J World Prehist (2005) 19:169–228
DOI 10.1007/s10963-006-9004-x

ORIGINAL PAPER

From Pleistocene Mariners to Complex Hunter-Gatherers: The Archaeology of the California Channel Islands

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Published online: 6 September 2006

Abstract California's Channel Islands were home to some of the most distinctive Native American peoples along the Pacific Coast. Never connected to the mainland during the Quaternary, the Channel Islands have an impoverished terrestrial flora and fauna, but some of the richest and most productive marine environments in the Americas, including diverse kelp forest, intertidal, and offshore marine habitats. Native Americans occupied the Channel Islands for roughly 13,000 calendar years until the early nineteenth century, providing one of the longest and best preserved records of maritime hunter-gatherers in the Americas. We provide an overview and analysis of Channel Islands archaeology, from the relatively mobile peoples who colonized the islands during the Late Pleistocene to the complex hunter-gatherers documented by early Spanish explorers. Our analysis demonstrates the importance of Channel Islands archaeology for enhancing knowledge on a number of broad anthropological issues, including coastal and aquatic adaptations, seafaring, cultural complexity, trade and exchange, and ancient human impacts on the environment.

Keywords Channel Islands · California · Pacific Coast · Cultural complexity · Coastal adaptations · Shell middens · Seafaring

Introduction

Over the last several decades, the mild coastal climate and the lure of fame and fortune have attracted extraordinary population growth in southern California. This has resulted

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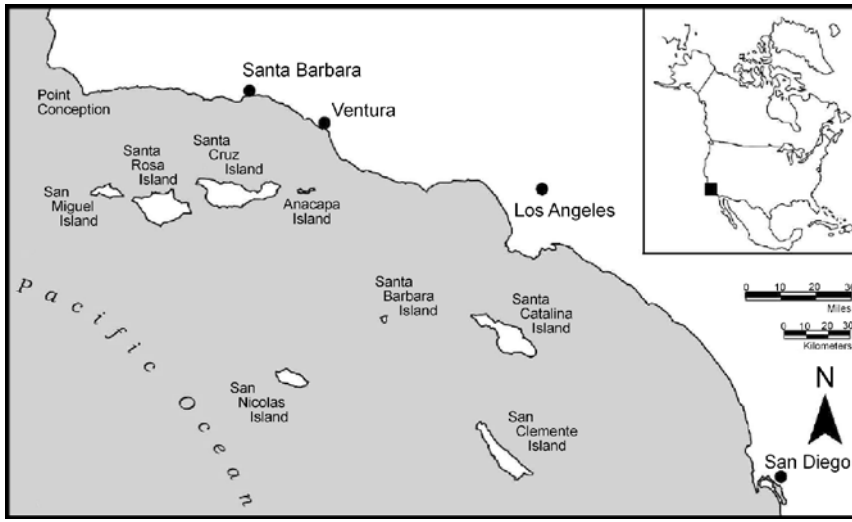

Fig. 1 The Channel Islands and the southern California Coast

in a booming economy and one of the most densely populated coastal landscapes in the Americas. Most residents of California and beyond, however, are unaware of the fact that this recent wave of settlement is part of a much longer trajectory of human occupation spanning at least 13,000 years. The Native peoples who inhabited coastal California left behind a remarkable archaeological record, including some of the earliest coastal sites in the Americas and thousands of sites of shell middens and lithic scatters with rich faunal and artifact assemblages. Unfortunately, population growth and urban sprawl along the mainland coast have destroyed or disturbed much of this extraordinary archaeological record. In contrast to the mainland, the eight Channel Islands are largely undeveloped, relatively isolated, and remain a microcosm of California before widespread historical development (Fig. 1).

Sometimes called a North American Galapagos, the Channel Islands contain distinct flora and fauna and one of the longest coastal archaeological sequences in the Americas. The combination of a long and continuous archaeological record and limited historical development has made the islands a focus of archaeological research for over a century. During the last 20 years, however, research on both the northern and southern island groups has greatly expanded, resulting in some of the most impressive coastal research in the Americas. Channel Islands archaeological data have been used to examine a number of broad anthropological topics, for instance, including the emergence of cultural complexity among hunter-gatherers (e.g., Arnold, 1992a,b, 1996, 2000, 2001a,b,c; Arnold, Colten, & Pletka, 1997a; Raab & Bradford, 1997; Raab & Larson, 1997), human impacts on the environment and historical ecology (Erlandson, Rick, & Vellanoweth, 2004a; Hildebrandt & Jones, 1992; Jones & Hildebrandt, 1995; Porcasi, Jones, & Raab, 2000; Rick *et al.*, 2006), the antiquity of coastal adaptations and seafaring (Arnold, 1995; Arnold & Bernard, 2005; Cassidy, Raab, & Kononenko, 2004; Erlandson, 1994, 2001, 2002; Fagan, 2004; Rick, Erlandson, & Vellanoweth, 2001a; Salls, 1991; and others), long-term trajectories in human social organization and environmental relationships (Kennett, 2005), subsistence and environmental change (Glassow, 1993a,b, 2002, 2005a), regional exchange and interaction (Arnold, 1991; Raab & Howard, 2002; Vellanoweth, 2001), and a variety of other issues.

While the occupations of the islands share a strong maritime orientation and technology, cultural variability is also evident in archaeological and ethnographic records. Historically, the northern islands were occupied by the Island Chumash, who spoke a distinct island dialect that is part of the larger Chumashan language family (see Jones & Klar, 2005, p. 472). The more widely dispersed southern islands were inhabited by Uto-Aztecan speaking peoples (Gabrielino or Tongva). Of the two, considerably more is known about the Chumash from ethnohistoric sources. Although the two groups are linguistically and culturally distinct, research on the two island groups and adjacent mainland shows many parallels and interconnections, as well as significant differences (see McCawley, 2002).

The archaeology of the Channel Islands has been discussed in recent syntheses of the North American Pacific Coast (Lightfoot, 1993; Moss & Erlandson, 1995), and California (Arnold, Walsh, & Hollimon, 2004; Fagan, 2003) or the California Coast (Erlandson, 1994; Erlandson & Glassow, 1997; Erlandson & Jones, 2002). Despite a long history of archaeological research in the area, a broad synthesis for all eight of the Channel Islands has never been published. In this paper, we provide an overview and analysis of the trans-Holocene archaeological record of Native American occupations of the Channel Islands, beginning with the earliest evidence for human occupation and following this through the Historic period. Our emphasis is on long-term cultural trajectories on the Channel Islands, demonstrating the dynamics of more than 10,000 years of Native American coastal and maritime lifeways. Due to the volume of research in the area, our focus is on work conducted during the last 25 years and is largely intended to promote interest in the area by non-Channel Islands specialists.

Environmental background

The Channel Islands, located off the California Coast between Point Conception and San Diego, are divided into northern (Anacapa, Santa Cruz, Santa Rosa, and San Miguel) and southern (San Clemente, Santa Catalina, San Nicolas, and Santa Barbara) groups (Figs. 2 and 3). The islands were never connected to the mainland during the Quaternary, making them somewhat distinct from the adjacent mainland. They are owned and managed by a variety of federal agencies and private organizations. The Northern Channel Islands and Santa Barbara Island form Channel Islands National Park, with western Santa Cruz owned by the Nature Conservancy and San Miguel owned by the US Navy. San Nicolas and San Clemente are both administered by the US Navy and contain naval installations. Santa Catalina contains the only formal city on the islands (Avalon), but most of the island is managed by the nonprofit Catalina Island Conservancy. Other than relatively small developments, and a long history of ranching, the islands remain largely undeveloped.

Ranging in size from about 2.6 to 249 km^2, the Channel Islands are between about 20 and 98 km from the mainland coast (Table I). The northern islands are an extension of the Santa Monica Mountains on the mainland (Weaver, 1969, pp. 9), forming an east-west trending line along the Santa Barbara Channel. The southern islands are considerably more dispersed and isolated. All of the islands have a Mediterranean climate, with mild summers and cool, wet winters. The relatively arid climate and generally alkaline archaeological soils have promoted good preservation of most archaeological constituents, although erosion by waves, wind, and running water have impacted many sites.

The Channel Islands contain a limited terrestrial fauna and flora, lacking many animals and plants common on the mainland (Schoenherr, Feldmath, & Emerson, 1999, pp. 7–17). The largest endemic land mammals–the island fox (*Urocyon littoralis*) occurs as a discrete subspecies on all the islands except Anacapa and Santa Barbara, and the island spotted

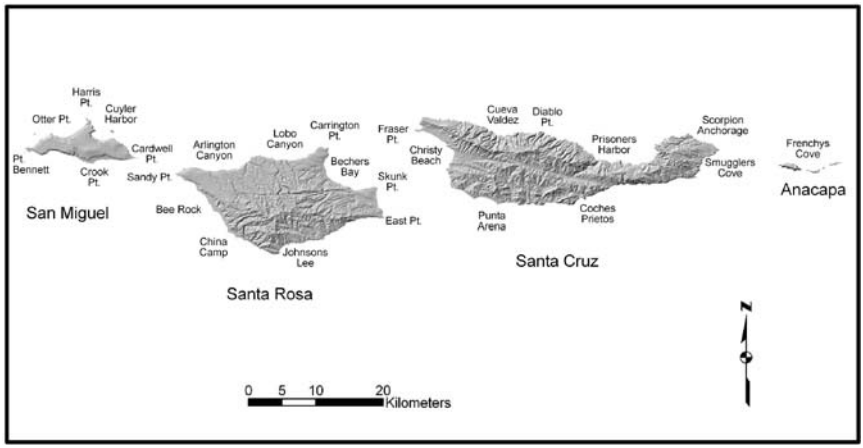

Fig. 2 The Northern Channel Islands showing topographic relief and major place locations

skunk (*Spilogale gracilis*) found on Santa Rosa and Santa Cruz–are each about the size of a house cat. During the Pleistocene, pygmy mammoths (*Mammuthus exilis*) lived on the Northern Channel Islands, but until the Historic period the islands were devoid of the herbivores, carnivores, and rodents that dominate the mainland coast. This includes a number of burrowing animals (gophers, badgers, ground squirrels, etc.) that have mixed mainland archaeological sites for millennia. Until historic times, the island deer mouse (*Peromyscus maniculatus*) was the only rodent to occur on all the islands, with the harvest mouse also found on Santa Cruz and Santa Catalina and occasional reports of shrews and woodrats on Santa Catalina (Schoenherr *et al*., 1999, pp. 189–191). The only other indigenous land mammal on the islands is the ground squirrel found only on Santa Catalina. The dearth of mammals, particularly burrowing rodents, has generally promoted high stratigraphic integrity

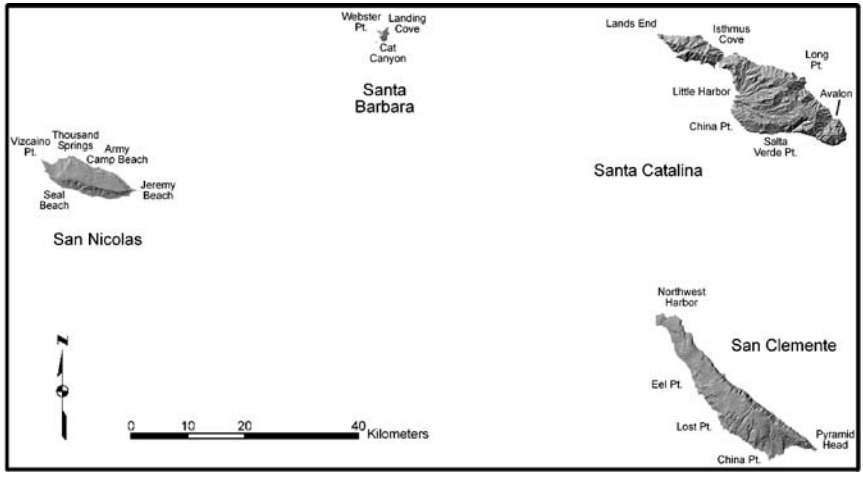

Fig. 3 The Southern Channel Islands showing topographic relief and major place locations

Table 1 General attributes of the Channel Islands[a]

Island	Area (km^2)	Maximum Elevation (m)	Distance from Mainland (km)	# of Land Mammals	Native Plant Taxa
Northern					
Anacapa	2.9	283	20	2	190
Santa Cruz	249	753	30	12	480
Santa Rosa	217	484	44	4	387
San Miguel	37	253	42	3	198
Southern					
Santa Barbara	2.6	149	61	2	88
Santa Catalina	194	648	32	9	421
San Nicolas	58	277	98	2	139
San Clemente	145	599	79	6	272

[a]Based on Schoenherr *et al.* (1999, pp. 7).

of island archaeological sites. While there are few terrestrial mammals, the islands are home to thousands of land and sea birds, along with several pinniped species that haul out onshore.

Vegetation communities on the islands are also distinct, including a number of endemic and relict species. The islands are currently dominated by introduced grasses, with considerable effort being devoted to reestablishing native species. A number of vegetation communities are found on the islands, including coastal sage scrub, oak and pine woodland, and chaparral. The greatest ecological diversity is found on the larger and more topographically diverse islands (Santa Catalina, Santa Cruz, and Santa Rosa). Ravaged by more than a century of historical overgrazing, island soils have periodically been exposed causing widespread deflation, gullying, and scouring of the landscape (see D. Johnson, 1972, 1980).

Channel Island marine environments are exceptionally productive, with the upwelling of nutrient-rich waters supporting large populations of pinnipeds, cetaceans, seabirds, shellfish, and fishes. The Channel Islands are located on a boundary between colder currents to the north and warmer currents to the south, providing a mix of cold and warm water marine fauna. The diversity of marine fauna and limited terrestrial resources have made the island's Native American peoples highly maritime throughout their occupation. Island ecosystems are susceptible to El Niño/La Niña cycles, periodic droughts, and other perturbations on a variety of different spatial and temporal scales. Droughts may be particularly problematic on the smaller (Anacapa, San Miguel, Santa Barbara) or more southern islands (San Nicolas, Santa Catalina, San Clemente), where sources of surface water tend to be limited, especially during the dry season between about June and September.

During the last 20,000 years, the geography of the Channel Islands has changed dramatically. Sea level was considerably lower during the Late Pleistocene and Early Holocene, making the islands larger in area and somewhat closer to the mainland (see D. Johnson, 1983; P. Porcasi, Porcasi, & ONeill, 1999). At the height of the last glacial, around 18,000 years ago, the northern islands formed one large island land mass (Santarosae), with the islands reaching their current configuration shortly after the onset of the Holocene. A number of additional islets were also located throughout the area, most of which are now submerged (P. Porcasi *et al.*, 1999). Due to dramatic changes in sea level, much of the early archaeological record may be submerged, a topic we return to below. Kinlan, Graham, and Erlandson (2005) noted that the dramatic changes in shoreline length, island area, and reef area following the close of the Last Glacial promoted reorganization of marine habitats, particularly kelp forests that influenced Native American settlement and subsistence strategies.

History, method, and theory

The Channel Islands have a long history of archaeological research, spanning over a century. Like most areas of North America, archaeological research on the islands progressed through phases of antiquarianism and exploration, culture history, and more recent paradigms (see Baldwin, 1996 for a detailed history). Some of the first relatively well documented projects were performed by Schumacher, Eisen, de Cessac, and Bowers in the late nineteenth century (Baldwin, 1996; Benson, 1997; Glassow, 1977; Schwartz & Martz, 1992). These researchers were largely concerned with cemetery excavations and obtaining unique specimens for museums such as the Smithsonian and other facilities. Research on the islands continued through the early nineteenth century led by researchers like David and Malcolm Rogers, Glidden, Sanger, Woodward, Olson, and Van Valkenberg. While much of this research continued to focus on acquiring museum specimens, the work of these early researchers also embraced the culture historical paradigm (e.g., Rogers, 1929). Although great time depth in the record was speculated, early research on the islands was largely devoid of direct temporal chronologies and the islands were often seen as cultural oddities. An exception to this was D. B. Rogers' (1929) cultural historic framework for the Santa Barbara Channel region, which included Oak Grove, Hunting, and Canaliño peoples, aspects of which remain in use today.

Beginning in the late 1940s, research on the Channel Islands surged. Phil Orr (1968), working primarily on Santa Rosa Island, began a long-term project aimed at determining the lifeways and antiquity of the island's earliest inhabitants. He was among the pioneers of radiocarbon dating on the islands, and although his sequence has been significantly revised, he determined that people had been on the islands since at least 10,000 B.P. Charles Rozaire's (1959, 1978, 1993) survey and excavation projects during the 1950s, 60s, and 70s on San Nicolas, San Miguel, Anacapa, and Santa Barbara islands were also among the pioneering research in the area. Meighan's (1959, 2000) research on Santa Catalina, San Clemente, and other islands brought new interest in scientific archaeology, prompting researchers to explore ecological paradigms. This surge in scientific archaeology persisted through the 1960s and 70s, as a series of researchers associated with various universities and museums worked on the islands, refined cultural chronologies, and explored new theoretical paradigms (e.g., Glassow, 1977; Greenwood, 1978; Meighan, 1959; Reinman, 1962; Rozaire, 1978).

In the 1980s and 90s, archaeological research on the Channel Islands increased again, with many of these projects persisting into the present day. Glassow's (1980, 1993a,b, 2002, 2005a) work on Santa Cruz Island began looking at long-term patterns in human subsistence and settlement. Arnold (1987, 1992a,b, 2001a) initiated surveys and excavations of Late Holocene chert quarries and villages that would form the foundation for her research on emergent cultural complexity. Meighan, Salls, Yatsko, Raab, and others began excavations at Eel Point and other San Clemente sites (see Raab & Yatsko, 1992; Salls, 1990a, 1991). Work by Schwartz, Rosenthal, Martz, and others (see Martz, 2005; Schwartz & Martz, 1992; Vellanoweth, Martz, & Schwartz, 2002a) at numerous sites on San Nicolas Island gave new perspective on the prehistory of this most distant island. Erlandson *et al.*'s (1996; Erlandson, Rick, Vellanoweth, & Kennett, 1999; Erlandson, Rick, Largaespada, & Vellanoweth, 2004b; Erlandson, Rick, & Batterson, 2004c; Erlandson, Braje, Rick, & Peterson, 2005a; Connolly, Erlandson, & Norris, 1995; Rick *et al.*, 2001a) investigation of Daisy Cave and numerous other early shell middens on the northern islands set the stage for establishing the antiquity and context of early human settlement on the islands. Kennett's (1998, 2005) research on Santa Rosa and other northern islands provided important theoretical and contextual frameworks for investigating patterns in trans-Holocene human occupations and adaptations. These and

other projects established a foundation for detailed theoretical and methodological inquiries that have given the Channel Islands international anthropological notoriety.

During the last 20 years, archaeological research on the Channel Islands has become increasingly sophisticated. Many excavations are now conducted in natural stratigraphic levels, large numbers of ^{14}C dates are available, surveys often include GPS and GIS technology, isotope analyses are performed on bone and shells, and there is a renewed interest in geoarchaeology, taphonomy, and site formation. Kennett's (1998, 2005; Kennett & Kennett, 2000) analysis of stable isotopes in archaeological sites on the Northern Channel Islands, for instance, has proven important for analyzing site seasonality and ancient changes in sea surface temperature that may have impacted human subsistence and other aspects of society. The analysis of human remains by Ezzo, Kerr, Walker, Hawley, & Yoshida (2002), Goldberg (1993), Hollimon (1990), Kerr (2003), Lambert (1994), Titus (1987), Walker and DeNiro (1986), Walker and Erlandson (1986), and others also demonstrates the significance of these techniques for analyzing changes in human diet, health, interpersonal violence, or cultural affiliation. Arnold, Ambos, and Larson's (1997b) use of ground penetrating radar and magnetometer work at the Prisoner's Harbor site on Santa Cruz Island shows the potential for this work in complex shell middens. Trace element analysis of obsidian from Channel Island sites has also proven to be an important tool in documenting long distance exchange and interaction (Rick, Skinner, Erlandson, & Vellanoweth, 2001b; Scalise, 1994). The ongoing re-analysis of the Arlington Woman skeletal remains and Arlington Springs site is a multidisciplinary endeavor drawing on high precision ^{14}C dating, CAT scans, ground penetrating radar, and other computer techniques to help document the context, chronology, and interpretation of some of the oldest human skeletal remains in the Americas (see Johnson, Stafford, Ajie, & Morris, 2002). Research on historical archaeology (Berryman, 1995; Braje, Erlandson, & Rick, 2006a), ancient human DNA (Potter, 2004), paleoethnobotany (Martin & Popper, 2001; Timbrook, 1993), radiocarbon methodology (Kennett, Ingram, Erlandson, & Walker, 1997; Rick, Vellanoweth, & Erlandson, 2005a), and direct AMS dating of key artifact types (Rick, Vellanoweth, Erlandson, & Kennett, 2002; Rick *et al.*, 2005a; Vellanoweth, 2001) have also enhanced Channel Islands archaeology. Although underwater archaeological research on historic shipwrecks has been conducted around the islands (Morris & Lima, 1996; Russell, 2004), no systematic underwater archaeology for prehistoric remains has been performed.

These methodological advances have enhanced archaeological interpretation of a series of broad theoretical issues: 1) the antiquity of island settlement, maritime adaptations, and seafaring; 2) Holocene settlement and subsistence strategies; 3) exchange systems and interaction spheres; 4) complex hunter-gatherers and emergent cultural complexity; 5) contact period culture; and 6) human impacts on island ecosystems. These and other research goals have driven recent work and made the Channel Island archaeological record central to a series of key theoretical debates.

13,000 years of island lifeways

At the time of European contact, Native peoples on the Channel Islands led lives focused around the ocean, with complex exchange networks between the mainland and islands, sophisticated boats, fishhooks, and harpoons, and a heavy reliance on marine hunting, fishing, and foraging. Population densities were generally high for hunter-gatherers and many islanders appear to have been relatively sedentary, living in circular, semi-subterranean houses aggregated in sizeable villages. Much recent archaeological research has sought to

understand when and how these developments evolved. It has become increasingly clear that most (if not all) of the islands were occupied throughout the Holocene, suggesting a long-term trajectory of cultural developments in the area. Although many of these regional developments may have been punctuated and rapid, many cultural practices also have their roots in long-term evolutionary trajectories.

In the sections that follow, we focus on these major developments, including changes in technology, subsistence, demography, social and political organization, and impacts on the environment. We rely on data from numerous key archaeological sites, usually referring to the ages of these sites in calendar years before present (cal B.P.). The ages provided for each site are generally 1 sigma calibrated age ranges provided by the original researchers and vary slightly depending on what was reported. Most dates from the northern islands and Santa Barbara Island were calibrated using Calib 4.3 (Stuiver & Reimer, 1993, 2000), applying a ΔR of 225 ± 35 years to compensate for local upwelling (Kennett *et al*., 1997).

Maritime foundations: The Terminal Pleistocene and Early Holocene (13,000–7000 years ago)

California has one of the most extensive records of early coastal adaptations in the New World and many of the earliest sites are located on the Channel Islands. Early syntheses of the archaeology of the Santa Barbara Channel area identified Milling Stone (a.k.a. Oak Grove) cultures as the earliest well-defined cultural horizon on the mainland coast (Olson, 1930; Rogers, 1929; Wallace, 1955), and the lack of such sites on the Channel Islands led many to conclude that the islands were settled significantly later in time. Recent research has shown, however, that the earliest island occupations were roughly contemporary with the Folsom and possibly Clovis traditions (Erlandson *et al*., 1996; Johnson *et al*., 2002). No Clovis or Folsom points have been found on the islands, but a few isolated Paleoindian fluted points from mainland coastal or peri-coastal areas may provide cultural precursors to the first islanders. Alternatively, the Paleoindian and Paleocoastal traditions may have separate origins (Jones *et al*., 2002), an issue still to be resolved.

Determining when humans first reached the islands and how the earliest peoples adapted to island environments is difficult. According to Inman (1983), sea levels were roughly 120 m below present about 19,000 years ago, 50 m below present approximately 13,000 years ago, and 15 m below present about 9000 years ago. The bathymetry surrounding the Channel Islands is steep compared to many continental shelves around the world, so lateral movement of shorelines associated with sea level changes was relatively limited. The Northern Channel Islands were a single landmass (Santarosae) at the height of the Last Glacial, however, and some island shorelines moved as much as 15–20 km during the last 19,000 years (see Orr, 1968; D. Johnson, 1972; P. Porcasi *et al*., 1999). The inundation and erosion of former shorelines and coastal lowlands has destroyed or obscured those landforms where we might expect to find most of the evidence of early coastal occupations.

To compensate for these problems, recent work has focused on areas with relatively steep bathymetry (and limited shoreline movement), caves, and freshwater springs that may have enticed early peoples to move away from the coast long enough to leave behind archaeological evidence. If the earliest use of the Channel Islands was temporary or focused primarily on the milder and less stormy months from late spring to early fall, people often may have camped on the beach where archaeological evidence is unlikely to survive. Today, numerous sandy coves provide landing spots, shelter from the wind, easy access to freshwater, marine resources, and driftwood for fires. In this sense, upland sites may represent just a fraction of the earliest human use of the islands.

Five of the eight Channel Islands have now produced evidence for human occupation at least 8000 years ago. Santa Rosa, San Miguel, and probably Santa Cruz islands were settled by maritime peoples during the terminal Pleistocene; San Clemente Island was colonized at least 8500 years ago, and San Nicolas has produced provisional evidence for human occupation dating to as early as 8500 years ago (see Schwartz & Martz, 1992). Given the proximity of Santa Catalina Island to the mainland and San Clemente Island, and the intermediate location of Anacapa and Santa Barbara islands, it seems likely that all the Channel Islands were at least visited during the Early Holocene.

At least 44 Channel Island sites appear to be securely dated between about 12,000 and 7000 calendar years (Table 2). Most of these are from the Northern Channel Islands, where more archaeological research has been accomplished and concerted efforts have been made to identify early sites (see Orr, 1968; Erlandson, 1994; Erlandson *et al*., 2005a). For the Southern Channel Islands, the only well-documented early site is at Eel Point (SCLI-43) on San Clemente Island. Given the maritime character of the earliest assemblages, however, it seems likely that humans visited or settled all the islands by the Early Holocene and further research should greatly expand our knowledge of the geographic range and adaptive variability of the earliest islanders.

Terminal Pleistocene sites

The earliest reasonably secure evidence for human occupation of the Channel Islands comes from the Arlington Springs site (SRI-173), located near a freshwater spring on the northwest coast of Santa Rosa. In 1959, Phil Orr identified a human femur eroding from a thin paleosol exposed in the canyon wall about 11.4 m below the rim of Arlington Canyon. Orr (1962) established that the bone was *in situ* and ^{14}C dated two associated charcoal samples to $10{,}400 \pm 200$ B.P. ($\sim 12{,}340$ cal B.P.) and $10{,}000 \pm 200$ B.P. ($\sim 11{,}440$ cal B.P.). With no dates for the bones themselves, doubts about the age of "Arlington Man" persisted until Berger and Protsch (1989, pp. 59) reported a date of $10{,}080 \pm 810$ B.P. for human bone collagen, a date consistent with Orr's chronology. A team led by John Johnson and Don Morris has conducted additional field and laboratory work to help reconstruct the stratigraphy, chronology, and environmental context of the Arlington Springs site (Johnson *et al*., 2002). No further archaeological remains have been found in the terminal Pleistocene strata, but closer analysis of the human bones recovered by Orr found that Arlington "Man" was actually a woman.

A suite of AMS ^{14}C dates for charcoal, mouse bones, and human bone extracts supports a terminal Pleistocene age for Arlington Woman. Charcoal from the bone-bearing paleosol was dated to $10{,}090 \pm 70$ B.P. ($\sim 11{,}620$ cal B.P.), but mouse bone from the same soil was dated to $11{,}490 \pm 70$ B.P. ($\sim 13{,}450$ cal B.P.). New dates on various bone extracts range from 6610 ± 60 B.P. for osteocalcin to 9180 ± 70 B.P. and $10{,}960 \pm 80$ B.P. for decalcified collagen (Johnson *et al*., 2002, pp. 543). The osteocalcin date seems clearly erroneous and Johnson *et al*. have suggested that the age of Arlington Woman may lie between the ca. 11,000 B.P. date for human bone collagen and the 11,500 B.P. date on mouse bone. A precise calendar age for the skeleton cannot be calculated until the percentage of marine foods in the diet of Arlington Woman and an appropriate marine reservoir effect for the skeleton is established, however, which could affect the age of the skeleton by several centuries. For now, it seems most prudent to conclude that Arlington Woman died somewhere between 11,000 and 10,000 B.P. (ca. 13,000 to 11,500 cal B.P.). This uncertainty does not detract from the significance of the site, which demonstrates that maritime Paleoindians used watercraft to settle the Northern Channel Islands by the terminal Pleistocene.

Table 2 Terminal Pleistocene and Early Holocene sites from the Channel Islands

Site	Age (cal B.P.)[a]	Description	References
San Clemente			
SCLI-43	10,210-7760	Large, multi-component shell midden with evidence of early sea mammal hunting	Cassidy *et al*., 2004; Porcasi, 1995; Porcasi *et al*., 2000; Raab *et al*., 1995b; Salls, 1990a
San Nicolas			
SNI-339	8510-8350	Large habitation site on the southeastern end of the island	Martz, 2005; Schwartz & Martz, 1992
Santa Cruz			
SCRI-109	8920-7560	Large, multi-component shell midden; Early Holocene component dominated by mussels and other rocky shore shellfish species	Erlandson, 1994; Glassow, 1980, 1993a, b, 2002, 2005a; Sharp, 2000
SCRI-691	8880-8620	Small, interior shell midden located on a hilltop overlooking Scorpion drainage	Clifford, 2001
SCRI-429	7580-7360	A heavily eroded but moderately dense shell midden dominated by mussels and other rocky shore shellfish taxa	Glassow, 2005a; Kennett, 2005
SCRI-614	7080-6860	Shell midden deposit located in a rockshelter and dominated by rocky shore shellfish taxa	Clifford, 2001; Kennett, 1998
Santa Rosa			
SRI-173	13,000-7760	Deeply buried human bones eroding from arroyo fill in canyon wall	Erlandson, 1994; Johnson *et al*., 2002; Orr, 1968
SRI-116	10,170-9500	Early Holocene burial exposed in the sea cliff, overlain by dense shell midden of Middle Holocene age	Erlandson, 1994; Morris & Erlandson, 1993
SRI-6	9280-7390	Deeply buried shell middens dominated by abalone and other rocky shore shellfish taxa	Erlandson, 1994; Erlandson *et al*., 1999; Orr, 1968
SRI-1	9260-8890	Small, low density shell midden dominated by mussels and black abalones	Erlandson, 1994; Morris & Erlandson, 1993; Orr, 1968
SRI-5	8370-7490	Multi-component shell midden with a red abalone deposit and Early Holocene occupations	Erlandson, 1994; Orr, 1968
SRI-3	8300-7160	Dense shell midden with long occupation record dominated by rocky shore shellfish taxa and a diverse artifact assemblage	Erlandson, 1994; Orr, 1968
SRI-666	8100-7930	Large, badly eroded shell midden dominated by rocky shore shellfish taxa and a relatively dense assemblage of chipped stone tools	Erlandson, 1994; Rick *et al*., 2005b
SRI-84	8020-7930	Multi-component shell midden in a dune with early estuarine shellfish taxa	Rick *et al*., 2005b

Table 2 Continued

Site	Age (cal B.P.)[a]	Description	References
SRI-26	7940-7750	Red abalone midden buried a meter below the surface	Erlandson, 1994
SRI-342	7650-7510	Small shell midden dominated by rocky shore shellfish taxa	Kennett, 2005
SRI-246	7600-7480	Small cave site with an associated shell midden dominated by rocky shore shellfish	Kennett, 2005
SRI-77	7570-7410	Multi-component shell midden with early estuarine and rocky shore shellfish taxa	Rick *et al*., 2005b
SRI-81	7430-7300	Shell midden with estuarine shellfish taxa	Kennett, 2005; Rick *et al*., 2005b
SRI-4	7410-6990	Shell midden dominated by rocky shore shellfish	Kennett, 2005; Orr, 1968
SRI-147	7400-7230	Deeply stratified and dense shell midden deposit located at the confluence of two drainages in Jolla Vieja canyon	Kennett, 2005
SRI-462	7010-6840	Two small shell midden deposits with red abalone shells and other rocky shore shellfish	Kennett, 2005
San Miguel			
SMI-261	11,600-8500	Multi-component cave site with a diverse early artifact assemblage, including cordage and woven artifacts, and marine faunal constituents	Connolly *et al*., 1995; Erlandson *et al*., 1996; Rick *et al*., 2001a
SMI-522	10,250-8940	Dense, eroding shell midden composed primarily of mussels and other rocky shore shellfish taxa	Erlandson & Rick, 2002a
SMI-604	9950-9130	Multi-component cave site on Harris Point with rocky shore shellfish taxa	Rick *et al*., 2003
SMI-548	9950-8960	Small shell midden dominated by mussels, owl limpets, and other rocky intertidal shellfish taxa species	Erlandson *et al*., 2004b
SMI-608	9800-8575	Open air site dominated by mussels and black abalones with a large artifact assemblage	Braje *et al*., 2005; Erlandson *et al*., 2005a
SMI-BaBe3	9750-9090	Open air site dominated by rocky shore shellfish taxa	Erlandson *et al*., 2005b
SMI-610	9750-9020	Small, low-density shell midden dominated by rocky shore taxa and small numbers of chipped stone artifacts	Erlandson *et al*., 2005b
SMI-588	9600-8810	Low density shell midden deposit dominated by rocky shore shellfish taxa	This paper
SMI-606	9420-8060	Small, low-density shell midden dominated by rocky shore shellfish taxa and small amounts of bone and chipped stone artifacts	Erlandson *et al*., 2004c

Table 2 Continued

Site	Age (cal B.P.)[a]	Description	References
SMI-607	8920-8130	Small, low-density and badly eroded shell midden dominated by rocky shore shellfish taxa	Erlandson *et al*., 2005b
SMI-577	8910-8700	Thin, low density shell midden dominated by mussels and other rocky shore shellfish taxa	Braje *et al*., 2005
SMI-578	8870-8700	Severely eroded shell midden and stone tool scatter consisting of cores, flake tools, and tool-making debris	Braje *et al*., 2005
SMI-438	8760-8510	Large, multi-component shell midden with abundant rocky shore shellfish and fish bone	Erlandson *et al*., 2005b
SMI-623	8750-8580	Deeply buried shell midden dominated by mussels	Braje *et al*., 2005
SMI-442	8590-8375	Thin shell midden dominated by mussels eroding from the base of a large sand dune	Erlandson *et al*., 2005b
SMI-603	8410-7480	Multi-component cave site with a large Early Holocene artifact and faunal assemblage	Rick *et al*., 2001a; Vellanoweth *et al*., 2002b, 2003
SMI-433	8380-8100	Large shell midden with abundant rocky shore shellfish, sea mammal and fish bone, and a diverse artifact assemblage	Erlandson, 1994; Erlandson *et al*., 2005b; D. Johnson, 1972
SMI-350	7440-7360	Large shell midden with an early red abalone deposit	Erlandson *et al*., 2005b; Kennett, 2005
SMI-388	7360-7010	Shell midden deposit dominated by rocky shore shellfish taxa	Erlandson *et al*., 2005b; Kennett, 2005
SMI-481	7330-7180	Large, multi-component dune site with small, basal red abalone midden	Erlandson *et al*., 2005b; Rick, 2004a
SMI-1	7140-6880	Interior site with multi-component shell midden, sea mammal bones, and diverse artifact assemblage	Erlandson, 1991b; Kennett, 2005; Rozaire, 1978
SMI-657	7020-6800	Large shell midden dominated by red abalone shells	Braje *et al*., 2005

[a]The ages given for each site are generally 1 sigma calibrated age ranges provided by the authors. These distributions vary slightly depending on what was reported by the original researchers. Most northern islands dates were calibrated using Calib 4.3 (Stuiver & Reimer, 1993, 2000), applying a ΔR of 225 $\pm$ 35 years to compensate for local upwelling (Kennett *et al*., 1997).

Further evidence for a terminal Pleistocene occupation of the islands comes from Daisy Cave (SMI-261) on the northeast coast of San Miguel Island. With relatively steep offshore bathymetry, Daisy Cave remained relatively close to terminal Pleistocene shorelines and provided excellent shelter from the elements. Inside Daisy Cave, a single bone bead and two small chipped stone artifacts were found in a deeply buried soil dated to approximately 18,000 years ago. The interior of Daisy Cave has been heavily disturbed by previous excavators, however, and the context and chronology of these intriguing finds is not fully

understood. Along the dripline of a small rockshelter just outside the cave, in contrast, a sequence of finely stratified soils accumulated since the end of the last glacial. Here the earliest secure evidence for a human presence is found in Stratum G, a low density shell midden dated to approximately 11,500 cal B.P. (Erlandson *et al*., 1996; Rick *et al*., 2001a). Other than abalone (*Haliotis* spp.), mussel (*Mytilus californianus*), and other shellfish remains, the evidence for human occupation in Stratum G is limited to a few expedient chipped stone tools and small amounts of tool-making debris. Like Arlington Woman, however, this early midden demonstrates that maritime Paleoindians colonized the northern islands by the terminal Pleistocene and that they subsisted–at least in part–on marine shellfish from rocky intertidal zones.

Early Holocene settlement

The discovery of Terminal Pleistocene archaeological remains associated with caves and springs on the Northern Channel Islands has led to additional survey of such locations on San Miguel and Santa Rosa islands, resulting in the identification of numerous Early Holocene shell middens located in caves or on upland terraces near springs (see Braje, Erlandson, & Rick, 2005, pp. 17; Erlandson, 1994; Erlandson & Rick, 2002a, Erlandson *et al*., 1999, 2004b,c, 2005a). Most of these middens are relatively small and inconspicuous and were not recorded by early surveys focused on larger and denser island sites.

The most extensive evidence for early settlement patterns comes from San Miguel Island, where at least three caves have produced evidence for Early Holocene occupation (Rick, Erlandson, & Vellanoweth, 2003): Daisy Cave, Cave of the Chimneys (SMI-603), and Seal Cave (SMI-604). On the northwest coast of San Miguel Island, a survey and dating program led by Erlandson has identified 11 small shell middens dated between about 10,000 and 8000 years ago (Erlandson & Rick, 2002a; Erlandson *et al*., 2004b,c, 2005a; Erlandson, Rick, & Peterson, 2005b). All these sites appear to have been located near freshwater springs that may have attracted early people to camp away from the coast, possibly during the dry season in summer and early fall. They range from small shell middens that probably were occupied for no more than a few days, to more substantial sites where a variety of activities appear to be represented. One of the latter, SMI-522, is dated between about 10,200 and 9000 years ago and has produced a relatively diverse array of tools associated with shellfishing, fishing, and marine hunting (Fig. 4). Another more substantial shell midden, SMI-608, is located on the south coast of San Miguel and dates to ca. 9500 years ago (Erlandson *et al*., 2005a). This shell midden, ranging from 10 to 40 cm thick, formed in a well-developed paleosol buried 1.5–2.0 meters below the modern surface. Five ^{14}C dates on well-preserved marine shells suggest that the main site area was occupied between about 9600 and 9400 cal B.P., while a low density midden locus about 50 m to the west has been tentatively dated to 9750 cal B.P. (Erlandson *et al*., 2005a, pp. 679). Local bathymetry suggests that SMI-608 was located about 500–750 m from the contemporary shoreline, near the base of a steep escarpment where freshwater and shelter from the wind may have been more readily available.

On the northwest coast of Santa Rosa Island, at least six Early Holocene shell middens have been found (Erlandson, 1994). At SRI-6, situated on the bluffs at the mouth of Arlington Canyon, Orr (1968) described nearly 10 meters of stratified alluvium and windblown sands interdigitated with four buried middens at depths of roughly 2, 4, 5, and 7 meters. Orr reported uncorrected dates of 6820 ± 160 and 7440 ± 200 B.P. for the two middle middens, but never dated the others. In the 1990s, we found a shell midden exposed in the sheer

Fig. 4 Early Holocene shell midden (SMI-522) on northwestern San Miguel Island, with deposits dated from ca. 10,000 to 9000 calendar years ago

sea cliff located in a steeply sloping, discontinuous deposit between 3.5 and 10 m below the surface. An abalone shell from this buried midden was dated to about 9300 cal B.P. (Erlandson *et al*., 1999). With sea levels roughly 20–25 m below present at the time, SRI-6 may have been located roughly 2.5 km from the coast. Another cluster of early sites is located on the southeast coast of Santa Rosa Island around the margins of the ancient Abalone Rocks Estuary (Rick, Kennett, & Erlandson, 2005b). One of the larger and denser of these estuarine sites, SMI-666 (a.k.a SRI-91-15; Erlandson, 1994, pp. 192), is dated to about 8000 years ago, covers an area about 140 m long by 50 m wide, and may have been an early base camp.

The best known Early Holocene site on Santa Cruz Island is located at Punta Arena on the southwest coast. Here, a large shell midden known as SCRI-109 caps a dune located near the base of a prominent rocky point. A perennial stream enters the sea about 200 m to the east and extensive rocky intertidal, kelp forest, and shallow reef habitats are located nearby. Most of these deposits date to the Middle Holocene, but an Early Holocene component was identified in the 1970s, when Glassow (1980, pp. 82) collected two column samples from eroding site profiles and obtained a basal date of about 7750 cal B.P.

The Southern Channel Islands have produced few Early Holocene sites so far. One of the most important island sites is located at Eel Point on San Clemente Island, situated 63 km off the San Diego Coast. Located on a point on the west coast of San Clemente, SCLI-43 contains a 3.5 m deep, stratified shell midden deposited during the Early, Middle, and Late Holocene. Dated between about 9000 and 8000 cal B.P., and encompassing an area about 30 m in diameter, the early component contains remnants of habitation structures, hearths, work areas, and extensive midden features (Cassidy *et al*., 2004, pp. 114).

The sites described above provide a general picture of the antiquity and nature of early human settlement on the Channel Islands. The known sites demonstrate that early maritime people used a variety of site types in both coastal and interior areas. Many of these early sites appear to have been short-term campsites or specialized shellfish processing sites, but

several (Eel Point, Daisy Cave, SMI-522, SMI-608, SRI-666, etc.) appear to be the result of more substantial occupations. Although numerous early sites located along now submerged coastlines have probably been lost to sea level rise and coastal erosion, the number of known sites suggests that the Northern Channel Islands (and possibly the southern islands) were used by maritime peoples very early and relatively intensively.

Technology

At many early Channel Island sites, technologies were relatively expedient. In part, this may be due to small sample sizes or the seasonal or specialized nature of most site occupations, but the simple nature of early technologies at many sites may be due to the heavy economic emphasis on shellfish harvesting, which requires little sophisticated technology. Stone tools at most sites consist mostly of cores, flaked and battered core tools, and retouched and utilized flake tools. These are made from rock types available in the Santa Barbara Channel, with only limited evidence for long distance trade. Bifaces are relatively rare at most early island sites, most consisting of leaf-shaped or lanceolate forms similar to those from early mainland sites (Fig. 5). Several small and distinctive contracting stemmed points ("Arena" points) have been found in Northern Channel Island sites, however, and several eccentric crescents have also been discovered in recent years. Arena points probably were used as dart points to dispatch sea mammals and crescents may be transverse projectile points used in hunting waterfowl or sea birds (Erlandson 1994, p. 264). Bone and shell tools or ornaments are also relatively rare, but have been found at several Northern Channel Islands sites. Many early sites contain shell beads made from the purple *Olivella* snail, a precursor to the sophisticated shell bead trading network that developed later. Bone gorges, associated with thousands of fish bones at Daisy Cave, have been discovered at several Early Holocene island sites, representing some of the earliest evidence for hook-and-line fishing in the Americas (see Erlandson, 1994; Erlandson *et al*., 2005a, pp. 679; see Fig. 5). We know little about the weaving practices of early islanders, but almost 2,000 sea grass artifacts were recovered from Early Holocene levels at Daisy Cave and Cave of the Chimneys.

A large assemblage of Early Holocene artifacts has been found at Daisy Cave where chipped stone artifacts are common, but are dominated by debitage and expedient tools made from local raw materials. Also found were numerous small bipoints (fish gorges) made from bird and mammal bone, along with pieces of bone gorge-making debris. The assemblage contains several bifaces including an eccentric crescent, spire-removed *Olivella biplicata* shell beads, and a small knife fragment made of ground mussel shell. Remarkably, the artifacts also include hundreds of pieces of cordage and a few fragments of twined basketry made from sea grass (*Phyllospadix* sp.) (Connolly *et al*., 1995; Norris, 1997), probably preserved because they accumulated in seabird guano. In nearby Cave of the Chimneys, numerous well preserved sea grass knots, loops, and strands of cordage were recovered from strata dated between about 8400 and 7500 cal B.P., along with 27 spire-removed *Olivella* beads, a bone fish gorge, a few chipped stone artifacts (including a small obsidian flake), and chunks of asphaltum (Vellanoweth, Rick, & Erlandson, 2002b; Vellanoweth, Lambright, Erlandson, & Rick, 2003).

At SMI-608, a variety of chipped stone artifacts were recovered, including 11 bifaces, at least 35 flake tools, 7 cores or core tools, a hammer stone, and abundant tool-making debris (Erlandson *et al*., 2005a, pp. 679). A small, stemmed dart point with a triangular blade and barbed corners is similar to the "Arena" points found at Daisy Cave and Punta Arena. The chipped stone artifacts represent a variety of activities, from raw material procurement, to core reduction, and the manufacture, use, and maintenance of formal and expedient tools.

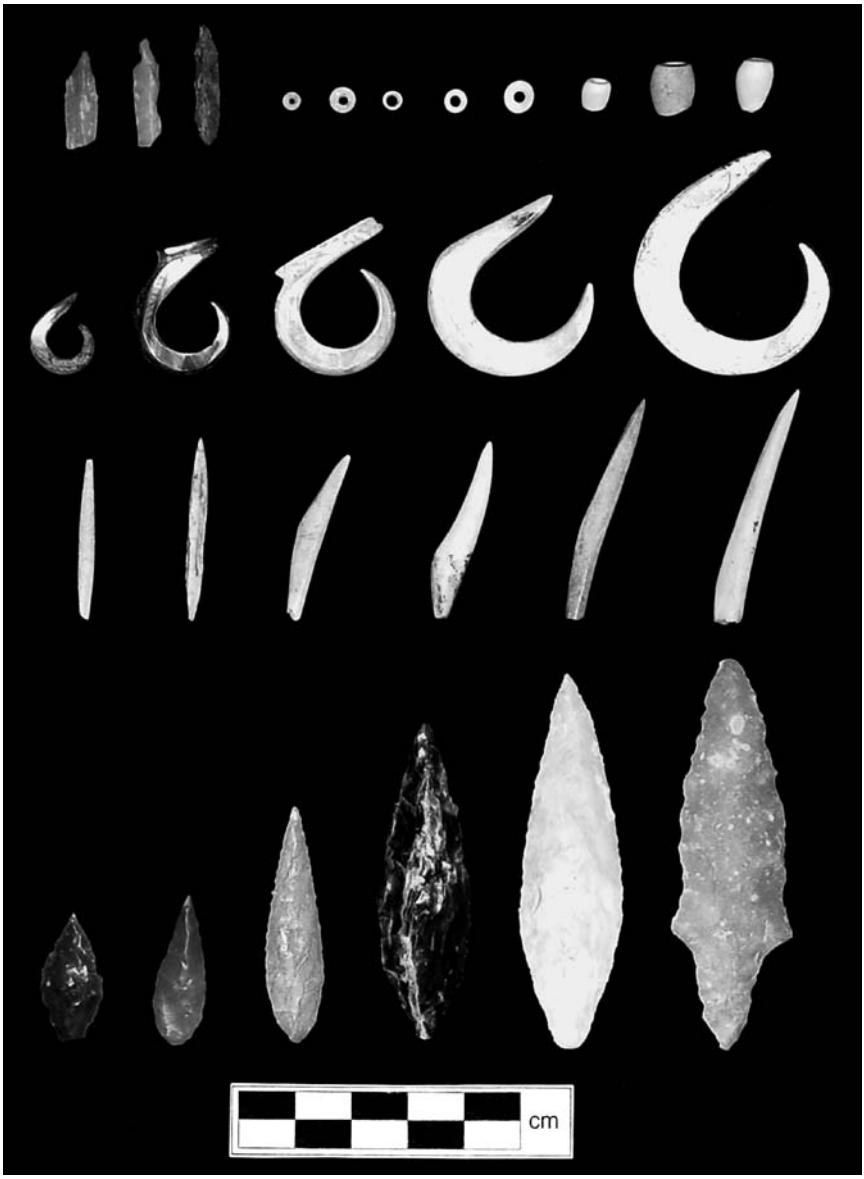

Fig. 5 Formal artifacts from the Channel Islands discussed in the text. Top row (left to right): chert microdrills (3), *Olivella* wall disk beads (2), *Olivella* callus beads (3), *Olivella* barrel beads (2), *Olivella* spire lopped bead (1). Second row (left to right): California mussel single-piece shell fishhooks (2), abalone single-piece shell fishhooks (3).Third row (left right): bone gorges (2), bone barbs (4). Fourth Row: chert projectile points

Most of the chipped stone artifacts appear to have been made from rock types available on San Miguel Island, but several tools made from a chalcedonic chert likely came from the east end of Santa Cruz Island about 75 km away. Five worked bone artifacts (a bone gorge fragment, a small bone tool fragment, and three pieces of sawn or abraded bone) were also identified along with eight spire-removed *Olivella* beads, representing some of the oldest

shell beads known from the Pacific Coast of North America (see Erlandson *et al*., 2005a, pp. 679–680; Fitzgerald, Jones, & Schroth, 2005). SMI-522, another relatively substantial midden dated between about 10,200 and 9000 cal B.P., has produced expedient core and flake technology, a serrated biface fragment, three bone gorges, and *Olivella* spire-removed beads that are generally consistent with tool assemblages identified at other early sites (Erlandson & Rick, 2002a).

On San Clemente Island, Early Holocene cultural deposits at Eel Point have produced evidence of two discrete occupational loci. At Locus 1, Cassidy *et al*. (2004, pp. 116) described "a low-lying arc of stones" that may have served as a wall or windbreak foundation, two overlapping hearths, ground-stone tools, lithic debris, and midden features. At Locus 2, a hard packed surface was identified along with associated domestic features including at least one posthole, ground stone and chipped stone artifacts, and midden debris. The early lithic assemblage includes cores, a burin, a chopper, a hammer stone, a stone anvil, a mano and a metate fragment, abraders, scrapers, flake tools, a wedge, drills, reamers, and tar applicators. Cassidy *et al*. (2004) suggested that many of these tools were part of a diverse toolkit used to build and maintain the relatively sophisticated watercraft needed to reach San Clemente Island.

Recent research has provided new insights into the technologies of early coastal peoples. Although early Channel Island assemblages are dominated by expedient flake or core tools, some sites provide evidence of more diverse technologies, including some of the oldest fishhooks, woven artifacts, and shell beads from the Pacific Coast of North America. The technologies represented at some key sites also hint at the existence of more diverse early subsistence strategies than previously recognized for the California Coast. The abundance of bone gorges and fish remains at Daisy Cave suggests that Paleocoastal peoples had a relatively sophisticated fishing technology, for example, and the abundance of bifaces at SMI-608 hints at a more sophisticated hunting technology and a greater reliance on sea mammal hunting than currently represented in the archaeological record.

Subsistence strategies

Subsistence data from several early Channel Island sites are consistent with general economic patterns identified for the southern California Coast, where shellfish and marine resources appear to have provided the bulk of the meat consumed by early coastal peoples (see Erlandson, 1994, pp. 260; Erlandson, Rick, Jones, & Porcasi, 2006). Shellfish are the most abundant constituent at nearly every island site for which quantitative data are available, but the dominant taxa vary from site to site. Mussels were a major resource at most sites, but black abalones dominated at SRI-6 and black turbans provided a major food source at Daisy Cave. Fish were secondary resources at most sites other than Daisy Cave, the only site where large numbers of fishing-related artifacts have also been found. Although many early studies of the Northern Channel Islands emphasized the significance of human hunting of pygmy mammoths (see Orr, 1968), no clear evidence of mammoth hunting currently exists (but see Agenbroad, 1998; Agenbroad, Johnson, Morris, & Stafford, 2005). Sea mammals were clearly taken by early islanders but there is little evidence, either faunal or technological, that they were major nutritional sources. Birds, too, appear to have been supplemental resources.

The dietary contribution of different animals varies from site to site, but marine resources clearly dominate the meat and protein intake of early islanders. For many early coastal groups, protein-rich marine resources probably were part of a dual economy in which terrestrial plant foods provided most of the calories consumed (Erlandson, 1991a). Since island plant foods were considerably less diverse and productive than along the mainland coast, marine

resources must have been especially vital for early islanders. Nonetheless, plant foods may have been an important source of calories for early islanders. For example, among the charcoal recovered from the excavated sample at SRI-6 were two charred fragments of relatively large seeds. These are probably from a type of fruit seed, but were too fragmented and weathered for specific identification (Erlandson *et al*., 1999). During the terminal Pleistocene and Early Holocene, pine and oak forests were probably more extensive than the relict stands that persist on Santa Cruz and Santa Rosa islands today.

One of the largest Early Holocene faunal assemblages from the islands is from Daisy Cave. At least 19 shellfish taxa were identified, including California mussels, *Tegula* spp., black abalone, and sea urchins. The Early Holocene levels also produced roughly 27,000 fish bones from at least 19 different taxa (Rick *et al*., 2001a). The fish remains suggest that the Paleocoastal occupants of Daisy Cave fished in a variety of habitats, but the dominance of sheephead, sculpins, rockfish, and surfperch suggest that fishing took place primarily in kelp forest and other rocky nearshore habitats. Much smaller numbers of pinniped, sea otter, and bird bones were recovered from the Early Holocene levels and dietary reconstructions suggest that fish and shellfish dominated the meat diet of the cave occupants (Rick *et al*., 2001a).

The early deposits at Cave of the Chimneys also produced a rich assemblage of marine faunal remains. Rocky shore shellfish, especially mussels, black abalone, red abalone, and turban snails were the most common resource, but rockfish, surfperches, and California sheephead were also identified (Rick *et al*., 2001a). Excluding large numbers of tiny rodent and reptile bones, which were probably of natural origin, much smaller quantities of mammal and bird bone were recovered, including two fragments of probable deer bone that may have been transported from the mainland for bone tool-making purposes. SMI-608 produced faunal samples that are similar to Cave of the Chimneys and other early island sites, including marine shell (e.g., mussel, black abalone, owl limpet, and turban), land snail shell, and small amounts of fish (California sheephead, surfperch, and sculpin), mammal, and other bone (see Erlandson *et al*., 2005a, pp. 680–682). The data from Cave of the Chimneys and SMI-608 are also comparable to early assemblages at SMI-522, SMI-548, and SMI-606 (Erlandson & Rick, 2002a; Erlandson *et al*., 2004b,c).

On Santa Rosa Island our understanding of human subsistence is limited to data from just a few early island sites. At SRI-6 on the northwest coast, 17 shellfish taxa were identified, but were primarily from black abalone and California mussel. Vertebrate remains were much less common, but include sheephead, rockfish, and clupeids, a few undiagnostic bird and sea mammal bone fragments, and rodent and lizard bones that were probably of natural origin. Recent research has identified a unique cluster of early sites around the margins of an ancient estuary on the southeast coast of Santa Rosa. Two sites (SRI-84 and SRI-666) dated prior to 7500 years ago have been documented near this paleoestuary, both demonstrating a mixed reliance on rocky shore and estuarine shellfish, a pattern more similar to the adjacent mainland than other island assemblages (Rick *et al*., 2005b).

On Santa Cruz Island, the early levels at SCRI-109 produced a faunal assemblage rich in California mussels and other rocky coast shellfish remains, with smaller quantities of sea mammal, fish, and bird bones (Glassow, 1993b, 2002, 2005a). In his detailed analysis of shellfish remains, Sharp (2000, pp. 64) identified possible evidence for increasing predation pressure from the Early to Middle Holocene, including a decline in average mussel size from about 7.9 cm to 5.6 cm. Glassow recently completed a monograph on his work at SCRI-109, so further details on the faunal remains and subsistence technology should soon be available (Glassow, personal communication).

Analysis of Early Holocene faunal remains from the Eel Point site on San Clemente Island suggests a relatively heavy reliance on sea mammals such as seals, sea lions, and dolphins (Porcasi *et al*., 2000), but shellfish (California mussels, etc.) from rocky shorelines still appear to have dominated the diet of the earliest site occupants (Erlandson *et al*., 2006). Although fishing seems to have been of limited economic importance during the early occupation at Eel Point, zooarchaeological data from the site support the technological and geographic evidence for the existence of a relatively sophisticated maritime adaptation on San Clemente Island by at least 9000 years ago.

Summary

Once thought to have been occupied relatively recently (Rogers, 1929; Yesner, 1987), California's Channel Islands are now known to have been settled by maritime Paleocoastal peoples at least 13,000 to 12,000 calendar years ago. Early island sites have produced some of the earliest evidence for maritime voyaging, shell middens, and marine fishing in the Americas, as well as the oldest fishhooks, basketry, and shell beads from the Pacific Coast of North America. These discoveries have contributed to the emergence of the coastal migration theory as a viable option for explaining the initial entrance of humans into the Americas. The antiquity and relatively large number of early sites now known from the Channel Islands also suggest that early island use was more intensive than once thought. This, in turn, raises the possibility that human impacts on insular and ecologically fragile island ecosystems may have begun earlier than previously believed possible.

Substantial progress has been made in understanding the nature of early human use of the Channel Islands, but many questions remain. When did humans first reach the various Channel Islands and when did the first relatively permanent occupation take place? Did humans contribute to the extinction of the pygmy mammoths on the northern islands and what effects did early islanders have on pinnipeds, sea otters, shellfish, and other marine species or communities? How important were plant foods in early island economies, which plants were used, and where were they obtained? What was the relationship of these early peoples with contemporary populations on the mainland or with the later islanders who developed into the Island Chumash or Tongva of historic times? To all these questions, at least for now, we have no clear answers.

Transition and expansion: Middle Holocene (7000 to 3500 years ago)

Between about 7000 and 3500 years ago, dramatic cultural and environmental changes took place on the Channel Islands. Increased evidence for permanent settlement, technological continuity and innovation, artistic elaboration, the beginnings of subsistence intensification, and the development of long-distance exchange systems all occurred during the Middle Holocene. It may also be the time when the ethnic divisions on the northern and southern islands first appeared. Some of the antecedents of social and political complexity seen later were probably first established during this time as well. Fueling these cultural changes may have been the relative abundance of food resources on the Channel Islands, seen in the formation of numerous shell middens containing a variety of shellfish and fish species and a probable increase in the use of sea mammals.

Many of these cultural developments coincided with environmental changes. The Altithermal, for instance, a 3000-year span of higher than average temperatures in western North America occurred during portions of the Middle Holocene (Antevs, 1952; Jones *et al*., 1999). Postglacial sea level rise slowed dramatically during the Middle Holocene,

approaching levels similar to modern times. These long-term environmental factors had profound effects on Native populations living in the Americas and particularly strong consequences for Channel Island peoples. Although many intriguing cultural, historical, and ecological questions can be addressed with Middle Holocene data, this time period remains the most poorly documented and least understood for the Channel Islands (see Glassow, 1997).

We explore some of the salient issues of the Middle Holocene archaeological record of the Channel Islands, relying on data from several key sites to illustrate temporal changes and spatial variability (Table 3). The cultural developments of this time period involved changes in land use practices by the Native Islanders over time. These included when and how people settled the landscape, obtained food for subsistence, and developed innovations in utilitarian technologies concomitant with changes in land use strategies. The development of long distance exchange networks provides some of the best and earliest evidence for trade and exchange involving island peoples. In many respects, the archaeological record of the Middle Holocene appears to fit nicely between cultural developments that happened before and after, seemingly a transition from earliest settlement to the relatively complex, politically stratified, and linguistically diverse ethnicities encountered by Europeans beginning in the sixteenth century.

Settlement

During the Middle Holocene, people began to use the islands more intensively than in earlier times (Kennett, 2005, pp. 128–153). The overall distribution of sites suggests settlement focused on the most productive island habitats, although Middle Holocene sites are found across the Channel Islands, including coastlines (SNI-161), marine terraces (SCLI-1215), caves (SMI-603) and rockshelters (SMI-261), and interior hilltops (SRI-50). People took advantage of marine ecosystems that flourished after sea level stabilization. Intertidal and subtidal shellfish communities appear to have been particularly productive during the Middle Holocene due partly to changes in Holocene environments. Stable littoral cells formed with headlands providing sediments for sandy beaches and creating ideal locations for human settlement. People used the juxtaposition of sandy and rocky coasts to their advantage. Evidence in the form of large, multi-component sites attests to the importance of these areas for human settlement. Smaller sites indicative of more ephemeral occupation, like those reported for Santa Cruz (Glassow, 2005a) and San Clemente islands (Raab, 1997), suggest the intensity of site use was dependent on the availability and distribution of resources.

Sites located along the shores of headlands were particularly favorable for fishing and gathering activities in nearshore and kelp bed habitats (Glassow, 2005a). Examples of headland sites include Otter Point (SMI-481), Punta Arena (SCRI-109), Thousand Springs (SNI-11), and Eel Point (SCLI-43), all sites with evidence for prolonged and intensive use. Because of their large size and well-stratified deposits, these and other sites have been the focus of archaeological inquiry (see Bleitz-Sanberg, 1987; Glassow, 2002; Sharp, 2000; Raab, 1997). How they fit into the overall Middle Holocene settlement pattern is difficult to discern, although each contains evidence that a variety of activities took place, especially processing food remains. On Santa Rosa, some interior sites have been found on hilltops adjacent to plant resources and located in exposed areas with excellent view, possibly for defensive or territorial purposes (Kennett, 2005; Kennett & Clifford, 2004). The Celery Creek site (SNI-351), situated on the central plateau and almost directly in the middle of San Nicolas Island, suggests that Middle Holocene populations utilized interior locations while conducting many of the same activities seen at coastal sites (Martz, 1994). This site's location adjacent to a

freshwater source and with clear views of much of the island's surface and surrounding ocean waters was an important factor in its use. In fact, radiocarbon dates suggest it was occupied for much of the Holocene (see Table 3). In general, however, human settlement during the Middle Holocene was focused around productive marine habitats, especially rocky coasts with relatively easy access to the ocean. On San Miguel and San Nicolas islands, the more heavily watered northwest coasts attracted heavy human settlement. These areas were also some of the most productive stretches of coastline.

On the east coast of Santa Rosa Island, the Abalone Rocks Estuary appears to have been a focus of human settlement for much of the Early and Middle Holocene, where several sites (SRI-77, SRI-191, SRI-192, SRI-667) contain dense occupations with a mix of marine and estuarine shellfish species (Rick *et al*., 2005b). Along the northwest coast of Santa Rosa Island a series of sites (SRI-3, 4, 5, and 6) excavated by Orr (1968) appear to contain cemeteries and/or dense concentrations of human settlement, most of which are dated to the Middle Holocene.

As the islands became a focal point for humans, land use patterns began to shift to more permanent settlements. The earliest evidence for permanent houses on the Channel Islands dates to the Middle Holocene. At the Nursery site (SCLI-1215) on San Clemente Island, four Middle Holocene house pits were excavated among a possible total of eighteen, although some of these may have been constructed and occupied later in time (Salls, Raab, & Bradford, 1993; Raab, 1997; Rigby, 1985). The four houses contained whale bone scapulae and ribs, presumably as structural members, storage pits, hearths, post molds, other household features, and were located in the lee of a fossil dune adjacent to a large shell midden. These house pits clearly illustrate that by the Middle Holocene, people settled the islands year-round and stayed in small villages with multiple households, probably representing extended families.

In addition to pit houses, indirect evidence suggests that people began to live on the islands more permanently with year-round occupation and more intensive use. For example, it is likely that people first transported island foxes (*Urocyon littoralis*) from the mainland to some of the Channel Islands during the Middle Holocene. A few San Miguel fox specimens may date to the Pleistocene (Guthrie, 1993), but no securely dated fox bones are known from the islands prior to 6000 years ago, with San Nicolas Island (the most remote Channel Island) receiving foxes as early as 5200 cal B.P. (Vellanoweth, 1998). If the islands were not being intensively used and permanently settled, it is doubtful that people would have invested the time and energy to capture, contain, and transport these animals across many kilometers of ocean water. Foxes may have been useful as fur-bearers, as scavengers to keep processing areas clean, as hunters to control disease-carrying mice populations, and as sources of edible meat during lean seasons or years.

Technology

In general, Middle Holocene technologies on the Channels Islands remained similar to those of the Early Holocene. However, more archaeological evidence of these technologies exists, suggesting island populations were growing and land use was intensifying. Technological advances in fishing and hunting gear appear to have occurred at the end of the Middle Holocene (Glassow, 1997; Raab, 1997). It is likely that population pressure, human induced environmental impacts, environmental or climatic perturbations, and changes in regional sociopolitical structure led to technological and cultural elaboration seen at the end of the Middle Holocene. The limited size of the islands, the discrete distribution of available resources, and the growth of human populations probably led to environmental circumscription, which forced people to adopt new technologies, settlement patterns, and subsistence pursuits

Table 3 Selected Middle Holocene sites from the Channel Islands

Site	Age (cal B.P.)[a]	Description	References
San Clemente			
SCLI-1178	6620-4830	Cave site with shell midden, containing abundant pink abalones and a human burial	Raab, 1997
SCLI-43	6450-3340	Large, multi-component shell midden with evidence of Middle Holocene dolphin hunting and diverse maritime lifeways	Cassidy *et al*., 2004; Porcasi, 1995; Raab, 1997; Salls, 1990a
SCLI-1215	5300-3990	Multi-component site with house pits, burials, whale bone structures, and other habitation debris	Raab, 1997
San Nicolas			
SNI-11	6980-3500	Multi-component dune site with shell midden, hearth features, faunal remains, and stone, bone, and shell artifacts	Bleitz-Sanberg, 1987; Martz, 2005; Martz, Grenda, & Rosenthal, 1999
SNI-351	6100-3520	Large site in dune field with abundant rocky coast fish and shellfish, stone tools, and *Olivella* beads	Martz, 1994, 2005
SNI-161	5670-3560	Multi-component dune site with red and black abalone middens, fish, bird, and sea mammal bones, projectile points, knife blades, and soapstone and *Olivella* beads	Vellanoweth, 1996; Vellanoweth & Erlandson, 1999
SNI-168	5460-3520	Large, multi-component dune site with fish, bird, and shellfish remains, and expedient and formal tools	Martz, 2005; Rosenthal & Jertberg, 1997
SNI-40	4390-3550	Residential site on dune, dominated by rocky shore fishes, sea mammals, and shellfish remains	Martz, 2005; Rosenthal & Jertberg, 1998a
SNI-165	4330-3830	Dune site with rocky shore fish, sea lion, bird, black abalone and turban snail, and shell beads	Martz, 2005; Rosenthal & Jertberg, 1998a
SNI-171	4270-3810	Large residential dune site with fish, bird, sea mammal, cetacean, and rocky shore shellfish remains	Martz, 2005; Rosenthal & Jertberg, 1997
SNI-157	4240-3720	West end site in dune field with sardines, rocky coast fish, fur seal, albatross, black abalone, and turban snail	Martz, 2005; Rosenthal & Jertberg, 1998a
SNI-16	4220-3840	Dune site with shellfish, fish, bird, and sea mammal remains, stone tools, and formal artifacts	Lauter, 1982; Martz, 2005
SNI-169	3830-3610	West end site with abundant fish remains and some rocky shore shellfish	Martz, 2005; Rosenthal & Jertberg

Table 3 Continued

Site	Age (cal B.P.)[a]	Description	References
Santa Catalina			
SCAI-17	5920-3900	Multi-component shell midden with shellfish, fish, and sea mammal remains, stone and bone tools, and beads	Porcasi, 2002; Raab *et al.*, 1995a; Raab, 1997
Santa Barbara			
SBI-19	4260-4060	Small, shallow shell midden on terrace, with shellfish and small amounts of fish and mammal bone	Rick, 2001
SBI-1	3830-3640	Shell midden located above Landing Cove on northeast coast of the island	Erlandson *et al.*, 1992
SBI-2	3610-3390	Dense shell midden with expedient stone tools and diverse shellfish and fish remains	Erlandson *et al.*, 1992
Anacapa			
ANI-5	5280-5120	Dense shell midden disturbed by historic activity	Greenwood, 1978; Rick, 2006; Rozaire, 1978
ANI-8	5020-4860	Small rockshelter with shell midden, artifacts, and human burials	Greenwood, 1978; Rick, 2006; Rozaire, 1978, 1993
Santa Cruz			
SCRI-610	6910-6780	Shell midden on island interior associated with large chert quarry	Clifford, 2001; Kennett, 2005; Perry, 2005
SCRI-549	6870-5280	Shell midden exposed in sea cliff and at least 65 cm thick, with abundant mussel and red abalone	Glassow, 2005a
SCRI-406	6760-4840	Small shell midden located at 1500 feet, including a bowl fragment, tarring pebble, manos and bifaces	Perry, 2004, 2005
SCRI-429	6470-6310	Shell midden located in sea cliff with fish, mammal, and shellfish remains, and abundant mussel and red abalone	Glassow, 2005a
SCRI-109	6400-4840	Large, multi-component shell midden, with red abalone component, dolphin bones, and diverse fish assemblage	Glassow, 1993a,b, 2002, 2005a,b; Sharp, 2000
SCRI-333	6170-3470	Large, multi-component shell midden with cemetery, red abalone midden, and house depressions	Glassow, Kennett, Kennett, & Wilcoxon, 1994; Wilcoxon, 1993
SCRI-427	6170-5550	Shell midden with shellfish, mammal, and fish bones, and abundant California mussel and red abalone	Glassow, 2005a
SCRI-698	6110-5860	Rockshelter with shell midden located on headland on east coast	Perry, 2004, 2005
SCRI-36	5020-4820	Interior residential site with shell midden and lithics	Peterson, 1994

Table 3 Continued

Site	Age (cal B.P.)[a]	Description	References
SCRI-236	5290-4870	Shell midden near Christy Beach, with red abalones, mussel, and other rocky shore shellfish	Glassow, 1993a, b
SCRI-608	4430-3490	Large shell midden site along a low, flat ridge with rocky shore shellfish and ground stone fragments	Kennett, 2005
Santa Rosa			
SRI-5	7230-4500	Multi-component shell midden with a red abalone deposit	Erlandson, 1994; Orr, 1968
SRI-3	6880-4110	Dense shell midden with long occupation dominated by rocky shore shellfish and a diverse artifact assemblage	Erlandson, 1994; Orr, 1968
SRI-192	6730-6560	Multi-component shell midden with small rockshelter and a variety of estuarine shellfish taxa	Rick *et al*., 2005b
SRI-116	6300-5040	Dense shell midden exposed in the sea cliff and inside a small cave	Erlandson, 1994; Kennett, 2005
SRI-667	6260-4180	Multi-component dune shell midden dominated by California mussel and estuarine shellfish in basal deposit	Rick *et al*., 2005b
SRI-43	6160-5260	Multi-component interior site with shell midden, human burials, and diverse artifact assemblage	Kennett, 2005; Orr, 1968; Rick *et al*., 2002
SRI-191	6110-4240	Multi-component shell midden with red abalone deposit, estuarine shellfish, and mussel and urchin layer	Rick *et al*., 2005b
SRI-109	5790-5150	Large shell midden located on prominent point adjacent to beach, with abundant red abalones and other shellfish	Kennett, 2005
SRI-147	5700-3980	Deeply stratified and dense shell midden deposit located at the confluence of two drainages in Jolla Vieja canyon	Kennett, 2005
SRI-41	5470-3630	Large and complex shell midden and burial site situated in sand dunes with abundant artifacts	Kennett, 2005; Orr, 1968
SRI-50	4820-4290	Interior site with shell midden located in logistical location, probably used in all seasons	Kennett, 2005
San Miguel			
SMI-1	7140-3250	Interior site with multi-component shell midden, sea mammal bones, and diverse artifact assemblage	Erlandson, 1991b; Kennett, 2005; Rozaire, 1978
SMI-261	6900-3540	Multi-component cave site with black abalone, mussel, turban, vertebrate remains, and expedient stone tools	Erlandson *et al*., 1996

Table 3 Continued

Site	Age (cal B.P.)[a]	Description	References
SMI-350	6860-6490	Large dune site on upper ridge of Harris Point with red abalone and other faunal remains	Kennett, 2005
SMI-603	6680-3960	Multi-component cave site with dense shellfish, fish, sea mammal, and bird remains, and expedient tools	Vellanoweth *et al*., 2002b, 2003
SMI-605	6740-6270	Small sandstone cave with thin deposits containing shellfish and vertebrate remains and *Dentalium* artifacts	Erlandson *et al*., 2005d
SMI-481	6620-3580	Large, multi-component dune site with Middle Holocene red abalone and mussel components containing artifatcs and abundant faunal remains	Rick, 2004a,b; Vellanoweth *et al*., 2006
SMI-557	6570-5960	Shell midden exposed in gully walls on south coast with dense concentration of red abalone shells	Braje *et al*., 2005; Glassow, 1993a
SMI-528	5900-4800	Multi-component shell midden located in dune system on Point Bennett with faunal remains and artifacts	Kennett, 2005
SMI-492	5580-5420	Multi-component shell midden in dune with human burials, diverse faunal remains, and artifacts	Kennett, 2005; Walker & Snethkamp, 1984
SMI-396	5120-3130	Large, multi-component dune site with shellfish and vertebrate remains, expedient stone tools, and asphaltum basketry impressions	Braje *et al*., 2006b
SMI-87	4790-3830	Large multi-component dune site with projectile points, a variety of shellfish remains, and a basketry impression	Rick, 2002, 2004a,b

[a]The ages for each site are generally 1 sigma calibrated age ranges provided by the authors. These distributions vary slightly depending on what was reported by the original researchers. Most northern islands dates and Santa Barbara Island were calibrated using Calib 4.3 (Stuiver & Reimer, 1993, 2000), applying a ΔR of 225 $\pm$ 35 years to compensate for local upwelling (Kennett *et al*., 1997).

at the close of this time period. Economic intensification, especially of fishing, promoted additional population growth and necessitated increases in trade, yet utilitarian technologies did not change much during the Middle Holocene.

Some archaeologists have suggested that there was a Middle Holocene "maritime optimum" on the Channel Islands; when people used existing technologies to harvest a variety of marine resources in a time of exceptional littoral productivity that required little technological innovation (Raab, 1997, pp. 32–33). The Little Harbor site on Santa Catalina Island (SCAI-17; Raab, Bradford, Porcasi, & Yatsko, 1995a), Eel Point on San Clemente Island (SCLI-43), and the Bird Blind site on San Nicolas Island (SNI-161; Vellanoweth, 1996; Vellanoweth & Erlandson, 1999) are shell middens that contain abundant evidence

of intensive littoral and nearshore use by humans with little technological changes from the Early Holocene. Local quarries provided raw materials for stone tool production including contracting-stemmed, square-stemmed, and side-notched projectile points, knife blades, macro-drills, and core/flake or expedient tools. Stone projectile points were used to hunt sea mammals, while knives and simple core and flake tools were used to butcher carcasses, process flesh (muscle, fat, ligaments, and skin), and detach bones for tool-making material. Utilized flakes and expedient stone tool making debris, however, make up the vast majority of chipped stone tools found at Middle Holocene sites. Indurated sandstone was used to make abraders, perforators, bowls, anvils, net weights and other ground stone tools, items that the islanders traded later in time.

Like maritime peoples worldwide, Channel Islanders used a variety of shell and bone tools for everyday purposes. The bone gorge, made from bird and sea mammal bone, and similar to ones found in the Early Holocene, was the primary fishhook used in nearshore, kelp bed, and offshore fisheries. Sea mammal bone was also used to manufacture harpoon shanks, abalone pries, flakers, and spears, while bird bone was used to make needles, awls, and other tools for fiber-based technologies. King (1990, pp. 80) argued that during the Middle Holocene people in southern California first began to use composite bone fishhooks, but relatively little is known about this early fishing technology largely because it is unclear if bone barbs identified in archaeological contexts are from composite fishhooks, harpoons, or other technologies. Abalone and clam shells were processed into adzes, simple containers, and spoons, and mussel shells were sharpened and used as knives. It is also possible that single piece shell fishhooks, an important fishing innovation that transformed Late Holocene economies, first appeared near the end of the Middle and beginning of the Late Holocene. Most shells, however, formed the basis for an increasingly rich ornament and decorative industry that began in the Middle Holocene.

Fiber-based technologies included nets, bags, baskets, twine, and rope commonly made from local sea grass (*Phyllospadix* sp.), although these perishables rarely survive in the archaeological record. More perishable artifacts are known from Early Holocene than Middle Holocene sites. This somewhat puzzling pattern is probably due to the emphasis of archaeologists on early sites, especially in caves and rockshelters (see Connolly *et al*., 1995; Vellanoweth *et al*., 2003). Indirect evidence for perishable technologies, however, is relatively abundant. The earliest evidence for coiled and twined basketry is found in Middle Holocene sites on San Miguel (SMI-87, SMI-396) and San Nicolas (SNI-11, SNI-161) islands. As early as 5000 years ago, people began water-proofing baskets with asphaltum (probably water bottles), leaving behind evidence in the form of asphaltum basketry impressions and tarring pebbles (Bleitz 1991; Braje, Erlandson, & Timbrook, 2006b; Rick, 2004a; Vellanoweth, 1996). The development of asphaltum-sealed water bottles may have been a response to Middle Holocene aridity and the growing need to store and transport water from springs that were less reliable and more widely scattered (Braje *et al*., 2006b). A variety of beads and ornaments were also produced during the Middle Holocene, when we see the first evidence for widespread trade and exchange networks.

Trade and interaction

The development of trade networks based on the flow of basic and luxury goods in and out of the Channel Islands connected islanders to each other and mainland peoples. As permanent settlement of the islands continued during the Middle Holocene, people had to maintain social and economic relationships throughout the region. Trade networks strengthened cooperative relationships, group cohesion, marriage alliance, and economic stability. Island

resources, especially marine shell, chert, soapstone, sandstone, ochre, and other minerals and pigments formed the nexus of materials used to produce utilitarian and luxury artifacts for trade. Evidence for inter-island and mainland exchange increases in Middle Holocene archaeological sites. It is during this time period that the diversity of artifact types and style increased. These networks were probably mediated by shared linguistic and cultural identity but evidence for Middle Holocene long-distance exchange seemed to, in most cases, cross ethnic boundaries, suggesting that a complex set of social, political, and economic factors were in place.

Regional exchange involved the movement of specific resources between the islands and beyond. Santa Catalina soapstone, highly valued for its workability and resistance to heat, was a valuable commodity traded widely in the region (Howard, 2002; Meighan & Rootenburg, 1957; Romani, 1982; Rosen, 1980; Wlodarski, 1979). Although soapstone is also found on the mainland, Santa Catalina soapstone is unique for the Channel Islands and was the primary source in the region. Soapstone was manufactured into beads, bowls, *comales* (cooking pans/griddles), effigies, and other utilitarian and ornamental items. Santa Catalina soapstone, in the form of raw material, artifacts, and manufacturing debris, has been found in Middle Holocene sites on the southern and northern islands. For instance, all three Middle Holocene components at the Bird Blind site (SNI-161) on San Nicolas Island contain soapstone artifacts, including unmodified chunks, beads, and an incised charmstone (Vellanoweth, 1996). On Santa Rosa Island, soapstone artifacts, especially beads, have been reported for Middle Holocene sites as well (Orr, 1968; Kennett, 1998). The occurrence of soapstone on Santa Catalina Island helped stimulate regional exchange networks. Northern islanders likely traded high quality cherts, absent from the southern islands, in exchange for soapstone and other goods.

Although stone was an important trade item, it was the availability and abundance of shellfish on the islands that was the backbone of exchange networks. The Channel Islands were a center for shell bead and tool production that maintained trade routes throughout the region. As a testament to the growing importance of shell artifacts, shell beads and other ornaments became more elaborate during the Middle Holocene. Shell artifacts were made from a variety of species including abalone, mussel, clam (*Tivela* spp., *Saxidomus* spp.), money tusk (*Dentalium pretiosum*), and particularly purple olive (*Olivella biplicata*). While simple spire-ground *Olivella* beads were typical during the Early Holocene, the Middle Holocene witnessed a florescence of new styles including rectangular, oval, and round disks made from the wall portion of this small gastropod. Rectangle beads were some of the earliest forms of wall beads produced on the Channel Islands and have been found in Middle Holocene components on all but Anacapa and Santa Barbara islands (Orr, 1968; Raab & Howard, 2002; Scalise, 1994; Vellanoweth, 2001). This stylistic explosion probably reflects an increased demand for island products from mainland groups, but it may also be an outcome of increased sedentism that resulted in island regionalization and the formation of separate cultural or ethnic identities. The archaeological record for this time period suggests that people on the mainland increasingly desired island goods, especially *Olivella* beads.

The Middle Holocene witnessed an expansion of long-distance exchange networks that connected people on the Channel Islands to the coastal mainland and beyond. Shell beads may have been one of the island goods traded to interior groups in exchange for obsidian (Fitzgerald *et al*., 2005; Rick *et al*., 2001b) and other commodities. The distribution of *Olivella* Grooved Rectangle (OGR) beads may provide some of the earliest evidence for the formation of distinct cultural interaction spheres on the Channel Islands and adjacent mainland. OGR beads, a relatively rare (<275) bead type manufactured from the wall portion of the shell, have been found in archaeological sites across the Southern Channel Islands,

the adjacent mainland coast, western Nevada, and central Oregon (Howard & Raab, 1993; Jenkins & Erlandson, 1996; Vellanoweth, 1995, 2001). These beads had sawn (rather than drilled) perforations that left a distinctive groove down the middle. Direct AMS radiocarbon dating shows they were made primarily around 5000 ± 500 cal B.P. OGR beads originated on the Southern Channel Islands and moved rapidly throughout the historically documented territory of Uto-Aztecan speaking peoples. To date, this bead type has not been found on the Northern Channel Islands and only four have been found in Santa Barbara County. That these Middle Holocene beads are found primarily in areas occupied historically by Uto-Aztecan speakers suggest that this trade was at least partially mediated by social and cultural factors–and that the ancestors of the Tongva may have reached the Southern Channel Islands by at least 5000 years ago.

Subsistence strategies

In many ways, Middle Holocene peoples on the Channel Islands had a cornucopia of subsistence resources from which to choose, and people appear to have had a relatively balanced marine diet. Littoral foraging, nearshore and kelp bed fishing, and sea mammal hunting provided a dietary nexus that was supplemented by birds, wild plant foods, and trade with mainland peoples (Glassow, 1993b; Raab, 1997; Vellanoweth & Erlandson, 1999). Although plants likely provided key nutrients to the overall diet, little archaeological evidence for this has survived. The majority of dietary reconstructions have focused on the relative contribution of marine resources (Bleitz, 1993; Erlandson, Vellanoweth, Rick, & Reid, 2005d; Glassow, 1993a; Kennett, 2005; Martz, 2005; Raab, 1992; Salls, 1988; Vellanoweth & Erlandson, 1999; Vellanoweth *et al*., 2002b). These reconstructions suggest island peoples adopted a relatively balanced diet, although shellfish made up the majority of animal flesh consumed. Fishing appears to have become more important for sustaining growing and more sedentary populations, a pattern that continued into the Late Holocene.

Considerable variation has been documented for Middle Holocene subsistence patterns across the Channel Islands. On the northern islands and San Nicolas, red abalone (*Haliotis rufescens*) middens accumulated between about 7500 and 3500 years ago (Glassow, 1993a, 2005a; Sharp, 2000; Vellanoweth, 1996; Vellanoweth & Erlandson, 1999). Red abalones appear to have favored the cooler waters off the Northern Channel Islands, but were also abundant on San Nicolas Island (Fig. 6). Similar sites accumulated on the southern islands, although warmer water abalone species were harvested (Raab, 1992; Raab, Porcasi, Bradford, & Yatsko, 1995b; Salls, 1988, 1991, 1992; Vellanoweth & Erlandson, 1999). As Sharp (2000) noted, some red abalone middens actually contain a mix of pink, red, and black abalones, and a wide variety of shellfish taxa. These data suggest that while some Middle Holocene sites may be dominated by red abalone shells, Middle Holocene shell middens on the whole are considerably more diverse.

Middle Holocene shell middens vary in size from large, dense sites (likely villages or residential camps) located within dunes, to small, relatively thin single-component sites that were probably temporarily or seasonally occupied. Although abalones (*H. cracherodii*, *H. corrugata*, *H. fulgens*, *H. rufescens*) are sometimes the most conspicuous constituent in these middens, other shellfish taxa typically include mussels (*Mytilus californianus*, *Septifer bifurcatus*), turban snails (*Tegula spp*.), owl limpets (*Lottia gigantea*), chitons (*Cryptochiton stelleri*), and other rocky shore species. In decreasing dietary importance fish, sea mammal, and bird round out the food refuse commonly found in Middle Holocene shell middens. On Santa Cruz Island, Glassow (2005a) estimated the dietary significance of excavated Middle Holocene shell middens using the weight method, finding that mussels accounted for at least

Fig. 6 Middle Holocene red abalone midden (SNI-161) eroding out of sand dune on northwestern San Nicolas Island

60% of all shellfish in what he called red abalone middens. Our own research at Otter Point (SMI-481) on San Miguel Island showed that in some cases red abalone made up over 70% of the faunal remains and over 90% of the edible flesh represented in the sample (Vellanoweth, Rick, Erlandson, & Reynolds, 2006). At the same time in a roughly contemporaneous component, mussel dominated the shellfish assemblage, accounting for over half of all fauna by weight. When relative dietary reconstructions were calculated, however, mussel supplied slightly under 12% of the total diet while sea mammal ($\sim$ 60%) and fish ($\sim$ 17%) contributed the vast majority of meat consumed. Red abalone was negligible, providing less than 1% of the meat diet in this component.

The Bird Blind site (SNI-161) provides another example of the diversity of subsistence strategies employed by islanders during the Middle Holocene. This site contains four discrete components separated by dune sand (Vellanoweth, 1996; Vellanoweth, 1998; Vellanoweth & Erlandson, 1999). The components range in age between about 5200 cal B.P. and 3000 cal B.P. In the earliest two components and the latest (Late Holocene), fish comprised roughly 50%, 70%, and 85% of the meat diet, respectively. In the third component ($\sim$ 3800 cal B.P.) the dietary contribution of animals was relatively balanced between shellfish, fish, and sea mammal, with red ($\sim$ 36%) and black ($\sim$ 13%) abalones dominating the shellfish taxa. Because San Nicolas is the outermost and most isolated of all the Channel Islands, we interpret the heavy use of fish at this site as an indicator of earlier than usual economic intensification based on fishing, a pattern more commonly seen during the Late Holocene (Vellanoweth & Erlandson, 1999). Other Middle Holocene sites with evidence for substantial use of nearshore fisheries include Eel Point, Big Dog Cave, and the Nursery site on San Clemente, as well as Little Harbor on Santa Catalina (Salls, 1988). California sheephead were more intensively exploited by people on the southern islands, perhaps reflecting more favorable conditions in the south (Raab, 1997, pp. 27–29). These and other subsistence-related differences between the islands should be expected considering the amount of environmental variation that exists in the southern California Bight.

Other cross-channel differences in subsistence patterns include the intensity of sea mammal hunting and offshore fishing. Hunting of sea mammals, including dolphins, appears to have peaked during the Middle Holocene on some of the Channel Islands (Glassow, 2005b; Porcasi & Fujita, 2000; Porcasi *et al*., 2000). The best archaeological evidence for Middle Holocene sea mammal hunting, however, comes from the southern islands including sites on San Clemente (Eel Point), Santa Catalina (Little Harbor), and San Nicolas (Thousand Springs). These sites contain an abundance of sea mammal bone, including whale, dolphin, elephant seal, sea lion, and sea otter (Bleitz, 1993; Porcasi, 2002; Porcasi *et al*., 2000). Ocean sunfish (*Mola mola*), a large, generally pelagic fish, and albatross (Diomedeidae) have also been identified in Middle Holocene components at some of these same sites (Porcasi, 1999a; Porcasi & Andrews, 2001). The Abalone Rocks Estuary on Santa Rosa Island, was also used during the Middle Holocene and appears to have been a focus of shellfish collecting during the Early and Middle Holocene (Rick *et al*., 2005b). More work on Middle Holocene sites would likely add to our understanding of the diversity of subsistence strategies that took place during this time period, when subsistence economies seemed to have transitioned from Early Holocene patterns focused on shellfish gathering to Late Holocene emphases on fishing. Clearly, the Middle Holocene was a time of great change, as human economies across the islands were expanding and diversifying.

Summary

In many ways, the archaeological record of the Middle Holocene fits nicely between the relatively mobile peoples of the terminal Pleistocene and Early Holocene and the complex, sedentary peoples identified on most of the islands during the Late Holocene. Temporally, culturally, and environmentally it was a time of transition, as populations probably grew and people used portions of the islands more intensively. The stabilization of sea level and apparent climatic variability also characterize the Middle Holocene and probably had profound effects on cultural developments, especially new and more diversified subsistence strategies. The cultural and environmental developments of the Middle Holocene were fundamental for paving the way for the rapid and dramatic changes that followed in the Late Holocene. Although we have amassed a great deal of information on Middle Holocene cultures of the Channel Islands, numerous questions remain and in many ways this is the least studied time period on all of the islands.

Diversity and complexity: The Late Holocene (3500 years ago to AD 1820)

The last 3500 years or so witnessed some of the most rapid and pronounced cultural developments on the Channel Islands and southern California Coast (see Erlandson & Jones, 2002). During this period, many of the developments or transitions that started in the Middle Holocene reached their zenith, as people were living in larger and increasingly sedentary villages, exchange relationships greatly intensified, and social and political hierarchies also increased. On San Clemente Island, there is only limited evidence for cultural complexity and a diverse array of site types, suggesting variability in social and political organization on the Channel Islands and southern California Coast (Raab, Yatsko, Garlinghouse, Porcasi, & Bradford, 2002). The Late Holocene also culminated with the first contacts with Europeans in the sixteenth century, the removal of most islanders to mainland missions by the early nineteenth century, and the ultimate occupation of the islands by Euroamericans. This was a period of great change for Native American peoples and the natural and cultural history of the Channel Islands. As part of a larger work on Late Holocene archaeology in California,

several syntheses of Late Holocene island adaptations were recently published (Kennett & Conlee, 2002; Munns & Arnold, 2002; Raab *et al*., 2002; Vellanoweth *et al*., 2002a), where interested readers may find more details on specific islands.

Many of the cultural hallmarks of historic island peoples probably first appeared in the Late Holocene. Items such as the circular shell fishhook, the plank canoe, *Olivella* cup beads, the bow and arrow, and toggling harpoons accompany significant social developments (Arnold, 1995; Arnold & Bernard, 1995; Erlandson & Rick, 2002b; Gamble, 2002; Glassow, 1996; Kennett, 2005; King, 1990; Munns & Arnold, 2002; Raab *et al*., 2002; Rick *et al*., 2002; Vellanoweth *et al*., 2002a). There were also substantial changes in subsistence, including increasing use of offshore resources like swordfish and tunas (Bernard, 2004; Rick, 2004a). As island populations greatly expanded and technologies became more sophisticated, we see some of the greatest human impacts on the environment (Erlandson *et al*., 2004a, 2005c; Raab *et al*., 1995b, 2002; Rick *et al*., 2006). Our knowledge of the complex archaeological record of each of these distinct topics comes to us from a series of archaeological sites that have been excavated on the eight islands (Table 4). The record is far from complete, with some of the bigger gaps on Santa Catalina Island and the smaller islands of Santa Barbara and Anacapa.

Settlement

The changes in settlement that occurred in a few contexts in the Middle Holocene (e.g., increased sedentism and reduced mobility) reached their pinnacle during the last 3500 years when several large villages were established on many of the islands. Associated with the formation of these large, multi-family villages–many of which persisted into historic times–is a diversity of site types. Small lithic scatters and camps, a wide variety of shell middens, possible defensive sites, and the use of rockshelters are all part of the Late Holocene system of settlement and land use (Fig. 7). Our understanding of these practices has recently expanded due to survey and excavation projects conducted on Santa Cruz, San Miguel, Santa Rosa, San Clemente, and San Nicolas islands. One major bias in Late Holocene research on the northern islands, however, is a focus on large villages and cemeteries that date to the last 1500 years, with comparatively little work done on the previous half of the Late Holocene, or site types other than villages. Our understanding of Late Holocene settlement, particularly on the northern islands, is also enhanced by ethnohistoric data, which provide names and locations of historic Chumash villages, many of which were also occupied prehistorically (see Arnold, 1990; Kennett, 2005; J. Johnson, 1999a).

Some of the most comprehensive research on Late Holocene Chumash culture and settlement on Santa Cruz Island has been reported by Arnold (1987, 1992a, 1994, 2001a, 2004) and her colleagues, who worked at a series of villages dated from about 1500 years ago through the historic era. This research suggests that most Island Chumash were living in large, multi-family villages scattered around some of the most defensible and productive areas on the islands. These communities participated in large exchange and interaction networks with other villages on the islands and mainland. Depending on their geographic location, many of these villages focused on the production of beads and microblades. On eastern Santa Cruz Island, several interior chert quarries, used largely for microblade production, demonstrate broader patterns of human procurement and land use.

Perry's (2003, 2004, 2005) trans-Holocene analysis of Santa Cruz Island settlement demonstrates that maritime subsistence patterns and cultural complexity increased during the Late Holocene. Perry's (2004) work which involved 66 sites and 90 distinct

Table 4 Selected Late Holocene archaeological sites from the Channel Islands

Site	Age (cal B.P.)[a]	Description	References
San Clemente			
SCLI-43	3560-520	Large, multi-component shell midden with dense artifact and marine faunal assemblages	Raab *et al*., 1994, 1995b, 2002; Porcasi *et al*., 2000; Raab & Yatsko, 1992; Salls, 1991
SCLI-120	~3000	Large habitation site on a marine terrace above Wilson Cove with dolphin, fish, and limited pinniped bones	Porcasi & Fujita, 2000
SCLI-1215	2910-460	Multi-component site with house pits and burials and a prehistoric fishing kit found with a burial	Raab *et al*., 1994; Salls, 1988
SCLI-1319	2300-290	Shell midden dominated by *Tegula* shells	Raab, 1992; Raab *et al*., 1994, 1995b, 2002
SCLI-1524	1170-320	Evidence for ritual occupation and raptor burials, grave goods, ceremonial dog and fox burials	Raab *et al*., 1994
SCLI-1318	1090-300	Shell midden dominated by *Tegula* shells	Raab, 1992; Raab *et al*., 1994, 2002
SCLI-259	980-760	Buried/eroded midden locus dated to Medieval Climatic Anomaly	Yatsko, 2000
SCLI-244	920-730	Partially buried and intact midden dated to Medieval Climatic Anomaly	Yatsko, 2000
SCLI-1492	~450[b]	Shell midden with dense fish remains located near center of island	Salls, 1988
SCLI-126	Historic[b]	Shell midden with historic artifacts and obsidian hydration readings that also suggest a Late Holocene prehistoric occupation	Goldberg, Titus, Salls, & Berger, 2000
SCLI-119	Historic[b]	Cave site with shell midden, dense fish assemblage, and some fishing related artifacts	Salls, 1988, 1990b
San Nicolas			
SNI-11	3840-510	Multi-component dune site with shell midden and diverse shellfish, bird, fish, mammal, and artifact assemblages	Bleitz, 1993; Martz, 2005; Schwartz & Martz, 1992; Vellanoweth *et al*., 2002a
SNI-169	3690-2830	West end site with bifaces, a scraper, net weight, and chipped stone debitage, and rich fish and mammal assemblages	Rosenthal & Jertberg, 1997; Vellanoweth *et al*., 2002a
SNI-168	3640-150	Large, multi-component dune site with soapstone pendants, beads, chipped and ground stone artifacts, and faunal remains	Rosenthal & Padon, 1995; Rosenthal & Jertberg, 1997; Vellanoweth *et al*., 2002a
SNI-39	3210-2780	Large dune site with *Olivella* beads, chipped stone tools, and fish, bird, sea mammal, and shellfish remains	Rosenthal & Jertberg, 1998a; Vellanoweth *et al*., 2002a

Table 4 Continued

Site	Age (cal B.P.)[a]	Description	References
SNI-161	3080-930	Multi-component dune site with dense shell midden and diverse artifact and faunal assemblages	Martz, 2005; Vellanoweth, 1996; Vellanoweth *et al*., 2002a
SNI-102	2780-2150	Camp site on southwestern plateau with chipped stone tools and a variety of shellfish and fish remains	Martz, 2005; Vellanoweth *et al*., 2002a
SNI-163	2330-2120	Intact shallow midden with shell fishhooks, beads, and chipped stone debitage, and shellfish, fish, mammal, and bird remains	Rosenthal & Jertberg, 1998a; Vellanoweth *et al*., 2002a
SNI-171	2130-1980	Large residential dune site with an obsidian biface, ground and chipped stone artifacts, a fishhook, and faunal remains	Rosenthal and Jertberg, 1997; Vellanoweth *et al*., 2002a
SNI-160	1710-930	Shell midden on dune with numerous fishhooks, soapstone beads, chipped stone and bone artifacts, shell beads, a twined bag, and a variety of shellfish, fish, bird, and mammal remains	Martz, 2005; Rosenthal & Jertberg, 1998b; Vellanoweth *et al*., 2002a
SNI-73	950-730	Residential site on southern terrace with dense fish, shellfish, sea otter, pinniped, and bird remains	Martz, 2005
SNI-25	740-Historic	Large village site on upper plateau with dense faunal remains, features, and a diverse artifact assemblage	Martz, 2005
Santa Catalina			
SCAI-17	1330-880	Multi-component shell midden with shellfish, fish, and sea mammal remains, stone and bone tools, and beads	Porcasi, 2002; Raab *et al*., 1995a
SCAI-26	660-280	Broad and shallow midden deposit associated with soapstone quarries	Howard, 2002; Reinman & Eberhart, 1980; Raab *et al*., 1994
SCAI-77	Protohistoric /Historic[b]	Large soapstone quarry with vessel scars and quarrying debris	Howard, 2002
SCAI-118	Historic[b]	Small camp site associated with soapstone quarries and vessel crafting	Rosen, 1980; Howard, 2002
SCAI-137	270-230	Protohistoric shell midden with abundant black abalone	Rosenthal *et al*., 1988
Santa Barbara			
CA-SBI-2	3610-2750	Dense shell midden with expedient stone tools and diverse shellfish and fish remains	Erlandson *et al*., 1992
CA-SBI-9	2680-2120	Shell midden with a diverse assemblage of shell, bone, and stone artifacts, and faunal remains	Erlandson *et al*., 1992; Rozaire, 1978

Table 4 Continued

Site	Age (cal B.P.)[a]	Description	References
CA-SBI-3	1350-1160	Lithic scatter and shell midden with a metate, mortars and pestles, a soapstone bowl, and chipped stone	Erlandson *et al*., 1992
CA-SBI-12	770-560	Shell midden with abundant owl limpet and black abalone remains	Rick & Erlandson, 2001
CA-SBI-16	670-550	Badly disturbed shell midden near landing cove on east coast	Erlandson *et al*., 1992
Anacapa			
ANI-1	3530-3430	Moderately dense shell midden that reportedly contained human burials	Greenwood, 1978; McKusick, 1959; Rick, 2006
ANI-4	3210-3070	Shell midden on northern terrace that may have contained human burials	Greenwood, 1978, McKusick, 1959; Rick, 2006
ANI-2	2910-2780	Dense shell midden bisected by main island trail	Greenwood, 1978; Rick, 2006
ANI-5	~850-450[b]	Dense shell midden disturbed by historical activities, with microblades and an *Olivella* cup bead	Greenwood, 1978; Rick, 2006; Rozaire, 1978
ANI-6	630-540	Eroding shell midden disturbed by historic activities with abundant fish and shellfish remains, and microblades	Greenwood, 1978; Rick, 2006; Rozaire, 1978, 1993
ANI-8	630-540	Small rockshelter with shell midden, microblades, and human burials	Greenwood, 1978; Rick, 2006; Rozaire, 1978, 1993
Santa Cruz			
SCRI-333	3640-1260	Large, multi-component shell midden with house features and abundant artifacts and faunal remains	Wilcoxon, 1993
SCRI-240	3210-Historic	Dense shell midden and village complex with house features and abundant artifacts and faunal remains. Location of historic village *Xaxas*	Arnold, 1990, 2001a; Graesch, 2004; Kennett, 2005; Noah, 2005
SCRI-1	2560-Historic	Large and dense shell midden. Location of historic village *Liyam*	Arnold, 1990; Glassow, 1993b; Kennett, 2005; Peterson, 1994
SCRI-195	2340-Historic	Large shell midden with house pits and abundant artifacts and faunal remains	Kennett, 2005
SCRI-423	2330-Historic	Large multi-component shell midden with *Olivella* beads and microblades. Probably part of historic village *Swaxil*	Kennett *et al*., 2000; Kennett, 2005
SCRI-191	1980-300	Dense shell midden with house features and abundant artifacts and faunal remains	Arnold, 2001a

Table 4 Continued

Site	Age (cal B.P.)[a]	Description	References
SCRI-236	1710-Historic	Shell midden and village complex with house features. Location of historic village *Ch'oloshush*	Arnold, 1990, 2001a; Glassow, 1993b; Graesch, 2004; Kennett, 2005; Noah, 2005
SCRI-474	1530-540	Large shell midden with house features, abundant artifacts, and faunal remains	Arnold, 2001a
SCRI-506	1050-Historic	Dense shell midden with house features, abundant artifacts. Along with SCRI-504 probable location of historic village *Nanawani*	Kennett *et al*., 2000
SCRI-647	1080-760	Seasonal residential base at 1200 feet with evidence for plant processing	Perry, 2003, 2004
SCRI-93	~ 1200-450[b]	Microblade quarry site with cores, flakes, and triangular prepared and trapezoidal microblades	Arnold, 1987
SCRI-328, -329, and -330	790-Historic	Dense shell midden with house features, abundant artifacts, and faunal remains. Three sites all situated on adjacent lobes form historic village *L'akayamu*	Arnold, 1990, 2001a; Graesch, 2004; Noah, 2005
SCRI-192	790-Historic	Dense shell midden and village complex with house features, abundant artifacts, and faunal remains. Location of historic village *Shawa*	Arnold, 1990, 2001a; Graesch, 2004; Noah, 2005
SCRI-306	670-410	Dense shell midden with house features, abundant artifacts, and faunal remains	Arnold, 1987
SCRI-507	260-Historic	Shell midden with microblades and Olivella beads disturbed by historic activities. Probably part of Historic village *Swaxil*	Arnold, 1990; Kennett *et al*., 2000; Kennett, 2005
Santa Rosa			
SRI-41	3450-1150	Large shell midden and cemetery site situated in sand dunes with abundant artifacts	Kennett, 2005; Orr, 1968
SRI-4	3160-2130	Large shell midden and cemetery site situated in sand dunes with abundant artifacts	Orr, 1968
SRI-3	2920-2360	Large shell midden and cemetery site situated in sand dunes with abundant artifacts	Orr, 1968
SRI-62	2680-Historic?	Large shell midden with house features. Probable location of historic village of *Nilal'uy*	Kennett, 2005
SRI-1	2680-2110	Large, multi-component shell midden with circular fishhooks and faunal remains	Orr, 1968; Rick *et al*., 2002

Table 4 Continued

Site	Age (cal B.P.)[a]	Description	References
SRI-2	2030-Historic	Large shell midden and village complex with house features, two cemeteries, and dense artifact and faunal remains. Location of historic village of *Niaqla*	Orr, 1968; Rick, 2004a
SRI-6	1580-550	Large shell midden with burials and artifacts exposed on terrace and in sea cliff	Erlandson *et al*., 1999; Kennett, 2005; Orr, 1968
SRI-15	1190-Historic?	Large shell midden with probable house features and diverse artifacts. Probable location of historic village *Nimikilkil*.	Kennett, 2005; Paige, 2000
SRI-77	1180-950	Large, multi-component shell midden with house features and dense artifact assemblage	Kennett, 2005
SRI-85	1170-420	Large shell midden with numerous house features and abundant artifacts	Kennett, 2005
SRI-97	770-Historic	Large shell midden and village site with house features, artifacts, and dense faunal remains. Probable location of historic village *Nawani*	Kennett, 2005
SRI-60	650-Historic	Large shell midden and village site with house features, abundant artifacts, and faunal remains. Location of historic village *Hichimin*	Kennett, 2005; Orr, 1968
SRI-40	330-Historic	Large shell midden and village complex with house features and dense artifact and faunal assemblages. Location of historic village *Silimihi*	Kennett, 2005
SRI-87	Historic	Large shell midden with house features and historic artifacts. Location of historic village *Qshiwqshiw*	Kennett, 2005
SRI-436	470-Historic?	Large shell midden with house features and dense faunal and artifact assemblages. Probable location of historic village of *He'lewashkuy*	Kennett, 2005
San Miguel			
SMI-261	3590-640	Multi-component cave site with shell midden, bead maker's artifact kit, sea grass artifacts, tarring pebbles, and dense faunal remains	Connolly *et al*., 1995; Erlandson *et al*., 1996
SMI-481	3470-380	Large multi-component dune site and dense Late Holocene shell midden and diverse faunal remains	Rick, 2004a, b

Table 4 Continued

Site	Age (cal B.P.)[a]	Description	References
SMI-525	3230-520	Dense, eroding shell midden with several discrete strata and abundant faunal remains	Kennett, 2005; Walker & Snethkamp, 1984
SMI-87	3200-2340	Large, multi-component dune site with projectile points, bone barbs, a shell fishhook, shell beads, and diverse faunal remains	Rick, 2002, 2004a,b
SMI-503/504	3050-1050	Shell midden in large dune complex with evidence for stone bowl manufacture	Conlee, 2000; Kennett & Conlee, 2002
SMI-528	1570-1120	Multi-component shell midden located in dune system on Point Bennett with abundant sea mammal bones and artifacts	Walker *et al*., 2002
SMI-163	1290-Historic	Shell midden with house features, abundant shell bead production, and fishhooks. Probable location of historic village *Tuqan*	Rick, 2004a,b
SMI-232	1280-1060	Dense shell midden and sea mammal bone bed located in gully exposure	Braje *et al*., 2005
SMI-468	1280-430	Large shell midden site with the remains of 10 probable house or other residential features	Kennett & Conlee, 2002; Rick, 2004a
SMI-602	540-Historic	Eroding shell midden and village complex with house features and artifacts on Point Bennett rookery	Walker *et al*., 2002
SMI-470	460-Historic	Dense shell midden with house features and abundant artifact and faunal assemblages. Probable location of historic village *Niwoyomi*	Rick, 2004a

[a]The ages given for each site are generally 1 sigma calibrated age ranges provided by the authors. These distributions vary slightly depending on what was reported by the original researchers. Most northern islands dates and Santa Barbara Island were calibrated using Calib 4.3 (Stuiver and Reimer, 1993, 2000), applying a ΔR of 225 ± 35 years to compensate for local upwelling (Kennett *et al*., 1997).

[b]Age estimated by original researchers based on artifact associations.

temporal components also documented the use of several new chert quarries, rockshelters, and continued use of villages around ideal locations. One of the more unique sites Perry (2004) identified is SCRI-647, an interior site situated at about 1200 feet in an oak and pine woodland. Interpreted as a seasonal residential base with evidence of microblade production and use of plant resources, this is one of the few interior Late Holocene sites that has been described.

Late Holocene occupation of Santa Rosa Island is similar to those of Santa Cruz. A series of large villages (SRI-2, SRI-60, SRI-97, etc.) that were occupied into the historic period contain rich faunal and artifact assemblages and surface house features (see Kennett, 2005; Rick, 2004a; Fig. 8). Kennett (2005, pp. 169–170) describes a reduction in the use of interior

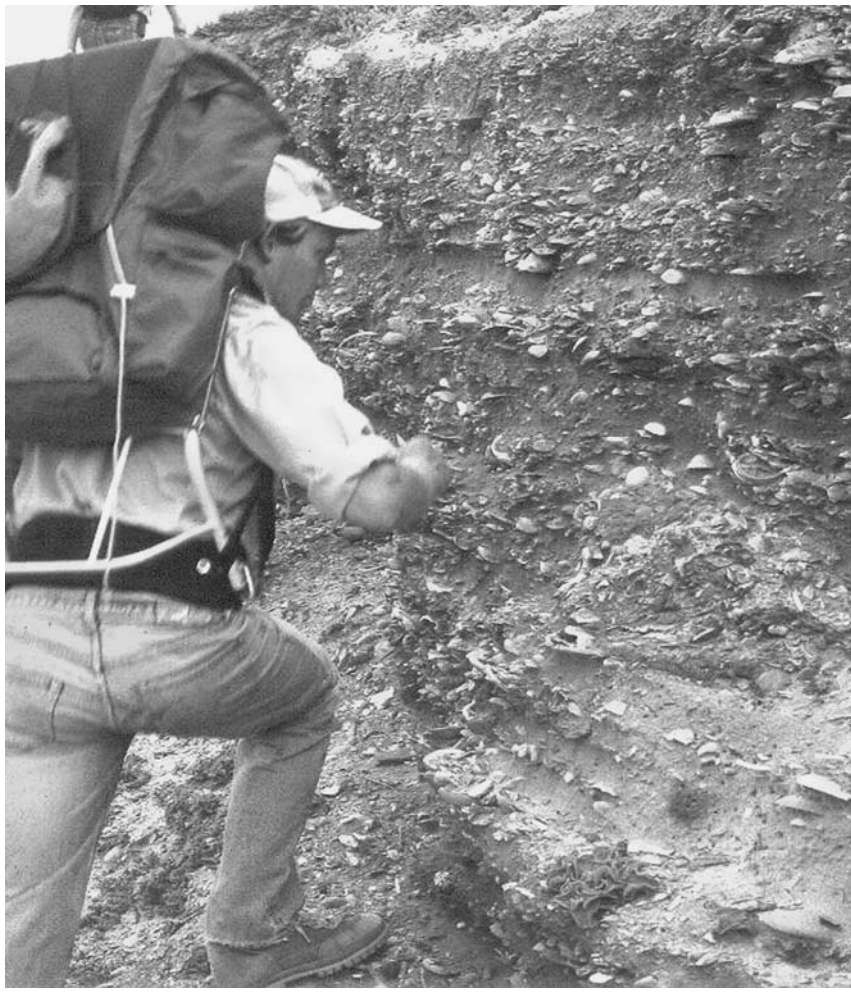

Fig. 7 Erlandson at dense stratified Late Holocene shell midden (SMI-525) on northwestern San Miguel Island. These deposits span roughly 3500 to 500 cal B.P (photo by Madonna Moss).

residences after 3000 years ago across the northern islands, arguing that between about 3000 and 1300 years ago settlement was similar to the Middle Holocene with limited evidence for large and diverse site types and sedentism. One such site with a cemetery that may hint at sedentism is SRI-41 at Canada Verde that also has extensive Middle Holocene deposits (see Kennett, 2005, pp. 137, 170; Orr, 1968), suggesting that further research is necessary to better define its chronology.

On San Miguel Island, populations appear to increase and, although there is greater settlement at large villages concentrated on the coast, a variety of site types were used, including rockshelters and interior sites (Kennett, 2005; Rick, 2004a). The settlement trend towards large villages after about 1500 years ago is apparent at a number of San Miguel sites, including SMI-163, SMI-468, SMI-470, and SMI-602. Prior to this time, large villages were generally rare or absent, although Rick's (2002, 2004a,b) work at SMI-87 provided a picture

Fig. 8 Historic and late prehistoric era Chumash village (SRI-97) on the south side of Santa Rosa Island (undulating hummocks and depressions in center of photo are the remains of semi-subterranean house pits surrounded by shell midden)

of a large site in a prominent location with diverse faunal remains and human burials. This site probably indicates increased sedentism, but still differs from the large sites dated to after 1500 years ago. Rockshelters and lithic scatters dated to the last 3000 years, suggest that logistical sites and camps were also an important component of Late Holocene settlement systems on San Miguel (see Rick, 2004a).

On the Southern Channel Islands, there is also evidence for increased population growth and a diverse range of site types and settlement strategies. On San Clemente Island, several Late Holocene sites have been tested, including the trans-Holocene deposits at Eel Point (SCLI-43), small *Tegula* middens (SCLI-1319 and SCLI-1318), rockshelters (SCLI-119), and village sites. Raab *et al*. (2002, pp. 26) suggested that the cultural complexity apparent on some of the other islands may not have been completely manifested on San Clemente. The available data, however, suggest a diverse settlement and occupation of the island during the Late Holocene. At the Lemon Tank site (SCLI-1524), for example, there is evidence of ritual activities, including human, dog, fox, and raptor burials (Raab, Bradford, & Yatsko, 1994). The Nursery site (SCLI-1215) also provided evidence of a house pit and burials. Yatsko's (2000) recent settlement and demographic analysis also indicates site abandonment during the Medieval Climatic Anomaly, a feature he attributed to climatic changes (e.g., drought).

On San Nicolas Island, a number of Late Holocene archaeological sites have been excavated and documented, with ^{14}C dates from 45 components at 36 different sites (Vellanoweth *et al*., 2002a, pp. 87). As Vellanoweth *et al*. (2002a) and Martz (2005) noted, Late Holocene peoples appear to have used all parts of the island, a pattern that differs from the focus on the northwest coast during the Middle Holocene. These include numerous sites on the island's upper plateau, suggesting that Late Holocene settlement may have involved movement to secondary areas. Sites such as Thousand Springs (SNI-11) suggest occupations spanning much of the Late Holocene (and earlier), and many of the larger shell middens and residential sites appear to be located in dunes (e.g., SNI-168, SNI-60). Similar to the other islands, San Nicolas' population may have reached its zenith around 1300 years ago. Recent work at SNI-25, a village occupied during late prehistoric and historic times, documented

numerous domestic features, hearths, ritual dog and fox burials, and diverse faunal and artifact assemblages, illustrating the relatively sedentary and complex lifestyles of the peoples of San Nicolas.

Although Santa Catalina Island is the most prominent of the southern islands, it has seen relatively limited archaeological research, with most of this work concentrated on soapstone quarries and associated sites (e.g., Howard, 2002; Rosen, 1980; Williams & Rosenthal, 1993). Consequently, many of the sites that have seen research (SCAI-26, SCAI-77, and SCAI-137) appear to be Late period or Protohistoric sites associated with soapstone procurement (see Howard, 2002). A few shell middens have also been excavated, such as SCAI-137, but our knowledge of the lifeways and settlement on Catalina is limited.

The small islands of Santa Barbara and Anacapa have also seen limited work. On Santa Barbara Island at least five sites dated to the Late Holocene have been identified and most of these appear to be camps (see Erlandson, Glassow, Rozaire, & Morris, 1992; Rick, 2001; Rick & Erlandson, 2001). Anacapa also contains about six shell middens and a rockshelter (ANI-8) that appear to date to the Late Holocene (Rick, 2006; Rozaire, 1978). Rozaire's excavation of ANI-6 and ANI-8 on West Anacapa produced microblades that suggest that Anacapa Islanders were involved in broader exchange systems or that this island was used sporadically by peoples based on adjacent Santa Cruz Island. The presence of chert deposits (see Schoenherr *et al*., 1999) on West Anacapa suggest that people may have used this source for stone tool production, although much of it appears to be of low quality.

Technology and exchange

Early and Middle Holocene archaeological data suggest a great deal of continuity in the types of technologies that people used. Continuity is also present in the Late Holocene archaeological record, but many new technologies that represent improved subsistence strategies, exchange, or other activities first appear to have been used during the last 3500 years. One of the most controversial and heavily debated technological innovations is the use of the *tomol* or *tiat*, a plank boat that is seaworthy and relatively efficient (see Arnold, 1995; Arnold & Bernard, 2005; Davenport, Johnson, & Timbrook, 1993; Fagan, 2004; Gamble, 2002). These boats were a hallmark of historically documented peoples in the region. Seaworthy craft were obviously available since the terminal Pleistocene (Erlandson, 2002), but plank canoes may have been necessary for regular journeys from the islands to the mainland, to carry more people or larger loads, and to take swordfish and other large pelagic marine species (see Arnold & Bernard, 2005; Gamble, 2002). They were also part of the Chumash system of wealth, power, and prestige. Recent research has focused on the origins and antiquity of plank boats, with some suggesting that plank boats or some other similar boat have been around since the Early Holocene (Cassidy *et al*., 2004; Fagan, 2004) and others arguing that they probably appeared sometime during the last 2000 to 1500 years (Arnold, 1995; Arnold & Bernard, 2005; Davenport *et al*., 1993; Gamble, 2002). Jones and Klar (2005) recently suggested that plank boats (and other artifacts) may have been introduced to the Chumash and Tongva by Polynesians around 1500 years ago. A central problem in this debate is that boats or their parts (e.g., planks, canoe drills) rarely preserve or are difficult to identify in the archaeological record. The oldest identified plank in southern California, however, comes from Daisy Cave on San Miguel Island and was dated to ca. 1300 cal B.P. (see Gamble, 2002, pp. 308). Several other boat making parts have also been identified in island settings. Current evidence suggests that large plank boats may have first appeared during the Late Holocene, but islanders had efficient boats since their colonization.

A number of other technologies also first appeared or became widespread in the Late Holocene. New or refined subsistence technologies include the single-piece shell fishhook, toggling harpoons, composite bone fishhooks, and a variety of arrow points (see Fig. 5). The single-piece fishhook significantly improved fishing capabilities in the area and some of the oldest specimens in the region come from the Channel Islands (see Rick *et al*., 2002; Strudwick, 1986). At the Eel Point site on San Clemente Island, several fishhooks and blanks may date to about 3200 cal B.P., while others may be roughly 4000 years old (see Raab *et al*., 1995b, pp. 14), but none of these have been directly AMS dated, leaving questions about their precise age. Vellanoweth and Erlandson (1999) also reported an associated date for single-piece fishhooks of roughly 3000 cal B.P from SNI-161 on San Nicolas Island. The oldest directly dated hooks currently come from San Miguel Island where a hook from SMI-87 was dated to 2500 cal B.P. (Rick *et al*., 2002) and another hook from SMI-152 recently dated to about the same age. These island dates for fishhooks are roughly comparable with early dates from the mainland (see Koerper, Prior, Taylor, & Gibson, 1995; Rick *et al*., 2002), suggesting their use around 3000 to 2500 cal B.P. or earlier. After about 2500 years ago, circular shell fishhooks become one of the most common subsistence artifacts in island sites.

Stone and bone tool production, except microblade technology, has seen relatively limited attention on the islands. This is partly because stone tools are generally found in fairly modest quantities and are often dominated by expedient tools. The bow and arrow probably first appeared on the Channel Islands around 1500 cal B.P., altering some hunting strategies and may have also marked a period of increased interpersonal violence (Kennett, 2005, pp. 187). Arrows and other projectile points and bifaces have been identified in a number of Late Holocene sites across the islands (Martz, 2005; Pletka, 2001a; Rick, 2004a; Vellanoweth *et al*., 2002a). Microblades have been identified on many of the islands with a huge production industry identified on the Northern Channel Islands and probably centered near Santa Cruz, where a large source of raw material exists (Arnold, 1987). Microblades were fashioned into drills and then used to perforate shell beads, making them integrally linked to island bead production and exchange systems (Arnold, 1987; Arnold, Preziosi, & Shattuck, 2001; Preziosi, 2001; see Fig. 5). Wake (2001) recently reported on a large assemblage of bone tools including barbs, gorges, awls, and knives from Late Holocene Santa Cruz Island and Rick (2004a) reported many similar artifacts from San Miguel and Santa Rosa islands. Finally, perishable artifacts or their impressions on tar are also occasionally identified in Late Holocene sites and include fibers from bags, water bottles, fishing line, and other artifacts (see Bleitz & Salls, 1993; Martin & Popper, 2001; Rick, 2004a).

Artifacts associated with exchange, personal ornamentation, and wealth greatly increased during the Late Holocene, particularly during the last 1000 years (Arnold & Graesch, 2001; King, 1990). While several types of *Olivella* and other beads have been identified in Early and Middle Holocene sites, the number and types of beads and ornaments identified in Late Holocene deposits increases exponentially, including numerous types of *Olivella*, red and black abalone, clam, mussel, *Trivia*, and other shell beads and ornaments (Arnold & Graesch, 2001; King, 1990; see Fig. 5). These beads were traded from islanders to mainlanders in a complex trade network that sometimes carried marine shell artifacts as far as the American Southwest.

During the last 1500 years, the Island Chumash manufactured beads by the millions (see Arnold, 1992a; Arnold & Graesch, 2001; Arnold & Munns, 1994; Graesch, 2004; Kennett & Conlee, 2002). The vast majority of these beads were made on the Northern Channel Islands, although beads were also made on the southern islands. Numerous island sites have produced these beads and associated artifacts, with some of the densest concentrations found in Late period and Historic villages on Santa Cruz, Santa Rosa, and San Miguel islands (Arnold,

2001a; Kennett, 2005). Some excavated levels at SRI-85 and SRI-97, for instance, contained over 40 kg of *Olivella* shell detritus per m^3, suggesting a major emphasis on bead making at some Late Holocene sites (Kennett & Conlee, 2002).

Less is known about bead production on the Southern Channel Islands, but Late Holocene people on San Nicolas were also producing *Olivella* and other beads for exchange (Vellanoweth *et al*., 2002a). On Santa Catalina Island, Ripper's Cove (SCAI-26), Miners Camp (SCAI-118), SCAI-77, and other sites have produced evidence of protohistoric specialization in soapstone *olla* and *comal* production for exchange (see Howard, 2002). Ground stone bowls intended for exchange may have also been mass produced on San Miguel (Conlee, 2000) and Vellanoweth *et al*. (2002a) and Thomas-Barnett (2004) also described a ground stone industry on San Nicolas Island. These data suggest that a variety of artifacts were made by Channel Islanders for trade. Much of this production-for-exchange on the islands may have resulted from the dearth of terrestrial resources on the islands and the need to acquire supplementary subsistence goods (e.g., acorns) from the mainland. Analysis of obsidian artifacts from Late Holocene island sites also suggests that these trade relations reached far into interior portions of California (Rick *et al*., 2001b). Although some Late Holocene artifacts may have been traded far and wide, the majority of beads and other artifacts were exchanged within Chumash and Tongva territory in a well defined network of interaction and trade.

Subsistence strategies

Correlating with many technological advances are a number of changes in Late Holocene subsistence. One of the most pronounced is an increase in the economic importance of fish and a decrease in the relative importance of shellfish (Kennett, 2005; Noah, 2005; Raab *et al*., 1995b, 2002; Rick, 2004a,b; Vellanoweth *et al*., 2002a,b; Vellanoweth & Erlandson, 1999). This change is probably related to population growth and the need for increased food yields provided by fish that other resource classes (e.g., shellfish) could not sustain. People continued to focus largely on nearshore fisheries, but during the last 1500 years there is an increase in fishing for deepwater fishes like tunas, swordfish, and mako sharks (Bernard, 2004; Bowser, 1993; Colten, 2001; Paige, 2000; Pletka, 2001b; Rick, 2004a). The increase in pelagic fishing may be related to the development of the plank canoe (Arnold & Bernard, 2005; Bernard, 2004; Davenport *et al*., 1993). The general increase in fishing efficiency is also related to the appearance of the single-piece fishhook.

At several sites on San Miguel Island (SMI-232, SMI-481, SMI-528), the densities of pinniped bones increase greatly around 1500 cal B.P., suggesting that some islanders were also intensively hunting pinnipeds during this time (Kennett, 2005; Rick, 2004a; Walker, Kennett, Jones, & Delong, 2002). After about 1500 cal B.P., the densities of pinniped remains in San Miguel Island sites are generally much lower. This reduction appears to be related to human hunting and other activities (see Rick, 2004a; Walker *et al*., 2002). At the Eel Point site on San Clemente Island, a trans-Holocene decline in marine mammal hunting efficiency was recently presented by Porcasi *et al*. (2000) who argued that during the Late Holocene people focused primarily on sea otters, with limited reliance on sea lions, fur seals, and dolphins that were important earlier in time. At several Late Holocene sites on Santa Cruz Island, Colten and Arnold (1998) and Colten (2002) noted that sea mammals were of supplemental importance to most economies. Collectively, these data suggest that sea mammal hunting varied on each of the islands, with some of the greatest hunting occurring on more distant islands (e.g., San Miguel, San Clemente).

Although their significance in human diets decreases, the variety of shellfish being used appear to increase in many Late Holocene sites, suggesting that people were intensifying

their subsistence strategies to deal with population growth and greater social circumscription. On San Clemente Island, black abalones appear to decline in sites through time, while small *Tegula* shells appear to increase during the Late Holocene, a pattern demonstrated by the occurrence of numerous small *Tegula* middens (SCLI-1318 and -1319) that may be processing or satellite camps (Raab, 1992; Raab *et al*., 2002). On the Northern Channel Islands, the diversity of shellfish taxa is generally high in Late Holocene sites (Kennett, 2005; Rick, 2004a). California mussel appears to be the dominant shellfish species at most northern island assemblages and the contribution of black and red abalones generally appears to decline. Recent analysis of a trans-Holocene sequence of California mussel and red and black abalone shell sizes on San Miguel Island, including over 10,000 shell measurements, documents some declines in shell size through time that suggest human predation pressure, but no catastrophic change throughout the sequence (Braje *et al*., 2006a; Erlandson *et al*., 2004a; Rick *et al*., 2006). At the Prisoner's Harbor site, a Historic and prehistoric village on Santa Cruz Island, Noah (2005, pp. 279–283) described a dense concentration of black abalone shells, associated with swordfish, sea turtle, sea mammal, a variety of other fish and shellfish remains, and metal crucifixes, that she argues may be evidence for a Chumash feasting ceremony.

Compared to other faunal classes, Birds are generally limited in Channel Island sites throughout the Holocene, and consequently less is known about archaeological bird remains than other faunal classes. On the Southern Channel Islands, however, the analysis of bird remains from the Little Harbor site on Santa Catalina, Eel Point on San Clemente, and Thousand Springs on San Nicolas has provided important information on bird exploitation (see Bleitz, 1993; Porcasi, 1999b). Porcasi indicated that birds were more important in Early and Middle Holocene sites than Late Holocene sites, where they generally provided only about 7 to 10 percent of the total diet (Porcasi, 1999b, pp. 51–53). Not surprisingly most of these bird bones were from marine species. Colten (2001) and Noah (2005) also demonstrated that birds were of supplemental importance to Late Holocene Santa Cruz Islanders, but a variety of taxa (gulls, pelicans, auklets, cormorants, etc.) were identified in their assemblages. Similar taxa were reported for Late Holocene sites on San Miguel Island by Guthrie (1980) and Rick (2004a). Ritual raptor burials have also been identified on San Clemente Island, demonstrating the significance of birds in island social and symbolic life (Raab *et al*., 1994).

The increase in marine fishing during the Late Holocene was associated with less diverse over-all diets and appears to have contributed to declines in general human health (see below) on the Northern Channel Islands (Lambert, 1993). According to Lambert's (1993) analysis of skeletal assemblages from the Channel Islands and mainland coast, there are significantly higher rates of enamel hypoplasia, Harris lines, and interpersonal violence during the Late Holocene. Polluted water sources and increased crowding in villages may have also led to declines in health as human populations coalesced around the island's fairly limited potable water supplies. Interestingly, research on the Southern Channel Islands has found only limited evidence of interpersonal violence and comparatively healthy populations during the Late Holocene, emphasizing variability in the archaeological record or differences in sociopolitical organization (see Ezzo *et al*., 2002; Kerr, 2003; Raab *et al*., 2002, pp. 25; Titus, 1987).

Coupled with increased subsistence efforts, these changes in human health on the northern islands suggest that during the Late Holocene Native peoples in the region were having a particularly pronounced impact on the environment and quality of life on the Channel Islands. Erlandson *et al*. (2004a, 2005c) recently synthesized aspects of human impacts on the San Miguel Island environment, documenting apparent impacts, but indicating that

these were considerably less than those of the historic and modern periods. Rick *et al*. (2006) recently expanded on this research indicating that through time the Channel Islands and Santa Barbara Channel region were increasingly becoming anthropogenic landscapes shaped by the activities of Channel Islanders who had both positive and negative impacts. Raab *et al*. (2002), Porcasi *et al*. (2000), and others have argued for significant declines in human foraging efficiency during the Late Holocene on San Clemente Island. Guided by optimal foraging theory, they have argued for significant declines in marine mammals and shellfish starting in the Early and Middle Holocene resulting in the Late Holocene increase in fishing, a pattern that occurs with some variability on the Northern Channel Islands as well (Kennett, 2005; Rick, 2004a). In the San Francisco Bay area of California, Broughton (1994, 1997, 1999) has identified evidence for declining human foraging efficiency, or human hunting impacts on local animal populations. While Porcasi *et al*. (2000) and others have identified similar processes on San Clemente Island, such declines on the islands appear to be complex and warrant further research (see Kennett, 2005, pp. 220–223). This pattern is comparable to the variability noted by Butler and Campbell (2004) on the Northwest Coast of the Americas.

Cultural complexity

Associated with the dramatic changes in Late Holocene human subsistence, technology, health, and environmental impacts are a number of social and political developments, including heightened cultural complexity. In recent years, researchers have sought to explain when, how, and why Channel Islanders and Native peoples on the southern California Coast became increasingly complex and hierarchical, developments thought to correlate with the appearance of a simple chiefdom among the Chumash (see Arnold, 1992a, 2001b,c; Gamble, 2005; Kennett, 2005; Munns & Arnold, 2002; Raab & Larson, 1997; Vellanoweth *et al*., 2002a).

Much of this research has centered on understanding the evolution of cultural complexity among islanders and, in particular, the Chumash. This work has been guided by a number of theoretical paradigms including, Marxism, cultural ecology, and behavioral/evolutionary ecology (see Arnold, 1991, 1992a, 1993, 1997, 2001b; Arnold *et al*., 1997a; Colten, 1993; Larson, Johnson, & Michaelson, 1994; Raab & Larson, 1997). The Middle to Late period Transition (Transitional period; Arnold, 1992a) or Medieval Climatic Anomaly (Jones *et al*., 1999; Raab & Larson, 1997), ranging from roughly AD 1150 to 1300 or AD 800 to 1350, respectively, has received the most attention, although sites from this time period are generally limited. Arnold (1992a, 1992b, 1997, 2001a; Arnold *et al*., 1997a), Colten (1993), and others suggest a major cultural reorganization of Chumash society during the Transitional period, sparked by a period of elevated sea surface temperatures, variations in marine productivity, and drought. Aspects of this model have been challenged by Raab *et al*. (1995a) and Raab and Larson (1997) who argue that drought rather than changes in marine productivity were a catalyst to changes in Late Holocene social organization.

Recent research by Kennett (2005; see also Kennett & Conlee, 2002; Kennett & Kennett, 2000) has examined Island Chumash society across the Holocene. Grounded in behavioral ecology, Kennett (2005) employs a long-term perspective in looking at changes in hunter-gatherer societies. He emphasizes variability in the regional archaeological record, and a host of local responses to a variety of environmental and cultural variables. In his model, Island Chumash cultural complexity increases between 1500 and 650 years ago within the context of long-term population growth, climatic instability, resource intensification, and increasing patterns of interpersonal violence (Kennett, 2005; Kennett & Conlee, 2002;

Kennett & Kennett, 2000). Raab (1996), Raab and Larson (1997), Raab *et al*. (2002), and others have also explored changes in cultural complexity, emphasizing the importance of population growth, resource depression, and other factors in promoting increased social hierarchy. Arnold (1992a) and Johnson (2000) have indicated the importance of inter-village trade in developing political hierarchies. All of these models document a series of abrupt changes occurring largely during the Late Holocene and culminating in the Late period.

Data from individual burials and cemeteries have also been used to examine changes in sociopolitical complexity in the region, particularly evidence for hereditary (ascribed) leadership (Gamble, Walker, & Russell, 2001; King, 1990; Martz, 1992). Burial data are valuable for interpreting social organization because they can provide information on the status of individuals. King (1990), relying partly on burial data from SCRI-333 on Santa Cruz Island, suggested that Chumash cultural complexity and hereditary status differentiation may have emerged roughly 2500 years ago or earlier. Munns and Arnold (2002, pp. 144–145) challenged King's assertions for social ascription around 2500 years ago, suggesting the data were too limited to propose such an early date (but see Gamble *et al*., 2001). All the burial data from the Channel Islands and much of the data from the adjacent mainland comes from reanalyses of materials excavated 50 years ago or more by Phil Orr, Ronald Olsen, David Banks Rogers, and other early scholars working in the region. These studies often did not have the tight chronological or stratigraphic control necessary for defining changes in time, making the interpretation of burial data in the region somewhat problematic.

As stated above, analyses of patterns of health, disease, and violence from human skeletal remains from the Northern Channel Islands have also been used to explore the evolution of Chumash society (Hollimon, 1990; Lambert, 1993, 1994; Lambert & Walker, 1991). To Lambert (1993, 1994) and Lambert and Walker (1991), growing population densities and greater circumscription and territoriality promoted declines in health and increased violence. When compounded with environmental perturbations these events were important causes of cultural change and complexity. Hollimon's (1990) study of gender roles, health, and status of the Santa Barbara mainland and Channel Islands confirms many of Arnold's hypotheses about cultural changes during the Transitional period. Hollimon (1990, pp. 213–214) indicated that people living during the Transitional period suffered poorer health than people living before or after this time, and that cultural changes were probably instituted to buffer subsistence stress. Kennett (2005) and Raab and Larson (1997) also used some of these data to suggest that increased violence and subsistence stress around 1500 years ago may have promoted instability in the area and led to more competition and greater cultural complexity.

Collectively, the archaeological data from the Channel Islands suggest a great deal of spatial and temporal variability in human social organization and complexity. It is also clear that many of these developments (sedentism, exchange and interaction, etc.) have their roots in the Middle Holocene or earlier. The Island Chumash on the northern islands clearly had elaborate forms of social organization and exchange evident in the Late Holocene archaeological record. On San Nicolas Island, Vellanoweth *et al*. (2002a) documented similar patterns. On San Clemente Island, Raab *et al*. (2002) noted that there is limited evidence for cultural complexity, illustrating that the people who inhabited the various islands followed multiple trajectories and pathways throughout the past.

Culture contact

The final chapter of the Native American occupation of the Channel Islands began in the mid sixteenth century with the first contact with Europeans, intensified during the late eighteenth

century, and came to a close by AD 1820 to 1835 when the last islanders were removed to mainland missions. The first Europeans known to contact Channel Islanders were members of a Spanish maritime expedition led by Juan Rodriguez Cabrillo in AD 1542, who made landfall on Santa Catalina and San Miguel islands (Wagner, 1929). Several other early explorers made sporadic and often poorly documented visits to the islands (Erlandson and Bartoy, 1995). In recent years, a debate has arisen over the nature of these early contacts during the Protohistoric period (AD 1542–1769) and the possible impacts such contacts had on Native American populations and culture. In a preliminary study of paleodemography based on the frequency of ^{14}C dated sites, Erlandson, Rick, Kennett, and Walker (2001) speculated that population declines from introduced diseases may have occurred during the century after Cabrillo's visit, then populations may have rebounded before the onset of the Mission period. J. Johnson (1988, 1999b, pp. 96), Arnold *et al*. (2004, pp. 7–8), and others have suggested that these early contacts had little or no impact on populations and cultures.

Although the impacts of Protohistoric cultural contacts remain uncertain, during the Mission period (AD 1769–1834) introduced diseases affected Native populations on the mainland and islands. Moreover, islanders were brought to the mainland in a campaign to convert all of the neophytes at the missions. Using mission records, J. Johnson (1982, 1988, 2001) has traced baptisms for several Northern Channel Island villages to the missions. These records have also been used to examine patterns of inter-island and inter-village marriage on the northern islands (Johnson, 1993). Over the last several years, Arnold (1990), J. Johnson (1982, 1988, 1999a), Kennett (2005; Kennett, Johnson, Rick, Morris, & Christy, 2000), and others have made detailed efforts to locate the 22 Chumash communities described for the northern islands in ethnohistoric sources. Most of these village locations are now relatively well established and excavations have also shown some of the dynamics of the contact period on the islands. After the secularization of the missions, many Island Chumash formed communities along the southern California mainland, illustrating that the distinct nature of island social life persisted later in time (Johnson & McLendon, 1999).

Compared to the Chumash, early historic and ethnographic accounts of the Island Tongva are extremely limited, leaving archaeology as the primary means of reconstructing contact era cultural processes. On the southern Islands, evidence for Mission era ceremonialism and ritual, including dog and raptor burials were identified at the Lemon Tank, Big Dog Cave (SCLI-119), and Ledge (SCLI-126) sites (Raab *et al*., 1994; Rechtman, 1985). Salls (1988, 1990b) also reported on the fishery at Big Dog Cave, which in many ways is similar to other precontact fisheries. Preliminary evidence on San Nicolas Island also provides evidence for Protohistoric occupation, including needle-drilled *Olivella* beads, European glass, and glass trade beads.

During the Historic period, the use of imported technologies (glass beads, iron needles, etc.) also had profound impacts on traditional cultural practices. Graesch (2001) described a variety of Historic period artifacts from Santa Cruz Island, including bronze crucifixes, metal fishhooks, nails, blades, and other tools, glass beads, worked bottle glass, and shell artifacts that had been perforated with iron needles. These needle-drilled shell beads are a hallmark of many Chumash sites dated to the Historic period (see Graesch, 2001; Kennett, 2005; Rick, 2004a). *Olivella* rough chipped wall disk beads appear in abundance during the Historic period and red abalone disk beads also greatly increase during this time. The increase in these beads and other artifacts may be responses to the influx of glass beads that prompted islanders to expand bead making efforts.

Changes in world view, technology, and health during the contact era profoundly transformed the lives of the Island Chumash and Tongva. The final removal of the last Chumash to the Missions by about AD 1820 and Juana Maria from San Nicolas by AD 1853 ushered in a

new era of Channel Islands history. The islands were occupied sporadically by Chinese and other abalone fishers during the mid nineteenth century. Native Alaskans were also brought to the Channel Islands to hunt sea otters in the early portions of the nineteenth century and often had violent interactions with the Chumash (Ogden, 1941). All the islands also had fairly long and sizable ranching histories during the nineteenth and twentieth centuries that in many cases had devastating effects on the local ecology (see D. Johnson, 1980; Schoenherr *et al*., 1999; Swanson, 1993). Naval installations on San Nicolas and San Clemente islands, park service facilities on other islands, and a small town and other facilities on Santa Catalina, however, constitute the only sizable settlements on the islands today. Under federal and private management the islands have remained free of the urban sprawl that plagues the mainland. Nonetheless, by the early to mid nineteenth century the Channel Islands were transformed into a new landscape, bringing to a close more than 10,000 years of Native American island and maritime cultures.

Summary

During the Late Holocene, the archaeological record contains the full manifestation of the Channel Island societies encountered by early European explorers. Technologies like the plank canoe, circular shell fishhook, stone microdrills, and *Olivella* cup beads transformed island economies and social networks. Subsistence practices became increasingly focused on fishing, resulting in some cases in declines in human health and impacts on the environment. Although a great deal of information has been amassed on the Late Holocene environments and cultures of the Channel Islands, many questions remain. In particular, there are a dearth of data from the early phases of the Late Holocene (ca. 3500 to 1500 cal B.P.), little is known about the people who inhabited Santa Catalina, Santa Barbara, and Anacapa islands, and greater comparisons of the Southern and Northern Channel Island records are needed.

Summary and conclusions

The Channel Islands contain one of the longest, continuous records of coastal hunter-gatherers in the Americas. The Chumash, Tongva, and their predecessors were among the most sophisticated and elaborate hunter-gatherers on earth, with large and dense populations, complex exchange networks, social hierarchy and inherited leadership, and complex maritime subsistence strategies. The archaeological and ethnohistoric records of the region also demonstrate considerable variability in these practices (e.g., Altschul & Grenda, 2002; Kennett, 2005; Raab *et al*., 2002). Review of this trans-Holocene archaeological sequence demonstrates that many of the cultural practices described in early historic accounts have their roots in deep history, especially aspects of marine subsistence. Our analysis of this sequence illustrates several long-term trends in Channel Island prehistory that are of significance to broad anthropological issues, such as the origins of maritime Paleocoastal peoples, the emergence of sedentary communities, the development of exchange systems, interaction spheres, and shell bead currencies, the appearance of hierarchy and social ranking, changes in marine subsistence strategies, human impacts on the environment, and responses to natural and culturally induced environmental change.

Only limited evidence of human occupation during the terminal Pleistocene exists on the Northern Channel Islands, but after about 10,000 years ago the volume and types of archaeological sites increased considerably. Four of the islands (San Clemente, Santa Cruz, Santa Rosa, and San Miguel) contain evidence of occupation prior to about 8500 years ago

and San Nicolas at 98 km offshore has evidence of human occupation possibly as early as 8500 years ago. These earliest occupants lived on islands where marine and terrestrial ecosystems were in a dramatic phase of reorganization, as rising sea levels reduced island area, separating Pleistocene Santarosae into the four separate northern islands, where pygmy mammoths had recently gone extinct. Most research currently suggests that these early occupations were by people who were relatively mobile and focused largely on shellfish, supplemented by marine mammals, fishes, and birds. There is great variability in this pattern (Porcasi *et al*., 2000; Rick *et al*., 2001a), however, and due to the destructive effects of sea level rise and coastal erosion our understanding of early island lifeways is far from complete. The Eel Point site, one of the most intensively studied early island sites, contains evidence of structural remains and a diversified maritime economy about 8500 years ago, providing limited evidence for sedentism and the more sophisticated marine foraging that was to appear during the Middle and Late Holocene. Although *Olivella* shell beads provide evidence of bead production during the Early Holocene, and mainland or other sources of island stone suggest trade or long-distance procurement strategies during this time, exchange systems were relatively limited during these early times. Clear evidence of social ranking is also absent in the archaeological record of the early Channel Islands and mainland, but some of the foundations of later developments (shell beads, basketry, fishhooks, seaworthy boats, etc.) were founded very early in Channel Island prehistory.

The Middle Holocene archaeological record demonstrates considerable cultural overlap with the Early Holocene, but new and unique cultural patterns also appear between about 7000 and 3500 years ago, setting the stage for many of the rapid cultural changes of the last 3500 years. Middle Holocene peoples, for example, had complex and far reaching exchange networks. The *Olivella* Grooved Rectangle bead, for instance, was made on the Southern Channel Islands and traded into mainland California, Nevada, and Oregon (Howard & Raab, 1993; Vellanoweth, 2001). There is also evidence for increased sedentism in the Middle Holocene, but many sites suggest that people were fairly mobile during this time. Although subsistence pursuits were focused largely on nearshore marine resources, new and unique subsistence strategies included dolphin hunting (Glassow, 2005b; Porcasi & Fujita, 2000), fishing for *Mola mola* (Porcasi & Andrews, 2001), and the taking of albatross (Porcasi, 1999a). Archaeological data from the Channel Islands currently suggest that the Middle Holocene was a time of transition, with a great deal of continuity with the Early Holocene, but glimpses of the rapid and pronounced cultural changes of the Late Holocene.

After about 3500 years ago, the pace of cultural change appears to accelerate, with the introduction of the single-piece fishhook, plank canoes, bow and arrow, new shell bead types, and several types of specialized craft production. Increased cultural complexity is perhaps the most heavily studied aspect of the Late Holocene archaeological record, as craft production, village organization, burial data, and other variables have been used to argue for the development of a simple chiefdom among the Island Chumash (Arnold, 1996, 2001c). These artifact forms and changes in social organization appear to correlate with sustained periods of drought and one of the coldest and most variable periods of sea surface temperature recorded for the Holocene (Kennett & Kennett, 2000), suggesting that people were increasingly forced to adapt to environmental fluctuations. Compounded by increased population density and territoriality, the Late Holocene landscape was one of great environmental and social uncertainty. For the Island Chumash and Tongva, this period of instability concluded with the arrival of the representatives of European colonial powers, a demographic and cultural catastrophe for the traditional cultures that had lived on the Channel Islands for more than 10,000 years.

The long Channel Islands archaeological sequence provides considerable insight into the evolution of coastal hunter-gatherer societies, illustrating the importance of investigating long term cultural histories to inform issues of broad anthropological importance. These data demonstrate that people with fully maritime capabilities were present in the Americas as much as 13,000 years ago, the contemporaries of Folsom and possibly Clovis peoples. Viewed over the long-term, the Channel Islands record of cultural and environmental change helps inform the evolution of maritime foraging strategies, the development of regional and long-distance exchange networks, and the movement of goods, ideas, and people. The emergence of cultural complexity among the Chumash and Tongva supplies important details on social and political dynamics in coastal and island settings where agriculture was not practiced (Arnold, 1996, 2001c; Sassaman, 2004). While this complexity has often been viewed as a relatively recent phenomenon on the Channel Islands, we have argued that many of the rapid and profound changes of the past 1500 years have their roots in much earlier cultural developments. The subsistence data also provide perspectives on historical ecology and human impacts on the environment that can be used as baselines to help remediate modern ecological degradation in the area (see Erlandson *et al*., 2004a, 2005c; Rick *et al*., 2006).

By comparing the full duration of the Channel Islands archaeological record, we see the incremental patterns of cultural evolution that are the result of millennia of interaction, environmental change, and population growth and decline. These changes appear to have been gradual at times and punctuated and rapid at others, but it is only within the long-term context of the record that the full manifestation, origins, and implications of these developments comes to light (Ames, 1991; Lightfoot, 1993). Ultimately, the 13,000 year history of humans on the Channel Islands is a testament to the resilience and diversity of the Chumash, the Tongva, and their predecessors. The archaeological record provides valuable insights into the lives and collective history of ancient Channel Islanders, providing an important backdrop for understanding the nature and structure of California and its islands today. The challenge is to ensure that this incredible record is preserved for the future and that the interpretations of island archaeology are increasingly applied to issues of broad social, cultural, and environmental significance.

Acknowledgments We are indebted to a number of colleagues for shaping our thinking on Channel Islands archaeology, including Jeanne Arnold, Julie Bernard, Roger Colten, Bob DeLong, Jim Estes, Lynn Gamble, Mike Glassow, Anthony Graesch, Mike Graham, Dan Guthrie, Sandra Hollimon, John Johnson, Doug Kennett, Pat Lambert, Pat Martz, Don Morris, Ann Munns, Anna Noah, Peter Paige, Jenn Perry, Scott Pletka, Judith Porcasi, Mark Raab, Steve Schwartz, John Sharp, Pandora Snethkamp, Phil Walker, and Andy Yatsko. For our research on the Northern Channel Islands, we are indebted to Bob DeLong, Ann Huston, Georganna Hawley, Kelly Minas, Don Morris, Steve Schwartz, Mark Senning, and Ian Williams. We also thank Pat Martz, Steve Schwartz and Lisa Thomas-Barnett for facilitating research on San Nicolas Island. Judy Cooper helped prepare Figures 2 and 3. Finally, we thank Angela E. Close, anonymous reviewers, and the editorial staff of the *Journal of World Prehistory* for help in the revision and production of this manuscript.

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