CHAPTER 9

Emergence of Late Holocene Sociopolitical Complexity on Santa Rosa and San Miguel Islands

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At the time of European contact (AD 1542), the people of Santa Rosa and San Miguel Islands lived in relatively large coastal villages, were heavily dependent on fishing, produced a variety of trade items, and participated in an extensive interregional exchange network (J. Johnson 1982b, 1988, 1993; Kennett 1998). Santa Rosa and San Miguel are two of the four northern Channel Islands that extend east-west for approximately 88 km along the southern margin of the Santa Barbara Channel (figure 9.1). Historically, people on these islands spoke a dialect of the Chumash language (Cruzeño), distinct from the related languages on the mainland coast and interior (Klar, Whistler, and McLendon 1999). Chumash is an ancient language with no affinities with other languages in California (Klar, Whistler, and McLendon 1999). Although mainland and island languages were not mutually intelligible, there is strong evidence for intermarriage throughout Chumash territory and an exchange of resources and ideas within the region and beyond (Arnold 1995a; J. Johnson 1988).

During the early contact period, population densities in the Santa Barbara Channel region were some of the highest in California (Moratto 1984:2) and among the highest for hunter-gatherers worldwide (R. Kelly 1995). Chumash populations were concentrated on the mainland coast, but large numbers of people also lived on the northern Channel Islands. An estimated 3000 people lived on the islands of Santa Cruz, Santa Rosa, and San Miguel (J. Johnson 1982b). Chumash informants in the late 19th and early 20th centuries named ten villages on Santa Rosa and San Miguel Islands (J. Johnson 1982b, 1993; see figure 9.1). Locational information for many of them is clear, and historic artifacts substantiate their existence (Arnold 1990a; J. Johnson 1982b, 1993; Kennett 1998). Baptismal records indicate that intermarriage between these island communities and mainland villages across the Santa Barbara Channel was extensive (J. Johnson 1988). Archaeological evidence for the relative permanence of these villages comes from the large size and depth of midden deposits, the presence of substantial domestic features such as house depressions and cemeteries, and diverse faunal and artifact assemblages (Kennett 1998).

The Chumash are often described as one of the most socially and politically complex hunter-gatherer-fisher societies in North America (e.g., Arnold 1991a, 1992a, 1993b; Colten 1993; Gamble 1991). In recent years there has been considerable disagreement about the timing and nature of the shift toward greater sociopolitical complexity in the Santa Barbara Channel region (Arnold 1991a; Arnold, Colten, and Pletka 1997; C. King 1990; L. King 1969, 1982; Martz 1984; Raab and Larson 1997). Based primarily on burial lots from different parts of the Santa Barbara Channel region, C. King (1990) interpreted Chumash prehistory as a gradual shift of the social system from egalitarian to nonegalitarian form. He argued that gradual intensification of the economic system resulted from maximizing the benefits of exchanging food and nonfood items among different environmental zones (C. King 1976). King (1990) also suggested that hereditary religious and political leaders emerged among the Chumash as early as 600 BC.

Arnold (1987, 1991a, 1992a, chapter 8, this volume) argued that the emergence of hereditary social ranking occurred after AD 1150, much later than C. King suggested. She views this emergence as a punctuated event triggered by environmental deterioration, particularly a significant ocean warming that impacted marine productivity between about AD 1150 and 1300. Arnold (1991a, chapter 8, this volume) suggested that elites emerged to manage economic activities in the region, particularly the production of bead money on the islands and the transport of food and non-

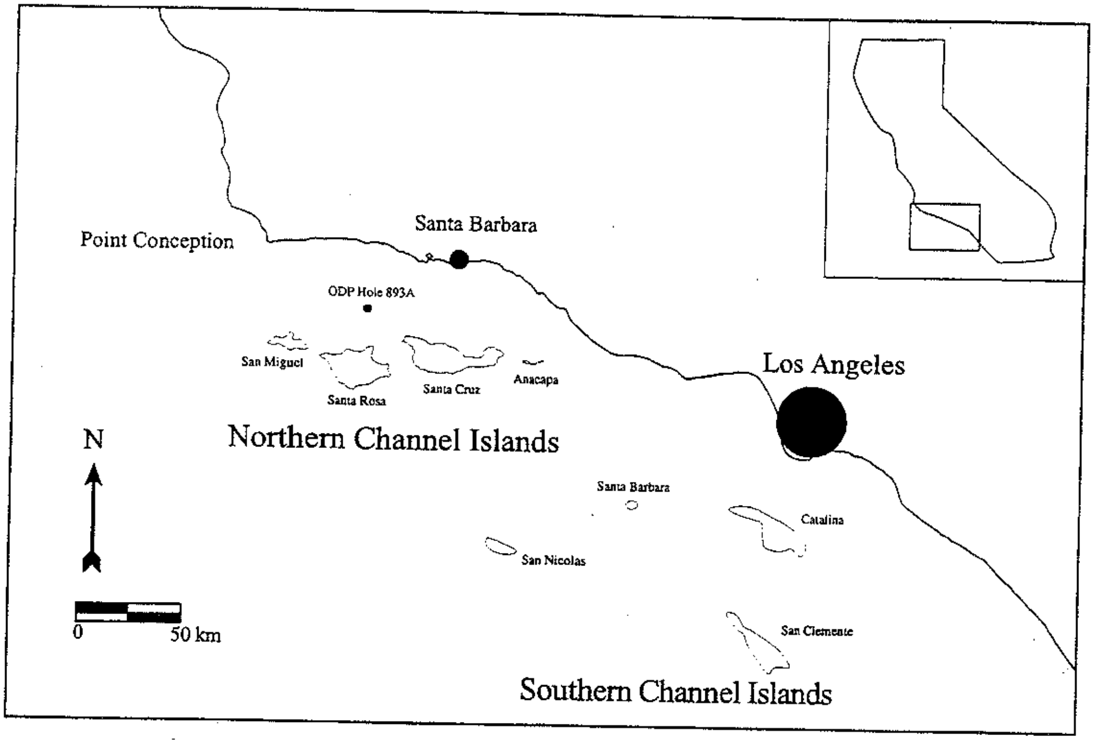

Figure 9.1 The Southern California Bight area, showing the Northern Channel Islands.

food items across the channel. Based on a variety of paleoclimatic indicators (Larson and Michaelson 1989; Pisias 1978, 1979), Arnold (1991a) proposed that elevated sea surface temperatures, reduced marine productivity, and drought enabled elites to control economic activities in the region. Arnold (1992a) argued that the people of Santa Cruz Island increased production of nonfood items, particularly shell beads, as population-resource imbalances increased, ostensibly in exchange for food with people living on the mainland coast.

More recently, Raab (1994; Raab and Larson 1997) argued that diminishing water supplies associated with widespread drought between AD 1150 and 1300 prompted the consolidation of Santa Barbara Channel populations around perennial water sources, solidification of territorial boundaries, increased warfare for scarce resources, and the emergence of a hierarchical social system after AD 1300. Citing evidence from SBA-1731 for a relatively productive marine system (see Erlandson 1993a), Raab (1994; Raab and Larson 1997) argued that marine productivity did not decrease between AD 1150 and 1300 and that settlement shifts evident on Santa Cruz Island during this interval are better explained as a response to fluctuations in the terrestrial, rather than marine, environment. Based on tree ring analysis (Larson and Michaelson 1989), Raab and Larson (1997) linked these changes to widespread cultural change and drought conditions across western North America (see also Jones et al. 1999; Jones and Kennett 1999).

Much of the recent debate regarding the emergence of more complex sociopolitical organization in the Santa Barbara Channel region has focused on the last 800 years of Chumash prehistory. Both Arnold (1991a, 1992a, 1995a, 1997) and Raab (1994; Raab and Larson 1997) have argued for punctuated shifts in sociopolitical organization associated with environmental changes. Arnold emphasized evidence for lowered marine productivity and elite control of labor on Santa Cruz Island, while Raab emphasized lowered terrestrial productivity and competition for limited water supplies. In this paper we explore the emergence of several hallmark Chumash behaviors—sedentism, intensive fishing, production of trade items, and exchange—on Santa Rosa and San Miguel Islands in light of a new paleoclimatic sequence for the region (Kennett 1998; Kennett and Kennett 2000) and new archaeological data from Santa Rosa and San Miguel. Based on these new data, we argue that the social, political, and economic strategies that clearly dominated in the region after AD 1300 emerged earlier, between about AD 650 and 1300, as behavioral responses to climatic and social instabilities in the region. To put the more rapid cultural shifts after AD 650 into a broader context, we consider cultural developments that occurred throughout the Late Holocene.

ENVIRONMENTAL SETTING

Compared with Santa Cruz Island to the east, the outer islands of Santa Rosa and San Miguel are less rugged and topographically variable. Santa Rosa, located 44 km from the mainland, is 217 km^2 in size. A mountain range runs through the center of the island, but elevations do not exceed 484 m. The northern part of Santa Rosa is dominated by a series of relatively flat, uplifted quaternary terraces (Orr 1968). The distance between the coast and the central range is shorter on the south side of the island, and the terrain is more rugged compared to the north coast. San Miguel Island (37km^2) is less topographically variable than Santa Rosa Island. Located 42 km south of Point Conception, it is the most exposed of the northern Channel Islands to the northwesterly winds that blow down the California Coast. Rolling hills and dune fields dominate the landscape. Two small peaks, Green Mountain and San Miguel Hill, neither of which exceeds 255 m in elevation, are located in the center of the island.

Santa Rosa and San Miguel are influenced by a Mediterranean climate with cool, wet winters and warm, dry summers (C. Smith 1952). January through March tend to be the wettest and coolest months, with rainstorms blowing across the island chain from the eastern and northern Pacific. Variable amounts of rainfall occur as these storms cross the islands. As frontal activity dies down in April and May, strong northwest winds blow in the Santa Barbara Channel, impacting areas west of Santa Cruz Island (B. Fagan 1993). Storm fronts are rare between June and September, and there is very little rain during this season. Coastal fog is common during the summer but dissipates starting in October when storm fronts again begin to hit the Southern California bight.

Compared with the mainland coast, fresh drinking water is limited on Santa Rosa and San Miguel Islands. Nonetheless, Santa Rosa Island has a number of streams and springs that provide reliable water throughout the year. The largest and most reliable creeks are found on the north coast where drainages are long and watersheds are laterally extensive (Kennett 1998). Drainages are shorter on the southwestern sides of the island, and fewer reliable streams exist. In addition to streams that flow during the wet season months, a variety of springs, seeps, and vernal pools are available seasonally on various parts of the island (Orr 1968). Only three substantial drainages are present on San Miguel Island (Kennett 1998). Small amounts of water are available in these drainages throughout the year. A number of seeps and springs occur along the north coast of the island (Power 1979). Potable water is more limited on the south side of San Miguel Island.

Other than humans, no large terrestrial animals are native to San Miguel and Santa Rosa Islands. Domesticated dogs and the small island fox (*U. littorallis*) were the largest indigenous land mammals available to humans on the islands during the Late Holocene (Fausett 1993). Plant communities on Santa Rosa and San Miguel are much less diverse relative to mainland communities, and the maritime climate on the islands tends to promote plant species more closely related to Central California (Timbrook 1993). Woodlands, grassland, and coastal sage-scrub communities provided the most economically valuable plant resources to the island Chumash (e.g., seeds, roots, and tubers). These plant communities are patchy, and their productivity varies from island to island. Geological and elevational differences, coupled with ground water availability and wind exposure, create a variety of plant microhabitats (Junak et al. 1995). Santa Rosa supports more diverse floral communities than San Miguel Island. Large stands of trees are absent on San Miguel, but coastal dune, coastal bluff, coastal sagebrush, and native grassland plant communities are interspersed between windswept sand dunes (Hochberg, Junak, and Philbrick 1980; Philbrick and Haller 1977).

The distribution and productivity of plants on the islands is highly dependent on annual rainfall (Junak et al. 1995). Native grasslands and acorn-bearing oak trees are extremely productive during wet years. In general, plants living in grassland and coastal sagebrush communities produce edible seeds, roots, and tubers from May to August. Blue dick bulbs (*Dichelostemma capitatum*) are available throughout the year, but they produce a small purple flower that makes them more visible between March and May. There are ethnohistoric records of people on the islands collecting blue dick bulbs during these months (Timbrook 1993). Acorns and pinenuts are available on Santa Rosa Island between October and December.

Similar to the terrestrial environment, the spatial composition and productivity of marine resources surrounding the northern Channel Islands are not uniform. Each island has a distinct character that results from its geographic position along the California Coast; proximity to the cold, nutrient-rich California current; and physical characteristics unique to each (Engle 1993, 1994). The primary productivity (plankton, etc.) in the Santa Barbara Channel region supporting this rich marine environment is also not uniform and can be linked directly to water temperature variations and regional oceanographic circulation. The cold California current and seasonal upwelling of nutrient-rich waters support the high primary productivity and the rich nearshore fishery in the Santa Barbara Channel. Sea surface temperatures grade from warm to cold between Anacapa and San Miguel Islands, directly affecting the biogeography of different marine organisms around the islands. The distribution and composition of algae, kelp beds, benthic biota, shellfish, and fish for each island also reflect this temperature gradient (Engel 1993, 1994; Murray, Littler, and Abbott 1980; Neushal, Clarke, and Brown 1967; Seapy and Littler 1980).

Geographic proximity to the California current also influences the distribution of sea mammals on the northern

Channel Islands. Harbor seals live and breed along the shores of all the islands (Bartholomew 1967; LeBoeuf and Bonnel 1980; Odell 1971), but the largest number occurs in the cool productive waters surrounding San Miguel Island. The high primary and secondary productivity surrounding San Miguel also supports one of the largest sea mammal colonies on the west coast of North America, with the highest concentrations of animals occurring on the western end of the island at Point Bennett (B. Stewart et al. 1993). Harbor seals (*P. vitulina*), northern fur seals (*C. ursinus*), California sea lions (*Z. californianus*), and elephant seals (*M. angustirostis*) have all established viable breading colonies at Point Bennett. Every year, large numbers of northern fur seals, California sea lions, and elephant seals visit San Miguel at various times to molt and breed (Le Boeuf and Bonnel 1980). Archaeological evidence indicates that southern fur seals (*A. townsendi*) were also common at Point Bennett at certain times during the past (Walker and Snethkamp 1984; Walker et al. 2000). Although there are seasonal fluctuations in species composition at the rookery, incredibly high animal densities occur throughout the year.

Many of the marine resources that were available to people living on the islands are present throughout the year. Mollusks are found in the rocky intertidal zone for much of the year, except for some summers when they are not edible because of "red tide," a small microorganism that makes shellfish meat poisonous. Kelp bed fish are present throughout the year, and fishing would have been impeded only during the worst of winter storms (Landberg 1965). Large numbers of schooling fish (sardines, yellowtail, bonito) enter the channel during summer and fall, sometimes venturing close to shore in search of food. This pulse was of great importance historically to the Chumash who were consummate open ocean fisherpeople (Landberg 1965). Sea mammals are also more readily available between May and August when large concentrations are found at rookeries on San Miguel Island (B. Stewart et al. 1993). Male northern fur seals and California sea lions leave the rookery in September, but the females and pups remain. Harbor seals are present throughout the year but breed in rookeries on San Miguel, Santa Rosa, and Santa Cruz Islands during the summer. Elephant seals visit rookeries on San Miguel Island to breed during January and February. Female elephant seals also revisit San Miguel Island during summer months to molt.

In addition to seasonal fluctuations in resource availability, there are significant interannual, decadal, and century scale climatic changes that impact the marine and terrestrial resource base of the northern Channel Islands. The dynamic interplay between atmospheric and oceanographic phenomena makes short-and-long term climatic patterns incredibly variable. Fluctuations in rainfall directly affect the distribution and productivity of native grasses and oak woodland (Junak et al. 1995). Changes in upwelling, or more intense influences from warm equatorial water associated with El Niño/southern oscillation (ENSO) events, periodically affect marine productivity (Ambrose et al. 1993; Dayton et al. 1992; Tegner and Dayton 1987, 1991). Atmospheric responses to ENSO events are extremely complex. In the Santa Barbara Channel area, increased precipitation often occurs during strong El Niños, because equatorial storms have a tendency to track farther north as water temperatures increase in the eastern Pacific. Weak and moderate El Niño events are not as clearly linked to increased precipitation levels in Southern California. For instance, the moderate El Niño of 1976–1977 was associated with one of the driest periods of the last 50 years (Ramage 1986).

PALEOCLIMATIC CHANGE

New palaeoclimatic data for the Santa Barbara channel area provide a proxy for fluctuations in marine and terrestrial productivity during the Late Holocene (1050 BC to present) (Kennett and Kennett 2000). The most reliable precipitation record for the Central California Coast is based on tree ring sequences (*Pseudotsugo macrocarpa*) from the transverse ranges of central Santa Barbara County and Santa Gorgonia Peak, located 75 km to the south (Larson and Michaelson 1989; Michaelson et al. 1987). Due to the absence of long-lived trees along the Central California Coast, the tree ring sequence spans only the last 1500 years. Fluctuations in precipitation across California during this period also are suggested by a number of other proxy climate records (Graumlich 1993; LaMarche 1974; Scuderi 1984; Stine 1994) that generally agree with the results obtained locally.

The new marine record, derived from a 200 m long core, is based on oxygen and carbon isotopic data for two foraminifera species, *N. pachyderma* and *G. bulloides*. The upper 17 m of the core, taken from deep sea sediments in the Santa Barbara basin just north of Santa Rosa Island (Behl and Kennett 1996; Kennett and Ingram 1995a, 1995b; Kennett and Kennett 2000), contains Holocene sediments. The last 3000 years are represented in the top 5 m of finely laminated sediment. The climate record spans the Holocene at a 50 year resolution from 12,000 to 3000 years ago and 25 year increments for the rest of the Holocene. Sea surface temperatures were inferred from the oxygen isotopic composition of *G. bulloides* (surface dwelling foraminifera) based on the experimental work of Bemis et al. (1998). This new record does not agree with the marine climate sequence produced by Pisias (1978, 1979), which archaeologists in the region have used for the last 20 years (e.g., Arnold 1987, 1991a, 1992a; Glassow, Wilcoxon, and Erlandson 1988).

The new marine record indicates that climatic conditions during the Holocene were not stable but cyclical. In general, the Early Holocene was more stable than the Late Holocene, and the last 1500 years appear to have been particularly unstable (50 year intervals). Based on current data (25 year intervals), average sea surface temperatures during the Late Holocene fluctuated ~6°C between 9 and 15°C. Three general climatic phases are discernable during this interval (Kennett and Kennett 2000). Between 1050 BC and AD 450, sea surface temperatures were relatively warm and stable, fluctuating from 11 and 15°C around the Holocene median of 12.5°C. This was followed by one of the coldest and unstable marine intervals during the Holocene (AD 450 to 1350). Surface water temperatures during this interval ranged between 9 and 13.5°C and were, on average, 1.5°C colder than the Holocene median. Water temperatures were warmer and more stable after AD 1350. The greatest climatic instability occurred between AD 350 and 650 and again between AD 950 and 1550 (Kennett 1998; Kennett and Kennett 2000). Although the impact of climatic changes on the marine resource base around the islands during this interval is not straightforward, it appears that the most productive interval for marine resources was between AD 450 and 1350 (see Kennett and Kennett 2000 for details). Warmer marine conditions, less favorable for high productivity, occurred between 1050 BC and AD 450 and again after AD 1350, with the possible exception of a short interval centered around AD 1700 (Little Ice Age).

The relationship between marine and terrestrial conditions is complex, but historical data for the California Coast suggest that these two climate systems are interrelated (Jones and Kennett 1999). Based on the available data, cool and highly variable marine conditions between AD 450 and 1350 generally correlate with greater terrestrial climatic variability and regional decreases in precipitation (Larson and Michaelson 1989; Stine 1994). Three dry intervals (<17 inches) are broadly defined based on these data: AD 500 to 800, AD 1000 to 1250, and AD 1650 to 1750. Each of these intervals is punctuated temporally by greater precipitation levels (>17 inches). Based on lake level fluctuations in the southern Sierra Nevada, Stine (1994) also defined two primary intervals of extended drought during the last 3000 years, occurring between AD 900 to 1100 and AD 1200 to 1350. Interestingly, the earliest part of Stine's (1994) first drought conflicts with Larson and Michaelson's (1989) interpretation of climatic conditions as wet in the Santa Barbara Channel region. This conflict may be due to slight chronological differences between the two records. In general, however, Stine's (1994) data correlate fairly well with the inferred dry interval between AD 1000 and 1250 in the Santa Barbara Channel record (Larson and Michaelson 1989) and with tree ring studies from elsewhere in California (Graumlich 1993). The implication is that, when marine conditions were cold and productive between AD 450 and 1350, the terrestrial environment was generally dry and less productive. Fresh water was probably limited during this interval, particularly on the islands where watersheds are small relative to the mainland. The interval between AD 800 and 1000 is interesting because it appears that both marine and terrestrial realms were more productive and less variable, favorable conditions for increases in human population on the islands.

HISTORY OF RESEARCH

The earliest archaeological interest in the northern Channel Islands was initiated by the US Coastal Survey during the 1870s (e.g., Bowers 1878; Dall 1874; Rau 1884; Yarrow 1879). Accounts of well-preserved archaeological material prompted expeditions sponsored by the Smithsonian Institution (Bowers 1878), the California Academy of Sciences (Eisen 1904), and what was then the Robert H. Lowie Museum of Anthropology at the University of California, Berkeley (Heizer and Elsasser 1956). The primary objective of these early expeditions was to obtain museum-quality skeletal and artifact collections for study and display. Artifacts and skeletal material were collected from Santa Rosa and San Miguel Islands during this time through casual surface collection or undocumented excavation of burials (Dall 1874; Heye 1921; Schumacher 1875a; Yarrow 1879). Jones' cemetery excavations on Santa Rosa Island are noteworthy owing to the field records and artifact collections made available for study at the Phoebe Hearst Museum at the University of California, Berkeley (Heizer and Elsasser 1956). Most of the burials Jones excavated date to the Late Holocene (Kennett 1998; C. King 1990).

Archaeological investigations on Santa Rosa and San Miguel Islands in the early half of this century are better documented than those of the 19th century, and extensive artifact collections are available in museums for study (Orr 1968; D. Rogers 1929). Prior to World War II, there was a flurry of archaeological activity on the outer islands (Comstock 1939; Edwards 1956; D. Rogers 1929; Von Bloeker 1939; Woodward 1940a, 1940b). In the 1920s, Rogers made several trips to Santa Rosa and San Miguel looking for intact deposits to conduct more extensive archaeological excavations (Glassow 1977). In the summer of 1927, Rogers excavated 12 sites on Santa Rosa Island, including three villages dating to the Late Holocene (SRI-60, SRI-62, and SRI-84). Rogers (1929) used material from the islands to create a cultural chronology comparable to that established for the coastal mainland (Glassow 1977). The Los Angeles Natural History Museum also sponsored several expeditions to Santa Rosa Island just before and after World War II (Comstock 1946).

The most extensive work on the outer islands during this century was conducted by Phil Orr on Santa Rosa Island between 1946 and 1967. Orr's (1968) primary interest was in the Pleistocene occupation of the island, but he was also interested in prehistoric land use during the Holocene and how settlement locations changed through time (Orr 1951, 1967, 1968). Over a 21-year period, Orr recorded 182 sites on the island and excavated 23 locations. Many of Orr's excavations focused on cemeteries associated with residential sites. His primary focus was on three large cemeteries on the north coast dating to the Early Holocene (SRI-3), the Middle Holocene (SRI-41), and the Late Holocene (SRI-2) (Erlandson 1994; Kennett 1998; Orr 1968). At SRI-2, Orr also excavated large sections of shell middens and nine different houses, exposed several house floors, and used radiocarbon dates to establish chronological controls (Orr 1968:217)

The formation of Channel Islands National Monument and ultimately Channel Islands National Park has stimulated numerous field and laboratory studies over the last 30 years. Much of the recent work done on Santa Rosa and San Miguel Islands has focused on documenting the number and type of archaeological sites through systematic archaeological surveys (e.g., Greenwood 1978a; Kennett 1996, 1998; Rozaire 1965, 1993; York 1996). Rozaire (1965) conducted several large-scale excavations on San Miguel Island (SMI-1, SMI-261, SMI-525), but most sampling was restricted to smaller scale excavation (e.g., Erlandson, et al. 1996; Erlandson, et al. 2000; Erlandson, et al. 1997; Kennett 1998; Vellanoweth, Rick, and Erlandson 2000; Walker and Snethkamp 1984). These studies were designed to maximize the amount of information obtained from small samples through detailed laboratory analyses while preserving the integrity of archaeological deposits for future research. Researchers have centered on the earliest occupants of Santa Rosa and San Miguel Islands (Erlandson 1994; Erlandson et al. 1996; Erlandson et al. 2000), the distinct ecology of the islands (Kennett 1998; Walker and Snethkamp 1984) and the emergence of sedentary villages and more complex sociopolitical organization (Kennett 1998). Radiocarbon-based cultural chronologies for Santa Rosa and San Miguel Islands have improved greatly during this period (Erlandson 1994; Erlandson et al. 1996; Kennett 1998; Walker and Snethkamp 1984).

PREHISTORIC CONTEXT

Archaeological deposits on the northern Channel Islands provide some of the best evidence for human occupation along the west coast of North America during the terminal Pleistocene and Early Holocene (9017 to 5550 BC) (Erlandson 1993b, 1994; Erlandson et al. 1996; Erlandson et al. 1997; Erlandson et al. 2000; J. Johnson et al. 2000; Orr 1968). The earliest evidence for occupation of the Santa Barbara Channel region is a terminal Pleistocene deposit in Daisy Cave on San Miguel Island (Erlandson et al. 1996) and the human skeletal material from Arlington Springs on northern Santa Rosa Island (J. Johnson et al. 2000). Daisy Cave also contains some of the best-preserved Early Holocene material on the islands (Erlandson et al. 1996). Beyond Daisy Cave, the number of sites dating to the Early Holocene is relatively small and the dominant settlement and subsistence strategies are difficult to define (Kennett 1998). Many of the earliest sites are located on the outer islands of San Miguel and Santa Rosa (Erlandson 1994; Kennett 1998). It is possible that people used the outer islands sporadically, rather than permanently, during much of this time period.

Except for Daisy Cave, where fishing appears to have been relatively intensive (Rick, Erlandson, and Vellanoweth 2001), all Early Holocene shell middens on Santa Rosa and San Miguel islands contain a limited array of shellfish and fish species. Relatively large mussels (*Mytilus californianus*) and black and red abalones are common in these early deposits. Fish and sea mammal remains are often present, but not dominant. This pattern is supported by quantitative data from midden deposits on Santa Rosa Island (Erlandson et al. 2000; Kennett 1998) and is consistent with a site on Santa Cruz Island (SCrI-109; Glassow 1993a) dating to this time. Future studies may document greater variation in diet on the northern Channel Islands during the Early Holocene.

Human settlements proliferated on Santa Rosa and San Miguel Islands after 5550 BC, and they appear to have been permanently occupied after this time (Kennett 1998). The earliest evidence for permanent settlement on the islands is SRI-3, a large cemetery located at the mouth of Arlington Canyon on the north coast of Santa Rosa Island (Erlandson 1994; Orr 1968). The dominant settlement strategy to emerge on Santa Rosa and San Miguel Islands after ~5550 BC appears to be semisedentary in nature, with periodic movement between the coast and the interior of the islands (Kennett 1998). Large coastal sites appear to have served as primary residential loci, continually occupied and reoccupied through the Middle Holocene. Substantial interior middens dating to this interval also appear to be semipermanent residential bases used periodically during the year, probably on a regular seasonal cycle. A large number of temporary camps appear to have been used to extract and process shellfish (Kennett 1998).

A small number of large coastal middens dating to the Middle Holocene have been identified on Santa Rosa and San Miguel Islands (Kennett 1998). The lateral extent of many of these sites and relatively diverse tool and faunal assemblages suggest a certain degree of sedentism, as do large cemeteries at SRI-3, SRI-4, SRI-5, and SRI-41 (Kennett 1998; C. King 1990; Orr 1968). On Santa Rosa Island these residential bases occur in large dune fields, and the laterally extensive nature of the deposits does not indicate permanent habitation but rather persistent and regular reoccupation. Residential bases were situated on long stretches of rocky coast, and the presence of large red abalone and California mussel shells indicate that this habitat was extremely productive. Proximity to fresh water was also an important determinant of settlement location. On Santa Rosa Island, the four known large residential settlement loci were established near some of the largest perennial streams on the island. Systematic surveys along the coast of the island suggest that this pattern is real and not an artifact of sampling bias (Kennett 1998). Middle Holocene sites were located on the south side of the island, but they appear to be more temporary in nature.

Large residential bases on the coast appear to be the primary settlement loci during the Middle Holocene, but all or segments of the population periodically occupied sites in the interior, probably seasonally (Kennett 1998). People may have aggregated together on the coast part of the year and then splintered into smaller family units to exploit resources in the interior of Santa Rosa Island. A large number of more temporary encampments also appear to have been occupied seasonally. Some of these temporary camps were used to extract and process large quantities of red abalone for transport to more permanent settlements on the coast or in the interior. Although inter island variability exists, these subsistence-settlement strategies appear to have dominated on Santa Rosa and San Miguel Islands throughout the Middle Holocene (5550 to 1050 BC) in the face of large-scale climatic variations.

LATE HOLOCENE SETTLEMENT PATTERNS

Significant changes in the distribution of settlements and cemeteries occurred on the northern Channel Islands after about 1050 BC. The available chronological and typological information for archaeological sites on San Miguel and Santa Rosa Islands that have been securely dated to the Late Holocene are presented in Tables 9.1 a–d (see Kennett 1998). Chronological information is based on radiocarbon dates and time-sensitive artifacts. All these sites appear to be residential bases occupied (or reoccupied) long enough to develop substantial midden deposits. Sites have been divided into four primary chronological occupation phases; 1050 BC to AD 650, AD 650 to 1150, AD 1150 to 1300, and AD 1300 to 1750. These chronological categories generally correspond to the Late Early/Early Middle period, the Late Middle period, the Middle to Late period Transition, and the Late period of Santa Barbara Channel prehistory (Arnold 1992a; Kennett 1998; C. King 1990; Erlandson and Colten 1991b). All radiocarbon dates are presented in table 9.1 as calendar years (BC/AD), with the intercept or most likely age within a one-sigma range shown in parentheses.

Compared to the Middle Holocene, one of the most striking differences in Late Holocene settlement patterns is the absence of substantial interior residences. Very few substantial interior midden deposits on Santa Rosa and San Miguel Islands have been ^{14}C dated after 1050 BC (Kennett 1998). Peterson (1994) reported "residential bases" in the interior of Santa Cruz Island dating after this time, but these appear to have been occupied for short episodes. Similar sites occur on Santa Rosa and San Miguel Islands, but they are much more ephemeral than Middle Holocene interior residences. The absence of substantial interior middens dating after 1050 BC suggests that people were becoming more tethered to coastal locations. Short-term (i.e., daily) logistical forays to collect and process plants are suggested by the presence of globular mortars at certain interior locations (Kennett 1998).

The character of coastal settlements on the outer islands from 1050 BC to AD 650 did not change substantially compared with the Middle Holocene (Kennett 1998). No domestic features, such as house depressions or floors, have been documented at coastal sites dating to this interval. Artifact assemblages at these locations are no more diverse than in middens dating to the Middle Holocene. In fact, settlements along the coast dating to between 1050 BC and AD 650 are difficult to identify because formal artifacts are rare and faunal assemblages are not diverse (Kennett 1998). Radiocarbon dating is the only way to securely identify sites dating to this interval. Consequently, we suspect that sites dating to this time are underrepresented in the archaeological record. Based on the available data, it appears that most of the coastal villages occupied during the Middle Holocene (SRI-5, SRI-40, SRI-116) continued to be used well into the Late Holocene (until AD 650). Cemeteries at some of these sites also indicate a certain degree of settlement continuity (Kennett 1998; C. King 1990). Residential middens and cemeteries were also established at other locations, however, in association with small drainages and more varied coastal habitats. Burials at interior locations began during this interval, a pattern that became much more dominant after AD 650 (Kennett 1998).

The first evidence for settled villages, comparable to that recorded by the Spanish at historic contact, dates to after AD 650 (table 9.1b). Indeed, some of these village locations appear to have been occupied continuously until historic contact (Kennett 1998). Evidence for relatively stable settlements after this time includes more substantial domestic features, large and deep midden deposits, and greater faunal and artifact diversity. This shift did not occur abruptly, but more stable settlements became predominant on Santa Rosa and San Miguel after AD 650. Compared to the Middle Holocene, village locations varied greatly with respect to proximity to rocky coastlines (Kennett 1998), but access to at least a small section of beach was an important

Table 9.1a Available data for archaeological deposits on Santa Rosa and San Miguel islands dating to between 1050 BC and AD 650

SITE #	LOCATION	RADIOCARBON (1 SIGMA)	REFERENCE
SRI-41	Cañada Verde	1230(1070)917 BC	Orr (1968)
		240(200)130 BC	Kennett (1998)
SRI-62	Johnson's Lee	200(110)10 BC	Orr (site record)
		720(530)410 BC	Kennett (1998)
SRI-96	China Camp	AD 120(190)260	Orr (site record)
			Kennett (1998)
SRI-1	Garanon	360(240)160 BC	Erlandson and Morris (1990)
SRI-2	Skull Gulch	AD 260(390)480	Orr (1968)
SRI-3	Tecolote/Arlington	930(800)410 BC	Orr (1968)
			Erlandson (1994)
SRI-4	Tecolote/Arlington	400(370)190 BC	Orr (1968)
		1160(800)260 BC	
SRI-19	Dry Canyon	1010(920)840 BC	Orr (site record)
			Kennett (1998)
SRI-28	China Camp	AD 470(570)640	Orr (site record)
			Morris (site record)
			Kennett (1998)
SRI-31	Bee Canyon	1250(1110)970 BC	Orr (site record)
			Morris (site record)
			Kennett (1998)
SRI-173	Arlington Canyon	60 BC (AD 70) AD 180	Orr (1968)
SRI-432	Ford Point	AD 240(350)440	Morris (site record)
			Kennett (1998)
SRI-587	Cañada Verde	800(760)610 BC	Kennett (1998)
SMI-488	NW San Miguel Is.	760(700)510 BC	Walker and Snethkamp (1984)
SMI-492	NW San Miguel Is.	AD 590(670)710	Walker and Snethkamp (1984)
SMI-503	NW San Miguel Is.	480(380)340 BC	Walker and Snethkamp (1984)
		730(550)430 BC	Conlee n.d.
SMI-504	NW San Miguel Is	1090(990)900 BC	Walker and Snethkamp (1984)
SMI-525	Point Bennett	1190(1070)960 BC	Walker and Snethkamp (1984)
		1260(1160)1040 BC	
SMI-528	Point Bennett	AD 450(560)640	Walker et al. (2000)
		AD 400(490)610	
		AD 490(590)660	
SMI-536?	Cuyler Harbor?	210 BC (AD 30) AD 205	Hubbs
		AD 80(290)540	Kennett (1998)

determinant of settlement location. Arnold (1991a) suggested that beaches were critical for landing plank canoes, the primary watercraft used starting about AD 500. Proximity to sandy beaches may also have been important for acquiring *Olivella biplicata*, the primary shellfish species used to make beads.

Some notable shifts in cemetery locations also occurred after AD 650. The large burial grounds that predominated during earlier periods were not used extensively after AD 650. After this time, cemeteries were associated with coastal villages and occurred more frequently at interior cave and hilltop locations, a pattern that appears to have developed some time after 1050 BC. C. King also noted interesting differences in burial patterns after this period:

> The phases and subphases so far described (6000 BC to AD 650) are mainly defined on the basis of cemeteries from which burial lots cannot be sorted into more than one time period. Beginning with phase M3 burials (after AD 650), the burials found in island cemeteries in the sample I studied are from a number of phases (calendar years added) (1990:35).

In other words, after AD 650 some cemeteries may have been used more or less continuously into the Historic period, supporting the settlement data that suggest continuity at certain locations after this time.

Although some coastal communities were relatively stable on Santa Rosa and San Miguel after AD 650, settlement at

Table 9.1b Available data for archaeological deposits on Santa Rosa and San Miguel islands dating to between AD 650 and 1150.

		DOMESTIC FEATURES		ASSOCIATED ARTIFACTS					
SITE #	SIZE (M^2)	PITS	BERMS	WB	TRP	JF	LP	RADIOCARBON (1 σ)	REFERENCE
SRI-2	50,000	p	p	p	p	p	p	AD 710(790)890	Orr (1968) Kennett (1998)
SRI-6		*	-	p	p	-	-		Orr (1968) Kennett (1998)
SRI-15	28,000	-	p	p	p	-	p	AD 790(970)1030	Orr (site record) Morris (site record) Kennett (1998)
SRI-28	9,200	-	p	p	-	-	-	AD 470(570)640	Orr (site record) Morris (site record) Kennett (1998)
SRI-31		p	p	p	p	-	-	AD 540(610)670 AD 640(690)770	Kennett (1998)
SRI-40	17,500	p	p	p	p	p	p		Orr (1968) Kennett (1998)
SRI-41	105000	-	p	-	-	p	-	AD 690(760)820	Orr (1998) King (1990) Kennett (1998)
SRI-60	12000	p	p	p	p	p	p		Heizer and Elsasser (1956) Rogers (1929) Orr (1968) Kennett (1998)
SRI-77	10000	p	p	p	-	-	-	AD 670(890)1030	Kennett (1998) Kennett (1998)
SRI-85	6612	-	p	p	p	-	-	AD 790(1040)1290	Orr (1968) Kennett (1998)
SRI-130/131	14177	p.	p	p	p	-	-	AD 640(690)770 AD 680(730)810	Orr (site record) Morris (site record) Kennett (1998)
SRI-116		-	-	p	p	-	-		Kennett (1998)
SMI-468	5250	-	p	p	p	-	-	AD 1050(1160)1250	Greenwood (site record) Kennett (1998)
SMI-503/504	20425	-	-	p	-	p	p	AD 710(810)920	Walker and Snethkamp (1984) Conlee n.d. Bowser (1993)
SMI-510	65,000	-	-	-	-	p	-	AD 700(770)850	Walker and Snethkamp (1984)
SMI-525	54,000	-	-	-	-	-	-	AD 670(730)820	Walker and Snethkamp (1984) Bowser (1993)
SMI-528	55,000	-	-	p	-	p	p	AD 690(770)860 AD 490(590)660	Walker et al. (2000) Kennett (1998)

WB=Wall Bead; TRP=Trapezoidal Microblade; JF=J-Shaped Fishhook; LP=Leaf-Shaped Arrow Point; *Identified by Orr (1968), but not visible today.

some locations appears to have been disrupted between AD 1150 and 1300 (table 9.1c) (Erlandson, Kennett, and Walker 1997; Kennett 1998). A limited number of villages were definitely inhabited during this interval, but the outer islands seem to have been partially abandoned. Arnold (1991a) noted a similar pattern on Santa Cruz Island and argued that some sites ^{14}C dated to this period could have been occupied intermittently. Paleoclimatic reconstructions for the region suggest that the years leading up to this interval were particularly dry and severe droughts could have occurred more frequently, possibly accounting for the hiatus in settlement. Indeed, the most stable coastal communities were positioned on the largest drainages on San Miguel and Santa Rosa Islands (Kennett 1998).

Sedentary communities solidified on Santa Rosa and San Miguel Islands after this apparent settlement disruption (table 9.1d). Substantial coastal villages were evenly spaced around these islands between AD 1300 and 1750. Many of them were occupied between AD 650 and 1150, then abandoned between AD 1150 and 1300, and reoccupied. Most villages were established near perennial streams, but this does not appear to be a necessary determinant of location (Kennett 1998). Beach access also appears to have been important for some communities. Residential middens in the interior portions of the islands are rare, but burials in caves and on hilltops became much more common, at least on Santa Rosa Island (Kennett 1998). Shell lenses exposed in river cuts and in small rockshelters dating to this period

Table 9.1c Archaeological deposits on Santa Rosa and San Miguel Islands that clearly date to between AD 1150 and 1300

SITE #	LOCATION	RADIOCARBON DATES	CLOSEST PERENNIAL STREAM	REFERENCE
SRI-2	Skull Gulch	AD 1300(1340)1420 AD 1220(1300)1400	Tecolote	Orr (1968) Kennett (1998)
SRI-15	Abalone Point	AD 1300(1330)1410 AD 1190(1280)1320	Garanon Canyon	Orr (site record) Morris (site reocrd) Kennett (1998)
SRI-97	China Camp	AD 1130(1220)1280 AD 1190(1250)1290 AD 1160(1230)1290	unnamed	Morris (site record) Kennett (1998)
SRI-85	Old Ranch Canyon (mouth)	AD 1300(1330)1410 AD 1270(1320)1400	Old Ranch Canyon	Morris (site record) Kennett (1998)
SMI-468	Otter Canyon	AD 1310(1350)1420 AD 1070(1190)1270 AD 1050(1160)1250	Otter Canyon	Rozaire (site record) Greenwood (site record) Kennett (1998)

Table 9.1d Archaeological sites on Santa Rosa and San Miguel islands dating to between AD 1300 and 1750

SITE #	SIZE (M²)	FEATURES		ASSOCIATED ARTIFACTS					RADIOCARBON	PRIMARY REFERENCES
		PITS	BERMS	TM	CC	LB	CF	CB		
SRI-2 Skull Gulch	50,000	p	p	p	p	p	p	p	AD 1490(1560)1650 AD 1440(1480)1640 AD 1300(1340)1420 AD 1220(1300)1400	Orr (1968) King (1990) Kennett (1998)
SRI-15 Abalone Point	28,000	p	p	p	p	-	p	p	AD 1400(1440)1480 AD 1300(1330)1410 AD 1190(1280)1320	Orr (site record) Morris (site record) Kennett (1998)
SRI-40 Cañada Verde	17,500	p	p	p	p	p	p	p	AD 1660(1690)1800	Jones (1901) Orr (1968) Kennett (1998)
SRI-60 Beecher's Bay	6000	p	p	p	p	p	p	p	AD 1650(1690)1800	Jones (1901) Rogers (1929) Kennett (1998)
SRI-62 Johnson's Lee	62,500	p	-	p	p	p	p	p		Rogers (1929) Orr (1968)
SRI-84 Old Ranch Canyon	12,240	p	p	p	p	p	p	p		Orr (site record) Morris (site record) Kennett (1998)
SRI-85 Old Ranch Canyon	1,875	-	p	p	p	-	p	-	AD 1450(1490)1540 AD 1300(1330)1410 AD 1270(1320)1400	Orr (1968) Kennett (1998)
SRI-87 Old Ranch Canyon	24,000	-	-	p	p	p	p	p		Orr (site record) Morris (site record) Kennett (1998)
SRI-88 Old Ranch Canyon	625	-	-	p	p	-	-	-		Orr (site record) Morris (site record) Kennett (1998)
SRI-97 China Camp	9,100	p	p	p	p	p	-	-	AD 1680(1720)1850	Orr (1968) Morris (site record) Kennett (1998)
SRI-98 China Camp	8,840	p	p	p	p	-	-	-		Orr (1968) Morris (site record) Kennett (1998)
SRI-130/131 Jolla Vieja	1,200	p	p	p	p	-	-	-		Orr (site record) Morris (site record) Kennett (1998)
SRI-427 San Augustine	34,000	p	p	p	p	p	-	-		Morris (site record) Kennett (1998)
SRI-432 Ford Point	6,600	p	p	p	p	-	-	-		Morris (site record) Kennett (1998)
SMI-161/163 Cuyler Harbor	4,000	p	p	p	p	-	-	-	AD 1490(1640)1660	Rozaire (site record) Greenwood (site record) Kennett (1998)
SMI-470 Otter Point	7373	p	p	p	p	p	p	-	AD 1710(1830)1950 AD 1700(1830)1950	Rozaire (site record) Greenwood (site record) Kennett (1998)
SMI-602 Point Bennett		p	-	p	p	p	p	p	AD 1420(1460)1510 AD 1430(1460)1510 AD 1560(1660)1690 AD 1710(1840)1950	Kennett (site record) Walker et al. (2000) Kennett (1998)

Notes: TM=Triangular Microblade (w/retouch), CC=Olivella Callus-Cup Bead, LB=Olivella Lipped Bead, CF=Circular Fishhook (grooved shank), CB=Concave Base Arrow Point suggest temporary rather than permanent occupation of the interior (Kennett 1996; York 1996).

LATE HOLOCENE SUBSISTENCE STRATEGIES

Radiocarbon dated column samples from residential middens on San Miguel and Santa Rosa Islands indicate that significant dietary shifts and changes in subsistence took place between 1050 BC and AD 1750 (table 9.2; Kennett 1998). Though these column samples are small (25 x 25 x 10 cm), they present the best available evidence for long-term stability and change in subsistence strategies on the islands. We focus on the relative importance of fish and shellfish because bird bone is generally scarce in these deposits, and the sea mammal remains may be either over or under represented. Recent larger scale excavations on the west end of San Miguel Island near Point Bennett suggest that the exploitation of sea mammals increased after AD 500 (Walker et al. 2000). Settlement focus on the coast in the Late Holocene (see above) also suggests that plant foods decreased in importance or that islanders were obtaining these foods from the mainland.

During the Middle Holocene, the available data suggest that shellfish were the dominant source of meat for many people living on Santa Rosa and San Miguel Islands (Kennett 1998). Column sample data indicate that shellfish remained a prominent meat source during the Late Holocene (table 9.2), but its importance relative to fish decreased through time. Shellfish continued to be a dominant meat source at some locations between 1050 BC and AD 650, indicating some continuity with Middle Holocene subsistence strategies. Compared with most Middle Holocene faunal assemblages, however, the diversity of shellfish types in middens dating after 1050 BC is much greater and the average size of most important species (abalone and mussel) tends to be much smaller. It appears that after 1050 BC people were spending more time foraging for shellfish in the intertidal zone for less return.

It is in this context that some individuals appear to have experimented with more sophisticated fishing technology and going offshore to catch fish. Fish bone is relatively uncommon in most Middle Holocene deposits, and fishing technology was not sophisticated (Glassow 1980; Kennett 1998). After about 1050 BC, fish and fishing became generally more important to people living on the islands, especially after about AD 650 (Kennett 1998). The column sample data in table 9.2 show that the dietary importance of shellfish and fish varied greatly between 1050 BC and AD 650. At some locations, however, fish became a much more important dietary component; fish and fishing steadily increased on Santa Cruz Island (Glassow 1980, 1993a). It was during this interval that more sophisticated fishing technology was developed regionally, including the J-shaped fishhook (Erlandson and Rick, chapter 10, this volume; Glassow 1996c) and the ocean going plank canoe that augmented existing types of watercraft (Arnold 1995a; Davenport, Timbrook and Johnson 1993; Hudson, Timbrook, and Rempe 1978; C. King 1990).

These column sample data also suggest that after AD 950 fish were consistently the most dominant meat source. Other studies corroborate the importance of fish after AD 1300 (Glassow 1980, 1993a; Bowser 1993; Colten 1993, 1995; Pletka 1996), and the Santa Rosa Island data suggest that the importance of fish and fishing increased substantially between AD 950 and 1300 (Kennett 1998; Kennett and Kennett 2000). Increased importance of fishing is supported by an exponential increase in fish bone density in middens dating to this interval (Kennett and Kennett 2000).

TECHNOLOGY AND TRADE

The diversity of formal artifacts increased markedly in residential middens on Santa Rosa and San Miguel Islands after about AD 650 (Kennett 1998). There is also more evidence for intense production of certain types of trade items. Here, we focus on the production of beads, microblades, and ground stone artifacts (mortars and pestles), the most visible specialized industries on the northern Channel Islands.

Various bead types were produced on the northern Channel Islands during the Holocene, but the most intensive production of beads for trade occurred between AD 1300 and 1750 (Arnold 1987; C. King 1990). These highly standardized beads were produced from the callus portion of the *Olivella* shell, a small gastropod found along sandy beaches on the islands. Strands of beads served as a medium of exchange, and most of the beads found throughout the Santa Barbara Channel area were produced on the northern Channel Islands (C. King 1990). Sites on certain parts of the islands are literally covered with *Olivella* bead manufacturing detritus.

The production of callus-cup beads varied spatially on the islands (table 9.3, figure 9.2a). The manufacturing workshops at large coastal villages and smaller sites in the interior appear to be more logistical types of encampments (Kennett 1998; R. Peterson 1994). Bladelet manufacturing has even been identified on the small island of Anacapa during this period (Rozaire 1993). Arnold (1987; Arnold and Munns 1994) documented the most intensive production of callus-cup beads at sites on the west end of Santa Cruz Island. Large-scale bead manufacturing also occured on the east end of Santa Rosa Island (Kennett 1998), where bead making detritus is particularly concentrated at several sites at the mouth of Old Ranch Canyon (SRI-84, SRI-85, SRI-87, SRI-88).

Although the most intensive bead manufacturing occurred between AD 1300 and 1750, *Olivella* bead making

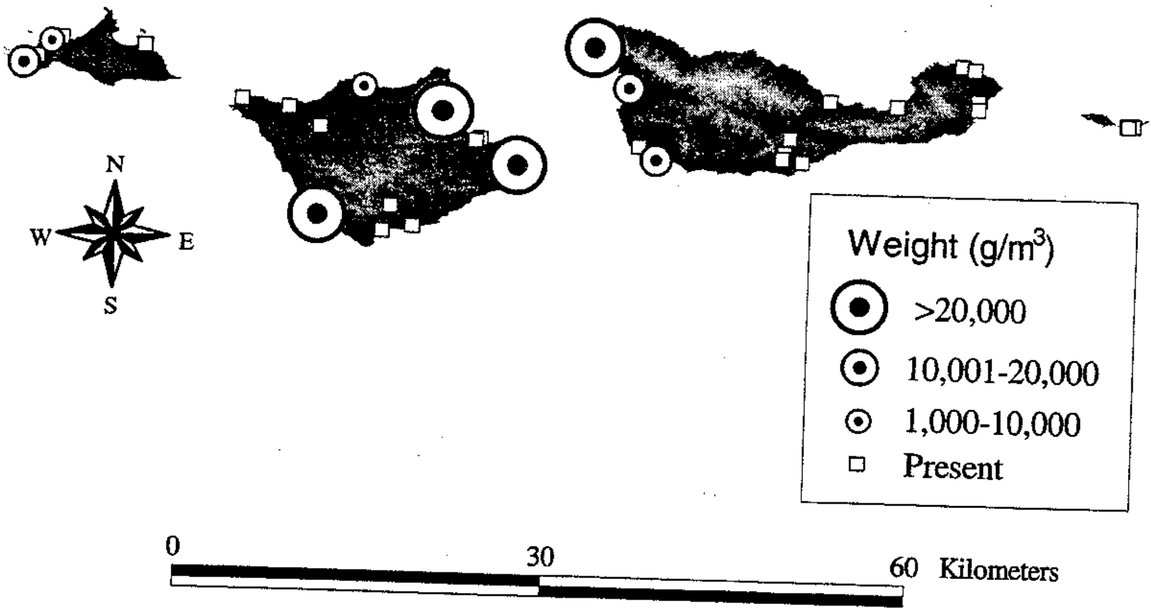

Figure 9.2a Distribution and intensity of *Olivella* bead manufacturing at sites on the Northern Channel Islands, AD 1300-1750. White squares are locations where bead-making detritus was found associated with prepared triangular microblades.

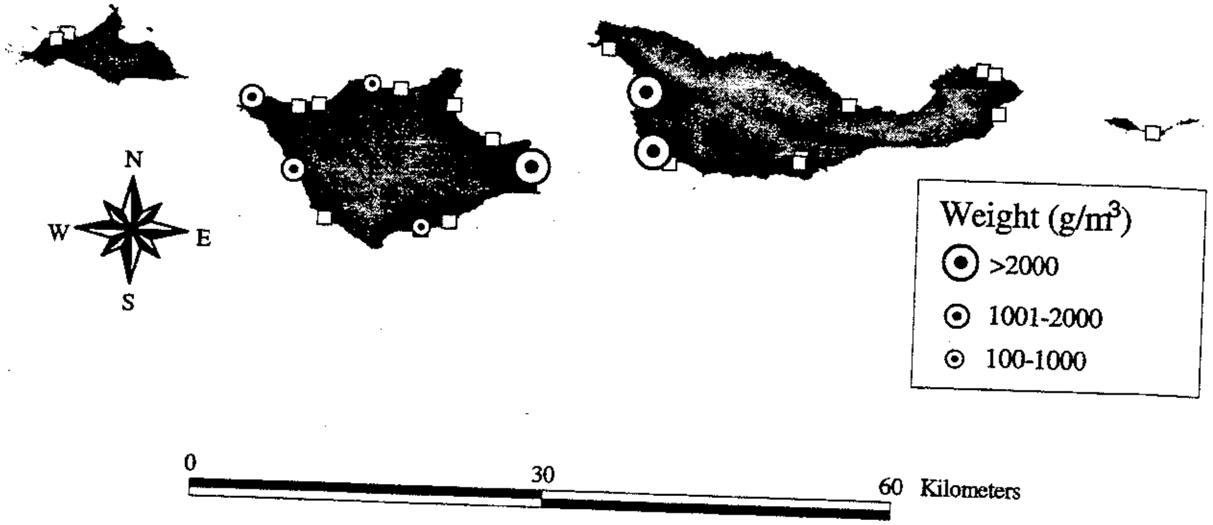

Figure 9.2b Distribution and intensity of *Olivella* bead manufacturing at sites on the Northern Channel Islands, AD 650-1300. White squares are locations where bead-making detritus was found associated with trapezoidal microblades.

increased at some locations between AD 650 and 1300, at least compared to the rest of the Holocene (table 9.3, figure 9.2b). We calculated *Olivella* bead detritus densities for all the ^{14}C dated column samples on Santa Rosa and San Miguel Islands (Kennett 1998; Walker and Snethkamp 1984). Little evidence for bead manufacturing exists in levels dating to the Middle Holocene, although finished beads found at sites and in burial lots show beads were being produced (C. King 1990). Trace amounts of *Olivella* bead detritus were found in column samples dating between 1050 BC and AD 650. A slight increase is evident between AD 650 and 1150, followed by a dramatic increase in production after AD 1150. The highest densities of *Olivella* detritus between AD 650 and 1300 are at sites on western Santa Cruz (Arnold and Munns 1994). This production increase may be more pronounced when additional levels dating to this interval are examined from eastern Santa Rosa and western Santa Cruz.

The slight increase in bead manufacturing between AD 650 and 1150 is contemporary with the first evidence for microblade production on eastern Santa Cruz Island (Arnold

Table 9.2 Faunal data (fish and shellfish) from radiocarbon dated column samples from Santa Rosa and San Miguel islands

NO.	SITE #	PROVENIENCE	AGE (1 σ)	FISH			SHELLFISH			REFERENCE
				WEIGHT	MEAT	%	WEIGHT	MEAT	%	
1	CA-SRI-31	Unit 2, 10-25	1250(1110)970 BC	57.10	1582	77.82	1358	450.90	22.18	Kennett (1998)
2	CA-SMI-525	Prof. D, Strat. 27, 227-235cm	1190(1060)960 BC	47.00	1301.90	86.59	607.30	201.62	13.41	Walker and Snethkamp (1984)
3	CA-SMI-504	Prof. N, Strat. 12, 200-230cm	1090(980)900 BC	0.00	0.00	0.00	55.30	18.36	100.00	Walker and Snethkamp (1984)
4	CA-SRI-19	Unit 1, 10-20cm	1010(920)840 BC	6.23	172.57	54.82	428.41	142.23	45.18	Kennett (1998)
5	CA-SMI-488	Profile N, Strat. 4, 45-60cm	760(690)510 BC	37.00	1024.90	93.57	212.00	70.38	6.43	Walker and Snethkamp (1984)
6	CA-SMI-503	Profile N, Strat. 8, 30-52cm	730(540)420 BC	125	3462.25	96.65	361.70	120.08	3.35	Walker and Snethkamp (1984)
7	CA-SRI-62	Unit 1, 40-50cm	720(530)410 BC	8.20	227.14	43.88	875.10	290.53	56.12	Kennett (1998)
8	CA-SRI-41	Unit 1, 20-30cm	340(200)130 BC	69.46	1924.04	81.3454	1329.3	441.23	18.65	Kennett (1998)
9	CA-SRI-62	Unit 1, 20-30cm	200(110)10 BC	7.50	181.50	41.21	779.99	258.96	58.79	Kennett (1998)
10	CA-SRI-96	Unit 1, 0-10cm	AD 120(190)260	80.90	2240.93	90.78	685.94	227.73	9.22	Kennett (1998)
11	CA-SRI-432	Unit 1, 0-10cm	AD 250(360)450	13.20	365.64	62.06	673.23	223.51	37.94	Kennett (1998)
12	CA-SRI-31	Unit 1, 28-40cm	AD 540(610)670	65.96	1827.09	74.99	1835.02	609.22	25.01	Kennett (1998)
13	CA-SMI-492	Prof. N, Strat. 9, 48-64cm	AD 590(670)700	300.00	8310.00	94.89	1349.30	447.97	5.1150	Walker and Snethkamp (1984)
14	CA-SRI-31	Unit 1, 12-20cm	AD 640(690)790	27.72	755.92	69.55	996.98	331.00	30.45	Kennett (1998)
15	CA-SRI-130	Unit 1, 7-20cm	AD 640(690)770	11.60	321.32	36.59	1677.60	556.96	63.41	Kennett (1998)
16	CA-SRI-130	Unit 1, 40-44cm	AD 680(730)810	6.25	173.12	76.70	158.45	52.60	23.30	Kennett (1998)
17	CA-SMI-525	Prof. D, Strat. 9, 70-79cm	AD 680(730)820	196	5429.20	97.68	389.80	129.11	2.32	Walker and Snethkamp (1984)
18	CA-SRI-41	Unit 1, 0-10cm	AD 690(760)820	18.79	520.48	60.65	1017.20	337.71	39.35	Kennett (1998)
19	CA-SMI-510	Prof. N, Strat. 6, 89-97cm	AD 700(770)850	38.00	1052.60	66.49	1598.00	530.54	33.51	Walker and Snethkamp (1984)
20	CA-SRI-15	Unit 1, 126-135cm	AD 780(890)1000	21.23	588.07	87.84	245.28	81.43	12.16	Kennett (1998)
21	CA-SRI-15	Unit 1, 117-126cm	AD 880(970)1030	74.40	2061.40	94.89	333.97	110.90	5.11	Kennett (1998)
22	CA-SRI-15	Unit 1, 80-95cm	AD 880(970)1030	124.00	3443.50	90.19	1127.60	374.40	9.81	Kennett (1998)
23	CA-SRI-15	Unit 1, 65-75cm	AD 880(970)1030	165.10	4573.27	89.66	1588.61	527.41	10.34	Kennett (1998)
24	CA-SRI-15	Unit 1, 19-30cm	AD 1140(1230)1270	80.70	2234.70	94.33	404.51	134.30	5.67	Kennett (1998)
25	CA-SRI-97	Unit 1, 60-70cm	AD 1200(1250)1300	78.40	2172.30	90.10	718.90	238.70	9.90	Kennett (1998)
26	CA-SRI-97	Unit 1, 40-50cm	AD 1200(1230)1290	88.60	2454.20	92.15	629.80	209.10	7.85	Kennett (1998)
27	CA-SRI-15	Unit 1, 0-10cm	AD 1190(1280)1320	75.86	2101.32	81.45	1414.17	478.47	18.55	Kennett (1998)
28	CA-SRI-85	Unit 1, 70-80cm	AD 1300(1330)1410	115.92	3210.98	88.55	1250.91	415.30	11.45	Kennett (1998)
29	CA-SRI-15	Unit 2, 40-50cm	AD 1300(1340)1410	81.80	2265.00	99.29	509.00	16.29	0.71	Kennett (1998)
30	CA-SMI-525	Prof. D, Strat. 3, 30-37cm	AD 1340(1410)1450	31.00	858.70	66.49	1303.30	432.69	33.51	Walker and Snethkamp (1984)
31	CA-SMI-485	Prof. S, 10-20cm	AD 1380(1440)1490	103.00	2853.10	93.20	626.60	208.03	6.80	Walker and Snethkamp (1984)
32	CA-SRI-15	Unit 2, 20-29cm	AD 1410(1450)1480	79.20	2194.00	99.01	682.90	21.85	0.99	Kennett (1998)
33	CA-SMI-602	Unit 5, 40-50cm	AD 1430(1460)1510	137.29	3802.93	94.50	667.18	221.50	5.50	Jones et al. (1998)
34	CA-SMI-602	Unit 5, 0-10cm	AD 1420(1460)1510	57.87	1603.00	96.71	164.12	54.49	3.29	Jones et al. (1998)
35	CA-SRI-85	Unit 1, 0-10cm	AD 1450(1490)1540	40.84	1131.27	86.08	551.20	183.00	13.92	Kennett (1998)
36	CA-SMI-602	Unit 2, Strat. B	AD 1560(1660)1690	16.73	463.42	89.53	163.20	54.18	10.47	Jones et al. (1998)
37	CA-SRI-60	Unit 1, 40-50cm	AD 1660(1690)1800	35.37	979.75	64.02	1658.22	550.53	35.98	Kennett (1998)
38	CA-SRI-40	Unit 1, 60-70cm	AD 1660(1690)1800	347.81	9634.34	90.35	3099.41	1029.00	9.65	Kennett (1998)
39	CA-SRI-97	Unit 1, 10-26cm	AD 1680(1710)1850	414.40	11478.00	98.22	626.18	207.89	1.78	Kennett (1998)
40	CA-SMI-602	Unit 2, Strat. A	AD 1710(1840)1950	43.82	1213.81	95.21	183.97	61.08	4.79	Jones et al. (1998)

See Kennett (1998) for meat weight multipliers.

Table 9.3 *Olivella* bead manufacturing densities in radiocarbon dated (1 σ) column samples from the Northern Channel Islands

#	SITE #	PROVENIENCE	AGE RANGE	OLIVELLA DETRITUS (G/M³)	REFERENCE
1	SRI-31	Unit 2, 10-25	1250(1110)970 BC	0	Kennett (1998)
2	SRI-19	Unit 1, 10-20cm	1010(920)840 BC	194	Kennett (1998)
3	SMI-488	Profile N, 0-10 cm	760(700)510 BC	275	Walker and Snethkamp (1984)
4	SRI-62	Unit 1, 40-50cm	720(530)410 BC	54	Kennett (1998)
5	SMI-503	Profile N, 0-35 cm	730(550)430 BC	375	Walker and Snethkamp (1984)
6	SRI-41	Unit 1, 20-30cm	340(200)130 BC	368	Kennett (1998)
7	SRI-62	Unit 1, 20-30cm	200(110)10 BC	454	Kennett (1998)
8	SRI-96	Unit 1, 0-10cm	AD 120(190)260	373	Kennett (1998)
9	SCrI-474	Unit 1S,11W, 70-75cm	(M2) AD 160-660	572	Arnold and Munns (1994)
10	SCrI-474	Unit 1S, 11W, 55-60cm	(M3) AD 660-980	1970	Arnold and Munns (1994)
11	SRI-31	Unit 1, 28-40cm	AD 540(610)670	507	Kennett (1998)
12	SRI-130	Unit 1, 7-20cm	AD 640(690)770	148	Kennett (1998)
13	SRI-130	Unit 1, 40-44cm	AD 680(730)810	417	Kennett (1998)
14	SRI-41	Unit 1, 0-10cm	AD 690(760)820	432	Kennett (1998)
15	SCrI-191	Unit 35S, 3W, 75-80	(M4) AD 980-1170	778	Arnold and Munns (1994)
16	SRI-31	Unit 1, 12-20cm	AD 640(690)790	1068	Kennett (1998)
17	SRI-15	Unit 1, 0-10cm	AD 1190(1280)1320	1402	Kennett (1998)
18	SCrI-474	Unit 1S, 11W, 10-15cm	(MLT) AD 1150-1300	6176	Arnold and Munns (1994)
19	SCrI-474	Unit 1S, 11W, 35-40cm	(MLT) AD 1150-1300	6176	Arnold and Munns (1994)
20	SCrI-191	Unit 35S, 3W	(MLT) AD 1150-1300	3000	Arnold and Munns (1994)
21	SRI-85	Unit 1, 70-80cm	AD 1300(1330)1410	6907	Kennett (1998)
22	SCrI-330	Unit 3S, 28W, 105-110cm	(L) AD 1300-1750	8428	Arnold and Munns (1994)
23	SCrI-191	Unit 35S, 3W, 35-40cm	(L) AD 1300-1750	11836	Arnold and Munns (1994)
24	SCrI-330	Unit 3S, 28W, 65-70cm	(L) AD 1300-1750	23036	Arnold and Munns (1994)
25	SCrI-330	Unit 3S, 28W, 40-45cm	(L) AD 1300-1750	13702	Arnold and Munns (1994)
26	SCrI-192	Unit 2N, 23E, 65-70	(L) AD 1300-1750	15794	Arnold and Munns (1994)
27	SCrI-192	Unit 2N, 23E, 40-45cm	(L) AD 1300-1750	14942	Arnold and Munns (1994)
28	SMI-485	Profile S, 0-40cm	AD 1380(1440)1490	5100	Walker and Snethkamp (1984)
29	SMI-602	Unit 5, 40-50cm	AD 1430(1460)1510	3576	Walker and Snethkamp (1984)
30	SMI-602	Unit 5, 0-10cm	AD 1420(1460)1510	3741	Walker and Snethkamp (1984)
31	SRI-85	Unit 1, 0-10cm	AD 1450(1490)1540	44118	Kennett (1998)
32	SMI-602	Unit 2, Strat. B	AD 1560(1660)1690	10425	Walker and Snethkamp (1984)
33	SRI-60	Unit 1, 40-50cm	AD 1660(1690)1800	33088	Kennett (1998)
34	SRI-40	Unit 1, 60-70cm	AD 1660(1690)1800	1701	Kennett (1998)
35	SRI-97	Unit 1, 10-26cm	AD 1680(1710)1850	48700	Kennett (1998)
36	SMI-602	Unit 2, Strat. A	AD 1710(1840)1950	11875	Walker and Snethkamp (1984)

1987, 1990b; Kennett 1998). On the northern Channel Islands, microblades were fashioned into drills for perforating shell beads, an integral part of the industry. Three types of microblades were produced on the islands: trapezoidal, triangular without retouch, and triangular with retouch (figure 9.3). Trapezoidal microblades were dominant between about AD 900 and 1150, while triangular microblades with retouch dominated after AD 1150 (Arnold 1987, 1990b). Triangular microblades without retouch are associated with assemblages dominated by both of these forms and appear to be temporally undiagnostic (Arnold 1987).

Microblade production always appears to have been focused on the east end of Santa Cruz Island, where quality chert outcrops and subsurface chert beds occur naturally (Arnold 1987; Kennett 1998). Smaller concentrations of chert are present elsewhere on the islands, and there is some evidence that these sources were used to produce microblades during this period (Erlandson et al. 1997). It is unlikely, however, that production on other parts of the northern Channel Islands ever reached the scale visible on eastern Santa Cruz Island. Microblade cores are rare at archaeological sites on Santa Rosa and San Miguel, but trapezoidal microblades and drills are common at coastal village sites on these islands, and triangular forms are dominant after AD 1300 (Kennett 1998). Microblades and drills are always associated with *Olivella* bead manufacturing detritus.

Mortar and pestle production has been documented at 16 sites on San Miguel Island (Conlee 2000; Rozaire 1993; Walker and Snethkamp 1984). Radiocarbon dates on levels with small amounts of manufacturing debris suggest that the industry extends back to at least 550 BC but was limited until about AD 650 (Conlee 2000). Based on the density of manufacturing debris, mortar and pestle production appears to have been most intense on San Miguel Island between about

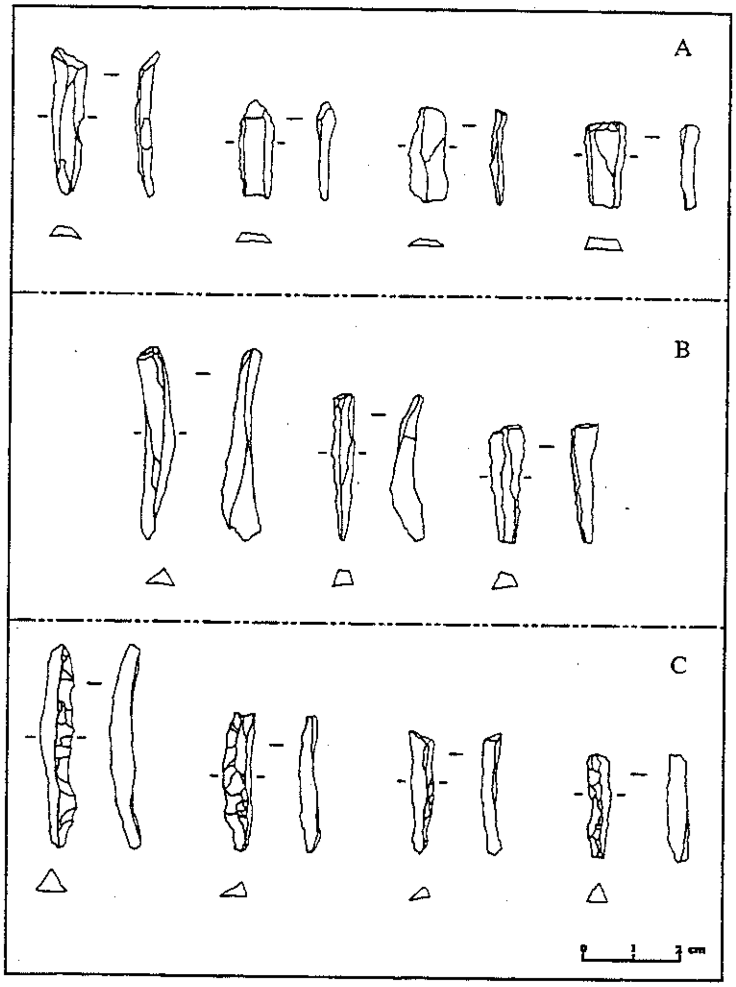

Figure 9.3 Three microblade types manufactured and used on the Northern Channel Islands in the Late Holocene: (A) trapezoidal, used primarily from AD 900 to 1150; (B) triangular without retouch, produced between AD 900 and 1750; and (C) prepared triangular microblades (note retouch) made between AD 1300 and 1750. *Drawings by J. Toohey, layout by C. Kantner*

AD 650 and 950, continuing after this time at a much lower level.

Ground stone quarrying and production activities were centered at SMI-503 and SMI-504, adjacent sites on the northwest coast of San Miguel Island. These sites are located directly above an Eocene conglomerate formation exposed in the sea cliff (Bremner 1932; Weaver and Doerner 1969). Spherical boulders of volcanic porphyry from this formation, graded from gray to red, provided the raw material for mortar and pestle manufacturing. Chipping waste litters the surface of these sites, along with mortars and pestles in all stages of production (Walker and Snethkamp 1984). The upper stratum at SMI-504 dates between about AD 700 and 950 and contains the highest densities of manufacturing debris relative to earlier and later strata (Conlee 2000). Habitation debris at these locations suggests at least temporary occupation during mining and quarrying activities. Levels at four other sites in the vicinity of SMI-503 also have high concentrations of chipping debris that date to this same interval. The intense production of ground stone on San Miguel Island is somewhat paradoxical given the current lack of oak trees and other plant foods. Mortars and pestles in the Santa Barbara Channel area were used primarily to grind acorns (Glassow 1980). Other California groups used them to process rodents, fish, insects, and large mammals, but on San Miguel Island they were probably manufactured to process plant foods (Conlee 2000). Although plant foods were probably more plentiful than today, it seems likely that mortars and pestles were being manufactured for export or that acorns (or other plant foods) were being imported to the islands. Regardless, increased production of ground stone represents an increase in intervillage exchange and integration among groups in the region.

SUMMARY AND DISCUSSION

Major changes in settlement, subsistence, and socioeconomic organization are evident in the Late Holocene archaeological record for Santa Rosa and San Miguel Islands. Although a great deal of local variability is evident, the dominant settlement and subsistence strategies employed by islanders changed after 1050 BC. The primary coastal settlements occupied during the Middle Holocene continued to be used into the Late Holocene. Many Middle Holocene cemeteries also have burial lots that date between 1050 BC and AD 650, suggesting a certain degree of continuity with Middle Holocene settlement practices. Other residential bases were established, however, in association with more diverse coastal habitats and secondary drainages. The most economically valuable species of shellfish (mussel and abalone) are smaller in deposits dating after 1050 BC, and shellfish assemblages in general are more diverse compared to the Middle Holocene. Fish bone is slightly more common in midden deposits between 1050 BC and AD 650, but formal tools are rare, and it is likely that these types of sites are underrepresented archaeologically.

The apparent absence of substantial residential middens in the interior of the islands after 1050 BC suggests a shift in focus towards marine resources (shellfish and fish). Globular mortars found at some interior locations provide evidence that plant resources were being collected logistically from coastal residences. Geographic positioning, combined with midden constituent data, indicates that shellfish exploitation remained a prominent activity. However, fishing became more important at certain locations during the Late Holocene, and more sophisticated fishing technology was developed regionally.

Changes in subsistence and settlement on Santa Rosa and San Miguel Islands between 1050 BC and AD 650 did not occur abruptly. Larger numbers of residential bases on the coast suggest that population levels on the islands increased compared to the Middle Holocene. The absence of substantial interior middens indicates that people became more tethered to coastal locations. No domestic features are evident at coastal locations, suggesting a certain degree of residential mobility. Shellfish harvesting profiles suggest that people occupied a series of coastal villages in different locations throughout the year, probably within a more restricted range than previously (Kennett 1998). A decrease in mussel and abalone size and an increase in shellfish diversity indicate that people were working harder for less, while others used alternative strategies, such as intensified fishing, to supplement their diets. Changes in intertidal resources were probably related to a combination of unfavorable marine conditions and population-dependent increases in human predation.

More sedentary village communities appear to have emerged on the northern Channel Islands between AD 650 and 1150. These villages were distributed evenly around the coastlines of the islands, many associated with perennial streams and relatively long sections of beach. Village locations varied greatly but tended to be atop sea cliffs or at headlands. Domestic features, particularly faint house depressions and berms, are evident at many of these villages. The extent and depth of these middens, coupled with the presence of domestic features and diverse faunal and artifact assemblages, suggest that these communities were relatively stable. Faunal and artifact assemblages are more diverse compared with earlier sites, and fish remains increased exponentially at many of these locations. Shellfish harvesting profiles are also comparable to contact period deposits, suggesting a certain degree of settlement stability (Kennett 1998). The shift towards more sedentary living did not occur abruptly, nor does the timing appear to be the same on all the islands. Rather, more stable settlements became predominant on the outer islands after AD 650.

Arnold (1991a) suggested that beaches were critical for landing plank canoes, the primary watercraft used in the Santa Barbara Channel region after AD 500 (Arnold 1995a; Davenport, Timbrook, and Johnson 1993). This view is interesting given the exponential increase in fish bone at coastal villages dating to this period and the clear and temporally consistent dietary importance of fish. New paleoclimatic data for the region suggest that exponential increases in fishing occurred during an interval when marine productivity was relatively high and terrestrial productivity was generally low (Kennett 1998; Kennett and Kennett 2000). Therefore, intense use of marine resources may be related, at least in part, to decreasing productivity of the terrestrial environment.

The close proximity of settlements to sandy beaches may also be related to acquiring the *Olivella* shells found in these habitats. Bead manufacturing intensified at certain locations on eastern Santa Rosa and western Santa Cruz Islands after AD 650, about the same time that the production of trapezoidal microblades became more visible on the east end of Santa Cruz Island and mortar and pestle manufacturing intensified on San Miguel Island (Arnold 1987; Conlee 2000; Kennett 1998; Walker and Snethkamp 1984). Increased production of nonfood trade items after AD 650 suggests that people began to establish more exchange relationships with inhabitants of other island and mainland villages. Trapezoidal microblades and drills from sources on eastern Santa Cruz Island are found at villages on western Santa Cruz and Santa Rosa (Arnold 1987; Kennett 1998). Increased production of mortars and pestles suggests these items were being exported, that plant foods were being imported, or both (Conlee 2000). This production level constitutes more evidence that exchange relationships among individuals were becoming more important during this interval and possibly reflects increased integration among communities and greater sociopolitical complexity.

The emergence of more sedentary villages, intensified fishing, and increased production of nonfood trade items coincides with increases in territoriality. Greater territorial behavior is suggested by the even distribution of coastal villages around Santa Rosa and San Miguel after AD 650 and the lack of intervisibility between these communities (Kennett 1998). This situation is similar to the historically known settlement distribution; indeed, some of these locations were occupied continuously until the Historic period. The strategic position of these communities afforded commanding views along the coast and out to sea.

Settled village living, intensive fishing, and production of nonfood trade items that emerged between AD 650 and 1150 became dominant strategies on the northern Channel Islands after AD 1300. Following severe settlement disruption between about AD 1150 and 1300. Arnold (1992a) first documented such a disruption on Santa Cruz Island and referred to this interval as the Transitional period. Many sites on the island appear to have been abandoned during this period (Arnold 1991a). A similar pattern is evident on San Miguel and Santa Rosa Islands (Erlandson, Kennett, and Walker 1997; Kennett 1998). Based on Pisias's (1978, 1979) sea temperature curve, Arnold (1991a; Arnold and Tissot 1993), Colten (1993, 1995), Pletka (1996), and others have argued that unusually high sea surface temperatures (some exceeding 24°C) damaged the kelp beds surrounding the northern Channel Islands during this interval. Evidence of warm sea surface temperatures is supported by growth patterns in black abalone collected from sites dating to this interval (Arnold and Tissot 1993). Arnold (1991a, 1992a) argued that reduced marine productivity and coeval droughts resulted in subsistence stress and partial abandonment of some sites for a short time during the Transitional period. A new marine climate sequence suggests, however, that marine conditions were cold, not warm, and marine productivity was quite high. This premise is supported by oxygen isotopic measurements on mussel shells from ^{14}C dated archaeological levels on Santa Rosa Island (Kennett 1998). More work is needed to determine why these new data do not correspond with the black abalone data from Santa Cruz Island, but we suspect chronological inconsistencies between the two records may be responsible.

We argue here that settlement disruption during this interval is better explained by a series of severe droughts registered in paleoclimatic records across California (Jones and Kennett 1999; Kennett and Kennett 2000; Larson and Michaelson 1989; Raab and Larson 1997; Stine 1994). On the islands, the best sequences spanning this interval are associated with large watersheds that provide perennial water supplies even during extended droughts. Radiocarbon dated archaeological levels from Santa Rosa Island that fall within this period also have high densities of fish remains, and shellfish assemblages indicate that marine productivity was relatively high. Based on the available data, we propose that people living in well-watered areas had a competitive advantage over people who did not. These people began to intensively fish to compensate for shortfalls in terrestrial resources associated with drought conditions. It is likely that individuals developed new strategies for obtaining carbohydrate-rich plant foods, including the establishment of more exchange relationships with people from mainland villages. People living at poorly watered locations probably used a variety of strategies to deal with their predicament. Some undoubtedly chose to eke out a living at marginal locations, suffering the health and reproductive consequences of their decision. Others probably sought refuge with relatives living in villages near well-watered locations elsewhere in the Santa Barbara Channel region.

A cultural resurgence occurred on the northern Channel Islands after drought conditions ameliorated around AD 1300. People reestablished settlements occupied prior to AD 1150, and new villages appeared. Large house depressions are evident at virtually all of these villages, and faunal assemblages are extremely diverse. Bead manufacturing exploded, particularly at settlements on western Santa Cruz and eastern Santa Rosa Islands (Arnold 1991a; Kennett 1998). Subsurface mining for chert on eastern Santa Cruz intensified as the demand for microblades and drills increased (Kennett 1998). Exchange relationships with mainland villagers were also well established (C. King 1990), and the plank canoe provided the primary mode of transportation across the channel (Arnold 1995a).

Most island settlements established after AD 1300 appear to have been occupied well into the Mission period. Similar to settlements dating between AD 650 and 1150, villages were evenly spaced around San Miguel and Santa Rosa Islands. More villages were occupied between AD 1300 and 1750 than are documented ethnohistorically, however, suggesting that protohistoric disease may have affected islanders before the Mission period (Erlandson and Bartoy 1995, Erlandson, Kennett, and Walker 1997). After Spanish colonization of the mainland in the late 1700s, many people left the islands because populations had been decimated by disease, their exchange networks had collapsed, and climatic instabilities during the early 19th century had taken their toll (J. Johnson 1982b; Larson et al. 1994).

All the behavioral strategies that dominated the northern Channel Islands after AD 1300—sedentism, intensive fishing, and intensive production of nonfood items—have earlier incipient origins, between AD 650 and 1150 (or earlier). A variety of long-and short-term processes are undoubtedly responsible for the emergence of these behavioral strategies. There is evidence of gradual population growth, expanded diet breadth, and intensified fishing (Kennett 1998). Settlement mobility decreased as many of available stretches of coast were increasingly occupied. The interval when sedentary villages were established, fishing intensified, and the production of nonfood trade items increased was one of great climatic and social instability. Osteological data suggest that these developments occurred as diseases spread to island populations, when health problems were on the rise, and as lethal violence increased exponentially (Lambert 1994, 1997; Lambert and Walker 1991; Walker 1989a, 1989b). Gradual decreases in health and stature and increases in violence prior to this time are probably best explained by population-dependent demands on resources, but the sudden increase between AD 650 and 1150 requires an alternative explanation, as do the interrelated behavioral responses.

Marine conditions now appear to have been generally cool and unstable between AD 450 and 1350. Even with highly variable conditions during this interval it is unlikely that decreased marine productivity caused subsistence stress. Cool and unstable marine conditions could have had a tremendous impact on regional rainfall patterns, because it appears that cool water conditions correlate well with relatively dry conditions. On the islands water is one of the most limited resources. Plant resources are also limited, and decreased rainfall may have significantly affected their productivity. Competition for terrestrial resources, particularly access to perennial water, could account for reduced mobility and increased violence. Because one of the wettest intervals in the last 1500 years appears to have occurred between AD 800 and 1000, alternative hypotheses should be considered, however.

Violence increased after AD 650 when the bow and arrow was becoming the weapon of choice on the northern Channel Islands (Lambert 1994). The bow and arrow spread rapidly across North American between AD 150 and 600 due to intergroup contact, conflict, and competition (Blitz 1988). Its introduction into California after about AD 500 is suggested by the replacement of large atlatl dart points with small arrow points and the simultaneous appearance of arrow shaft straighteners (Moratto 1984). In the Santa Barbara Channel area, the bow and arrow is marked by the appearance of small leaf-shaped projectile points between AD 500 and 800 (Glassow 1996c). The introduction of this technology parallels exponential increases in violence regionally, although many of the projectile point wounds between AD 500 and 800 appear to have resulted from atlatl darts or spear points (Lambert 1994, 1997), an expected pattern when new technology is introduced into a region. The bow and arrow was in full use by AD 800 (Lambert 1994).

The bow and arrow was introduced into the Santa Barbara Channel region when terrestrial conditions appear to have been generally poor. This introduction was a phenomenon that undoubtedly opened new possibilities for resource exploitation and territorial expansion. Extremely accurate within a 20 m range, this technology would have provided greater hunting efficiency than the atlatl (Blitz 1988). The flatter trajectory and higher velocity, coupled with the ability to shoot projectiles at a faster rate, would have significantly altered individual and group interaction, particularly during times of local resource stress or competition for limited resources.

Greater chronological precision is needed in both paleoclimatic and archaeological records to assess why people on the northern Channel Islands became more violent after AD 650 and more information is needed regarding the introduction of the bow and arrow and its effect on local politics. Alternative proxies of terrestrial climatic conditions are also needed to extend the paleoclimatic record back in time. In addition, Lambert's (1994) chronology is based on C. King's (1990) seriation of burial lots and is tied to a limited number of ^{14}C dates. Each burial (or clearly associated objects) needs to be ^{14}C dated directly to compare the timing and nature of health problems and violence with the new climatic reconstructions becoming available for the region.

Our current working hypothesis is that the climatic instability and resource stress associated with persistent drought stimulated greater conflict and competition for access to perennial water sources on the islands starting about AD 500. This situation promoted greater sedentism near perennial water sources and territorial behavior. Violent interaction and competition were exacerbated by the introduction of the bow and arrow between AD 500 and 800. Competition for resources continued between AD 650 and 800, even when both marine and terrestrial conditions were favorable. Favorable water availability undoubtedly promoted population increases at certain locations and the establishment of sedentary villages in more marginal locations. More intensive fishing, production of non-food trade items, and increased trade emerged in this context as new behavioral strategies to deal with subsistence problems associated with decreased mobility. Decreased settlement mobility and territorial behavior would have exacerbated resource stress for some groups of people when perturbations in the terrestrial environment occurred between AD 1150 and 1300, a problem dealt with previously in the Holocene by periodic movement. Drought conditions served to fix, in an evolutionary sense, certain behavioral strategies—sedentism, intensive fishing, exchange, and the production of trade items—some of the hallmarks of island Chumash society after AD 1300.

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Notes

1. Hole 893a (Ocean Drilling Project) is plotted relative to the northern Channel Islands and the mainland coast. The core provides the newest marine paleoclimatic data for the region (Kennett 1998; Kennett and Kennett 2000).

CATALYSTS TO COMPLEXITY

Late Holocene Societies of the California Coast

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