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Advances in Southern Channel Islands Archaeology: 1983 to 1993

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A summary of research in the southern Channel Islands of California is presented. This research shows that these islands have been occupied for nearly 10,000 years. Residential structures and the distribution of a type of marine shell bead suggest that sedentism and a regional interaction sphere arose in this region as early as 5,000 years ago. Additional information is presented on chronological trends and the impact of humans on nearshore ecosystems, including fish and shellfish populations. These data are leading archaeologists to reassess the age and origins of marine cultural traditions in southern California.

WHILE archaeological research on California's Channel Islands (Fig. 1) has progressed for more than a century, the results have been far from uniform (Glassow 1977; Moratto 1984; Raab and Yatsko 1990). As investigations of large northern islands such as Santa Cruz and Santa Rosa steadily advanced, southern islands such as Santa Catalina, San Clemente, and San Nicolas received more intermittent attention, and relatively little mention in print (Rogers 1929; Orr 1968; Glassow 1977, 1980; King 1990; Arnold 1992; Erlandson 1994). There are, of course, notable exceptions to this pattern. Meighan's (1959) research at the Little Harbor site on Santa Catalina Island, for example, continues to be cited as a landmark investigation of coastal prehistory and cultural ecology (Glassow 1980:80; Moratto 1984:161). Nonetheless, the southern islands remain poorly represented in the archaeological literature, despite the presence of archaeological sites as ancient, numerous, and well preserved as those of the northern islands. However, this picture is rapidly changing. During the last decade, the scope and intensity of southern islands ar-

chaeology expanded greatly, leading to significant research advances, and some of these developments are reviewed. Before embarking on this discussion, however, it is important to acknowledge that this review is constrained in certain ways.

The California Channel Islands are usually assigned to northern and southern groups (Power 1980:3). The northern group, extending from the Santa Barbara coast to beyond Point Conception, consists of Anacapa, Santa Cruz, Santa Rosa, and San Miguel islands (Fig. 1). The more widely dispersed southern group, including Santa Catalina, San Clemente, and San Nicolas islands, located off Los Angeles, Orange, and San Diego counties, is the focus of attention in this paper. Santa Barbara Island has been excluded from this discussion. Although this island was occupied for at least 4,000 years, its small size (ca. 2.6 km.²), rugged coastline, and lack of perennial water appear to have discouraged substantial prehistoric settlement (Glassow 1977:21-48; Erlandson et al. 1992).

Although southern islands archaeology has

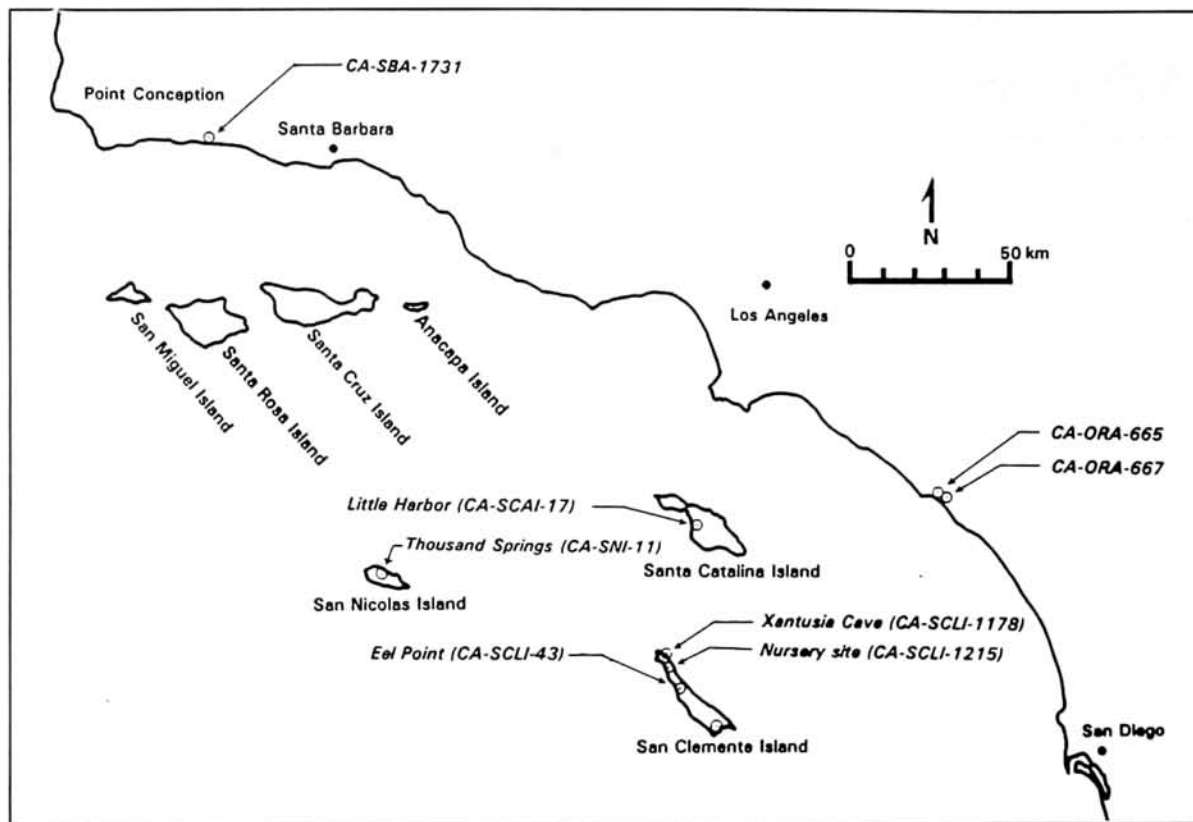


Fig. 1. The California Channel Islands region, showing some of the sites discussed in the text.

advanced on a number of fronts in recent years, the focus of this discussion is primarily on the topics of cultural chronology and the ecology of island cultural adaptations. In this summary of chronological trends, Erlandson and Colten's (1991:1-2) division of the Holocene into Early, Middle, and Late periods is adopted, along with their notation of "RYBP," or radiocarbon years before present.

In much of California, the Early-Middle Holocene transition, roughly dated to between 6000 and 7000 RYBP, is when mortars and pestles first appear widely, presumably for processing acorns and other plant foods. Hunting and fishing technologies also diversify in many areas about this time, and the importance of sea mammals, land mammals, and fish seems to increase relative to shellfish. During the Middle-Late Holocene transition (ca. 3000 to 3500 RYBP), a further diversification in subsistence, technology, and ornaments occurs in many coastal areas . . .

This scheme offers two advantages. First, its divisions reflect widely recognized techno-economic trends that are the object of many current coastal research projects. Second, it offers a useful framework for assessing cultural developments without attempting to reconcile a host of disparate coastal chronologies (cf. Moratto 1984:xxxii-xxxiii; Erlandson and Colten 1991:2).

Within this temporal framework, research advances in several areas are examined: evidence for the occupation of the southern islands during the Early Holocene; the Middle Holocene emergence of fully maritime economies, a regional sphere of cultural interaction, and substantial residential sedentism; and Late Holocene connections between the southern islands and the mainland, including aboriginal ceremonialism. Connected to these developments, patterns of human predation on marine

ecosystems and the effects of marine paleotemperature and paleoclimatic factors on maritime cultural evolution are discussed.

The large number of radiocarbon dates collected during the last decade on the southern islands and adjacent mainland is among the most important research advances. In this discussion, citation of these dates is necessarily selective, however, owing to limitations of space. Regional chronology building is also hindered by the problem of radiocarbon dates collected and processed under less-than-ideal circumstances (Erlandson 1994:61-62). On this account, some of the dendrocalibrated dates (see Table 1) should be viewed merely as informed estimates; particularly when dates have not been corrected in the laboratory for fractionation. The dendrocalibrated age estimates (Table 1) were calculated with the CALIB 3.0.3 computer program (Stuiver and Reimer 1993). Many of these dates are derived from marine shell. Although some researchers have questioned the suitability of shell for radiocarbon dating, recent research suggests that reliable shell dates can be obtained, if the appropriate laboratory processing and dendrocalibration techniques are employed (see Erlandson 1994:61-62). As presented in Table 1, correction of shell dates for the "reservoir effect" involved two components: (1) a time-dependent global ocean correction (-402 years) incorporated into the CALIB 3.0.3 marine calibration curve, and (2) an additional local ocean offset of -225 ± 35 years for southern California (Taylor 1987:129; Stuiver and Braziunas 1993:138; 155-156; Erlandson 1994: 61-62).

RESEARCH SUPPORT

In the past, a lack of sustained institutional support frequently stalled archaeological research in the relatively remote setting of the southern islands. Dramatic changes in this situation boosted research enormously between 1983 and 1993. Federal environmental legis-

lation of the last three decades, and federal control of six of the Channel Islands (including military reservations and the Channel Islands National Park), created a continuing need for archaeological research. Compliance with historic preservation laws launched scores of archaeological research projects on San Clemente and San Nicolas islands during the last ten years (Raab and Yatsko 1990; Schwartz and Martz 1992).

It is important to understand, however, that the research results described in this paper are not merely the result of increasing research activity. Unfortunately, despite a large number of archaeological investigations carried out under legal mandates, conspicuous scientific progress remains elusive in many regions (Martz 1993; Sutton 1993). The florescence of research in the southern islands during the last decade can be credited to innovative resource management programs sponsored by the United States Navy. The Navy administers both San Clemente and San Nicolas islands. Navy-sponsored programs on these islands provide for long-term cooperative research agreements (CRAs) and contract investigations of more limited duration. Under terms of these CRAs, the Navy provides logistical support to academic institutions for continuing, basic scientific research, in return for joint use of the resulting data for resource management purposes (Schwartz and Martz 1992; Raab and Yatsko 1990). CRAs, in their support of basic research, not only provide a framework for scientific advance, but also a context for "plugging in" necessary contract studies.

Cooperative research has proceeded on San Clemente Island, for instance, under agreements with the UCLA Archaeological Survey (1983-1987) and CSU, Northridge (1988-present), among others. A series of nine San Clemente archaeological field schools, plus numerous independent research and graduate thesis/dissertation projects, have resulted in a large body

Table 1
RADIOCARBON DATES FROM THE SOUTHERN CHANNEL ISLANDS

Lab. No.	Provenience	¹⁴ C age ^a	δ ¹³ C	¹³ C Adj.	Material	Calibrated Years B.P. ^b
SCAI-17, Little Harbor, Santa Catalina Island						
M-434 ^c	Unit 8, 24 in.	3,880 ± 25	-- ^d	-- ^d	charcoal	4,181-4,397(4,333)
Beta-47277 ^c	Unit 33W, 40-50 cm.	4,620 ± 80	+2.3	5,070 ± 80	shell	4,978-5,270(5,121)
Beta-47275 ^c	Unit 2.5N, 30-40 cm.	4,760 ± 90	+1.8	5,200 ± 90	shell	5,219-5,437(5,295)
UCLA-1880B ^f	Unit 1, 50 cm.	4,780 ± 60	0 ± 2 ^f	-- ^d	shell	5,221-5,335(5,285)
Beta-47273 ^c	Unit 1, 50-60 cm.	4,890 ± 80	+1.9	5,340 ± 80	shell	5,328-5,572(5,463)
UCLA-1928A ^f	Unit 1, 40 cm.	4,980 ± 60	0 ± 2 ^f	-- ^d	shell	5,442-5,589(5,540)
Beta-47274 ^c	Unit 1, 50-60 cm.	5,105 ± 60	-- ^h	5,105 ± 60	charcoal	5,749-5,917(5,892)
Beta-47278 ^c	Unit 83W, 40-50 cm.	6,860 ± 190	-24.1	6,880 ± 190	charcoal	7,529-7,892(7,649)
SCLI-43B, Eel Point, San Clemente Island						
LJ-4130 ^g	"Foxhole," 51-66 cm.	8,180 ± 110	-- ^j	8,180 ± 110	shell	8,275-8,473(8,362)
UCLA-2758E ⁱ	Unit 3, 250-260 cm.	9,655 ± 325	-- ^j	9,655 ± 325	shell	10,302-11,198(10,904)
UCLA-2758C ⁱ	Unit 3, 140-160 cm.	9,775 ± 165	-- ^j	9,775 ± 165	charcoal	10,628-11,074(10,979)
UCLA-2758D ⁱ	Unit 3, 180-190 cm.	9,870 ± 770	-- ^j	9,870 ± 770	charcoal	10,034-12,574(11,000)
Beta-75092 ^k	Unit 3, 250-260 cm.	5,060 ± 50	+2.2	5,510 ± 50	shell	5,580-5,701(5,631)
Beta-75555 ^k	Unit 3, 250-260 cm.	5,470 ± 160	-23.4	5,500 ± 160	charcoal	6,063-6,436(6,290)
Beta-75093 ^k	Pit A, 150-160 cm.	7,490 ± 70	+0.7	7,910 ± 70	shell	7,988-8,159(8,096)
Beta-76021 ^k	Pit A, 150-160 cm.	8,120 ± 310	-25.3	8,110 ± 300	charcoal	8,547-9,432(8,989)
SCLI-1178, Xantusia Cave, San Clemente Island						
LJ-4169 ^l	90 cm.	4,950 ± 90	-- ^d	-- ^d	shell	2,880-3,104(2,993)
UCLA-2551 ^l	Burial, 90-105 cm.	5,130 ± 55	-- ^d	-- ^d	bone	3,539-3,662(3,633)
LJ-4168 ^l	90 cm.	6,300 ± 90	-- ^d	-- ^d	shell	4,438-4,670(4,528)
SCLI-1215, Nursery Site, San Clemente Island						
UCLA-2586 ^m	Feat. 27, House Pit 1	3,750 ± 35	-- ^d	-- ^d	charcoal	2,040-2,200(2,139)
Beta-66816 ⁿ	S23/W10, 10-20 cm.	450 ± 70	-24.8	450 ± 70	charcoal	460-533(509)
Beta-66817 ⁿ	Floor, House Pit 3	4,360 ± 70	+0.8	4,790 ± 70	shell	2,693-2,888(2,852)
Beta-69355 ⁿ	Feat. 3, House Pit 2	4,370 ± 70	+2.1	4,820 ± 80	shell	2,747-2,912(2,864)
UCLA-2585 ^m	Burial 3	5,495 ± 45	-- ^d	-- ^d	charcoal	4,260-4,441(4,339)
SCLI-1318, San Clemente Island						
Beta-39143 ^o	4S/3W, 0-10 cm.	1,560 ± 60	-- ^o	-- ^o	shell	786-934(891)
Beta-39144 ^o	4S/3W, 0-10 cm.	250 ± 50	-- ^o	-- ^o	charcoal	0-308(295)
Beta-39145 ^o	4S/3W, 10-20 cm.	1,770 ± 50	-- ^p	-- ^p	shell	1,008-1,158(1,076)
Beta-39146 ^o	4S/3W, 10-20 cm.	350 ± 50	-- ^o	-- ^o	charcoal	308-497(357)
SCLI-1319, San Clemente Island						
Beta-39147 ⁿ	8N/0W, 0-10 cm.	2,160 ± 50	-- ^o	-- ^o	shell	1,393-1,534(1,482)
Beta-39148 ⁿ	8N/0W, 0-10 cm.	240 ± 50	-- ^o	-- ^o	charcoal	0-305(290)
Beta-39149 ⁿ	8N/0W, 10-20 cm.	2,830 ± 50	-- ^o	-- ^o	shell	2,185-2,330(2,296)
Beta-39150 ⁿ	8N/0W, 10-20 cm.	300 ± 70	-- ^o	-- ^o	charcoal	286-458(308)

Table 1 (Continued)
RADIOCARBON DATES FROM THE SOUTHERN CHANNEL ISLANDS

Lab. No.	Provenience	¹⁴ C age ^a	δ ¹³ C	¹³ C Adj.	Material	Calibrated Years B.P. ^b
SCLI-1524, Lemon Tank, San Clemente Island						
Beta-39151 ^a	9S/15E, 30-40 cm.	370 ± 50	-- ^p	-- ^p	charcoal	315-503 (346)
Beta-39152 ^a	15E/0N, 40-50 cm.	1,140 ± 90	-- ^p	-- ^p	seeds	952-1,171 (1,028)
Beta-39153 ^a	9S/16E, 30-40 cm.	300 ± 60	-- ^p	-- ^p	charcoal	290-455 (308)
SCAI-26, Ripper's Cove, Santa Catalina Island						
GaK-7481 ^q	6N/118.5W, 20-30 cm.	220 ± 80	-- ^d	-- ^d	charcoal	0-308 (283)
GaK-7478 ^q	12/7.5E, 40-50 cm.	470 ± 90	-- ^d	-- ^d	charcoal	460-542 (513)
GaK-7479 ^q	0N/4.5E, 20-30 cm.	510 ± 90	-- ^d	-- ^d	charcoal	502-620 (525)
GaK-7480 ^q	1.5N/60W, 20-30 cm.	610 ± 90	-- ^d	-- ^d	charcoal	529-660 (601)
SNI-11, Thousand Springs Site, San Nicolas Island						
UCLA-2559D ^r	--	5,955 ± 120	-- ^d	-- ^d	charcoal	4,694-4,991 (4,835)

^a Radiocarbon years before present, uncorrected for fractionation in nature (δ¹³C). When a ¹³C-adjusted age is known for a sample, the adjusted age was used for dendrocalibration.

^b Dendrocalibrated age of samples in years before present (present = A.D. 1950), with 1-σ age range and mean intercept in parenthesis, calculated by CALIB rev. 3.0.3 (Stuiver and Reimer 1993).

^c From Meighan 1959.

^d Unknown if sample was δ¹³C adjusted.

^e From Raab et al. n.d.

^f From Kaufman 1976.

^g Date not δ¹³C adjusted in the lab; marine carbonate δ¹³C value estimated at 0 ± 2 ‰, following Table 1 of CALIB 3.0.3.

^h Small sample (Beta-47274) converted to AMS date (ETH-8620), δ¹³C value not reported; date "adjusted by carbon 13 for total isotope effect generated in both nature and during the physical and chemical laboratory procedures. The carbon 13 content was measured concurrently with that of carbon 14 and carbon 12 in the accelerator beam, allowing precise correction" (Beta Analytic laboratory report of 7 February 1992).

ⁱ From Salls 1988; Breschini et al. 1992.

^j Value unknown; see Salls 1988:361.

^k Date on file, Northridge Center for Public Archaeology, CSU, Northridge.

^l From Foley 1987.

^m From Rigby 1985.

ⁿ From Raab and Bradford MS.

^o From Raab 1992.

^p Dates not δ¹³C adjusted.

^q From Reinman and Eberhart 1980.

^r From Schwartz and Martz 1992.

of scientific data, research manuscripts, and publications by these institutions and the Navy. Many of these efforts are cited in the discussion that follows. Santa Catalina Island, owing to its prehistoric cultural affinities with San Clemente Island, was also involved in some of this research (e.g., Raab et al. n.d.; Salls 1988; Bradford 1992; Porcasi 1992). Studies at the Little Harbor site on Santa Catalina Island have proven particularly productive. Comparison of San Clemente and Santa Catalina data played a large role in the research advances described in this paper.

MARITIME ORIGINS AND CHRONOLOGY

Maritime Origins

As a result of research during the last decade, archaeologists have begun to rethink the antiquity and origins of southern California coastal cultures (Erlandson and Colten 1991; Jones 1992; Erlandson 1994). After the Little Harbor site (CA-SCAI-17) appeared in print nearly 35 years ago (Meighan 1959), many archaeologists concluded that the earliest Californians shunned marine economies in favor

of terrestrial hunting and gathering. With an age of $3,880 \pm 250$ RYBP, Little Harbor—perhaps the first radiocarbon-dated southern California coastal site—suggested that the Channel Islands were settled no earlier than the mid-Holocene. In this scenario, Little Harbor served as an intermediate stage in a gradual, trans-Holocene shift from terrestrial to maritime hunting and gathering; perhaps under the pressure of population growth and environmental change.

This scenario of hunter-gatherers turning reluctantly from the land to the sea has proven remarkably durable. Despite the fact that coastal sites with dates between 8,000 and 9,000 RYBP have been known from the central or southern California coasts for 20 years, many researchers continued to view the development of “real” maritime adaptations as a Late Holocene phenomenon (Chartkoff and Chartkoff 1984:128-129; Moratto 1984:104-108, 144-146; Yesner 1987). This conclusion was reinforced by the paucity of published data on early coastal sites and prevailing models of maritime cultural evolution. Among the latter was Osborn's (1977) argument that ancient peoples turned to marine resources only under the impact of dwindling terrestrial food supplies. Even more recently, Yesner echoed this hypothesis as an explanation of the apparently “late” occupation of the California Channel Islands:

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

Research advances of the last decade, including information summarized below, show that these models need to be substantially revised, if not discarded altogether, in reconstructing Channel Islands prehistory (see also Erlandson and Colten 1991; Jones 1991, 1992; Erlandson 1994).

Chronological Developments

A greatly expanded radiocarbon chronology of coastal occupation offers convincing evidence of an initial occupation of the Channel Islands and mainland coast during the Early Holocene, with widespread coastal settlement by the Middle Holocene. Recent syntheses of California maritime prehistory identify perhaps ten coastal or peri-coastal sites dated to between 9,500 and 10,500 RYBP (Erlandson and Colten 1991; Jones 1991, 1992; Erlandson 1994). Five sites in this time span are reported from the California Channel Islands (Erlandson 1991; Jones 1991). Scores of sites are currently known with ages between 8,000 and 9,500 RYBP (Erlandson and Colten 1991; Jones 1991, 1992:427-428). At least 75 sites with ages between 7,000 and 8,000 RYBP have been reported on the central and southern California coast (Erlandson and Colten 1991:2; Jones 1992).

The Eel Point site (CA-SCLI-43) on San Clemente Island is currently the oldest confirmed occupation of the southern Channel Islands. Eel Point contains three defined archaeological loci (Fig. 2) comprising a total of at least 2 ha. (Salls 1990). Salls (1988:361, 372) reported 24 radiocarbon dates from loci B and C. The most recent of the Locus B dates reported by Salls was $2,430 \pm 75$ RYBP (UCLA-2532B), while the three earliest dates from Locus B place initial human occupation of the site between approximately 9,000 and 10,000 RYBP (Table 1). The Locus C dates reported by Salls range between $1,090 \pm 25$ (UCLA-2757B) and $4,500 \pm 350$ RYBP (UCLA-2574).

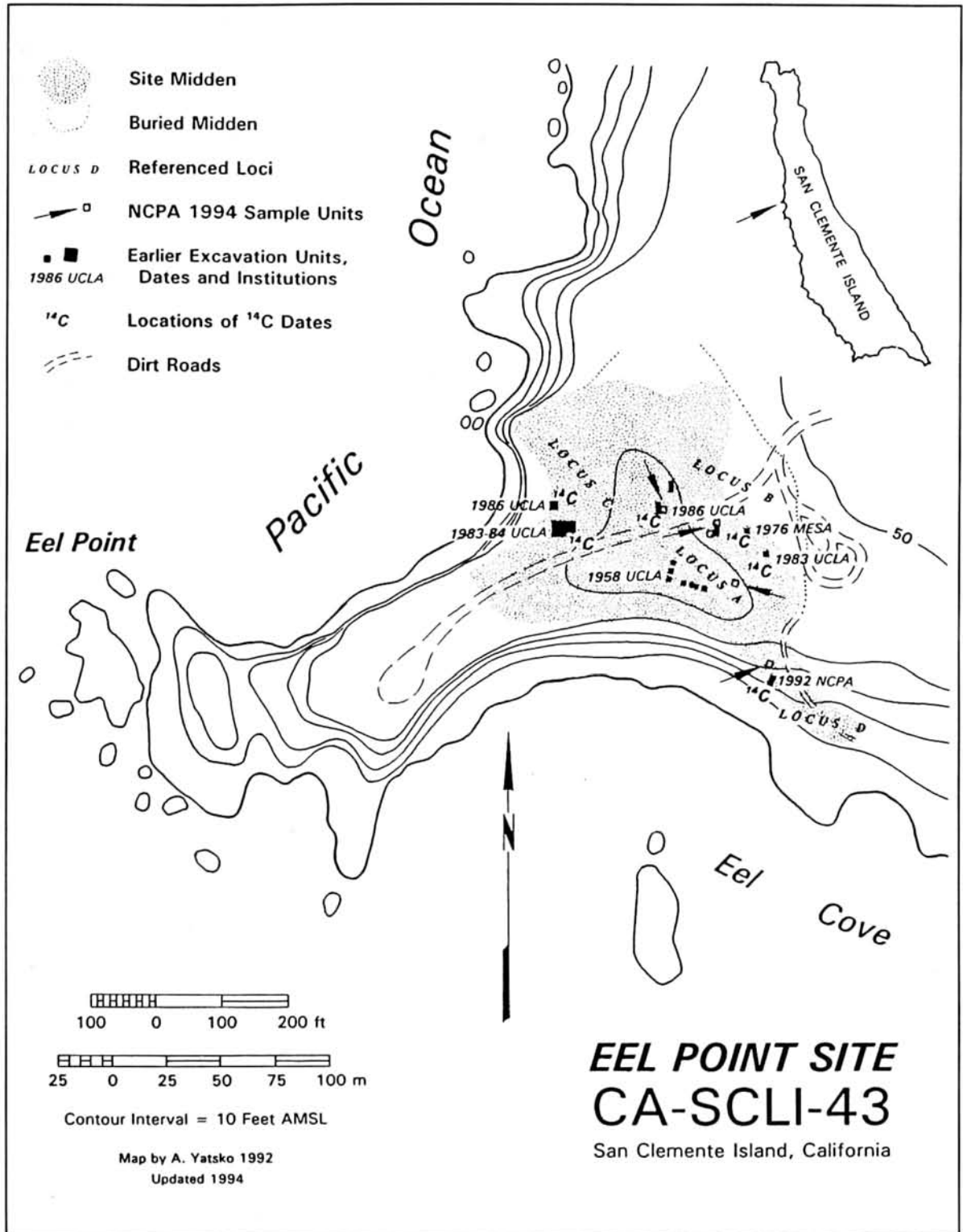


Fig. 2. Eel Point locality (SCLI-43), San Clemente Island, including areas of previous archaeological investigations.

A complete list of these dates was provided by Salls (1988:361, 372) and Breschini et al. (1992:51).

Three of the Locus B dates, ranging between $9,655 \pm 325$ and $9,870 \pm 770$ RYBP (Table 1), are among the oldest reported from the southern California coast. Indeed, Eel Point is widely cited as one of the earliest sites on the North American Pacific coast on the basis of these dates (Salls 1990, 1991, 1992; Erlandson and Colten 1991:9; Jones 1991:427-428; Erlandson 1994:214-215). Despite this notoriety, questions remained about the site's radiocarbon chronology:

After calibration, the marine shell dates suggest that the early occupation of SCLI-43B occurred primarily between 7900 and 8500 cal BP . . . In contrast, calibration of the early charcoal dates results in calendar ages falling between about 9900 and 10,800 cal BP. Thus, the midpoints of the charcoal dates pre-date those of the oldest marine shell dates by between 1400 and 2300 calendar years . . . the discrepancy between the oldest shell and charcoal dates is curious [Erlandson 1994:214].

Questions of this kind, among others, led to excavations at the Eel Point site during the summer of 1994 by the authors. Excavation Unit 3, from which the three oldest of Salls' (charcoal) dates were obtained (Salls 1988:361), was re-opened. Shell and charcoal samples collected by the authors from the basal stratum of this pit (250 to 260 cm.) produced ages of $5,510 \pm 50$ (Beta-75092) and $5,500 \pm 160$ RYBP, respectively (Table 1). The great difference in age obtained by the authors and Salls for the same cultural stratum (ca. 4,150 years) is indeed curious. Factors that may account for this discrepancy include contamination of samples with asphaltum and the "old wood" problem (Erlandson 1994:61).

Before the radiocarbon assays reported by Salls, the earliest date obtained from Eel Point was $8,180 \pm 110$ RYBP (LJ-4130). This date was obtained on shell collected by M. Axford in

the late 1970s from a military "foxhole" in Locus B (Salls 1988:359). During 1994, excavations near this foxhole (Unit A) resulted in the recovery of shell and charcoal samples for radiocarbon dating from the basal cultural stratum (150 to 160 cm.). The resulting dates were $8,110 \pm 300$ RYBP (Beta-76021) from the charcoal sample and $7,910 \pm 70$ RYBP (Beta-75093) from the shell sample (Table 1). These results are consistent with Erlandson's (1994) analysis above; i.e., the oldest cultural deposits at Eel Point appear to have an antiquity of about 7,900 to 8,100 RYBP, or about 8,100 to 9,000 calendar years before present (CYBP). Based on these dates, Eel Point and strata E and F of Daisy Cave (SMI-261) on San Miguel Island (Erlandson 1994:194) are perhaps the oldest securely dated occupations currently known on the Channel Islands.

The authors are currently engaged in construction of an Eel Point site chronology, based on approximately 30 radiocarbon dates obtained during the 1994 excavations noted earlier. While this task is not complete, an interesting chronometric pattern in the four recent basal dates from Eel Point (Table 1) can be seen. Comparison of the paired shell and charcoal dates from the basal strata of excavation Units A and UCLA's Unit 3 shows that in both cases the fully corrected and calibrated ages of the shell samples are younger than their charcoal counterparts (Table 1). Current discussions of the "reservoir effect" point out that the radiocarbon age of marine shell tends to be *older* than that of contemporaneous terrestrial materials, until appropriate corrections are applied (Taylor 1987:127-132; Stuiver and Braziunas 1993; Erlandson 1994:61-62). In the present instance, the corrected and calibrated shell dates are *younger* than their paired charcoal samples by a factor of about 10 percent of the charcoal age. In this instance, then, corrected dates appear to understate the true age of the shell specimens in question, assuming the

latter are contemporaneous with their paired charcoal samples. This seems a safe bet, since the samples were carefully collected from well-defined cultural strata in an environment free of burrowing animals and other sources of post-depositional "faunalurbation" (Raab and Yatsko 1990). Interestingly, a pair of shell (Beta-47273) and charcoal (Beta-47274) samples from the basal stratum of the Little Harbor site (Table 1) reflects roughly the same pattern (the calibrated shell date is 7.3 percent younger than the charcoal date). The fact that these differences are a fairly constant percentage of the age of the charcoal samples suggests a chronometric effect rather than random statistical variation. This is a topic slated for additional research by the authors.

The other southern islands and the mainland also evidence comparatively early dates. The oldest date from the Little Harbor site (CA-SCAI-17) on Santa Catalina Island is $6,880 \pm 190$ RYBP. This date, from a possible hearth feature (Raab et al. n.d.), is the earliest currently known from Santa Catalina Island. Raab et al. (n.d.) identified five possible cultural components within the Little Harbor site, the most important of which (to the present discussion) is designated Component 2. Component 2 is a well-defined midden stratum whose age is bracketed by four radiocarbon dates ranging between $4,780 \pm 60$ and $5,340 \pm 80$ RYBP (Table 1). Based on these results, the long-accepted date of $3,880 \pm 250$ RYBP (Meighan 1959) for the Little Harbor site is anomalous. This date is probably the average age of charcoal samples from "three of the sheltered pockets of midden material in order to get enough for a radiocarbon assay" (Meighan 1959:384).

Although these dates make the site older than previously estimated, Little Harbor is by no means anomalous in relation to its age or the maritime character of its economy. Foley (1987:3) reported a radiocarbon date of 6,300

± 90 RYBP from the base of archaeological deposits in Xantusia Cave (also called North End Shelter, SCLI-1178) on San Clemente Island (Table 1). Two other dates were obtained from this sea cave, $4,950 \pm 90$ and $5,130 \pm 55$ RYBP, the latter from a human burial in the abalone shell deposit (Foley 1987:11). These dates are close to those of Component 2 at Little Harbor.

A date of $5,955 \pm 120$ RYBP is the earliest currently reported from San Nicolas Island (Table 1). This date is the oldest of 13 reported from SNI-11, the Thousand Springs site (Schwartz and Martz 1992). Schwartz and Martz (1992) offered an insightful summary of research to date on San Nicolas Island.

San Clemente Island Case Study

On the southern islands, some of the most systematic studies of cultural chronology to date have been conducted on San Clemente Island; much of this effort being closely connected to site survey programs. The reason for this connection becomes clear when it is recognized that San Clemente Island has one of the densest concentrations of archaeological sites in western North America. Surveys of the island show that 100 to 300 archaeological sites per km.² exist on some parts of the island (Raab and Yatsko 1990). Any assessment of chronological trends must reckon with this profusion of sites. Accordingly, between 1985 and 1992, the Natural Resources Office of the Naval Air Station North Island conducted a series of surveys aimed at verifying the accuracy of earlier surveys, and to record the number and character of archaeological sites on various parts of the island. This work was carried out under contract, as part of academic research efforts, and as in-house, volunteer-based surveys. Significant deficiencies in existing site records were demonstrated by these surveys (Yatsko 1989).

Between 40 and 90 percent of the identifiable sites had not been located by earlier

surveys, and the sites that were found frequently were poorly documented. Recently documented site densities range from 50 per km.² on the upper island to between 100 to 300 per km.² on lower marine terraces. Currently, there are estimated to be 7,650 archaeological sites across the island's 152 km.², based on a survey of 15 percent of the island's surface, employing stratified, random cluster sample design. This survey documented 1,145 sites within 73 25-ha. sample units and test excavated 27 of these sites for datable carbon samples. Site types on San Clemente Island include small shell middens, lithic quarries (Howard 1991), specialized manufacturing sites, rock shelters, and pithouse villages. Midden sites typically contain large, well-preserved faunal assemblages of marine origin (Salls 1988, 1989, 1990; Yatsko 1989; Raab 1992). Eighty-two radiocarbon assays were obtained on charcoal and marine shell, with dates ranging between approximately 200 and 3,000 RYBP. These dates are not listed here, as research on them is continuing. However, a preliminary time-trend analysis of the dates has revealed two notable trends (Yatsko and Raab n.d.), discussed below in connection with paleoenvironmental data.

MARITIME SEDENTISM AND ECONOMY

Residential Architecture and Sedentism

When the Spanish arrived in California, they found the Indians of the Santa Barbara Channel—the Canaliños—living in large, sedentary coastal villages that owed their existence to well-developed maritime economies. The origins of this maritime sedentism is a topic of great archaeological interest. The Nursery site (SCLI-1215) on San Clemente Island offers considerable insight into this domain of cultural development.

As currently understood, the occupation span of the Nursery site extends from about 5,500 to 450 RYBP (Table 1). Glass trade

beads are of early historic origin. Rigby (1985:5) reported a date of $5,495 \pm 45$ years (UCLA-2585), obtained from a "carbonized wood offering associated with burial 3." Excavations revealed at least 18 house pits and a large, shell-bearing midden. Some of the former contain the remnants of house structures constructed in shallow pits, utilizing whale jaws, scapulae, and ribs as roof members. A detailed description of these structures was provided by Salls et al. (1993).

Three structures at the Nursery site have been dated by means of radiocarbon dating or time-diagnostic artifacts. House Pit 1 (as designated here) was a saucer-shaped depression filled with shell-bearing midden. A circular house floor was exposed that measured 4.7 m. north-south, 4 m. east-west, and 50 cm. deep. Three features were encountered on the floor. Feature 24 was identified as a mold impression of the center support post (Rigby 1985:9). Features 26 and 27 were hearths containing a large amount of burned sea mammal bone and charcoal. Rigby also noted a possible entryway on the east edge of the house where the rim shows a "polish" and evidence of two post holes. Eight post holes were found surrounding the rim of this house pit.

During the summer of 1990, students in an archaeological field school directed by Raab and Yatsko excavated House Pit 2. This house was constructed in a circular pit 4.5 m. wide, and about 50 cm. deep. Whale bone roof members were set in holes between 10 and 30 cm. in diameter at the floor perimeter. In one instance, the stub of a whale rib was still in place in one of these holes. Large quantities of whale bone were found on the house floor, including masses of whale bone at the east and west periphery of the floor (Salls et al. 1993:186-188). These bones appear to have formed part of the entrance to the house, as a tongue of hard-packed floor sloped upward to a gap in these bones, forming a short ramp from the floor to the out-

side surface. To the left of the entryway (viewed from the outside), a wall screen was created by setting at least six whale ribs into the earth in a stockade fashion. Pit features and a hearth were found on the house floor. Since description of this house in print (Salls et al. 1993), a date of $4,820 \pm 80$ RYBP (Beta-69355; Table 1) was obtained from an abalone shell taken from a pit (Feature 3) constructed in the floor of this house.

Several house pits at the Nursery site were partially excavated by the authors during a summer field school in 1993. These features contained remnants of whale-bone roof structures, floor surfaces with artifacts and pit features, and post-occupational refuse deposits similar to house pits 1 and 2.

One of the most provocative results of these investigations is the age of some of these structures. A charcoal sample from Feature 27 of House Pit 1 yielded a radiocarbon date of $3,750 \pm 35$ years (UCLA-2586; Rigby 1985; Table 1). House Pit 3, excavated during 1993, produced a date of $4,790 \pm 70$ RYBP (Beta-66817; Table 1). This date is derived from a "basket load" of *Tegula* sp. shells thrown into House Pit 3 not long after its abandonment. Significantly, this mass of shell also contained *Olivella* Grooved Rectangle beads. Ten beads of this type were also found in refuse deposits thrown into House Pit 2 ($4,820 \pm 80$ RYBP, Beta-69355). This finding is consistent with the recent discovery of this rare and distinctive bead type elsewhere in the Channel Islands and on the adjacent mainland coast in contexts that date between 4,900 and 5,200 RYBP. The discussion of a Middle Holocene cultural interaction sphere below examines these bead data.

The data outlined above indicate that substantial residential structures were constructed at the Nursery site at least as early as 4,800 RYBP. The authors have argued elsewhere that residential architecture of this type reflects the emergence of an appreciable degree of seden-

tism (Salls et al. 1993). Only after such sedentism was achieved can one imagine the investments of labor and materials required to build these structures. These findings, in sharp contrast to Yesner's (1987) earlier characterization of the Channel Islands as marginal environments for hunter-gatherers, pose interesting questions for future research. In a worldwide ethnographic survey, Pálsson (1991) showed that intensification of fishing is strongly correlated with coastal sedentism. Did intensification of fishing during the Middle Holocene encourage a more "logistically organized" division of labor and sedentism (Raab 1993a)?

Maritime Economy

The degree of residential sedentism at the Nursery site is difficult to reconcile with "marginal" maritime economies. The available data, meager at present, suggest that southern island dwellers were obtaining most of their subsistence from the sea. Foley (1987:10-11) reported stable carbon and nitrogen isotope values for a human skeleton excavated from Xantusia Cave (SCLI-1178) on San Clemente Island (-12.58 ‰ $\delta^{13}\text{C}$ and $+22.14$ ‰ $\delta^{15}\text{N}$). These values are indicative of a diet heavily dependent on marine foods; indeed, these values suggest an even greater reliance on marine foods than Late Prehistoric dwellers of the northern Channel Islands documented by Walker and DeNiro (1986:55). This comparison, based on a single case from the southern islands, should clearly be advanced with caution. It may be reasonable to suggest, however, that the larger northern islands supplied larger amounts of terrestrial foods than San Clemente Island (Raab and Yatsko 1990). Still, if a maritime-adapted population is one that gets most of its calories or protein from marine sources (see Yesner 1980:728), the Xantusia Cave evidence suggests the existence of such an adaptation at least as early as the Middle Holocene. The

Xantusia Cave skeleton yielded a radiocarbon date of $5,130 \pm 55$ RYBP (UCLA-2551; Table 1), contemporaneous with the span of ages assignable to the houses at the Nursery site on San Clemente Island.

SOUTHERN ISLANDS CULTURAL INTERACTION SPHERE

Howard and Raab (1993) showed that *Olivella* Grooved Rectangle (OGR) beads, a rare type manufactured from the purple olive shell (*O. biplicata*), have been found in cultural deposits with mean dates that range between 4,800 and 5,200 RYBP at the Little Harbor site (SCAI-17) on Santa Catalina Island, at the Nursery site (SCLI-1215) on San Clemente Island, and sites on the adjacent Orange County coast. These beads are also associated with cultural components of currently unknown age on San Nicolas Island. Bennyhoff and Hughes (1987:141-142) assigned OGR beads to their Classes N1 and N2, defined as "Rectanguloid to oval bead with ground edges and an elongate perforation formed by a central groove transverse to the long axis of the shell." These beads are quite distinctive and not easily mistaken for any other type.

Ten OGR beads were recovered from the 1991 excavations at the Little Harbor site; nine of these from a stratum (Component 2) with a mean age of 5,200 RYBP (Raab et al. n.d.). Recent excavations at two Orange County sites of similar age have produced a total of six OGR beads. The Orange County sites are problematic in that, like many mainland southern California locales, the effects of faunalurbation and related problems of stratigraphic interpretation are pervasive. Nevertheless, one OGR specimen was recovered from ORA-665 (Gibson 1992a), a site with eight radiocarbon dates (Mason et al. 1992a:58) ranging between $4,590 \pm 80$ and $5,010 \pm 90$ RYBP. Five specimens were recovered from ORA-667 (Gibson 1992b). Seven dates from this site span $4,800 \pm 65$ to

$5,025 \pm 60$ RYBP, from contexts near the excavation unit from which these beads were recovered. An additional 16 radiocarbon dates from this site have a similar time range (Mason et al. 1992b:15). Readers are directed to Mason et al. (1992a:58, 1992b:15) for a complete listing of these dates.

These beads appear to be restricted in their geographic distribution to the southern Channel Islands, adjacent portions of the mainland coast, and the western Great Basin (Howard and Raab 1993). Their known distribution does not extend to the northern Channel Islands. King (1990:111) noted that:

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

This observation is interesting in that distinct southern and northern Channel Islands aboriginal cultural spheres were discernable during the era of early European contact (circa A.D. 1540 to 1769). The northern sphere, culminating in the Chumash Indian culture of the ethnohistoric record (Landberg 1965), clearly has great antiquity, originating early in the Holocene by some accounts (King 1990). To the south, Santa Catalina and San Clemente islands, and probably San Nicolas Island as well, were occupied at the time of European contact by populations with cultural affiliations to the Gabrielino Indians of Los Angeles and Orange counties (Johnston 1962; Bean and Smith 1978; Johnson 1988). The distribution of OGR beads may reflect their movements within a social network that linked the southern islands and the mainland as early as 4,800 RYBP.

MISSION-ERA CEREMONIALISM

Important information has emerged in the last decade on the sociocultural makeup of the southern islands during late prehistory and the

early historic era, particularly in the areas of ritual and ceremonialism. Ethnographic data suggest close social ties between San Clemente and Santa Catalina islands and the adjacent mainland (Johnson 1988). Moreover, ethnographic studies by DuBois (1908:75) and Kroeber (1925:621) document the importance of the Chinigchinich religion among these peoples.

Excavations by the authors during 1988 and 1989 at the Lemon Tank site (SCLI-1524) on San Clemente Island offer considerable insight into Mission-era (A.D. 1769-1833) Chinigchinich ceremonialism. Three radiocarbon dates were obtained from Lemon Tank, the oldest of which is $1,140 \pm 90$ RYBP (Beta-39152). This date was derived from a cache of *Calandrinia ciliata* seeds (Eisentraut 1990). Two other radiocarbon dates (charcoal from hearths) were obtained for this site as well: 370 ± 50 RYBP (Beta-39151) and 300 ± 60 RYBP (Beta-39153).

Salls and Hale (1990) presented evidence related to the two central rituals of the Chinigchinich religion; i.e., the toloache (jimson weed/datura) initiation rite and the "panes," or "eagle ceremony," described by Fr. Boscana at the Mission San Juan Capistrano (Boscana 1933) and others.

Toloache initiation rites incorporated a brew produced from the roots of jimson weed (*Datura* sp.). Hallucinations induced by this drink were part of a ritual in which boys were initiated into adulthood. The "eagle ceremony," a rite that expressed mourning for the dead, incorporated the ritual sacrifice of raptors, or birds of prey. In this ceremony, a dance culminated with the killing of the bird by "magic" (Kroeber 1925:676). The bird was then buried in a shallow grave, and the spirit of the bird was believed to travel to the place of the dead (Salls and Hale 1990).

Eight raptor burials, strongly suggestive of the mourning ceremony, were excavated at the Lemon Tank site. One of these, Feature 119,

was buried with grave goods that included a basket containing abalone vessels and *Olivella* shell beads (Salls and Hale 1990). Ceremonial canid burials were also present at Lemon Tank. Of 11 canid burials, six were domestic dogs and five were of the island fox (*Urocyon littoralis*). Feature 27, a dog burial, contained abalone shell vessels filled with seeds, a burned basket, and shell beads. Placed on the shoulder of the dog was a quartz crystal, an important symbol in native California belief (Salls and Hale 1990:30). Also present, in front of the left femur, was a large bifacial point or knife (Salls and Hale 1990:30).

Significantly, archaeological features similar to those at Lemon Tank have also been reported from the Ledge (SCLI-126) and Big Dog Cave (SCLI-119) sites on San Clemente Island (Rechtman 1985).

CULTURAL ECOLOGY

Human Maritime Predation

Yesner (1987) pointed out a persistent tendency to view the ocean as a "Garden of Eden," i.e., an inexhaustible supply of food for small populations of hunter-gatherers operating with simple technologies (see Erlandson 1994:273). This view fails to consider that human predators may have an appreciable impact on certain marine environments. Evidence related to prehistoric fishing and shellfish collecting in the southern islands suggests that over-exploitation of marine species may have played a role in shaping aboriginal subsistence patterns.

In an analysis of prehistoric regional fishing patterns, Salls (1988:209-220) offered an "alternate stable states" model to explain changing patterns of resource exploitation. He argued that ecosystems may alternate between markedly different structural phases, based upon critical predator/prey relationships. Salls (1988) cited an example of this mechanism from the work of Simenstad et al. (1978). The latter investigators

documented the effect of predation by Aleuts on sea otters on Amchitka Island, Alaska. Those studies show that sea otters play a crucial role in regulating nearshore marine ecology in the Amchitka region. Otters prey heavily on sea urchins, thus restraining the population size of the latter. When the number of otters is reduced by human hunters, the number of urchins increases explosively. Since the urchins are herbivores that feed on kelp stands, a large urchin population leads quickly to a reduction in the size of these stands. The kelp provides food and shelter for a large number of fish species. These fish in turn support sea mammals and birds. Thus, disappearance of the kelp stands profoundly alters the diversity and number of all of these life forms. In this fashion, two dramatically different phases, or stable states, of the nearshore ecology may exist, depending upon the abundance of the sea otter.

Salls (1988) documented similar shifts in alternate stable states on San Clemente Island at the Eel Point site (SCLI-43) over a period of millennia. A sample of 7.97 m.³ of midden containing 1,619 fish elements (30% statistically random sample of all fish bone elements) was analyzed from one portion of the site (Locus B), while a sample of 33 m.³ of midden containing 20,665 fish elements (30% statistically random sample) was analyzed from another (Locus C, Salls 1988:353-382). One of the most provocative results of these studies was selective procurement of at least one fish species throughout the period of the site occupation. The California sheephead (*Semicossyphus pulcher*) accounts for a major proportion of the total fish catch; typically ranging from 50 to 80 percent of all fish taken by aboriginal fishers during the whole prehistoric period (Raab and Yatsko 1992:179-186).

The role of the sheephead as a "keystone predator" within the nearshore marine habitat has been well documented. Cowen (1981:225) reported a 26% increase in the sea urchin

population of the Dutch Harbor area of San Nicolas Island in a period of only one year after experimental removal of sheephead. Since the sheephead is a principal predator of the sea urchins, this effect is not unexpected. Salls (1988:209-220) drew a parallel between the ecological role of sheephead in the San Clemente Island marine ecosystem and of the sea otter in the Aleutian case documented by Simenstad et al. (1978). Salls suggested that aboriginal fishermen triggered alternate stable states in the marine environment by removing significant numbers of sheephead. A low population of sheephead would result in a population increase of sea urchins. A larger number of urchins could then be expected to result in reduction of the kelp stands upon which this species feeds. A reduction in the size of the kelp beds would lower the species diversity, as well as the number of individuals of each species in the nearshore habitat. In a synopsis of Holocene sheephead exploitation at the Eel Point site, Salls (1988:630) made the following observations:

Overlying level VIII at Area C is a 5 cm thick layer of compact and concentrated sea urchin (*Strongylocentrotus purpuratus*) testae and spines which were distributed across the site to the exclusion of all other marine species. Following this sea urchin level, there appears to be a reduction in the effective targeting of sheephead in Levels X to XII . . . This procurement decline coincides with a general increase in the overall average and modal size of the fish. Predominant sea-urchin levels, such as those at Eel Point, have also been observed in some middens on San Nicolas Island.

Research also reveals a pattern of over-exploitation of the intertidal zone on San Clemente and Santa Catalina islands by shellfish gatherers. On San Clemente Island, three sites (SCLI-1318, SCLI-1319, and SCLI-1325), located on the marine terraces of the island's west shore, were partially excavated to recover samples of midden for the purpose of studying

patterns of faunal exploitation, particularly of shellfish. Two of these sites have been dated by means of radiocarbon assays (see Table 1), revealing late prehistoric and historic occupations of the island: SCLI-1318 at 250 ± 50 RYBP (Beta-39144) and 350 ± 50 RYBP (Beta-39146), and SCLI-1319 at 240 ± 50 RYBP (Beta-39148) and 300 ± 70 RYBP (Beta-39150). All shell from these samples was identified to the species level. These species clearly are derived from the rocky intertidal zone that characterizes virtually all of the west shore of San Clemente Island.

Examination of the midden contents revealed that two species, *Tegula funebris* (black turban snail) and *Haliotis cracherodii* (black abalone), account for the largest proportion of the midden shell by weight. *Tegula*, in fact, account for between 70 and 90 percent of shell in these middens by weight (Raab 1992; Raab and Yatsko 1992:182-186). The large proportion of these small snails (average weight is about 2.5 to 3.0 g.) in the middens may seem surprising in view of the fact that they represent such a small food item. In other environmental settings, shellfish species of this size may be ignored entirely as food items (Yesner 1981:155).

Clearly, however, *Tegula* were collected in substantial quantities for food on San Clemente Island. How can we account for this fact? Estimated meat yield by species in the San Clemente Island middens provides an answer to this question (Raab 1992). Abalone were the largest "meat package" available in the tide pools, and therefore tended to structure the subsistence base. Apart from abalone, turban snails are the only shellfish that occur in the intertidal zone in sufficient numbers to be of economic use. Since abalone are easily depleted, however, it appears that *Tegula* were used to make up shortfalls in subsistence needs (Raab 1992). Viewed from this perspective, the inclusion of turban snails in the "dietary breadth" is not anomalous but does

suggest the need to supplement easily over-exploited first-rank food resources (abalones) with smaller species. This phenomenon is not restricted to instances on San Clemente Island. Bradford (1990), in an analysis of the shellfish economy at Ripper's Cove (SCAI-26), Santa Catalina Island, identified a similar pattern for abalone and wavy turban snails (*Astraea undosa*) in cultural components ranging in age between 220 ± 80 (GaK-7481) and 610 ± 90 RYBP (GaK-7480; Reinman and Eberhart 1980:72).

The comparatively small size of the black abalone from middens on San Clemente Island is also an important clue regarding intensity of human predation. Prehistoric shell specimens were found to range typically between 70 and 80 mm. in length, while extant abalone populations free of human predation display a much wider size range, with the modal size of larger specimens ranging between 140 and 150 mm. The extant specimens are a mature population consisting of many age cohorts, while the midden specimens reflect a much more constrained age distribution (Raab and Yatsko 1992:187). By contrast, the prehistoric specimens could be characterized as a juvenile population, ranging between about three to four years of age.

A similar pattern has been documented elsewhere. Rosenthal et al. (1988:78-81) recorded information on over 2,800 black abalone shells from middens in the Bulrush Canyon sites (SCAI-137), Santa Catalina Island. Rosenthal et al. (1988:21) reported two charcoal radiocarbon dates from Bulrush Canyon (LJ-4755 and LJ-4756), although no details were provided about how these assays were performed. The ages of these samples are given as "A.D. 1680 \pm 100" and "A.D. 1720 \pm 90" from Test Pit 1. Interestingly, the Bulrush investigators found that mean black abalone shell lengths ranged between 55 and 94 mm. This size range is similar to that of the pre-

historic shell specimens from San Clemente Island, suggesting high levels of predation on black abalone from the Bulrush Canyon sites. The narrow age spectrum of both the San Clemente and Santa Catalina samples suggests that abalone had little opportunity to grow old in the presence of the islands' prehistoric human populations.

The excellent analysis of prehistoric sea mammal hunting along the California and Oregon coasts by Hildebrandt and Jones (1992) also bears on the topic of over-exploitation of marine resources. Their analysis, based in part on Channel Islands data, suggests that long-term patterns of sea mammal hunting were driven by over-exploitation of this resource.

Marine Paleotemperature

As archaeologists increasingly appreciate how maritime cultural adaptations reflect variability in marine ecosystems, paleoenvironmental forces take on increasing significance. A number of researchers has drawn attention to the possible role of marine paleotemperature in determining the productivity of ancient coastal environments in southern California (e.g., Raab et al. n.d.; Walker and Sneathkamp 1984; Glassow et al. 1988; Arnold 1992; Colten 1992; Arnold and Tissot 1993). These discussions are based on an 8,000-year record of sea surface temperature (SST), based on analysis of temperature-sensitive radiolarian assemblages in varved sea cores from the Santa Barbara Basin (Pisias 1978, 1979; see Fig. 3B). This paleotemperature curve, which records February SST, or the low point of annual water temperature, is currently the only reconstruction available.

Although changing SST may not have produced identical effects everywhere in the region, it is reasonable to hypothesize that marine habitats responded to changing sea temperature in significant, ecologically explicable ways. The effect of sea temperature on kelp growth is

one of the record's most important implications. Giant brown algae of the genus *Macrocystis* form magnificent "kelp forests" that support a prolific web of life that includes fish, sea mammals, and birds. The abundance of kelp bed species in archaeological faunal assemblages indicates the importance of this biological community to coastal peoples, particularly inhabitants of the California Channel Islands (Landberg 1965, 1975; Walker and Sneathkamp 1984; Glassow and Wilcoxon 1988; Glassow et al. 1988; Raab and Yatsko 1990; Arnold 1992).

The paleotemperature model emphasizes that water temperatures above 20°C have a destructive impact on kelp beds (Walker and Sneathkamp 1984; Glassow et al. 1988; Arnold 1992; Colten 1992). Far-reaching cultural evolutionary impacts may be attributed to paleotemperature trends. Periods during which SST exceeded 20°C are thought to have been hostile to the existence of kelp forests, thus causing food shortages for coastal populations. Colten (1992) and Arnold (1992) argued that elevated SST at about A.D. 1100 to 1300 had a particularly devastating impact on maritime subsistence, thus acting as a "kicker" in the subsequent emergence of a chiefdom on Santa Cruz Island. Arnold (1992) suggested that shell bead manufacture was brought under elite control in an effort to buffer subsistence failures caused by warm water destruction of kelp beds.

Development of independent "thermometers" of ancient sea temperature clearly is important in bolstering the paleotemperature model. Important progress has been made on this front. Arnold and Tissot (1993) presented evidence of prehistoric warm water episodes in the northern Channel Islands based on a morphometric study of black abalone (*Haliotis cracherodii*) shell growth. This study has great potential for paleotemperature research, since black abalone shells are frequently found in California coastal middens (Raab 1992). Glassow et al. (1994) approached this problem

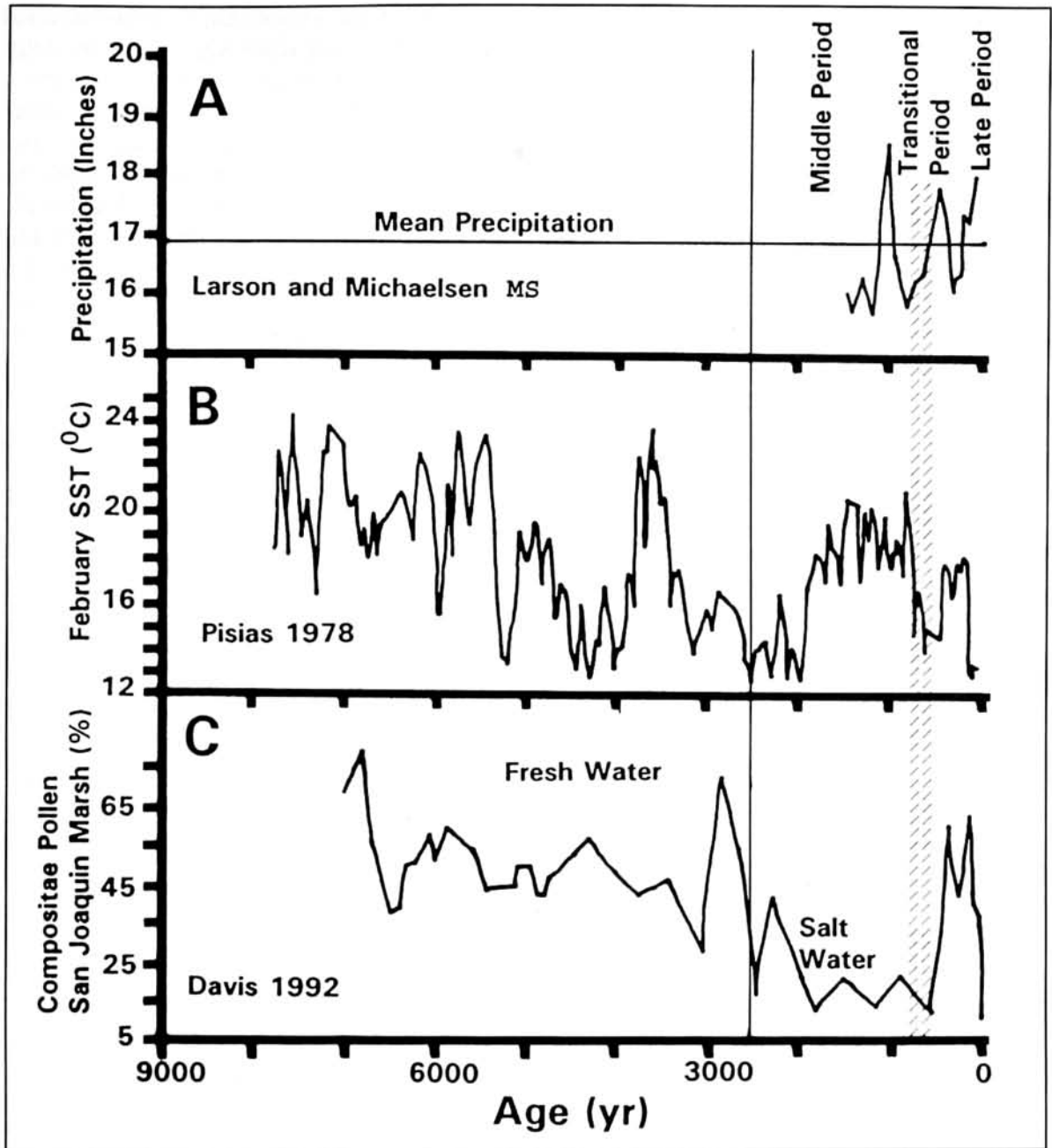


Fig. 3. Comparisons of Holocene sea temperature and moisture trends in southern California (from Larson and Michaelsen MS; Pisias 1978; Davis 1992).

from another direction, presenting evidence of significant SST cooling in the northern Channel Islands between 4,500 and 5,900 RYBP, based on oxygen isotopic studies of mussel (*Mytilus californianus*) shells from middens.

Evaluation of the paleotemperature model ultimately requires assessment of subsistence trends in relation to water temperature variation. Cases are presented from the northern islands in which cool temperatures are linked to increased

marine food availability (Walker and Snethkamp 1984; Glassow et al. 1988) and warm SST is correlated with depressed food availability (Arnold 1992; Colten 1992).

Recent research in the southern islands by Raab et al. (n.d.) called some of these interpretations into question. Work at the Little Harbor site (SCAI-17) was undertaken, in part, to evaluate the paleotemperature model in the southern islands. The maritime subsistence economy of Little Harbor was diverse and clearly maritime in orientation, including shellfish, fish, and sea mammals (Meighan 1959; Kaufman 1976; Salls 1988; Bradford 1992; Porcasi 1992). Radiocarbon dates show that midden deposits containing these abundant food resources were deposited about 5,200 RYBP, ostensibly during a period of warmer-than-present SST.

Warm sea conditions are reflected in the site's marine faunal assemblage. Raab et al. (n.d.) identified dolphin (Delphinidae) bones representing five species and members of the genus *Stenella*. *S. coeruleoalba*, the blue or white dolphin, is of particular interest in this assemblage, as both are indicators of past marine conditions. This species is rarely seen today in California waters, since Baja California is typically the northern limit of its range. It has been sighted as far north as British Columbia in warm water years but is a resident of the tropics or subtropics, as are all members of this genus. A single *S. longirostris* (spinner dolphin) was also reported by Bleitz-Sanburg (1987:91, 194-195) from midden Stratum I of site SNI-11, San Nicolas Island. Unfortunately, radiocarbon dates for this stratum range from 1,870 B.C. to A.D. 1377 (Bleitz-Sanburg 1987:70-71). Fish bones are abundant at Little Harbor, and these point to elevated SST as well. Salls (1988:731) identified large numbers of tunas and other large, pelagic, warm water species. These warm water animals, in concert with other lines of evidence, point to warmer-

than-present sea temperatures during at least some of the Middle Holocene occupation of the Little Harbor site (Raab et al. n.d.).

These results, which also draw upon faunal data from San Clemente Island, question whether elevated sea temperature results in depressed marine food resources. Raab et al. (n.d.) examined instances in which highly productive marine economies, as measured by quantities of shellfish, fish, bird, and sea mammal bones in middens, are apparently associated with periods of elevated sea temperature in both the northern and southern Channel Islands.

Paleoclimate

Only in the last decade have high-resolution paleoenvironmental records become available for the southern California coast. Although these data are derived from the southern California mainland, they have important implications for Channel Islands archaeology. A case in point is the debate about the effects of marine paleotemperature discussed earlier. As noted above, Arnold (1992:75-76) argued that sea temperature trends are related to disruptions of maritime hunter-gatherer-fisher economies in the northern Channel Islands between about A.D. 1100 and 1300. These disruptions are thought to have been of sufficient severity to cause abandonment of some coastal sites, occupational hiatuses in others, deterioration of the health status of island dwellers, and greater incidence of violence.

Recent reconstructions of coastal precipitation trends, based on pollen and tree-ring data, suggest that drought cycles may have played a major, if not crucial, role in bringing about the effects described by Arnold (Raab 1993b). One of the most important paleoclimatic records available from the southern California coast is an 8,000-year pollen record based on a radiocarbon-calibrated, 687-cm. core taken from the San Joaquin Marsh, located 7 km. from the

Pacific Ocean at the head of Newport Bay, Orange County, California (Davis 1992). This pollen record reflects major shifts in effective moisture during the last 8,000 years. Since San Joaquin Marsh exists between fresh- and saltwater environments, decreased runoff and lower discharge of springs feeding the marsh permitted saltwater incursions (Davis 1992:93). Conversely, periods of high stream flow are marked by comparatively rapid sedimentation rates, abundant palynomorphs, and high percentages of Compositae pollen (Davis 1992:92-98). Davis' data (1992; Fig. 3C) showed that the lowest period of effective moisture in the entire 8,000-year pollen record from the San Joaquin Marsh was experienced from about 1,800 to 700 years B.P. (A.D. 200 to 1300). This interval brackets the period of A.D. 1100 to 1300 identified by Arnold (1992) as one of pervasive disruptions to cultural systems on Santa Cruz Island.

Tree-ring data are also important indicators of precipitation and other paleoclimatic phenomena. Larson and Michaelsen (MS) offered a 1,600-year tree-ring record from the southern California coast (Fig. 3A). This record, commencing at A.D. 400, was produced with data from trees located in the Transverse Ranges of central Santa Barbara County, California (ca. 140 km. northwest of San Joaquin Marsh), and from San Geronio Peak, located about 200 km. east of Santa Barbara. Summarizing the climatic record reflected in these data, Larson and Michaelsen (MS:22-23) noted that, "Between A.D. 1100 to 1250 climatic conditions maintained a sustained low for a period of more than 150 years. The interval between A.D. 1120 and 1150 was particularly harsh." Consistent with the San Joaquin Marsh pollen record, the interval from A.D. 1100 to 1300 is reconstructed as one of extreme drought conditions.

Some of the most provocative evidence of climatic deterioration in approximately the same time frame is provided by Stine (1994). Stine

presented radiocarbon dates from drowned trees in Sierra Nevada lakes, streams, and marshes. These trees were able to grow during dry periods, only to be killed as water levels came back up with the return of moister conditions. These events occurred at the same time at four study locations, indicating a regional pattern. Stine (1994:549) found that two periods of "epic" drought occurred between about A.D. 892 to 1112 and A.D. 1209 to 1350; the first event lasting more than 220 years and the second more than 140 years. Both of these events bracket Arnold's (1992) Middle-to-Late transitional period. These events correspond to the lowest moisture levels recorded at San Joaquin Marsh and in Larson and Michaelsen's (MS) tree-ring data as well.

The evidence of environmental stress is not confined to indicators such as pollen and tree rings. Several studies show a dramatic increase in the incidence of disease, malnutrition, and violence during the Middle-to-Late transition (Walker 1986, 1989a, 1989b; Walker and Lambert 1989; Lambert and Walker 1991; Lambert 1993). Figure 4 shows these calamities peaking while effective moisture at San Joaquin Marsh was at its lowest point in the Holocene. There is also evidence from the domain of mortuary studies that points to the emergence of social ranking during this stressful period (Martz 1984; Lambert and Walker 1991; Raab 1994).

What are the implications of these findings for the Channel Islands? Drought conditions were likely to be particularly devastating to island populations. Islands are comparatively small precipitation catchments and, depending upon their geological character, may afford comparatively few sources of water. "Carry-over" effects (Shaw and Homburg 1992:358) from one year to the next would impose a particularly stressful pattern of decreasing effective moisture. Viewed from the perspective of the paleoclimatic data, drought conditions are a reasonable hypothesis in accounting for

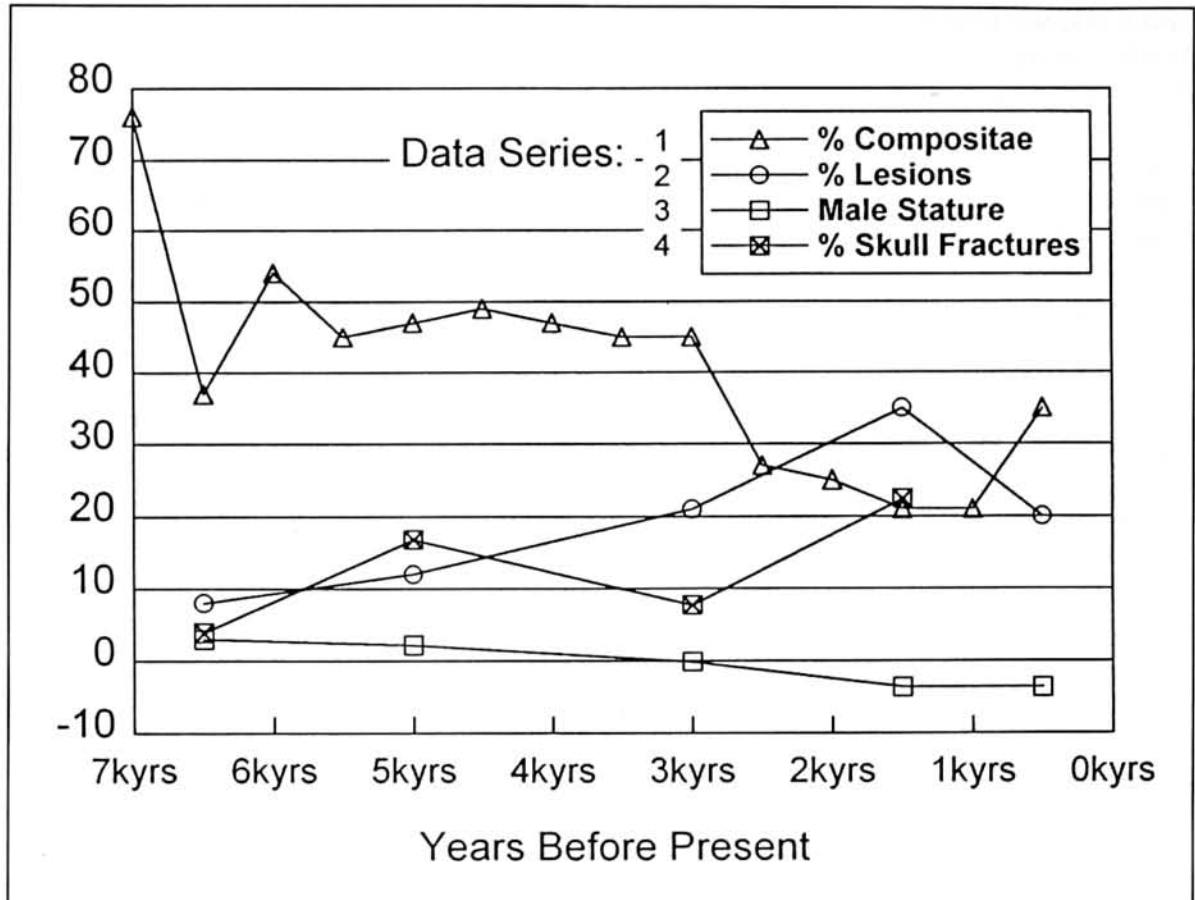


Fig. 4. Effective moisture at San Joaquin Marsh (% Compositae) as compared to disease, skull trauma, and male stature trends for burial populations of the California Channel Islands and adjacent mainland coast (after Davis 1992; Lambert 1993).

Arnold's (1992:76) citation of widespread site abandonment and increased incidence of disease and violence on Santa Cruz Island during the interval of A.D. 1100 to 1300.

This hypothesis may be strengthened by human osteological data. Walker (1986:347) showed that cribra orbitalia (caused by chronic anemia, this form of porotic hyperostosis produces characteristic osseous lesions in the eye orbits) was common in Late Prehistoric populations of the northern Channel Islands and adjacent mainland. Walker (1986:346) concluded that in the prehistoric northern Channel Islands, including Santa Cruz, "high nutrient losses associated with diarrheal disease may often be more significant in the etiology of cribra

orbitalia than a low intake of essential nutrients." Walker (1986:351) identified the most likely cause of this condition as waterborne pathogens.

Consistent with this conclusion, Walker (1986:351) showed that the incidence of porotic hyperostosis in the northern Channel Islands is inversely related to island size: smaller islands offer fewer and more intensively used water sources. During periods of severe drought, even comparatively large islands such as Santa Cruz must have experienced shrinking water sources, exacerbating the pathogenic process described by Walker. This scenario suggests that chronic illness and water shortages may have combined to discourage island occupation

during droughts. Violence stemming from competition for dwindling water supplies is also a logical consequence of drought conditions.

These data have broad implications. Davis (1992:98) observed that "Cooling recorded in the marine record (Pisias 1978) . . . corresponds to wet periods at San Joaquin Marsh." A comparison of these records suggests that the opposite may be true as well, i.e., warming seas correspond to significant moisture deficits in the coastal zone. It is also worth noting that Shaw and Homburg (1992) reconstructed high flows within the Santa Ana River Basin of southern California just prior to European contact (A.D. 1540), a pattern consistent with Davis' (1992) reconstruction of dramatically improved moisture conditions during the Late Period (Fig. 3C). This drainage system included the San Joaquin Marsh (Davis 1992) before the advent of modern flood-control construction.

Shaw and Homburg (1992) suggested that the large aboriginal populations encountered by Europeans in coastal southern California may be accounted for in part by movement of peoples to the coast from drought-stricken interior regions, and rapid population growth resulting from favorable environmental conditions on the coast during late prehistory. This dynamic may deserve consideration in reconstructing late Holocene demographic and settlement trends, including the rise of socioeconomic complexity within coastal societies. These findings also bring California archaeology into a frame of reference long appreciated by archaeologists in the American Southwest and elsewhere. Some of the paleoclimatic forces that influenced Late Holocene coastal California, including droughts, may have been part of larger climatic patterns responsible for abandonments of regions of the Southwest by Puebloan peoples (Cordell 1984: 304-325).

Patterning in the temporal distribution of sites from San Clemente Island (Yatsko and Raab n.d.) appears to correlate with some of the

paleoenvironmental trends cited above. When frequencies of San Clemente Island radiocarbon dates are compared with curves for sea temperature change (Pisias 1978, 1979) and dendroclimatic precipitation (Larson and Michaelson MS), provocative patterns emerge. The most dramatic is a hiatus in San Clemente Island dates for the period between about 850 and 650 radiocarbon years B.P. (A.D. 1100 to 1300). This apparent hiatus corresponds to the Middle-to-Late Period transition postulated by Arnold (1992) as one of stress-induced cultural change in the northern Channel Islands. This hiatus, if real, suggests a low or spatially aggregated population during the Middle-to-Late Period transition on San Clemente Island or the possibility of island abandonment. A depressed near-shore marine environment and/or an extended drought would have been catastrophic on San Clemente Island. If these conditions did exist, it seems likely that the inhabitants of the islands would have retreated to more productive, or less stressed, areas of the island's environment. Alternative strategies include migration or population extinction, not uncommon outcomes in the human biogeography of islands (Terrell 1986; Keegan and Diamond 1987).

Another significant trend in the radiocarbon dates is an apparent correlation between high frequencies of Late Period sites on San Clemente Island (and the Southern California mainland; see Breschini et al. 1992) and cool sea surface temperatures and above average rainfall. This suggests that favorable environmental conditions, such as those described by Shaw and Homburg (1992) for the mainland after A.D. 1300, may have resulted in an absolute increase in the number of occupied sites, with implications for a larger island population and/or intensification in the use of its resources. This possibility is interesting in connection with the intensive exploitation of San Clemente Island's intertidal zone during the same time frame, as

reflected in the *Tegula* processing sites described earlier.

Provisionally, then, the San Clemente Island data provide some support for the hypothesis that environmental stress affected southern islands populations sufficiently to require new response options, including intensification of subsistence strategies, adopting new technologies, extending networks of exchange relationships, and increased specialization or migration. Continuing research on San Clemente Island, sponsored by the Natural Resources Office of the Naval Air Station, North Island, will investigate models involving risk minimization and optimal foraging theory within considerations of natural and human-induced paleoenvironmental stresses.

These advances in paleoclimatic research suggest future avenues of research in the southern Channel Islands. Studies can target time intervals of warm and cool sea temperatures in order to understand relationships between ocean temperature and marine subsistence productivity. Bioarchaeological studies can examine patterns of pathology during periods of increased and decreased moisture. Examination of relationships between settlement patterns and island water sources during wet and dry periods may prove informative. Island paleoenvironmental records based on pollen or tree-ring studies are also worthwhile objectives.

CONCLUDING REMARKS

Two trends seem well established in southern islands archaeological research, based on the experience of the last decade. First, sporadic, largely descriptive studies have given way to sustained, critical evaluation of hypotheses and explanatory models of cultural behavior. The debate about the effects of marine paleotemperature is an example of this trend. Studies of this kind require archaeologists to work in concert with scientists from many fields, and thus advance general explanations of cultural

evolution. Studies of cultural ecology, many based on explanatory models, are increasingly important in California coastal archaeology (Glassow et al. 1988; Erlandson 1991, 1994; Erlandson and Colten 1991; Jones 1991, 1992; Arnold 1992; Hildebrandt and Jones 1992; Raab 1992; Raab and Yatsko 1992; Lambert 1993). Research in the Channel Islands will undoubtedly continue to play a critical role in these studies.

Second, research advances of the last decade have moved southern islands archaeology decisively beyond single-site or single-island perspectives to a regional frame of reference. The research advances discussed above show how this perspective was able to integrate the results of investigations as disparate in nature as basic research on Santa Catalina Island, archaeological field schools on San Clemente Island, and contract studies in Orange County. Only in this way can archaeologists hope to advance their understanding of phenomena such as cultural interaction spheres or the impact of paleoenvironmental forces on cultural systems.

The authors are greatly encouraged by the last decade of archaeological research in the southern Channel Islands. If the next decade is as productive as the last, Channel Islands archaeology will take its place among the most dynamic spheres of research in North American archaeology.

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