. S.
1964 Archaeology of the South Coast Ranges of California. Unpublished Ph.D. dissertation, Department of Anthropology, University of California, Berkeley.

1976 *Archaeology of the South Coast Ranges of California.* Contributions of the University of California Archaeological Research Facility No.34, Berkeley.

Porcasi, J. F., T. L. Jones, and L. M. Raab
2000 Trans-Holocene Marine Mammal Exploitation on San Clemente Island, California: A Tragedy of the Commons Revisited. *Journal of Anthropological Archaeology* 19:200-220.

Porter, S. C., and G. H. Denton
1967 Chronology of Neoglaciation in the North American Cordillera. *American Journal of Science* 265:177-210.

Powell, J. W.
1891 Indian Linguistic Families of America North of Mexico. *Annual Report of the Bureau of American Ethnology for the Years 1885-1886:* 7-142.

Preston, W. L.
1996 Serpent in Eden: Dispersal of Foreign Diseases into Pre-Mission California. *Journal of California and Great Basin Anthropology* 18:2-37.

1997 Serpent in the Garden: Environmental Change in Colonial California. In *Contested Eden: California before the Gold Rush*, edited by Richard J. Orsi. pp. 260-298. University of California Press, Berkeley.

Price, T. D.
1989 Bones, Chemistry, and the Human Past. In *The Chemistry of Prehistoric Human Bone*, edited by T. D. Price, pp. 1-10. Cambridge University Press, Cambridge.

Price, T. D., and J. A. Brown
1985 *Prehistoric Hunter-Gatherers: The Emergence of Cultural Complexity.* Academic Press, New York.

Priestley, H. I.
1972[1937] *A Historical, Political, and Natural Description of California by Pedro Fages, written for the Viceroy in 1775.* Translated by Herbert Ingram Priestley. Ballena Press, Ramona, California.

Quinn, W. H., V. T Neal, and S. E.Antunez de Mayolo, 1987 El Niño Occurrences over the Past Four and a Half Centuries. *Journal of Geophysical Research* 92:14449-14461.

Quintero, L.
1987 Room and Board at Deer Springs: Faunal Analysis as an Aid to Settlement Studies. Unpublished Master's thesis, Department of Anthropology, California State University, San Diego.

Raab, L. M.
1994 The Dead at Calleguas Creek: A Study of Punctuated Cultural Evolution during the Middle-Late Period Transition in Southern California. Center for Public Archaeology, California State University, Northridge. Prepared for Environmental Division, Naval Air Weapons Station, Point Mugu, California. Manuscript on file, Department of Anthropology, California State University, Northridge.

Raab, L. M., K. Bradford, J. C. Porcasi, and W. J. Howard
1995 Return to Little Harbor, Santa Catalina Island, California: A Critique of the Marine Paleotemperature Model. *American Antiquity* 60:287-308.

Raab, L. M., and A. Yatsko
1992 Ancient Maritime Adaptations on San Clemente Island. In *Essays on the Prehistory of Maritime California*, edited by T. L. Jones, pp. 173-193. Center for Archaeological Research at Davis, Publication No. 10. University of California, Davis.

Redmond, K. T., and R. W. Koch
1991 Surface Climate and Streamflow Variability in the Western United States and their Relationship to Large-scale Circulation Indices. *Water Resources Research* 27:2381-2399.

Richman, J. R.
1993 *Mytilus californianus* as an Overexploited Prehistoric Food Resource. Unpublished Senior thesis, Department of Anthropology, University of California, Davis.

Rivers, B., and T. L. Jones
1993 Walking on Deer Trails: A Contribution to Salinan Ethnogeography based on the Field Notes of John Peabody Harrington. *Journal of California and Great Basin Anthropology* 15:146-175.

Roberts, N.
1998 *The Holocene: An Environmental History.* Blackwell, Malden, Massachusetts.

Rogers, D. B.
1929 *Prehistoric Man of the Santa Barbara Coast, California.* Santa Barbara Museum of Natural History, Special Publications No. 1.

Roos, M.
2002 Reconstruction of 1000 Years of Runoff for the Sacramento River System Using Tree Rings. Paper presented at the California Weather Symposium, Sierra College, Rocklin, California

Rosenthal, J. S., J. Meyer, and G. White
1995 Archaeological Investigations at the Crazy Creek Site, CA-LAK-1682 and CA-LAK-1683, Lake County California. Anthropological Studies Center, Sonoma State University, Rohnert Park. Copies available from the Northwest Information Center, Department of Anthropology, Sonoma State University, Rohnert Park.

Ross, L. A.
1976 *Fort Vancouver, 1829-1826: A Historical Archaeological Investigation of the Goods Imported and Manufactured by the Hudson's Bay Company.* Submitted to the National Park Service, Washington, D.C.

Rypins, S., R. Byrne, S. L. Reneau, and D. R. Montgomery
1989 Palynologic and Geomorphic Evidence for Environmental Change during the Pleistocene-Holocene Transition at Point Reyes, Central Coast California. *Quaternary Research* 32:72-87.

Salls, R.
1988 Prehistoric Fisheries of the California Bight. Unpublished Ph.D. dissertation, Department of Anthropology, University of California, Los Angeles, California.

1989 The Fisheries of Mission Nuestra Señora de la Soledad, Monterey County. *Research in Economic Anthropology* 11:251-284.

1992 Prehistoric Subsistence Change on California's Channel Islands: Environmental or Cultural? In *Essays on the Prehistory of Maritime California*, edited by T. L. Jones, pp. 157-172. Center for Archaeological Research at Davis, Publication No. 10. University of California, Davis.

Sapir, E.
1921 A Supplementary Note on Salinan and Washo. *International Journal of American Linguistics* 2:68-72.

Sauer, C.
1962 Seashore--Primitive Home of Man? *Proceedings of the American Philosophical Society* 106:41-47.

Schenck, W. E.
1926 The Emeryville Shellmound: Final Report. *University of California Publications in American Archaeology and Ethnology* 23:147-282.

Schonher, T., and S. E. Nicholson
1989 The Relationship between California Rainfall and ENSO Events. *Journal of Climate* 2:1258-1268.

Sealy, J. C., and N. J. van der Merwe
1986 Isotopic Assessment of Holocene Human Diets in the Southwestern Cape, South Africa. *Current Anthropology* 27:135-150.

Service, E.
1962 *Primitive Social Organization: An Evolutionary Perspective*. Random House, New York.

Shackleton, N. J., and N. D. Opdyke
1973 Oxygen Isotope and Paleomagnetic Stratigraphy of Equatorial Pacific Core V28-238: Oxygen Isotope Temperatures and Ice Volumes on a 10^5 and 10^6 Year Scale. *Quaternary Research* 3:39-55.

Shnirelman, V. A.
1992 Crises and Economic Dynamics in Traditional Societies. *Journal of Anthropological Archaeology* 11:25-46.

Simms, S.
1984 Aboriginal Great Basin Foraging Strategies: An Evolutionary Analysis. Unpublished Ph. D. dissertation, Department of Anthropology, University of Utah.

Skinner, E. J.
1986 Appendix A: Analysis of Flaked Stone from the Crane Valley Hydroelectric Testing Program. In *Cultural Resources of the Crane Valley Hydroelectric Project Area, vol. III, Part 2*, by S. K. Goldberg, S. S. Salzman, E. J. Skinner, J. Burton, M. E. Scully, J. Holson, and M. J. Moratto. Submitted to Pacific Gas and Electric Company, San Francisco. Copies available from Infotec Research Incorporated, Fresno.
1990 Flaked Stone Analysis. In *Archaeological Excavations at Sites CA-MNO-574, CA-MNO-577, CA-MNO-578, and CA-MNO-833: Stoneworking in Mono County, California.* Infotec Research Incorporated. Copies available from the Office of Cultural Studies, Environmental Division, California Department of Transportation, Sacramento.

Smith, E. A.
1983 Anthropological Applications of Optimal Foraging Theory. *Current Anthropology* 24:625-651.

Smith, F. R.
1932 *The Mission of San Antonio de Padua.* Stanford University Press, Stanford, California.

Soil Conservation Service
1978 *Soil Survey of Monterey County, California.* United States Department of Agriculture in cooperation with the University of California Agriculture Experiment Station. United States Government Printing Office, Washington D.C.

Speth, J. D.
1990 Seasonality, Resource Stress, and Food Sharing in So-called "Egalitarian" Foraging Societies. *Journal of Anthropological Anthropology* 9:148-188.

Speth, J. D., and K. A. Spielmann
1983 Energy Source, Protein Metabolism, and Hunter-Gatherer Subsistence Strategies. *Journal of Anthropological Archaeology* 2:1-31.

Steward, J. B.

1938 *Basin-Plateau Aboriginal Sociopolitical Groups*. Smithsonian Institution Bureau of American Ethnology Bulletin 120. Washington D.C.

Stine, S.
1990 Late Holocene Fluctuations of Mono Lake, Eastern California. *Palaeogeography, Palaeo- climatology, Palaeoecology* 78:333-381.

1994 Extreme and Persistent Drought in California and Patagonia during Mediaeval Time. *Nature* 369:546-549.

Stuiver, M. S., and H. A. Polach
1977 Discussion: Reporting of ^{14}C Data. *Radiocarbon* 19:355-363.

Stuiver, M., and P. J. Reimer
1993 A Complete Program for Radiocarbon Age Calibration. *Radiocarbon* 35:215-230.

Suchanek, T. H.
1981 The Role of Disturbance in the Evolution of Life History Strategies in the Intertidal Mussels *Mytilus edulis* and *Mytilus californianus*. *Oecologia* 50:143-152.

Sulman, F. G.
1982 *Short- and Long-Term Changes in Climate*, vol. 1. CRC Press, Boca Raton, Florida.

Swernoff, Michael
1982 Cultural Resources Survey, Upper Stony Creek, El Piojo, and San Antonio River Valleys, Fort Hunter Liggett.-Manuscript on file, Fort Hunter Liggett Environmental Office.

Taber, R. D., and R. F. Dasmann
1958 *The Black-tailed Deer of the Chaparral: Its Life History and Management in the North Coast Ranges of California*. Game Bulletin No. 8, California Department of Fish and Game, Sacramento.

Tartaglia, L. J.
1976 Prehistoric Maritime Adaptations in Southern California. Unpublished Ph.D. dissertation, Department of Anthropology, University of California, Los Angeles.

Teggart, F. J.
1911 The Portola Expedition of 1769-1770, Diary of Miguel Costanso. *Publications of the Academy of Pacific Coast History* 2:164-327.

Tegner, M. J., and Dayton, P. K.
1987 El Niño Effects on Southern California Kelp Forest Communities. *Advances in Ecological Research* 17:243-279.

1991 Sea Urchins, El Niños and the Long-term Stability of Southern California Kelp Forest Communities. *Marine Ecology Progress Series* 77:49-63.

Testart, A.
1988 Food Storage among Hunter-Gatherers: More or Less Security in the Way of Life. In *Coping with Uncertainty in Food Supply*. edited by I. De Garine, and G. A. Harrison, pp. 170-174. Clarendon Press, Oxford.

True, D. L.
1966 Archaeological Differentiation of Shoshonean and Yuman-speaking Groups in Southern California. Unpublished Ph.D. dissertation, Department of Anthropology, University of California, Los Angeles.

Truett, J.
1996 Bison and Elk in the American Southwest: In Search of the Pristine. *Environmental Management* 20:195-206.

Turner, K.
1987 *Aspects of Salinan Grammar*. Ph.D. dissertation, University of California, Berkeley. University Microfilms, Ann Arbor.

Uhle, M.
1907 The Emeryville Shellmound. *University of California Publications in American Archaeology and Ethnology* 7:1-106.

Van Geen, A., S. N. Luoma, C. C. Fuller, R. Anima, H. E. Clifton, and S. Trumbore
1992 Evidence from Cd/Ca Ratios in Foraminifera for Greater Upwelling off California 4000 Years Ago. *Nature* 358:54-56

Walker, P. L., and M. J. DeNiro
1986 Stable Nitrogen and Carbon Isotope Ratios in Collagen as Indices of Prehistoric Dietary

Dependence on Marine and Terrestrial Resources in Southern California. *American Journal of Physical Anthropology* 71:51-61.

Walker, P. L., and P. M. Lambert
1989 Skeletal Evidence for Stress during a Period of Culture Change in Prehistoric California. In *Advances in Paleopathology: Monographic Publication No. 1*, edited by L. Capasso, pp. 207-212. Marino Solfanelli, Chieti, Italy.

Walker, P. L., M. J. DeNiro, and P. M. Lambert
1989 The Effects of European Contact on the Health of Alta California Indians. In *Columbian Consequences*, vol.1, edited by D. H. Thomas, pp. 349-364. Smithsonian Institution Press, Washington D.C.

Walker, P. L., D. J. Kennett, T. L. Jones, and R. DeLong
2000 Archaeological Investigations at the Point Bennett Pinniped Rookery on San Miguel Island. In *Proceedings of the Fifth California Islands Symposium*, edited by D. R. Brown, K. C. Mitchell and H. W. Chaney, pp. 628-632. U.S. Department of the Interior Minerals Management Service, Pacific OCS Region.

Wallace, E.
1978 Sexual Status and Role Differences. In *California*, edited by R. F. Heizer, pp. 683-689. Handbook of North American Indians, vol. 8, W. G. Sturtevant, general editor, Smithsonian Institution, Washington D.C.

Wallace, W.
1955 A Suggested Chronology for Southern California Coastal Archaeology. *Southwestern Journal of Anthropology* 11:214-230.

1978 Post Pleistocene Archaeology, 9000-2000 B.C. In *California*, edited by R. F. Heizer, pp. 25-36. Handbook of North American Indians, vol. 8, W. G. Sturtevant, general editor, Smithsonian Institution, Washington D.C.

Watts, D. C.
1984 Bones along the Bayshore: A Study of Mammalian Exploitation and Cultural Taphonomy of Faunal Assemblages from Two Bayshore Shellmounds, CA-ALA-328 and CA-ALA-329. Unpublished Master's thesis, Department of Anthropology, California State University, Hayward.

Warren, C. N.
1964 Cultural Change and Continuity on the San Diego Coast. Unpublished Ph.D. dissertation,
Department of Anthropology, University of California, Los Angeles.

West, G. J.
1987 *Examination for Pollen in Selected Sediments from the Chevron Point Arguello Project, Santa Barbara County*. Brienes, West, and Schulz Consultants, Davis, California.

1988 Exploratory Pollen Analysis of Sediments from Elkhorn Slough. In *Archaeological Investigations at Elkhorn Slough, CA-MNT-229, A Middle Period Site on the California Coast*, by S.A. Dietz, W. Hildebrandt, and T. L. Jones, pp. 25-56. Papers in Northern California Anthropology No. 3., Berkeley.

Whistler, K. W.
1988 Pomo Prehistory: A Case for Archaeological Linguistics. *Journal of the Steward Anthropological Society* 15:64-98.

White, G.
1989 A Report of Archaeological Investigations at Eleven Native American Coastal Sites, MacKerricher State Park, Mendocino County, California. Prepared for California Department of Parks and Recreation. Copies available from Northwestern Information Center, Sonoma State University, Rohnert Park.

Wickstrom, B. P.
1995 The 1993-1994 Program for the Identification and Management of Three Archaeological Resource Classes: Low Density, Low Variability Flaked Stone Artifact Scatters, and Isolated Bedrock Mortar Sites. Manuscript on file, Environmental Office, Fort Hunter Liggett Military Installation

Wickstrom, B. P., and T. L. Jackson
1994 Archaeological Data Potential Assessment at CA-MNT-515, CA-MNT-540, CA-MNT-567, and CA-MNT-862, Fort Hunter Liggett Military Installation, California. Biosystems Inc., Santa Cruz. Copies available from the Northwestern Information Center, Sonoma State University, Rohnert Park.

Willey, G., and P. Phillips

1958 *Methods and Theory in American Archaeology*. University of Chicago Press, Chicago.

Willoughby, N. C.
1963 Division of Labor among the Indians of California. *University of California Archaeological Survey Reports* 60:7-79. Berkeley.

Wilmsen, E. N.
1989 *Land Filled with Flies*. Chicago: University of Chicago Press.

Woolfenden, W. B.
1996 Quaternary Vegetation History. In *Sierra Nevada Ecosystem Project: Final Report to Congress, vol. II Assessments and Scientific Basis for Management Options*. University of California Davis Centers for Water and Wildland Resources.

Wohlgemuth, E. E.
1996 Resource Intensification in Prehistoric Central California: Evidence from Archaeobotanical Data. *Journal of California and Great Basin Anthropology* 18:81-103.

Wolgemuth, E. E., W. R. Hildebrandt, and K. Ballantyne
2002 *Data Recovery Excavations for Unanticipated Discovery at CA-MNT-1942, Big Creek Bridge (BR. NO. 44-56), Monterey County, California Highway 1, P.M. 28.1*. Far Western Anthropological Research Group, Davis. Copies available from the Northwestern Information Center, Sonoma State University, Rohnert Park.

Yamada, S. B., and E. E. Peters
1988 Harvest Management and the Growth and Condition of Submarket Size Mussels, *Mytilus californianus*. *Aquaculture* 74:293-299.

Yarnal, B., and H. F. Diaz
1986 Relationships Between Extremes of the Southern Oscillation and the Winter Climate of the Anglo-American Pacific Coast. *Journal of Climatology* 6:197-219.

Zihlman, A. L.
1981 Women as Shapers of Human Adaptation. In *Woman the Gatherer*, edited by F. Dahlberg, pp. 75-120. Yale University Press, New Haven.

APPENDIX I

OXYGEN ISOTOPE ANALYSIS OF CALIFORNIA MUSSEL (*Mytilus californianus*) SHELLS from CA-MNT-521, -569B, -1223, -1227, -1233, and CA-SLO-267

DOUGLAS J. KENNETT

Oxygen isotope analyses were completed on 42 mussel (*Mytilus californianus*) shells from archaeological sites CA-MNT-521 (N=8), CA-MNT-569B (N=6), CA-MNT-1223 (N=2), CA-MNT-1227 (N=1), CA-MNT-1233 (N=3), and CA-SLO-267 (N=22), and on one modern shell in order to evaluate paleo sea surface temperature changes through time and the seasonality of mussel collection. Studies of modern marine molluscs from known environments indicate that oxygen isotopic analysis is an effective method for reconstructing sea surface temperature (Epstein et al. 1951, 1953; Glassow et al. 1994; Kennett and Voorhies 1995, 1996; Killingley 1981; Killingley and Berger 1979; Shackleton 1969, 1973). This is because the temperature dependent ratio of ^{18}O to ^{16}O in sea water preserves in calcareous fossils, such as molluscs (Epstein et al. 1951, 1953; Wefer and Berger, 1991). Incremental samples taken along a shell's growth axis enable reconstruction of oxygen isotopic ratios, and hence, seasonal temperature changes through the life of a mollusc. Readings from the final growth increment of a mussel's shell indicate sea temperature at the time the mollusc was collected. Comparing such values with contemporary seasonal sea temperatures indicates the season of the shell's collection.

OXYGEN ISOTOPE ANALYSIS

Oxygen isotopic analysis of molluscan shell carbonate is a well established technique for determining sea-surface temperature and the season of prehistoric shellfish harvesting. The method was initially recognized as a powerful tool for paleo-environmental reconstruction because oxygen isotopic ratios in calcareous fossils contain information about the physical and chemical environment of their growth (Wefer and Berger 1991). Two environmental factors contribute to the isotopic composition of shell carbonate: the isotopic composition of seawater and water temperature. Urey (1947) showed that the stable oxygen isotopic composition of calcium carbonate deposited by marine molluscs was temperature dependent and thus of great value as a paleothermometer. The isotopic exchange during precipitation of calcium carbonate from water can be expressed as:

$$\frac{1}{3}\mathrm{CaCO}_3^{16} + \mathrm{H_2O}^{18} \Leftrightarrow \frac{1}{3}\mathrm{CaCO}_3^{18} + \mathrm{H_2O}^{16}$$

Isotopic fractionation between carbonate and water during precipitation has a value of 1.0286 ‰ at 25°C (O'Neil et al. 1975). Because this fractionation factor is temperature dependent, the oxygen isotopic composition of carbonate is a function of temperature. A paleotemperature equation was developed by Epstein et al. (1951, 1953) based on oxygen isotopic measurements of mollusc shell carbonate precipitated at known water temperatures. In the equation:

$$T = A - B(\delta c - \delta w) + C(\delta c - \delta w)^2$$

T is equal to temperature in °C, and A, B, and C are constants respectively equaling 16.4, 4.2, and 0.13. The symbol δc is the oxygen isotopic ratio of the carbonate, expressed as a deviation in ‰ (parts per mil) from a standard carbonate (Peedee Belemite [PDB]). The symbol δw represents the oxygen isotopic composition of the water expressed in a similar fashion, as a deviation from standard mean ocean water (smow). In order to solve the equation for temperature (T), the value of the water must be known. When the delta value for the water (δw) is constant, the oxygen isotopic ratio increases/decreases by approximately 0.2‰ for every 1°C increase/decrease in water temperature.

Thus, in the open ocean where the composition of sea-water has been relatively stable since the middle Holocene (~6000 years to the present day [Fairbanks1989]), oxygen isotopic measurements of calcium carbonate extracted from the sequential growth increments of molluscs reflect seasonal fluctuations in water temperature. The season of molluscan death can also be estimated from the final growth increment. Shackleton (1969) was the first to point out the applicability of this technique for archaeologists interested in determining the season of mollusc collection from shells in archaeological deposits.

Paleotemperature equations for inferring sea-surface temperature have also been refined for calcite and aragonite, two different mineral phases of calcium carbonate (Horibe and Oba 1972). Epstein et al. (1953) based their equation on organically precipitated calcium carbonate in the molluscs of the genus *Haliotis*, a large gastropod with a complex mineral structure consisting of both aragonite and calcite. Horibe and Oba (1972) determined that the relationship between sea-surface temperature and $\delta^{18}O$ is different for aragonite and calcite, based on two pelecypods from Mutsu Bay, Japan. Based on experiments with *Anadara broughtoni*, the temperature dependence of $\delta^{18}O$ in aragonite is expressed as:

$$t°C=13.85 - 4.54(\delta c-\delta w) + 0.04(\delta c-\delta w)^2$$

Based on experiments with *Patinopecten yessoensis*, the equivalent equation for calcite is:

$$t°C=17.04 - 4.34(\delta c-\delta w) + 0.16(\delta c-\delta w)^2$$

The methods for extracting seasonal information from mollusc shells were initially worked out by Shackleton (1973) and have changed little since. Calcium carbonate samples are extracted along a shell's growth axis from the growth margin towards the hinge. Using specimens of *Patella tabularis* collected alive from Nelsons Bay Cove, South Africa, Shackleton determined that oxygen isotopic changes through the growth of mollusc shells paralleled seasonal fluctuations in temperature and that the shell margin samples accurately reflected the season of molluscan death. Shells from prehistoric midden deposits, dating between 9000 and 5000 years ago indicated that molluscs were harvested primarily during winter (cold water) months.

Based on this study, Shackleton (1973) outlined a number of criteria that should be met to make seasonal temperature determinations using oxygen isotopic analysis. First, shell growth must take place under conditions of isotopic equilibrium with the surrounding water. Second, the isotopic composition of the water in which the shellfish lives must remain constant throughout the year. Third, the shell must precipitate carbonate throughout the year at a relatively fast rate. Finally, the seasonal temperature range must be greater than week-to-week variations in water temperature.

More recent literature has focused on establishing the precision of the oxygen isotopic method for determining seasonality. Based on a study of modern and archaeological *Mytilus californianus* specimens from the California coast, Killingley (1980, 1981; also see Killingley and Berger 1979), Glassow et al. (1994) proposed that the month of prehistoric shellfish collection can be determined by statistical treatment of oxygen isotopic data. Bailey et al. (1983; also see Deith 1985; Kennett 1998) argued, in contrast, that determining the season of molluscan death to the month was unrealistic because of known oxygen isotopic differences between species and regional climatic variation through time.

METHODS

All shells were cleaned and rinsed with deionized water to remove adhering midden soil and visible organic material. The outer surfaces of the shells were etched using a dilute solution of HCL (0.5 molar) to remove any diagenically altered carbonate (Bailey et al. 1983). Calcite samples were extracted from the exterior prismatic layer of the shell in 2 mm increments along the shell's growth axis (0.5 mm drill) (see Glassow et al. 1994). Powdered calcite samples (~0.3 mg) were heated at 400°C under vacuum for one hour to remove organic compounds. After cooling to room temperature, samples were reacted with orthophosphoric acid at 90°C (Fairbanks auto-sample device). The oxygen isotopic ratio of the evolved CO_2 was measured using mass spectrometry (Finnegan/MAT251-Mass Spectrometer) (Killingley and Berger 1979; Glassow et al. 1994).

Water temperatures were calculated using the paleotemperature equation developed by Horibe and Aba (1972) for calcite. All measurements are expressed in δ (delta) notation, as a deviation from an internationally accepted standard, PeeDee belemite, a carbonate fossil from South Carolina (Herz 1990). More negative δ ϖalues indicate higher proportions of the lighter ^{16}O isotope compared with the heavier ^{18}O isotope and vice versa. The precision of the oxygen isotopic ratios is +/-0.1.

A total of 239 oxygen isotopic measurements was made on 43 whole or nearly whole mussel shells (Table AI-1). Multiple samples from the complete growth axis were taken from ten archaeological specimens and one modern specimen. Samples from these shells reflect sea temperatures during the course of at least one full seasonal cycle, and oxygen isotopic variation in the growth increments records successive seasonal changes in sea-surface temperature. Two-four samples were taken from each of the other 33 shells; one from the terminal growth margin, and the others from successive 2 mm increments in from the edge of the shell. These were used only for evaluating the season of the shell's collection. Values obtained from all samples are listed in Table AI-1 along with temperature calibrations.

After oxygen isotope samples were extracted, specimens sampled along their entire growth axis were subjected to radiocarbon analysis. Dates were corrected on a sample-specific basis for isotope fractionation, and the resulting ages were converted into calendric dates using the Stuiver and Reimer (1993) program with a reservoir value (DR) of 290±35 (Ingram and Southon 1996). Dates obtained from these specimens were used to help define the span of occupation at sites (see Chapters 5 and 6).

HISTORIC SEA TEMPERATURES FOR THE CENTRAL CALIFORNIA COAST

Evaluation of the sea temperatures inferred from the shells requires some comparison with present day/historic sea temperatures. Annual sea-surface temperature records are available from two sources. Records from the Hopkins Marine Station in Pacific Grove extend back to 1919, which is the longest historic record available from California. These data show a mean ocean temperature of 13.08 °C (Table AI-2). Due to annual changes in upwelling intensity, January has the coldest mean sea temperature of 11.92 °C, and the three coldest months are January through March. The lowest monthly temperature in the record was 9.86 °C in January 1925. The warmest temperatures occur between July and October, with the peak usually occurring in September (mean = 14.36 °C). The highest monthly temperature recorded was 17.39 °C in September 1983. While the record from Pacific Grove is the longest available for California, it is only partially applicable to the findings from Big Sur because of the distance between the sites and Monterey Bay, where the historic temperatures were collected. The temperature record available from Big Sur (Table AII-3) is shorter, but more directly applicable. Temperatures spanning from 1972 to 1994 show a lower mean sea temperature of 11.48 °C which reflects the more exposed situation of Big Sur relative to the shelter afforded within Monterey Bay. There is also less variability in the sample. The coldest months are April though June and the warmest month is October (mean of 13.14 °C). The coldest monthly temperature was 9.41 °C in May 1991; the highest was 15.35 °C. The sea temperature profile is best divided into three temperature/seasonal zones. Peak temperatures occur in the fall between September and November. Coolest temperatures occur in the spring between March and June. Moderate temperatures occur in both the winter (December-February) and summer (July, August). During periods of inter-mediate conditions, winter distinguishes itself by descending temperatures while summer is marked by ascending temperatures.

The historic records also establish the range and means of sea temperatures associated with ENSO events. The range in sea temperatures during the 1983 El Niño was 12.06 - 15.35 °C at Big Sur.

RESULTS

Comparison of oxygen isotopic profiles from the archaeological shells with the historic temperatures provides insights into the seasonality of mussel collection as well as some insights into paleo sea temperature trends. The latter were reported previously by Jones and Kennett (1999) and are also discussed in Chapter 2. Based on the calibration curve developed by Horibe and Aba (1972), sea-surface temperatures recorded in the carbonate of the archaeological samples were between 7.54 and 18.87 °C, indicating a wider range than is present today off the Big Sur coast. This range of variation also shows patterning through time: between A.D. 1 and 1300 sea temperatures were about 1 °C cooler than present and fairly stable; between A.D. 1300 and 1500 there was greater seasonal variation with extremes above and below historic levels, and between A.D. 1500 and 1700, seas were 2-3 °C cooler than today (Jones and Kennett 1999).

Evaluations of seasonality were made on the basis of results from samples taken from the terminal edges of shells in comparison with those obtained 2 mm in from the edges, although these interpretations were complicated by changes through time in sea temperatures off the coast. The modern sea temperature profile off Big Sur can be broken into four temperature zones:

Spring (March-June): Coldest seas- ≤11.10° C
Early summer (June-July): Mid-range- 11.11-12.30° C, temperatures ascending
Late summer/Early fall (August-October): Warmest seas- > 12.30° C,
Winter (November-February): Mid-range- 11.11-12.30° C, temperatures descending

If there was no evidence for change through time in sea temperatures, interpretations of seasonality could be rendered according to the historic temperature ranges and determinations of ascending versus descending trends based on comparison between edge samples and samples 2 mm in from the edges. In recognition of the variation through time, however, different frameworks were developed for each of the three time periods represented in the archaeological sample: Middle (600 B.C.-A.D. 1000; CA-MNT-521 and CA-SLO-267), Middle-Late Transition (A.D. 1000-1400; CA-MNT-1233), and Late-Protohistoric (A.D. 1400-1700; CA-MNT-569B, CA-MNT-1223, and CA-MNT-1227) (Table AI-4). Due to variation between the environmental and cultural records, and imprecision associated with the Middle-Late Transition, these temporal divisions differ slightly from those applied elsewhere in the monograph.

Findings from edge readings were compared with these ranges to determine season of collection, with additional comparison between edges and samples taken 2 mm in from the edges to determine ascending versus descending temperatures. The latter facilitates a distinction between early summer and winter.

Seasonality determinations were made for 42 specimens with 22 determinations from CA-SLO-267, eight from CA-MNT-521, six from CA-MNT-569B, three from CA-MNT-1233, two from CA-MNT-1223, and one from CA-MNT-1227 (Table A-I 5). The samples suggested shell collection during all seasons, with the greatest number of readings representing early summer (N=15).

The seasonality profile from CA-SLO-267 showed 10 samples representing early summer followed in frequency by nine specimens representing fall, two representing winter and only one represents spring. There seems to have been little if any use of CA-SLO-267 during the spring, or subsistence activities were focused on something other than shellfish.

Samples from other sites were considerably smaller, but CA-MNT-521 showed evidence for shellfish collection in the spring and early summer. CA-MNT-1233 was used during the spring; CA-MNT-569B was used during spring, early summer, and fall; CA-MNT-1223 was used during late summer through winter, and CA-MNT-1227 showed evidence for shellfish collection in the winter. Inland sites showed a high incidence of spring and early summer readings (12 of 14), while the coastal sites showed an emphasis on spring through late summer/early fall (Table AI-6).

When segregated by time and setting, Middle Period coastal sites showed an emphasis on early summer and late summer/early fall, while interior sites for the same period showed an emphasis on spring and early summer (Table AI-8). The available Late Period sample is very small, but the coastal sites seem to have been occupied during the fall and winter while the interior sites show evidence for shellfish collection from spring through fall.

Table AI-1 Results of Oxygen Isotope Analyses of Mussel (*Mytilus californianus*) Shells from CA-MNT-521, -569B, -1223, -1227, -1233, and CA-SLO-267

Site	Specimen	Unit	Depth (cm)	Lab. No.	Distance from edge (mm)	^{18}O	Inferred temperature (°C)	Inferred season of collection
CA-MNT-521	521-228	2	90-100	-	0	1.164	11.03	Spring
CA-MNT-521	521-228	2	90-100	-	2	1.353	10.30	
CA-MNT-521	521-248	2	110-120	-	0	1.236	10.75	Spring
CA-MNT-521	521-248	2	110-120	-	2	1.388	10.17	
CA-MNT-521	521-258	2	120-130	-	0	1.267	10.63	Spring
CA-MNT-521	521-258	2	120-130		2	1.092	11.31	
CA-MNT-521	521-263	2	130-140	-	0	1.021	11.59	Early summer
CA-MNT-521	521-263	2	130-140	-	2	0.882	12.13	
CA-MNT-521	521-263	2	130-140	-	4	1.186	10.94	
CA-MNT-521	521-263	2	130-140	-	6	0.967	11.79	
CA-MNT-521	521-270	2	140-150	-	0	1.264	10.64	Spring
CA-MNT-521	521-270	2	140-150	-	2	1.557	9.53	
CA-MNT-521	521-614	2	80-90	-	0	0.857	12.23	Early summer
CA-MNT-521	521-614	2	80-90	-	2	1.196	10.91	
CA-MNT-521	521-753	8	80-90	-	0	0.911	12.02	Early summer
CA-MNT-521	521-753	8	80-90	-	2	1.113	11.23	
CA-MNT-521	521-770	8	100-110	-	0	1.055	11.45	Winter
CA-MNT-521	521-770	8	100-110	-	2	0.718	12.79	
CA-MNT-569B	569-31	1	40-50	-	0	1.651	9.18	Spring
CA-MNT-569B	569-31	1	40-50	-	2	1.783	8.69	
CA-MNT-569B	569-100	4	0-10	-	0	1.295	10.52	Early Summer
CA-MNT-569B	569-100	4	0-10	-	2	1.975	7.99	
CA-MNT-569B	569-120	4	20-30	-	0	1.246	10.71	Early Summer
CA-MNT-569B	569-120	4	20-30	-	2	1.819	8.56	
CA-MNT-569B	569-126	4	30-40	-	0	1.705	8.98	Spring
CA-MNT-569B	569-126	4	30-40	-	2	1.173	10.99	
CA-MNT-569B	569-140	4	50-60	-	0	1.760	8.78	Spring
CA-MNT-569B	569-140	4	50-60	-	2	1.667	9.12	
CA-MNT-569B	569-155	4	70-80	-	0	1.154	11.07	Late Summer/Early Fall
CA-MNT-569B	569-155	4	70-80	-	2	0.546	13.48	
CA-MNT-1223	-	11	40-50	TJ2a	0	0.990	11.71	Late Summer/ Early Fall
CA-MNT-1223	-	11	40-50	TJ2b	2	1.485	9.80	
CA-MNT-1223	-	11	40-50	TJ2c	4	1.686	9.05	

Table AI-1 Results of Oxygen Isotope Analyses of Mussel (*Mytilus californianus*) Shells from CA-MNT-521, -569B, -1223, -1227, -1233, and CA-SLO-267 (continued)

Site	Specimen	Unit	Depth (cm)	Lab. No.	Distance from edge (mm)	^{18}O	Inferred temperature (°C)	Inferred season of collection
CA-MNT-1223	-	11	40-50	TJ2d	6	1.855	8.43	
CA-MNT-1223	-	11	40-50	TJ2e	8	2.101	7.54	
CA-MNT-1223	-	11	40-50	TJ2f	10	1.142	11.11	
CA-MNT-1223	-	11	40-50	TJ2g	12	1.293	10.53	
CA-MNT-1223	-	11	40-50	TJ2h	14	1.159	11.05	
CA-MNT-1223	-	11	40-50	TJ2i	16	1.072	11.39	
CA-MNT-1223	-	11	40-50	TJ2j	18	1.375	10.22	
CA-MNT-1223	-	11	40-50	TJ2k	20	1.135	11.14	
CA-MNT-1223	-	11	40-50	TJ2l	22	1.442	9.97	
CA-MNT-1223	-	11	40-50	TJ2m	24	1.628	9.27	
CA-MNT-1223	-	11	40-50	TJ2n	26	1.456	9.91	
CA-MNT-1223	-	11	40-50	TJ2o	28	1.235	10.76	
CA-MNT-1223	-	5	20-30	A5a	0	1.312	10.46	Winter
CA-MNT-1223	-	5	20-30	A5b	2	1.333	10.38	
CA-MNT-1223	-	5	20-30	A5c	4	1.055	11.45	
CA-MNT-1223	-	5	20-30	A5d	6	0.887	12.11	
CA-MNT-1223	-	5	20-30	A5e	8	1.006	11.64	
CA-MNT-1223	-	5	20-30	A5f	10	1.623	9.29	
CA-MNT-1223	-	5	20-30	A5g	12	1.669	9.11	
CA-MNT-1223	-	5	20-30	A5h	14	1.653	9.17	
CA-MNT-1223	-	5	20-30	A5i	16	1.614	9.32	
CA-MNT-1223	-	5	20-30	A5j	18	1.169	11.01	
CA-MNT-1223	-	5	20-30	A5k	20	1.085	11.34	
CA-MNT-1223	-	5	20-30	A5l	22	1.059	11.44	
CA-MNT-1227	-	6	20-30	TJ1a	0	1.593	9.40	Early summer
CA-MNT-1227	-	6	20-30	TJ1b	2	1.474	9.84	
CA-MNT-1227	-	6	20-30	TJ1c	4	1.791	8.66	
CA-MNT-1227	-	6	20-30	TJ1d	6	2.165	7.31	
CA-MNT-1227	-	6	20-30	TJ1e	8	1.746	8.83	
CA-MNT-1227	-	6	20-30	TJ1f	10	1.337	10.36	
CA-MNT-1227	-	6	20-30	TJ1g	12	1.694	9.02	
CA-MNT-1227	-	6	20-30	TJ1h	14	1.690	9.04	
CA-MNT-1227	-	6	20-30	TJ1i	16	1.930	8.16	
CA-MNT-1227	-	6	20-30	TJ1j	18	2.058	7.70	
CA-MNT-1227	-	6	20-30	TJ1k	20	1.387	10.17	
CA-MNT-1227	-	6	20-30	TJ1l	22	1.115	11.22	
CA-MNT-1227	-	6	20-30	TJ1m	24	1.419	10.05	
CA-MNT-1227	-	6	20-30	TJ1n	26	1.600	9.37	

Table AI-1 Results of Oxygen Isotope Analyses of Mussel (*Mytilus californianus*) Shells from CA-MNT-521, -569B, -1223, -1227, -1233, and CA-SLO-267 (continued)

Site	Specimen	Unit	Depth (cm)	Lab. No.	Distance from edge (mm)	^{18}O	Inferred temperature (°C)	Inferred season of collection
CA-MNT-1227	-	6	20-30	TJ1o	28	1.941	8.12	
CA-MNT-1233	-	2	70-80	TJ3a	0	1.563	9.51	Spring
CA-MNT-1233	-	2	70-80	TJ3b	2	1.485	9.80	
CA-MNT-1233	-	2	70-80	TJ3c	4	1.582	9.44	
CA-MNT-1233	-	2	70-80	TJ3d	6	1.713	8.95	
CA-MNT-1233	-	2	70-80	TJ3e	8	0.525	13.57	
CA-MNT-1233	-	2	70-80	TJ3f	10	0.720	12.78	
CA-MNT-1233	-	2	70-80	TJ3g	12	0.721	12.78	
CA-MNT-1233	-	2	70-80	TJ3h	14	0.412	14.03	
CA-MNT-1233	-	2	70-80	TJ3i	16	0.530	13.55	
CA-MNT-1233	-	2	70-80	TJ3j	18	0.320	14.41	
CA-MNT-1233	-	2	70-80	TJ3k	20	0.610	13.22	
CA-MNT-1233	-	2	70-80	TJ3l	22	0.579	13.35	
CA-MNT-1233	-	2	70-80	TJ3m	24	0.888	12.11	
CA-MNT-1233	-	2	70-80	TJ3n	26	0.339	14.33	
CA-MNT-1233	-	2	70-80	TJ3o	28	0.040	15.58	
CA-MNT-1233	-	2	70-80	TJ3p	30	1.019	11.59	
CA-MNT-1233	-	2	70-80	TJ3q	32	0.617	13.19	
CA-MNT-1233	-	2	70-80	TJ3r	34	0.630	13.14	
CA-MNT-1233	-	2	70-80	TJ3s	36	0.939	11.91	
CA-MNT-1233	-	2	70-80	TJ3t	38	0.228	14.79	
CA-MNT-1233	-	2	70-80	TJ3u	40	0.714	12.80	
CA-MNT-1233	-	2	70-80	TJ3v	42	1.440	9.97	
CA-MNT-1233	-	2	70-80	TJ3w	44	0.420	14.00	
CA-MNT-1233	-	2	70-80	TJ3x	46	1.177	10.98	
CA-MNT-1233	-	2	70-80	TJ3y	48	1.112	11.23	
CA-MNT-1233	-	2	70-80	TJ3z	50	0.666	13.00	
CA-MNT-1233	-	2	70-80	TJ3aa	52	0.629	13.15	
CA-MNT-1233	-	2	70-80	TJ3bb	54	0.962	11.82	
CA-MNT-1233	-	2	70-80	TJ3cc	56	0.931	11.94	
CA-MNT-1233	-	2	70-80	TJ3dd	58	0.878	12.15	
CA-MNT-1233	-	2	70-80	TJ3ee	60	0.811	12.42	
CA-MNT-1233	-	3	40-50	TJ6a	0	-0.233	16.75	Late summer/ Early fall
CA-MNT-1233	-	3	40-50	TJ6b	2	-0.324	17.14	
CA-MNT-1233	-	3	40-50	TJ6c	4	-0.112	16.23	
CA-MNT-1233	-	3	40-50	TJ6d	6	-0.198	16.60	
CA-MNT-1233	-	3	40-50	TJ6e	8	0.092	15.36	

Table AI-1 Results of Oxygen Isotope Analyses of Mussel (*Mytilus californianus*) Shells from CA-MNT-521, -569B, -1223, -1227, -1233, and CA-SLO-267 (continued)

Site	Specimen	Unit	Depth (cm)	Lab. No.	Distance from edge (mm)	^{18}O	Inferred temperature (°C)	Inferred season of collection
CA-MNT-1233	-	3	40-50	TJ6f	10	0.133	15.19	
CA-MNT-1233	-	3	40-50	TJ6g	12	0.895	12.08	
CA-MNT-1233	-	3	40-50	TJ6h	14	1.388	10.17	
CA-MNT-1233	-	3	40-50	TJ6i	16	1.513	9.70	
CA-MNT-1233	-	3	40-50	TJ6j	18	0.244	14.73	
CA-MNT-1233	-	3	40-50	TJ6k	20	-0.716	18.87	
CA-MNT-1233	-	3	40-50	TJ6l	22	-0.423	17.58	Winter
CA-MNT-1233	-	3	40-50	TJ6m	24	-0.215	16.67	
CA-MNT-1233	-	3	40-50	TJ6n	26	-0.649	18.57	Summer
CA-MNT-1233	-	3	40-50	TJ6o	28	-0.211	16.66	
CA-MNT-1233	-	3	40-50	TJ6p	30	0.688	12.91	Fall
CA-MNT-1233	-	3	40-50	TJ6q	32	1.021	11.59	
CA-MNT-1233	-	3	40-50	TJ6r	34	1.607	9.35	Summer
CA-MNT-1233	-	3	40-50	TJ6s	36	1.292	10.54	
CA-MNT-1233	-	3	40-50	TJ6t	38	0.893	12.09	Early summer
CA-MNT-1233	-	3	50-60	TJ7a	0	0.913	12.01	
CA-MNT-1233	-	3	50-60	TJ7b	2	0.611	13.22	
CA-MNT-1233	-	3	50-60	TJ7c	4	1.448	9.94	
CA-MNT-1233	-	3	50-60	TJ7d	6	1.363	10.27	
CA-MNT-1233	-	3	50-60	TJ7e	8	0.714	12.80	
CA-MNT-1233	-	3	50-60	TJ7f	10	0.446	13.89	
CA-MNT-1233	-	3	50-60	TJ7g	12	0.622	13.17	
CA-MNT-1233	-	3	50-60	TJ7h	14	0.423	13.99	
CA-MNT-1233	-	3	50-60	TJ7i	16	0.825	12.36	
CA-MNT-1233	-	3	50-60	TJ7k	20	1.503	9.74	
CA-MNT-1233	-	3	50-60	TJ7l	22	1.441	9.97	
CA-MNT-1233	-	3	50-60	TJ7m	24	1.196	10.91	
CA-SLO-267	-	12	30-40	A1a	0	0.988	11.72	Early fall
CA-SLO-267	-	12	30-40	A1b	2	1.257	10.67	
CA-SLO-267	-	12	30-40	A1c	4	1.426	10.03	
CA-SLO-267	-	12	30-40	A1d	6	1.445	9.95	
CA-SLO-267	-	12	30-40	A1e	8	1.667	9.12	
CA-SLO-267	-	12	30-40	A1f	10	1.400	10.12	
CA-SLO-267	-	12	30-40	A1g	12	1.550	9.56	
CA-SLO-267	-	12	30-40	A1h	14	1.531	9.63	
CA-SLO-267	-	12	30-40	A1i	16	1.752	8.81	
CA-SLO-267	-	12	30-40	A1j	18	1.232	10.77	

Table AI-1 Results of Oxygen Isotope Analyses of Mussel (*Mytilus californianus*) Shells from CA-MNT-521, -569B, -1223, -1227, -1233, and CA-SLO-267 (continued)

Site	Specimen	Unit	Depth (cm)	Lab. No.	Distance from edge (mm)	^{18}O	Inferred temperature (°C)	Inferred season of collection
CA-SLO-267	-	12	30-40	A1k	20	0.975	11.77	
CA-SLO-267	-	12	30-40	A1l	22	0.959	11.83	
CA-SLO-267	-	12	30-40	A1m	24	1.146	11.10	
CA-SLO-267	-	12	30-40	A1n	26	1.100	11.28	
CA-SLO-267	-	12	30-40	A1o	28	1.207	10.86	
CA-SLO-267	-	12	30-40	A1p	30	1.205	10.87	
CA-SLO-267	-	12	30-40	A1q	32	1.183	10.96	
CA-SLO-267	-	12	30-40	A1r	34	1.278	10.59	
CA-SLO-267	-	12	30-40	A1s	36	1.373	10.23	
CA-SLO-267	-	12	30-40	A1t	38	1.296	10.52	
CA-SLO-267	582-7-88	7	70-80	A2a	0	0.921	11.98	Winter
CA-SLO-267	582-7-88	7	70-80	A2b	2	0.877	12.15	
CA-SLO-267	582-2-80	2	40-50	A3a	0	0.767	12.59	Summer
CA-SLO-267	582-2-80	2	40-50	A3b	2	1.447	9.95	
CA-SLO-267	582-12-96	12	30-40	A100a	0	0.581	13.34	Fall
CA-SLO-267	582-12-96	12	30-40	A100b	2	0.987	11.72	
CA-SLO-267	582-28-114	28	70-80	A4a	0	1.143	11.11	Summer
CA-SLO-267	582-8-63	8	20-30	A4b	2	1.194	10.91	
CA-SLO-267	582-8-63	8	20-30	A4c	4	1.383	10.19	
CA-SLO-267	582-8-63	8	20-30	A4d	6	1.341	10.35	
CA-SLO-267	582-8-63	8	20-30	A4e	8	1.150	11.08	
CA-SLO-267	582-8-63	8	20-30	A4f	10	0.935	11.92	
CA-SLO-267	582-8-63	8	20-30	A4g	12	0.745	12.68	
CA-SLO-267	582-8-63	8	20-30	A4h	14	0.770	12.58	
CA-SLO-267	582-8-63	8	20-30	A4i	16	0.951	11.86	
CA-SLO-267	582-8-63	8	20-30	A4j	18	1.008	11.64	
CA-SLO-267	582-17-56	17	20-30	A7a	0	0.714	12.80	Fall
CA-SLO-267	582-17-56	17	20-30	A7b	2	0.395	14.10	
CA-SLO-267	-	8	10-20	A8a	0	1.048	11.48	Early summer
CA-SLO-267	-	8	10-20	A8b	2	1.212	10.84	
CA-SLO-267	-	8	10-20	A8c	4	0.995	11.69	
CA-SLO-267	-	8	10-20	A8d	6	0.716	12.80	
CA-SLO-267	-	8	10-20	A8e	8	0.857	12.23	
CA-SLO-267	582-8-30	8	10-20	A8a	0	0.840	12.30	
CA-SLO-267	582-8-30	8	10-20	A8b	2	1.203	10.88	
CA-SLO-267	582-8-63	8	20-30	A900a	0	0.839	12.30	Summer
CA-SLO-267	582-8-63	8	20-30	A900b	2	1.107	11.25	
CA-SLO-267	582-2-56	28	70-80	A9a	0	0.956	11.84	Early summer
CA-SLO-267	582-2-56	28	70-80	A9b	2	1.197	10.90	

Table AI-1 Results of Oxygen Isotope Analyses of Mussel (*Mytilus californianus*) Shells from CA-MNT-521, -569B, -1223, -1227, -1233, and CA-SLO-267 (continued)

Site	Specimen	Unit	Depth (cm)	Lab. No.	Distance from edge (mm)	^{18}O	Inferred temperature (°C)	Inferred season of collection
CA-SLO-267	582-2-56	28	70-80	A9c	4	1.019	11.59	
CA-SLO-267	582-2-56	28	70-80	A9d	6	1.222	10.81	
CA-SLO-267	582-2-56	28	70-80	A9e	8	1.065	11.41	
CA-SLO-267	582-2-56	28	70-80	A9f	10	1.305	10.49	
CA-SLO-267	582-2-56	28	70-80	A9g	12	1.068	11.40	
CA-SLO-267	582-2-56	28	70-80	A9h	14	0.701	12.86	
CA-SLO-267	582-2-67	2	30-40	A10a	0	0.492	13.70	Fall
CA-SLO-267	582-2-67	2	30-40	A10b	2	0.506	13.65	
CA-SLO-267	582-21-72	21	50-60	A11a	0	0.671	12.98	Fall
CA-SLO-267	582-21-72	21	50-60	A11b	2	0.815	12.40	
CA-SLO-267	582-3-60	3	40-50	A12a	0	0.544	13.49	Fall
CA-SLO-267	582-3-60	3	40-50	A12b	2	0.538	13.52	
CA-SLO-267	582-14-35	14	50-60	A13a	0	0.939	11.91	Summer
CA-SLO-267	582-14-35	14	50-60	A13b	2	1.268	10.63	
CA-SLO-267	582-11-81	11	40-50	A15a	0	1.000	11.67	Summer
CA-SLO-267	582-11-81	11	40-50	A15b	2	1.256	10.67	
CA-SLO-267	582-4-93	4	60-70	A16a	0	0.631	13.14	Fall
CA-SLO-267	582-4-93	4	60-70	A16b	2	0.760	12.62	
CA-SLO-267	582-7-76	7	50-60	A18a	0	0.605	13.24	Fall
CA-SLO-267	582-7-76	7	50-60	A18b	2	0.926	11.96	
CA-SLO-267	582-10-86	10	40-50	A20a	0	1.357	10.29	Spring
CA-SLO-267	582-10-86	10	40-50	A20b	2	1.138	11.13	
CA-SLO-267	582-10-122	10	60-70	A24a	0	1.048	11.48	Summer
CA-SLO-267	582-10-122	10	60-70	A24b	2	1.278	10.59	
CA-SLO-267	582-14-74	14	40-50	A25a	0	0.782	12.53	Winter
CA-SLO-267	582-14-74	14	40-50	A25b	2	0.593	13.29	
CA-SLO-267	582-7-81	7	60-70	A26a	0	0.869	12.19	Summer
CA-SLO-267	582-7-81	7	60-70	A26b	2	0.915	12.00	
CA-SLO-267	582-2-120	2	70-80	A30a	0	0.627	13.15	Fall
CA-SLO-267	582-2-120	2	70-80	A30b	2	1.340	10.35	
Modern (July 1994)	-	-	-	-	0	1.009	11.63	
Modern (July 1994)	-	-	-	-	2	0.822	12.37	
Modern (July 1994)	-	-	-	-	4	0.413	14.03	
Modern (July 1994)	-	-	-	-	6	0.000	0.00	
Modern (July 1994)	-	-	-	-	8	0.411	14.04	

Table AI-1 Results of Oxygen Isotope Analyses of Mussel (*Mytilus californianus*) Shells from CA-MNT-521, -569B, -1223, -1227, -1233, and CA-SLO-267 (continued)

Site	Specimen	Unit	Depth (cm)	Lab. No.	Distance from edge (mm)	^{18}O	Inferred temperature (°C)	Inferred season of collection
Modern (July 1994)	-	-	-	-	10	0.608	13.23	
Modern (July 1994)	-	-	-	-	12	1.333	10.38	
Modern (July 1994)	-	-	-	-	14	0.853	12.25	
Modern (July 1994)	-	-	-	-	16	1.504	9.73	
Modern (July 1994)	-	-	-	-	18	1.036	11.53	
Modern (July 1994)	-	-	-	-	20	0.630	13.14	
Modern (July 1994)	-	-	-	-	22	1.114	11.22	
Modern (July 1994)	-	-	-	-	24	0.847	12.27	
Modern (July 1994)	-	-	-	-	26	1.016	11.61	
Modern (July 1994)	-	-	-	-	28	1.273	10.61	
Modern (July 1994)	-	-	-	-	30	1.615	9.32	
Modern (July 1994)	-	-	-	-	32	1.100	11.28	
Modern (July 1994)	-	-	-	-	34	1.033	11.54	
Modern (July 1994)	-	-	-	-	36	0.726	12.76	
Modern (July 1994)	-	-	-	-	38	0.997	11.68	
Modern (July 1994)	-	-	-	-	40	0.762	12.61	
Modern (July 1994)	-	-	-	-	42	0.725	12.76	
Modern (July 1994)	-	-	-	-	44	0.943	11.89	
Modern (July 1994)	-	-	-	-	46	1.119	11.20	
Modern (July 1994)	-	-	-	-	48	0.668	12.99	

Table AI-2 Mean Sea Temperatures for Monterey, from records of the Hopkins Marine Laboratory

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1919	13.77	13.18	12.63	12.17	12.36	12.67	12.80	13.40	13.85	13.09	12.14	11.20	12.77
1920	11.55	11.81	12.20	11.89	11.78	13.27	13.64	13.62	14.03	12.94	12.00	11.52	12.60
1921	11.07	11.26	11.90	11.35	11.75	13.51	13.46	13.66	12.96	12.98	11.78	11.06	12.23
1922	10.57	10.65	11.13	10.99	11.50	13.16	13.56	12.14	12.84	12.71	11.06	11.18	11.79
1923	10.80	10.58	10.77	12.29	11.76	12.14	12.58	12.68	13.95	13.45	12.95	11.68	12.13
1924	10.72	11.92	10.98	11.18	11.99	12.93	12.33	12.00	12.68	11.63	10.84	10.21	11.62
1925	9.86	10.99	10.97	12.00	12.27	12.07	12.97	13.38	13.81	13.48	12.25	12.15	12.18
1926	12.27	12.57	12.90	13.99	13.01	12.15	12.24	11.97	12.83	12.35	12.60	11.39	12.53
1927	11.41	11.55	11.20	11.43	11.59	12.28	13.12	13.29	13.16	12.45	13.93	12.46	12.32
1928	12.26	12.15	13.23	12.47	11.96	12.33	12.67	12.31	12.45	12.60	12.29	11.90	12.38
1929	11.60	11.55	11.64	11.29	12.13	13.23	14.33	13.98	14.67	13.79	13.07	13.19	12.87
1930	12.63	13.09	13.44	14.27	13.26	13.34	13.42	13.96	14.80	13.96	12.47	13.24	13.49
1931	12.96	13.93	13.89	12.64	14.85	15.45	14.22	14.71	14.98	15.12	11.92	11.12	13.81
1932	10.95	10.63	11.50	11.57	13.15	13.27	13.75	13.33	16.03	14.54	12.67	12.08	12.78
1933	10.50	10.89	11.33	12.09	11.60	12.80	13.08	14.11	14.02	12.70	11.97	11.04	12.17
1934	11.49	12.15	13.29	13.34	12.97	13.14	13.95	13.95	14.09	14.13	13.96	13.02	13.29
1935	12.06	12.28	11.78	11.83	12.65	13.08	13.38	13.75	14.03	13.65	11.92	12.45	12.73
1936	12.16	11.92	12.65	12.42	13.83	15.19	12.85	13.80	14.56	14.28	13.76	13.43	13.40
1937	11.38	11.05	12.13	12.19	11.89	14.27	14.58	14.25	13.76	14.43	13.51	13.47	13.07
1938	12.85	12.65	12.97	12.19	12.80	13.14	14.96	14.90	13.62	14.04	12.03	12.69	13.23
1939	12.03	10.81	10.71	12.11	12.98	12.71	13.80	14.96	15.26	14.71	13.83	14.17	13.17
1940													
1941	13.86	13.74	14.35	14.34	15.17	14.16	14.60	15.25	15.37	13.97	14.69	14.17	14.47
1942	13.02	13.04	12.34	12.87	13.07	12.66	14.16	13.87	14.72	13.05	12.55	11.78	13.09
1943	11.62	12.47	13.61	12.72	12.08	13.57	14.37	13.76	14.87	13.93	13.33	13.08	13.28
1944	12.64	12.00	11.90	12.18	12.76	13.54	14.69	13.46	13.63	14.17	13.96	12.77	13.13
1945	12.26	12.52	10.92	10.95	12.95	13.47	15.19	13.89	14.58	14.76	13.86	12.36	13.14
1946	11.45	11.21	11.11	12.31	13.02	14.11	14.00	14.00	13.94	13.44	12.28	12.43	12.77
1947	11.24	11.79	12.76	13.10	13.47	14.55	14.51	14.67	14.59	13.90	11.73	12.00	13.19
1948	11.92	11.61	11.21	12.77	13.32	14.15	14.47	14.61	13.61	13.36	12.20	11.06	12.86

Table AI-2 Mean Sea Temperatures for Monterey, from records of the Hopkins Marine Laboratory (continued)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1949	10.22	10.80	12.12	12.22	13.42	14.31	13.87	14.15	14.12	12.83	12.96	11.79	12.73
1950	10.87	11.31	11.90	12.05	11.94	13.72	14.18	14.42	14.38	13.05	14.17	13.45	12.95
1951	11.01	11.62	11.16	11.84	12.72	13.46	13.76	14.25	14.54	14.09	13.67	12.80	12.91
1952	11.95	12.16	11.60	12.20	12.48	13.27	14.66	13.10	13.34	13.20	12.58	12.75	12.77
1953	12.32	10.82	11.13	11.42	12.78	13.50	13.51	13.64	15.55	13.54	12.91	11.58	12.72
1954	11.90	12.19	12.36	13.26	13.18	12.81	13.53	13.97	14.05	13.31	12.89	12.18	12.96
1955	11.34	11.12	11.92	11.66	12.38	13.34	12.61	13.06	13.17	13.01	11.61	11.74	12.24
1956	11.75	10.80	11.61	11.86	13.29	12.90	13.48	13.35	15.11	14.20	11.90	12.04	12.69
1957	11.81	11.81	12.80	12.77	14.49	13.32	14.20	13.99	15.63	16.24	13.93	13.83	13.73
1958	13.30	14.44	13.67	14.25	14.00	16.79	14.00	15.99	15.58	15.24	13.50	13.97	14.56
1959	13.50	12.98	13.53	13.09	13.03	12.42	13.95	15.36	14.61	14.88	13.62	13.62	13.71
1960	12.43	12.59	12.33	12.89	12.19	14.42	14.10	13.51	13.44	14.22	12.75	12.50	13.11
1961	12.35	13.11	12.01	12.31	12.43	13.77	14.12	14.73	13.87	13.55	12.35	11.98	13.04
1962	11.27	11.85	11.78	12.20	12.49	12.49	13.00	14.35	13.27	13.63	12.81	12.05	12.62
1963	11.66	13.35	11.99	13.28	12.92	13.50	14.87	13.83	14.70	15.61	13.61	12.05	13.44
1964	12.11	11.90	11.39	11.49	12.06	13.13	13.40	13.70	13.78	14.00	13.44	12.23	12.71
1965	11.72	11.56	12.30	13.13	12.36	12.87	14.44	15.00	15.48	14.30	13.81	13.13	13.34
1966	12.15	12.25	12.06	12.97	13.15	13.57	13.76	13.98	14.36	13.72	13.68	12.91	13.21
1967	11.60	12.08	12.51	12.23	13.42	12.77	14.28	14.45	15.09	14.14	13.99	12.12	13.22
1968	11.52	13.03	13.44	12.64	12.64	13.15	13.86	14.56	14.41	13.19	12.91	11.74	13.09
1969	11.78	11.92	12.34	12.95	12.95	14.58	13.57	13.43	14.04	13.65	13.86	14.09	13.26
1970	12.83	12.85	13.21	12.07	12.48	13.26	13.63	13.38	13.07	13.34	13.28	12.35	12.97
1971	11.13	11.42	10.61	11.86	11.80	12.91	13.50	14.46	15.20	13.26	11.83	10.64	12.39
1972	10.56	11.61	12.55	12.76	12.49	13.42	15.83	15.38	14.90	15.57	13.83	12.40	13.44
1973	12.28	12.90	12.89	12.61	12.29	14.01	13.46	14.04	14.24	13.26	12.53	11.71	13.01
1974	11.03	11.13	11.55	12.61	12.34	13.24	14.34	15.21	14.53	14.75	12.83	11.91	12.95
1975	11.10	11.71	11.90	11.82									
1976													
1977							15.14	14.68	15.05	13.93	12.62	12.61	

Table AI-2 Mean Sea Temperatures for Monterey, from records of the Hopkins Marine Laboratory (continued)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Mean
1978	13.60	13.39	13.99	14.44	13.04	12.96	13.78	14.74	14.28	13.25	12.66	11.27	13.45
1979	11.84	11.57	12.36	13.11	13.50	13.98	13.74	14.61	15.48	15.57	13.35	12.37	13.45
1980	13.03	13.06	13.61	12.64	12.47	13.36	14.31	14.28	14.35	13.49	12.35	12.40	13.27
1981	13.44	13.21	13.44	12.43	12.51	13.75	13.53	14.45	13.83	13.22	14.13	13.27	13.43
1982	11.33	12.31	12.67	13.69	12.95	14.29	14.73	14.04	15.01	15.18	14.77	13.85	13.73
1983	13.57	14.38	14.34	13.39	14.15	13.91	15.20	16.00	17.39	17.13	15.41	13.43	14.85
1984	12.65	13.10	12.96	11.99	12.06	12.98	15.77	14.79	15.31	14.46	13.54	12.43	13.50
1985	11.95	12.03	11.89	12.35	12.31	14.39	14.49	15.03	14.76	13.81	11.40	11.71	13.01
1986	13.04	13.17	13.56	13.33	12.36	13.72	13.77	14.72	14.53	13.79	13.22	13.53	13.56
1987	12.52	12.71	12.79	12.69	13.57	13.66	14.87	16.06	15.36	15.07	14.53	12.72	13.87
1988	11.42	11.53	12.34	12.21	13.12	13.61	14.14	15.46	14.52	13.88	12.99	11.28	13.04
1989	10.75	10.89	12.21	13.19	13.10	13.43	13.29	14.14	14.01	13.52	12.92	13.12	12.88
1990	12.35	10.93	11.60	12.77	12.60	13.02	13.56	15.37	14.58	13.49	12.59	11.45	12.85
1991	11.61	12.29	11.79	12.21	11.49	12.29	13.53	14.89	13.93	13.96	12.02	11.46	12.62
1992	12.03	13.14	14.07	14.63	14.52	15.33	16.18	14.70	15.00	15.24	14.30	12.75	14.32
1993	12.21	13.76	14.92	14.08	14.12	15.93	14.98	16.34	15.18	14.88	14.50	13.13	14.50
1994	12.28	12.32	14.14	13.90	13.70	13.71	13.29	13.19	13.55	13.93	11.57	11.23	13.06
Mean	11.92	12.12	12.37	12.55	12.79	13.49	13.94	14.17	14.36	13.91	12.98	12.36	13.08
SD	0.88	0.94	1.00	0.84	0.80	0.87	0.80	0.91	0.87	0.94	0.95	0.90	

Table AI-3 Mean Monthly Sea Surface Temperatures from Granite Canyon, south of Carmel, Monterey County, California from 1972-1994

					° C								
Year	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	Mean
1972	10.94	11.15	10.70	10.05	10.20	10.85	12.65	11.75	12.76	15.06	13.38	13.11	11.88
1973	12.43	13.06	11.45	9.38	10.10	10.59	10.41	11.37	11.63	12.06	11.41	11.12	11.25
1974	10.76	10.57	10.91	9.87	9.42	10.38	11.29	12.49	12.36	14.01	11.64	11.45	11.26
1975	10.76	10.85	9.76	9.76	9.59	11.38	10.74	12.18	11.40	11.83	10.85	10.69	10.81
1976*	10.62	11.79	10.01	9.82	9.81	10.15	11.29	13.27	13.26	14.45	14.95	15.05	12.03
1977*	14.13	12.70	9.70	9.60	10.15	10.14	10.62	12.13	13.48	11.84	11.42	12.38	11.52
1978	13.07	12.42	12.45	11.84	9.54	9.80	10.31	12.02	12.26	12.04	12.14	11.28	11.59
1979	11.73	11.74	10.61	10.60	11.22	11.31	11.20	12.97	13.59	13.75	13.07	13.31	12.09
1980	13.34	13.36	12.03	10.12	10.28	10.67	11.94	12.32	12.63	12.32	12.55	13.34	12.08
1981	14.06	13.10	12.10	9.86	10.60	10.75	11.90	12.03	12.42	12.31	13.56	11.86	12.05
1982	11.08	11.86	11.51	11.03	11.17	11.65	11.45	11.38	13.09	13.45	14.84	13.73	12.18
1983*	14.19	14.68	13.77	12.06	11.39	11.20	12.22	14.03	15.35	15.30	14.66	13.07	13.49
1984	12.78	12.02	11.01	9.77	9.40	11.08	13.48	13.09	14.02	12.62	13.72	12.65	12.14
1985	12.47	11.36	10.61	10.63	9.95	11.59	11.80	12.40	13.24	12.60	11.79	12.53	11.75
1986	13.08	12.85	12.35	10.81	9.94	11.42	12.19	12.57	13.25	12.52	12.83	14.20	12.33
1987	12.85	12.59	11.91	10.88	12.03	11.30	11.71	14.49	13.29	14.51	14.08	12.89	12.71
1988	11.99	11.80	10.99	11.13	9.54	11.07	11.80	13.16	12.41	12.46	11.75	11.73	11.65
1989	11.04	10.86	10.94	11.42	10.31	11.01	10.66	12.76	12.39	12.95	13.04	13.72	11.76
1990	12.45	10.63	10.50	11.01	10.96	10.36	12.03	13.68	12.46	12.45	12.67	12.40	11.80
1991*	12.26	11.92	11.54	9.68	9.41	10.24	12.54	12.85	12.82	13.21	12.02	12.30	11.73
1992*	13.12	13.16	14.02	11.65	12.22	12.49	12.11	12.32	12.79	14.29	14.09	13.68	12.99
1993	13.40	13.31	12.39	10.50	11.36	11.01	12.37	12.86	12.59	13.87	14.54	13.50	12.64
1994	12.27	12.32	14.13	13.43	13.70	13.84	13.28						
Mean	12.34	12.11	11.37	10.52	10.34	10.92	11.64	12.63	12.90	13.14	12.87	12.69	11.48

Table AI-4 Seasonal Sea Surface Temperature Zones (° C) for Archaeological Time Periods on the Big Sur Coast Based on Findings from Jones and Kennett (1999)

Season	Middle Period	Middle-Late Transition	Late Period	Modern
Spring	≤ 10.75	≤ 12.25	≤ 9.2	≤ 11.1
Early summer	10.75-12.75	12.25-15.55	9.2-11.0	11.1-12.3
Late summer/ Early fall	≥12.75	> 15.55	≥ 11.0	≥ 12.3
Winter	10.75-12.75	12.25-15.55	9.2-11.0	11.1-12.3

Table AI-5 Summary of Seasonality Determinations by Site

Site	Spring	Early summer	Late summer/ Early fall	Winter	Total
CA-SLO-267	1	10	9	2	22
CA-MNT-521	4	3	0	1	8
CA-MNT-1233	2	0	1	0	3
CA-MNT-569B	3	2	1	0	6
CA-MNT-1223	0	0	1	1	2
CA-MNT-1227	0	0	0	1	1
	10	15	12	5	42

Table AI-6 Summary of Seasonality Determinations: Inland Versus Coastal Sites

Setting	Spring	Early summer	Late summer/ Early fall	Winter	Total
Inland sites	7	5	1	1	14
Coastal sites	3	10	11	4	28
Total	10	15	12	5	42

Table AI-7 Summary of Seasonality Determinations by Time and Setting

Period	Spring	Early summer	Late summer/ Early fall	Winter	Total
Middle Period coastal	1	10	9	2	22
Middle Period interior	4	3	0	1	8
Subtotal	5	13	9	3	30
Middle-Late Transition Coastal	2	0	1	0	3
Late Period coastal	0	0	1	2	3
Late Period interior	3	2	1	0	6
Subtotal	3	2	2	2	9
Grand total	10	15	12	5	42

REFERENCES CITED

Bailey, G. N., M. R. Deith, and N. J. Shackleton
1983 Oxygen Isotope Analysis and Seasonality Determinations: Limits and Potential of a New Technique. *American Antiquity* 48:390-398.

Deith, M. R.
1995 Seasonality from Shells: An Evaluation of Two Techniques for Seasonal Dating of Marine Molluscs. In *Palaeobiological Investigations Research Design, Methods and Data Analysis*, edited by N. R. J. Fieller, D. D. Gilbertson, and N. G. A. Ralph, pp. 119-130. *BAR International Series 266*, Oxford.

Epstein, S., R. Buchsbaum, H. Lowenstam, and H. Urey
1951 Carbonate-Water Isotopic Temperature Scale. *Bulletin of the Geological Society of America* 62:417-426.

Epstein, S., Buchsbaum, R., Lowenstam, H. and H. Urey
1953 Revised Carbonate-Water Isotopic Temperature Scale. *Bulletin of the Geological Society of America* 64:1315-1326.

Fairbanks, R. G.
1989 A 17,000-Year Glacio-Eustatic Sea Level Record: Influence of Glacial Melting Rates on the Younger Dryas Event and Deep-Ocean Circulation. *Nature* 342:637-641.

Glassow, M. A., D. J. Kennett, J. P. Kennett, and L. R. Wilcoxon
1994 Confirmation of Middle Holocene Ocean Cooling Inferred from Stable Isotopic Analysis of Prehistoric Shells from Santa Cruz Island, California. *The Fourth California Islands Symposium: Update on the Status of Resources*. Edited by W. L. Halvorson and G. J. Maender. Santa Barbara Museum of Natural History.

Herz, N.
1990 Stable Isotope Geochemistry Applied to Archaeology. In *Archaeological Geology of North America*, vol. 3, edited by N. P. Lasca and J. Donahue, pp. 585-595. Geology Society of America, Boulder.

Horibe, Y. and T. Oba
1972 Temperature Scales of Aragonite-Water and Calcite-Water Systems. *Fossils* 23/24:69-79.

Ingram, B. L., and J. R. Southon
1996 Reservoir Ages in Eastern Pacific Coastal and Estuarine Waters. *Radiocarbon* 38:573-582.

Jones, T. L., and D. J. Kennett
1999 Late Holocene Sea Temperatures Along the Central California Coast. *Quaternary Research* 51:74-82.

Kennett, D. J., and B. Voorhies
1995 Middle Holocene Periodicities in Rainfall Inferred from Oxygen and Carbon Isotopic Fluctuations in Prehistoric Tropical Estuarine Mollusc Shells. *Archaeometry* 37:157-170.

1996 Oxygen Isotopic Analysis of Archaeological Southern Pacific Coast of Mexico. *Journal of Archaeological Science* 23:689-704.

Killingley, J. S.
1980 Seasonality of Mollusk Collecting at Hubb's Midden 1959: VI: 28A. *Pacific Coast Archaeological Society Quarterly* 16(4):19-23.

1981 Seasonality of Mollusk Collecting Determined from ^{18}O Profiles of Midden Shells. *American Antiquity* 48:152-158.

Killingley, J. S., and W. H. Berger
1979 Stable Isotopes in a Mollusk Shell: Detection of Upwelling Events. *Science* 205:186-188.

Koerper, H. C., Killingley, J. S., and R. E. Taylor
1985 The Little Ice Age and Coastal Southern California Human Economy. *Journal of California and Great Basin Anthropology* 7:99-103.

O'Neil, J. R., L. H. Adami, and S. Epstein
1975 Revised Value for the $d^{18}O$ Fractionation Between CO_2 and H_2O at 25°C. *Journal of Research, U.S. Geological Survey* 3:623.

Shackleton, N. J.
1969 Marine Mollusca in Archaeology. In *Science in Archaeology*, edited by D. Brothwell and E. S. Higgs, pp. 407-414. Thames and Hudson, New York.

1973 Oxygen Isotope Analysis as a Means of Determining Season of Occupation of

Prehistoric Midden Sites. *Archaeometry* 15:133-141.

Stuiver, M., and P. J. Reimer
1993 A Complete Program for Radiocarbon Age Calibration. *Radiocarbon* 35:215-230.

Urey, H. C.
1947 The Thermodynamic Properties of Isotopic Substances. *Journal of the Chemical Society* 1947:562-581.

Wefer, G., and W. H. Berger
1991 Isotope Paleontology: Growth and Composition of Extant Calcareous Species. *Marine Geology* 100:207-248.

APPENDIX II
CEMENTUM ANNULI SEASONALITY ANALYSIS OF *Odocoileus hemionus* TEETH FROM TEN SITES ON THE BIG SUR COAST

STEVEN A. MOFFITT

Cementum annuli analysis was completed on 44 specimens of *Odocileus heminous* teeth recovered from eleven sites (CA-MNT-63, -521, -759/H, -1223, -1227, -1228, -1232/H, -1233, -1235, -1277/H, and CA-SLO-267). The deposition of annuli growth and rest bands in the teeth of mammals leaves a permanent record of the season of death of the animal that can be exploited by archaeologists. Wildlife managers have long used cementum-annuli analysis to age animals under their care. Biologists studying the Alaskan fur seal (*Callorhinus ursinus*) and the northern elephant seal (*Mirounga angustirostris*) made the initial discovery that the roots of mammal teeth have structural properties that correspond with the known ages of animals (Scheffer 1950, Laws 1952).

Cementum is a calcified tissue incrementally produced at the distal margin of the tooth throughout life. Cells of the dental follicle produce cementum on the surface of dentine and enamel. As the occlusal surfaces wear down and the tooth erupts minutely to compensate for the wear, cementum is deposited on the longitudinal areas of displacement, particularly in the regions of the apex of the root and forks of the roots in multirooted teeth.

Cementum annuli analsis has been shown to be consistently more accurate in determining the age of mammals than the previously used method of tooth eruption and wear (Lockard 1972:46). Numerous studies on both wild and domesticated populations including deer (Gilbert 1966; Lockard 1972; Low and Mct.Cowan 1963; Ransom 1966), red deer (Mitchell 1969), reindeer (Reimers and Nordby 1968), moose (Sergeant and Pimlott 1959), and sheep (Saxon and Higham 1969), among others, have clearly established the correlation between the depositional banding of cementum annuli in the teeth of known age control samples with the age of the animal at the time of death. Further investigation has determined that the banding is deposited seasonally. Cementum annuli thin-sections observed under transmitted polarized light has confirmed a seasonal growth pattern consisting of alternating translucent and opaque bands. The outer-most band indicates the season of death.

The biological basis for this visually distinct dual banding is not precisely understood. Alternate theories have been offered which suggest an environmental or metabolic influence (Stallibrass 1982), photo-periodicity (Pike-Tay 1991), climate (Klevezal and Kleinenberg 1969), latitude (Pike-Tay 1991), or the quantity and quality of food (Stallibrass 1982). Nutrition, which closely relates to environment, and hormonal changes or sexual cycles may be some of the metabolic causes of the banding (Stallibrass 1982). Recent experiments by Lieberman (1993, 1994) on the banding effects of diet on goat annuli support a nutritional/environmental correlation. Seasonal varia-tion of available forage may impact annuli in several ways. First, a change in band mineralization appears to occur as seasonal nutrition varies. The band may become hypomineralized as available calicium is reduced or hypermineralized when reduced nurtition restrains cementogenesis or impacts the production of Sharpey's fibres in the periodontal ligament (Lieberman 1994:528). Second, a seasonal change in available flora may require differential biomechanical forces for processing these different food items. Diets that contain material which is more difficult for the animal to chew and/or which is lower in nutrition may place greater stress upon the biological structures used to process the food. Lieberman (1993) reported that cementum may reflect the higher stress by containing an increased number of collagen fibre bundles which attach the tooth roots to the periodontal ligament, by an increased mineralization as the result of growing more slowly, or by a directional change in the mineralization of Sharpey's fibres at times when occusal forces are increased. Clearly, environment greatly influences the deposition and banding of annuli, whether directly or indirectly. Although the biological processes behind cementum annuli deposition and banding may not be explicitly known, most researchers agree that a comparative standard must be established from a control sample of known age/known season of death animals from the same geographical/environmental area in order to successfully apply this technique to age or seasonally date the death of an unknown sample (Beasley et al. 1992; Burke and Castanet 1995; Gordon 1993; Pike-Tay 1991; Stallibrass 1982).

Zooarchaeologists have been quick to capitalize on the discovery of seasonal banding and have expanded its application to archaeological faunal remains where teeth are often numerous and well preserved (Kay 1974). Archaeological applications of cementum analysis are dependent upon the clarity and regularity of the seasonal deposition pattern. Seasonality estimates are based upon the last increment deposited on the periphery of the tooth root. A one year cycle of cementum deposition leaves two bands on the periphery of the tooth root, a narrow dark band deposited during the non-growth winter season and a wide light band deposited during the summer growth season. The season of death of the animal is determined by estimating the amount of growth that has occurred on the last formed band of the tooth root. Since the width of the bands tend to narrow slightly as the animal grows older, especially the wider light colored growth band, the seasonal calculation for the death of the animal can only be reasonably estimated to a period of about three months (Quintero 1987; Spiess 1976, 1990).

Specific teeth in each species are favored for use in cementum analysis due to the clarity and regularity of their annuli deposition. For *Odocileus hemionus* specimens the permanent first incisors provide the most consistent annuli for seasonality assessments (Matson 1981; Quintero 1987; Thomas and Bandy 1973). The analysis of first incisors from modern herds of *Odocileus hemionus* revealed that 57% of the study sample produced annuli that closely matched the standardized model (Matson 1993).

While wildlife biologists established the basis for using this method on specific species in specific geographic/environmental regions, zooarchaeologists occassionally followed suit and constructed modern comparative collections for previously investigated species in different environmental regions (Beasley et al. 1992; Burke and Castanet 1995; Lieberman 1990, 1991; Pike-Tay 1991; Quintero 1987). It is important to use a local comparative collection as the standardized model for the analysis so that generalized designations such as spring, summer, and fall can correlate on a scale with actual months. Such a collection was used for this study along with the scale derived from that collection by Quintero (1987). The set consisted of teeth from 219 wild deer killed in 1984 in Los Angeles (5), Riverside (53), San Bernardino (87), and San Diego (74) counties. It was obtained from the State of California, Department of Fish and Game, and had been compiled to facilitate their deer herd management programs (Quintero 1987). The scale used for this analysis is a slight variation of the scale compiled by Thomas and Bundy (1973) for British Columbian deer teeth and accomodates the slight differences in environmental conditions (Quintero 1987):

Fall/Winter: Summer band complete, November to February.
Early Spring: Arrest band distinct, March to April.
Late Spring/Early Summer: Summer band, May to July.
Late Summer/Early Fall: Summer band over but not complete, August to October.

It is not possible to differentiate growth related periods during the winter months, because growth does not occur after early November and the growth arrest annuli are not formed until March. The summer scale is just the opposite, and is more accurate because the rapid growth period is easily augmented into discrete seasonal or three-month increments.

METHODS

Each sample was assigned a laboratory number prior to processing. In general, the teeth were in good condition although only one tooth was encased in bone matrix, allowing some protection to the root periphery.

The technique used to expose the annuli on the current sample followed the method developed by Bourque et al. (1978) and used by Quintero (1987). It is a modification of a technique first reported by Erickson and Seliger (1969) when they attempted to simplify and expediate the process originally developed by Low and Cowan (1963). First, all teeth were encased in a protective resin matrix to hold them securely. Following Bourque et al. (1978) and Quintero (1987), liquid plastic casting resin (Styrene Monomer/Polyester resin) was used, embedding the teeth in incremental layers. The resin was catalyzed and poured in layers over a tooth placed in a mounting cap. Each layer was allowed to set before the addition of the next layer. After the addition of the final layer each mounting cap was placed in a vacuum chamber for 24 hours to remove any bubbles which may have formed during the casting process and to force resin into the pulp cavity. The mounting cap was removed from the vacuum chamber and allowed to dry for another 24 hours. Each cast was then removed from its mounting cap. A Felker lapidary saw with a continuous face diamond blade that was constantly lubricated with a stream of water was used to cut a longitudinal (sagittal) section of each tooth root. Longitudinal sections are preferable to transverse sections because a larger portion of the root structure is exposed. Each cast was cut to expose the lingual-lateral quarter of the root where possible, however, several of the specimens were fragments or had broken roots which provided little choice of positioning. Each exposed surface was polished twice. First, with #400 grit on a high speed rotating lapidary wet polisher and then with #600 grit on a slow speed wet polisher. The exposed surface was then affixed to a 27 x 40 mm microslide with epoxy and allowed to dry for 72 hours. A thin-section approximately 100 microns in width was cut from the section affixed to the slide by using a Hillcrest thin-sectioning saw. The slide thin-section was ground to a width of approximately 30-50 microns. The final reduction was accomplished by using a Hillcrest thin-sectioning machine.

RESULTS

Each thin-section was examined under 40 to 100 magnification using a binocular microscope under transmitted light. The analysis was conducted on June 15, 1995 at Northern Arizona University, Flagstaff, Arizona. Sixteen of the 20 teeth (80%) provided seasonal estimations of death based upon the final incremental layer deposited on the periphery of the tooth root (Table 1). The majority of specimens (13) indicated a late fall or winter death. Three of the teeth indicated a mid-summer death. These specimens had an outer annuli band that was approximately deposited, indicating a June through August death. However, the sample is small and should only be tentatively used in making seasonality estimations. The remaining 20% of the specimens (4 teeth) either had incremental layers that were indistinct or the root was so damaged that the cementum layers were missing.

Table AII-1 Cementum deer teeth seasonality from study sites

Site	Specimen	Component	Unit	Depth (cm)	Tooth	Condition	Season
CA-MNT-63	-	Historic	3	30-40	Premolar	-	Fall/Winter
CA-MNT-63	-	Historic	3	30-40	Molar	-	Summer
CA-MNT-63	-	Historic	3	30-40	Premolar	-	Fall/Winter
CA-MNT-63	-	Middle	3	160-170	Molar	-	Fall/Winter
CA-MNT-759/H	-	-	1	30-40	Premolar	-	Late Summer
CA-MNT-759/H	-	-	1	70-80	Premolar	-	Fall/Winter
CA-MNT-1223	-	-	3	30-40	Premolar	-	Fall/Winter
CA-MNT-1223	-	-	3	40-50	Incisor	-	Fall/Winter
CA-MNT-1223	-	-	5	40-50	Premolar	-	Late Fall/ Early Winter (December- January)
CA-MNT-1223	-	-	8	20-30	Molar	-	Fall/Winter
CA-MNT-1223	-	-	8	50-60	Premolar	-	Fall/Winter
CA-MNT-1223	-	-	9	30-40	Premolar	-	Fall/Winter
CA-MNT-1223	-	-	11	0-10	Premolar	-	Fall/Winter
CA-MNT-1227	-	-	4	60-70	Premolar	-	Late Summer
CA-MNT-1227	-	-	5	30-40	Premolar	-	Fall/Winter
CA-MNT-1227	-	-	5	80-90	Premolar	-	Late Summer
CA-MNT-1227	-	-	6	60-70	Premolar	-	Fall/Winter
CA-MNT-1227	-	-	6	80-90	Molar	-	Fall/Winter
CA-MNT-1227	-	-	6	80-90	Molar	-	Late Summer
CA-MNT-1228	-	-	9	60-70	Premolar	-	Late Summer
CA-MNT-1232/H	-	-	3	140-150	Molar	-	Fall/Winter
CA-MNT-1233	-	-	3	30-40	Premolar	-	Late Summer/Early Fall
CA-MNT-1235	-	-	3	0-10	Premolar	-	Fall/Winter
CA-MNT-1277/H	-	-	4	30-40	Premolar	-	Fall/Winter
CA-MNT-1277/H	-	-	5	30-40	Incisor	-	Fall/Winter
CA-MNT-521	-	-	2	70-80	Premolar	-	Fall/Winter
CA-MNT-521	-	-	2	60-70	Premolar	-	Fall/Winter
CA-MNT-521	-	-	5	40-50	Canine	-	Fall/Winter
CA-MNT-521	-	-	2	50-60	Molar	-	Fall/Winter

Table AII-1 Cementum deer teeth seasonality from study sites (continued)

Site	Specimen	Component	Unit	Depth (cm)	Tooth	Condition	Season
CA-MNT-521	-	-	2	50-60	Premolar	-	Fall/Winter
CA-MNT-521	-	-	8	50-60	Premolar	-	Indistinct
CA-MNT-521	-	-	9	70-80	Molar		Fall/Winter
CA-SLO-267	582-04-79ae	-	4	50-60	Molar	Good	Fall/Winter
CA-SLO-267	582-10-64ac	-	10	20-30	Premolar	Fair	Fall/Winter
CA-SLO-267	582-10-64af	-	10	20-30	Premolar	Fair	Fall/Winter
CA-SLO-267	582-10-84ab	-	10	30-40	Molar	Fair	Fall/Winter
CA-SLO-267	582-11-90ah	-	11	40-50	Molar	Fair	Indistinct
CA-SLO-267	582-13-69ag	-	13	40-50	Molar	Good	Fall/Winter
CA-SLO-267	582-15-33ac	-	15	30-40	Molar	Poor	Indistinct
CA-SLO-267	582-20-50ad	-	20	30-40	Incisor	Good	Fall/Winter
CA-SLO-267	582-20-54ae	-	20	40-50	Premolar	Fair	Fall/Winter
CA-SLO-267	582-20-62aa	-	20	60-70	Premolar	Fair	Indistinct
CA-SLO-267	582-21-16ag	-	21	0-10	Premolar	Fair	Fall/Winter
CA-SLO-267	582-28-84ab	-	28	50-60	Molar	Fair	Fall/Winter

REFERENCES CITED

Beasley, M. J., W. A. B. Brown, and A. J. Legge
1992 Incremental Banding in Dental Cementum: Methods of Preparation for Teeth from Archaeological Sites and for Modern Comparative Specimens. *International Journal of Osteoarchaeology* 2:37-50.

Bourque, B. J., K. Morris, and A. Spiess
1978a Determining the Season of Death of Mammal Teeth From Archaeological Sites: A New Sectioning Technique. *Science* 199:530-531.

1978b Untitled. *Science* 202:542.

Burke, A., and J. Castanet
1995 Histological Observations of Cementum Growth in Horse Teeth and their Application to Archaeology. *Journal of Archaeological Science* 22:479-493.

Erickson, J. A., and W. Seliger
1969 Efficient Sectioning of Incisors for Estimating Ages of Mule Deer. *Journal of Wildlife Management* 33:384-388.

Gilbert, F. F.
1966 Aging White-tailed Deer by Annuli in the Cementum of the First Incisor. *Journal of Wildlife Management* 30:200-202.

Kay, M.
1974 Dental Annuli Age Determination on White-tailed Deer From Archaeological Sites. *Plains Anthropologist* 19:224-227.

Klevezal, G. A., and S. E. Kleinenberg
1969 *Age Determination of Mammals from Annual Layers in Teeth and Bones*. Jerusalem: Israel Program for Scientific Translations.

Lieberman, D. E.
1993 Life History Variables Preserved in Dental Cementum Microstructure. *Science* 261:1162-1164.

1994 The Biological Basis for Seasonal Increments in Dental Cementum and Their Application to Archaeological Research. *Journal of Archaeological Science* 21:525-539.

Lockhard, G. R.
1972 Further Studies of Dental Annuli for Aging White-tailed Deer. *Journal of Wildlife Management* 36:46-55.

Low, W. A., and I. McT. Cowan
1963 Age Determination of Deer by Annular Structure of Dental Cementum. *Journal of Wildlife Management* 27:466-471.

Matson, G.
1981 Workbook for Cementum Analysis. Milltown: Matsons Laboratory.

1993 Progress Report No. 13. Milltown: Matson's Laboratory.

Mitchell, B.
1969 Growth Layers in Dental Cement for Determining the Age of Red Deer (*Cervus elaphus* L.). *The Journal of Animal Ecology* 36:279-293.

Pike-Tay, A.
1991 *Red Deer Hunting in the Upper Paleolithic of Southwest France: A Study in Seasonality.* B.A.R. International Series 569. Oxford: British Archaeological Reports.

Quintero, L.
1987 Room and Board at Deer Springs: Faunal Analysis as an Aid to Settlement Patterns. Unpublished Master's thesis, Deparrtment of Anthropology, California State University, San Diego.

Ransom, A. B.
1966 Determining Age of White-tailed Deer from Layers in Cementum of Molars. *Journal of Wildlife Management* 30:197-199.

Reimers, E., and O. Nordby
1968 Relationship Between Age and Tooth Cementum Layers in Norwegian Reindeer. *Journal of Wildlife Management* 32:957-961.

Saxon, A., and C. Higham
1969 A New Research Method for Economic Prehistorians. *American Antiquity* 34:303-311.

Sergeant, D. E., and D. H. Pimlott
1959 Age Determination in Moose from Sectioned Incisor Teeth. *Journal of Wildlife Management* 23:315-321.

Stallibrass, S.
1982 The Use of Cement Layers for the Absolute Ageing of Mammalian Teeth: A Selective Review of the Literature with Suggestions for Further Studies and Alternative Applications. In: *Aging and Sexing Animal Bones from Archaeological Sites*, edited by R. Wilson, C. Grigson, and S. Payne, pp 109-126. B.A.R.:Oxford.

Spiess, A. E.
1976 Determining Season of Death of Archaeological Fauna by Analysis of Teeth. *Arctic* 29:53-55.

1990 Deer Tooth Sectioning, Eruption, and Seasonality of Deer Hunting in Prehistoric Maine. *Man in the Northeast* 39:29-44.

Thomas, D. C., and P. J. Bandy
1973 Age Determination of Wild Black-tailed Deer from Dental Annulations. *Journal of Wildlife Management* 37:232-235.