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Maritime Subsistence at a 9300 Year Old Shell Midden on Santa Rosa Island, California

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A deeply buried shell midden (CA-SRI-6) on Santa Rosa Island, California appears to have been a residential campsite occupied about 9300 years ago. Although few artifacts were recovered from this Early Holocene component, faunal remains suggest a heavy reliance on marine resources, probably supplemented by terrestrial plant foods. Dietary reconstructions suggest that shellfish (especially abalone) provided about 85% of the estimated meat yields, fish about 14%, with birds and sea mammals each contributing less than 1%. These data suggest that Early Holocene adaptations on the Channel Islands were distinct from the coastal mainland in many ways and that maritime hunter-gatherers had adapted to a variety of Pacific Coast habitats by this early time.

Introduction

In the New World there is increasing evidence for a broad array of subsistence strategies during the Terminal Pleistocene and Early Holocene, including an apparent focus on small game and plant resources at many sites (Erlandson 1991, 1994; Roosevelt et al. 1996; Sandweiss et al. 1998; Yesner 1996). These findings raise questions about cultural ecological models that routinely place big game hunting at the top of optimal subsistence strategies for early hunter-gatherers. To a considerable extent, this re-examination of Paleoindian subsistence has been fueled by the increasing antiquity of evidence for New World coastal adaptations, including a number of Terminal Pleistocene sites located along the Pacific Coast of North and South America (e.g., Erlandson et al. 1996; Keefer et al. 1998; Sandweiss et al. 1998). Coastal environments, which often provide a wide variety of marine and terrestrial resources, encourage diversified subsistence patterns, and optimal subsistence choices differ considerably from many landlocked environments.

The southern California coast has one of the longest and

best documented archaeological records for the development of maritime societies and the peopling of the Americas (Erlandson 1994; Jones 1991; Moss and Erlandson 1995). Since at least the 1920s, however, many archaeologists have suggested that California's Channel Islands were not settled until considerably after the adjacent mainland coast (e.g., Rogers 1929: 339; Olson 1930; Wallace 1955; Rozaire 1967; Yesner 1987: 301), presumably because of their geographic position and lower terrestrial plant and animal diversity. This notion persisted even after Orr (1962, 1968) documented several Terminal Pleistocene and Early Holocene sites on Santa Rosa Island, possibly because of skepticism over some of Orr's more controversial claims (Erlandson 1994). Today, we know the California Islands were settled remarkably early. Evidence from Daisy Cave (CA-SMI-261) on San Miguel Island, and Arlington Springs (CA-SRI-173) on Santa Rosa Island, suggests that boat-using Paleoindians first settled the islands no later than Folsom times, about 10,400 b.p. (radiocarbon years) or about 12,300 calendar years B.P. (Erlandson 1994; Erlandson et al. 1996; Johnson et al. in press). Two

Channel Island archaeological sites have produced apparently reliable ^{14}C dates greater than 10,000 years old, two in excess of 9000 b.p., and six in excess of 8000 b.p. (Erlandson 1994, 1997; Erlandson and Moss 1996: 286). All but two of these sites are located on the northern Channel Islands of Santa Rosa and San Miguel (FIG. 1), with one site each on Santa Cruz Island and San Clemente Island.

These sites contain a remarkable record of early maritime adaptations. Aside from radiocarbon dates, some general stratigraphic descriptions, and largely anecdotal constituent data, however, we know little about most of these sites or the occupants (see Erlandson 1994; Kennett 1998: 377). To some extent, this situation will be resolved by ongoing investigations at two key sites, Daisy Cave and Eel Point (CA-SCLI-43), but recently recovered assemblages from these sites have yet to be fully analyzed or published. In this paper, we report on our analysis of samples from a 9300 year old shell midden at CA-SRI-6, exposed in the sea cliff near the mouth of Arlington Canyon on Santa Rosa Island. Our investigations at this deeply buried, multicomponent site, accessed only by rappelling down the sheer sea cliff, recovered a sizable assemblage of faunal remains and a small sample of artifacts. Analysis of the faunal remains, in particular, allows us to reconstruct aspects of the local environment, marine resource harvesting patterns, the economic basis of the site, and the diet of the occupants. This rare quantitative faunal data from an early Channel Island site also reveals the diversity of early

maritime adaptations along the southern California coast and the broader implications of such patterns. First, however, we provide some environmental and archaeological background.

Site Location, Stratigraphy, and Chronology

CA-SRI-6 is located at the mouth of Arlington Canyon along the NW coast of Santa Rosa Island. Arlington Canyon is one of the larger drainages on the northern Channel Islands (Kennett 1998: 449) and contains a perennial stream and a series of bedrock sills where fresh water is available year round. CA-SRI-6 contains at least five archaeological components, of which Component V, the latest, dates to the Late Holocene, and Components I, II, III, and IV were dated to the Early Holocene (TABLE 1). Our analysis focuses on Component I, the basal stratum dated to 9300 calendar years B.P. Philip Mills Jones (1956) may have excavated at CA-SRI-6 in 1901, removing over 200 burials from a Late Holocene component, but the exact location of his work is not known. Phil Orr, who worked extensively on the NW coast of Santa Rosa Island in the 1940s, 1950s, and 1960s, first described CA-SRI-6 (also called Arlington Point) as one of his "Early Dune" localities:

On the east side of Arlington Canyon ... the sea cliff is recessed several hundred feet from the beach; at the top of this 100 foot cliff is a grassed-over mound composed of windblown sand, sandy clay, and shell, and very faint re-

Figure 1. The location of CA-SRI-6 and the Santa Barbara Channel area.

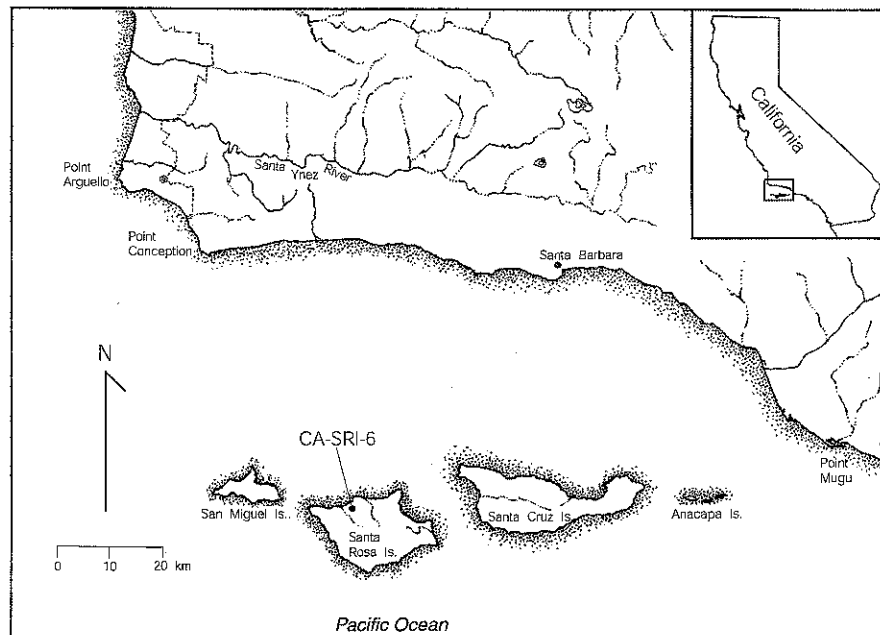


Table 1. Radiocarbon chronology for Early Holocene components at CA-SRI-6.

Component	Lab no.	Depth (m)	Uncorrected ¹⁴ C age b. p.	¹³ C/ ¹² C adjusted b. p.*	Material dated	Calibrated age range (midpoint b.p.)†
V	Beta-119882	0.2-0.3	1490 ± 80	1930 ± 80	California mussel	1300 (1260) 1160
IV	L-257	3.65	6820 ± 160	7260 ± 80	Red abalone	7540 (7470) 7390
III	Beta-47818	?	7090 ± 90	7530 ± 90	Black abalone	7820 (7710) 7620
II	IJ-27	4.57	7440 ± 200	7880 ± 200	Red abalone	8300 (8060) 7880
I	Beta-47625	7	8360 ± 80	8800 ± 80	Red abalone	9330 (9200) 9020

* Marine shell samples were adjusted for ¹³C/¹²C ratios to compensate for the differential uptake of carbon isotopes (isotopic fractionation). Shell samples were calibrated using a ΔR value of -225 ± 35 years for the effects of the local marine reservoir effect (see Stuiver, Pearson, and Braziunas 1986; Kennett et al. 1997).

† All samples were calibrated via CALIB 3.0.3 (Stuiver, Pearson, and Braziunas 1986; Stuiver and Reimer 1993).

mains of several house pits can be seen on the surface. ... Due to the inaccessibility of this site and to lack of time, no excavations have been carried out here, but the great amount of sea cliffing gives good exposure of strata showing depths of more than 20 feet of intermittent shell, sands, and clays, with another 10 feet or so of grassed-over midden on top. ... Exposed on the sea cliff and in the badland arroyos are thick beds of red abalone (*H. rufescens*) at depths of 6, 12, 15, and 23 feet. One of these at 12 feet was dated by radiocarbon at 6820 ± 160 BP ... another at 15 feet was dated at 7440 ± 200 BP (Orr 1968: 145).

Orr's work at CA-SRI-6 was limited largely to examining sea cliff profiles and collecting radiocarbon samples from some of the exposed shell midden strata. Orr noted that artifacts were "exceedingly rare" at CA-SRI-6 and those he collected came from the upper midden levels.

Most of what we know about the earliest occupation of CA-SRI-6 is the result of two recent visits. In 1991, Erlandson and Morris examined the site as part of a preliminary study of Early Holocene localities on the northern Channel Islands. The goals of this brief visit were to relocate this site, to determine why Orr never dated the deepest midden, and to collect ¹⁴C samples. Erlandson (1994: 191) noted that:

the red abalone middens at Arlington Point are not neatly stacked, but instead are scattered discontinuously over a large area. ... On the 30-m high terrace to the east, a localized red abalone midden was observed in a sloping paleosol between 6 and 8 m below the surface. This matches Orr's depth of 23 feet (7 m) for the lowest red abalone midden at SRI-6. This midden was exposed only along the nearly vertical sea cliff, and had to be accessed with climbing gear ...

Don Morris rappelled down the cliff face to examine this midden soil (see Erlandson 1994: 192), took notes on the midden constituents, and collected a small sample of artifacts and a large red abalone shell for ¹⁴C dating. The shell produced a ¹³C/¹²C adjusted ¹⁴C date of 8800 ± 80

radiocarbon years b.p. (Beta-47625), and a calibrated intercept of about 9200 calendar years B.P. (Stuiver and Reimer 1993). There are indications, however, that the local reservoir effect in the Santa Barbara Channel area was much diminished around this time (Erlandson et al. 1996; Kennett et al. 1997), suggesting that the site may actually have been occupied closer to 9300 or even 9400 calendar years B.P.

During more intensive investigations in 1997 (FIG. 2), we noted that the midden appears to have formed in a well developed soil 30-40 cm thick, a dark olive gray (10YR 3/2) sandy loam bracketed by alluvial sedimentary units (FIG. 3). The shell midden is visible for about 15 m across the sea cliff, with a depth varying between 3.5 m and 10 m below the modern marine terrace surface. This midden stratum dips to the west at about 25-30°, and appears to be contiguous with a well developed and essentially horizontal paleosol located 1 m to 1.5 m below the terrace surface just east of the site. Between these exposures, however, the midden soil has been truncated by erosion, resulting in a lateral discontinuity.

The location of this site on the sloping surface of an arroyo or canyon wall is somewhat unusual. We suspect the site occupants intentionally settled on the slope to escape the strong winds that often buffet the NW coast of Santa Rosa Island. About 9300 years ago, sea levels along the southern California coast are thought to have been between about 20 m and 25 m below present (Inman 1983: 9), leaving the site 2 km to 2.5 km from the coast. The shoreline itself may have been somewhat closer at the mouth of Arlington Canyon, however, as rapidly rising sea levels formed small embayments in many coastal canyon mouths during the Early Holocene (see Inman 1983; Erlandson 1994).

A major goal of our 1997 investigations was to collect a more representative sample of the midden constituents of this early shell midden. Because the site was accessible on-



Figure 2. Overview of seacliff exposures at CA-SRI-6 (looking east), with figures suspended at 9300 year old shell midden.

ly in vertical sea cliff exposures and deeply buried, conventional excavation procedures were impractical. Instead, we collected sediment samples from the eroding cliff face. A 121 liter (0.121 cu m) sample of midden soil was excavated from the central (and densest) part of the site, sealed in 5-gallon buckets and lowered to a screening crew at the bottom of the cliff. The excavated sediments were dry-screened over $\frac{1}{8}$ -inch mesh to reduce their bulk and later water-screened to remove the remaining earth. Along with the larger midden sample, we also collected a 3 liter sample of midden soil for fine-screen ($\frac{1}{16}$ -inch) processing for smaller constituents, including macrobotanical remains.

Artifacts

The small size of the artifact sample recovered is partly the result of our limited investigation. It may also be due, however, to a generally heavy reliance on shellfish collecting by Early Holocene peoples of the southern California coast, a subsistence activity that generally requires little technology (Moriarty 1967: 555; Erlandson 1994: 262). Owing to the low diversity of the island flora, early island sites also lack the well-formed grinding tools and core

hammers common in many Early Holocene sites of the mainland coast where collecting and processing of small seeds appears to have been a major subsistence activity.

The stone artifacts from Component I at CA-SRI-6 include four objects recovered from seacliff exposures and a small sample of chipped stone debitage from the excavated midden sample. A flat, water-rolled cobble of coarse sandstone, $20.1 \times 14.7 \times 3.2$ cm, is spalled at both ends with a few small pit-like depressions on the flat surfaces. It appears to have been used as a maul or hammerstone, and may also have been used as a grinding slab or anvil. Also recovered from seacliff exposures was a multiplatform core of Monterey chert, an angular chunk of Cico chert with a utilized graver-like tip, and a possibly utilized flake of metavolcanic rock. The only stone artifacts recovered from the midden were 13 pieces of chipped stone debitage, including two pieces of probable Cico chert. The only known outcrops of Cico chert are located on the NE end of San Miguel Island about 15 km to the west (see Erlandson et al. 1997).

Other materials include small amounts (0.28 g) of asphaltum (tar or bitumen), a substance that leaks into San-



Figure 3. Closeup of 9300 year old shell midden stratum at CA-SRI-6.

ta Barbara Channel waters through fissures in the ocean floor and washes ashore on northern Channel Island beaches. In historical times, asphaltum was used by Chumash Indians as a glue or mastic.

All bone and shell fragments were examined for modification and no bone artifacts or formal butcher marks were identified. Two pieces of purple olive (*Olivella biplicata*) shell possibly represent bead-making debris, since these small gastropods were the primary material Santa Barbara Channel peoples used to make beads for at least 10,000 years.

Macrobotanical Remains

Although we were unable to do flotation, approximately 0.38 g of charcoal was recovered from the $\frac{1}{8}$ -inch screen residuals, including two charred fragments of relatively large seeds. Phylissa Eisentraut of UCLA (personal communication 1998) noted that they appear to be from some type of fruit seed, but were too fragmented and weathered

for specific identification. In the future, flotation and botanical studies may provide valuable data on plant use during the earliest occupation of the site.

Faunal Remains

Considering the limited excavations, we recovered a relatively diverse assemblage of shellfish and vertebrate remains from Component I. Preservation generally is very good and a relatively large percentage of the remains was identified. Most of the remains were recovered from $\frac{1}{8}$ -inch screen residuals, but important information on smaller or more fragile site constituents comes from the smaller midden sample processed with $\frac{1}{16}$ -inch mesh.

Shellfish Remains

Among the 4.2 kg of well preserved shell recovered from the $\frac{1}{8}$ -inch screen, at least 17 types of shellfish and one land snail species were identified (TABLE 2). With few exceptions, all the shellfish taxa—abalones, barnacles, chitons, small gastropods, limpets, mussels, etc.—are found in open coast rocky shore habitats. These are by far the most productive intertidal habitats found on the Channel Islands throughout prehistory, but today the immediate site vicinity is dominated by sandy beach. Contrary to assertions of Orr (1968: 145) and Erlandson (1994: 191), our quantitative shellfish analysis clearly indicates that the 9300 year old component is not a red abalone midden; black abalones, common in northern Channel Island intertidal zones in historical times, dominate the shellfish assemblage. Island middens dominated by red abalones (primarily a subtidal species historically) have been shown to be associated with cool sea temperature conditions, more intense coastal upwelling, and higher marine productivity (Glassow et al. 1994). Variations in sea surface temperatures have been shown to be important paleoclimatic indicators (see Kennett et al. 1997; Kennett 1998). The dominance of black abalone here is consistent with evidence from Daisy Cave on eastern San Miguel Island, which suggests that Santa Barbara Channel waters were relatively warm between about 8000 and 10,000 calendar years B.P.

A small proportion of the shellfish taxa, especially Pismo clam (*Tivela stultorum*) and *Olivella biplicata*, are commonly found in surf-swept sandy beach habitats. The shellfish assemblage from CA-SRI-6 suggests that the local shoreline was dominated by rocky coast habitats during the Early Holocene, but a pocket beach may have existed around the mouth of Arlington Canyon about 9300 years ago.

Black abalone (*Haliotis cracherodii*) and California mussel (*Mytilus californianus*) dominate the assemblage, contributing almost 79% and 19% of the shell weight recovered in the $\frac{1}{8}$ -inch residuals, respectively. In fact, these ap-

Table 2. Shellfish Remains from the 9300 year old CA-SRI-6 sample. All weights in g.

Shellfish taxon	% total		% total	
	MNI	MNI	$\frac{1}{8}$ -inch weight	$\frac{1}{8}$ -inch weight
<i>Acmaea</i> sp. (limpet)	19	17.8	1.2	trace
<i>Balanus</i> sp. (acorn barnacle)	1	0.9	86.0	2.0
<i>Haliotis cracherodii</i> (black abalone)	24	22.4	1884.2	43.4
<i>Haliotis rufescens</i> (red abalone)	1	0.9	0.5	trace
<i>Haliotis</i> sp. (abalone), burned*	6	5.6	889.3	20.5
<i>Haliotis</i> sp. (abalone), unburned	2	1.9	635.9	14.7
<i>Katharina tunicata</i> (black katy chiton)	1	0.9	0.1	trace
<i>Lacuna</i> sp. (chink shell)	1	0.9	0.1	trace
<i>Mopalia ciliata</i> (hairy chiton)	1	0.9	0.1	trace
<i>Mytilus californianus</i> (California mussel)	21	19.6	807.1	18.6
<i>Olivella biplicata</i> (purple olive)	2	1.9	0.4	trace
<i>Pollicipes polymerus</i> (gooseneck barnacle)	1	0.9	0.8	trace
<i>Septifer bifurcatus</i> (platform mussel)	2	1.9	0.1	trace
<i>Serpulorbis squamigerus</i> (tube worm shell)	1	0.9	0.3	trace
<i>Strongylocentrotus</i> sp. (sea urchin)	1	0.9	0.8	trace
<i>Tegula funebris</i> (black turban)	2	1.9	0.6	trace
<i>Tetraclita rubescens</i> (barnacle)	1	0.9	1.3	trace
<i>Tivela stultorum</i> (Pismo clam)	1	0.9	4.8	0.1
Chiton, undifferentiated	1	0.9	0.1	trace
Land snail (<i>Helminthoglyptya ayresiana</i>)	18	16.8	24.7	0.6
$\frac{1}{8}$ -inch shell, undifferentiated	—	—	1.9	trace
> $\frac{1}{8}$ -inch shell total	107	—	4340.3	100
$\frac{1}{16}$ -inch shell, undifferentiated	—	—	481.3	—
> $\frac{1}{16}$ -inch shell total	108	100	4821.6	—

*Without epidermis, differentiating between nacreous (interior) portions of red and black abalone shells was difficult, especially when the shell was burned or weathered. Given the dominance of black abalone shell among identifiable fragments, the vast majority of undifferentiated abalone shell fragments are probably from black abalones.

pear to be the only major shellfish food species present in the sample; the others probably were incidental catches or inadvertently hauled into the midden attached to abalones, mussels, or kelp. The vast majority of barnacles (*Balanus* sp., *Pollicipes polymerus*), for instance, are the remains of small individuals that commonly encrust the shells of abalones and mussels. Aside from black abalones and mussels, the only other mollusc that made up more than 0.1% of the total weight was the land snail, *Helminthoglyptya ayresiana*. Land snail shells are not uncommon in Channel Island sites but their archaeological origin is uncertain because they are also widely distributed in geological deposits where the shells tend to accumulate on windblown surfaces or amidst vegetation. The land snail shells from CA-SRI-6 are interesting because a relatively large percentage (16.6%) of the shell fragments is burned. This might indicate that land snails were consumed by the site

occupants, but the small size of many of the recovered specimens suggests that they are nonculinary, burned by incidental contact with fire. The only other types of shellfish that exhibited clear evidence of extensive burning were the black abalone and the acorn barnacles (over 26% by weight).

Along with shell weights, we also calculated the minimum number of individuals (MNI) represented in the shell assemblage. The MNI values are more evenly distributed among the shell taxa, with black abalones (29.9%), California mussels (19.6%), land snails (16.8%), and limpets (17.8%) comprising about 84% of the individuals represented. As we will see below, however, these figures do not accurately represent the dietary significance of various taxa. The limpets, for instance, are all very small specimens that clearly represent incidental midden constituents, while the other three taxa provide widely varying amounts of edible meat per individual.

Vertebrate Remains

A total of 685 bone fragments, weighing 25.08 g, was recovered (TABLE 3). They were identified with an emphasis on differentiating human food refuse from vertebrate remains of natural origin. We had hoped to use comparisons of rates of burning among various taxa to help differentiate between bones deposited culturally vs. naturally (see Erlandson 1994). Unfortunately, the bone assemblage exhibits continuous patterns of bone discoloration ranging from virtually unaltered to black, so it was impossible to accurately distinguish burned and unburned elements. Like many shell middens of the California coast, much of the mammalian assemblage is also highly fragmented and largely unidentifiable to genus or species.

Several kinds of fish, mammal, bird, and reptile were identified. Identified fish (4 MNI) include the California sheephead (*Semicossyphus pulcher*), rockfish (*Sebastes* sp.), and the Clupeiformes (anchovies, sardines, etc.). Sheephead and rockfish are commonly found in rocky nearshore and kelp bed habitats, although numerous rockfish species inhabit a variety of Santa Barbara Channel habitats. The Clupeiformes also frequent a variety of habitats, but it seems likely that most of the fish were taken from the rocky nearshore or kelp bed zones.

A small number of bird and sea mammal remains were also present. Most of the small fauna category seems to consist of mouse and/or shrew bones, while most of the reptile remains are from the alligator lizard (*Gerrhonotus multicarinatus*). Finally, a number of small bone fragments could not be securely differentiated beyond the level of general vertebrate remains. For these unidentifiable fragments, we distinguished between those that were likely to

Table 3. Vertebrate remains from the 9300 year old component at CA-SRI-6. All weights in g.

Taxon	NISP	MNI	$\frac{1}{8}$ -inch weight	$\frac{1}{16}$ -inch weight	Total weight
Sea mammal?	6	1	0.04	—	0.04
Fish undifferentiated	209	—	7.43	0.14	7.57
Sheephead (<i>Semicossyphus pulcher</i>)	24	2	8.76	—	8.76
Rockfish (<i>Sebastes</i> sp.)	2	1	0.18	—	0.18
Clupeiformes	6	1	0.05	—	0.05
Bird undifferentiated	10	1	1.37	0.02	1.39
Alligator lizard (<i>Gerrhonotus multicarinatus</i>)	31	2	0.43	—	0.43
Reptile undifferentiated	29	1	0.51	0.07	0.58
Small fauna undifferentiated	237	—	3.22	0.39	3.61
Bone undifferentiated	131	—	2.05	0.42	2.47
Total	685	9	24.04	1.04	25.08

come from larger taxa that potentially represented dietary refuse and those that came from small fauna unlikely to have been eaten.

Dietary Reconstruction

The animals represented in the assemblage provide significantly different amounts of meat per individual and have dramatically different shell or bone-to-meat weight ratios. As a result, minimum number of individuals (MNI), number of identified specimens (NISP), or simple weight values for the various types of fauna do not accurately represent the economic importance of various faunal taxa or classes. The dietary significance of the faunal remains can best be evaluated by converting shell and bone weights or MNI into more appropriate analytical units, such as edible meat. Given the highly fragmented nature of the vertebrate remains we chose to convert shell and bone weights into estimated meat (TABLE 4). While the weight method is sub-

Table 4. Multipliers used in CA-SRI-6 dietary reconstruction.

Faunal Taxon	Meat multiplier	Protein multiplier	Source
Black abalone	0.944	0.187	Vellanoweth, Rick, and Erlandson in press
California mussel	0.298	0.144	Erlandson 1994: 59
Pismo clam	0.254	0.112	Erlandson 1994: 59
Other shell*	0.308	0.165	Weighted average for abalone and mussel
Bird	15.0	0.210	Ziegler 1975
Fish	27.7	0.185	Tartaglia 1976: 170
Sea mammal	24.2	0.100	Glassow and Wilcoxon 1988
Bone undifferentiated	22.3	0.165	Average for bird, fish, sea mammal

*Very small shell fragments, mostly abalone and mussel.

ject to a variety of problems (see Erlandson 1994: 57–58), investigators have shown that the systematic use of the weight method can provide valuable data on the relative importance of various classes of fauna at a site and on subsistence variation between sites (e.g., Colten 1993, 1995; Erlandson 1994: 111; Glassow 1980, 1992, 1993; Glassow and Wilcoxon 1988; Moss 1989; Peterson 1984; Vellanoweth 1996; Vellanoweth and Erlandson in press). A total of 4.7 kg of shell and bone were used to approximate the meat yields of various faunal classes by converting the shell weights for the four main dietary taxa (black abalone, California mussel, red abalone, Pismo clam), as well as the bone weights for all bird, fish, sea mammal, and undifferentiated bone (TABLE 5). The shell from minor or nondietary shellfish taxa, along with the bones of small rodents and reptiles or other small fauna, were excluded from these calculations.

Our analysis suggests that shellfish provided roughly 85% of the edible meat represented in the sample, while vertebrates provided about 15%. Black abalones dominate the shellfish yields and provide at least 73% of the total meat yield, while mussels provide roughly 5% of the total yield. Our data are consistent with Raab's (1992) contention that collecting black abalones was an optimal strategy, at least where they are abundant. Among the vertebrates, fish provided about 90% of the edible meat (13.5% of the faunal total), while birds, sea mammal, and undifferentiated fauna each provided 1% or less of the meat represented. Overall, the marine contribution of the estimated meat yields was a minimum of 98.5%, easily ranking the site occupants as fully maritime according to criteria suggested by Yesner (1980).

Discussion

The dietary reconstruction for Component I at CA-SRI-6 is consistent with general economic patterns identified at other Early Holocene sites from the southern California coast (see Erlandson 1994: 26), where shellfish and marine resources appear to have provided the bulk of the meat consumed by early coastal peoples. For many early coastal groups, protein-rich marine resources were probably one part of a dual economy in which terrestrial plant foods provided most of the calories consumed (Erlandson 1988, 1991). For island groups, however, marine resources must have been even more vital since terrestrial plant foods appear to have been both less diverse and less plentiful. The importance of terrestrial plant foods may also help explain why several early Santa Rosa Island shell middens (CA-SRI-1, 3, 5, 6, and 26) were located near the landward edge of the old coastal plain, some distance from Early Holocene shorelines. Despite a heavy reliance on marine

Table 5. Estimated dietary yields for 9300 year old CA-SRI-6 faunal sample. All weights in g.

<i>Taxon</i>	<i>Shell or bone</i>		<i>Meat yield</i>		<i>Protein yield</i>	
	<i>weight</i>	<i>%</i>	<i>weight</i>	<i>%</i>	<i>weight</i>	<i>%</i>
Black abalone	3409.9	72.1	3218.9	72.7	601.9	74.5
California mussel	807.7	17.1	240.7	5.4	34.7	4.3
Pismo clam	4.8	0.1	1.2	<0.1	0.2	<0.1
1/8-inch shell*	481.3	10.2	298.9	6.7	48.4	6.0
Shellfish subtotal	4703.7	99.5	3759.7	84.9	685.2	84.8
Bird	1.4	<0.1	21.0	0.4	4.4	0.5
Fish	21.6	0.5	598.3	13.5	110.7	13.7
Sea mammal	0.1	<0.1	2.4	<0.1	0.2	<0.1
Undifferentiated bone	2.1	<0.1	46.8	1.0	7.7	1.0
Vertebrate subtotal	25.2	0.5	668.5	15.1	123.0	15.2
Totals	4728.9		4428.2		808.2	

* To correct for the loss of small fragments of shell and bone lost through 1/8-inch screens, especially small mussel shell fragments and fish bones, we calculated the percentage of such shells or bones from the fine-screened sample retained in 1/16-inch screen. Conversion factors for 1/8-inch shell are averages for abalone and mussel shell; factors for undifferentiated bone are averages for bird, fish, and sea mammal.

resources, the earliest occupants of CA-SRI-6 may have settled near the base of the foothills where plant foods and perhaps fresh water were more readily available.

While general economic patterns at CA-SRI-6 are consistent with those elsewhere along the southern California coast, they also shed light on the adaptive diversity of California's early maritime peoples. Although shellfish appear to have been a dietary staple for both early island and mainland peoples, the heavy reliance on black abalone at CA-SRI-6 is unique, with early mainland groups relying heavily on either estuarine shellfish or California mussels (Erlandson 1994). The same is true of the CA-SRI-6 fishery, where the reliance on sheephead is quite different than the more typical mainland focus on estuarine fish. As expected, given the much higher diversity and productivity of land mammals on the mainland, many early mainland assemblages also tend to show a heavier reliance on terrestrial mammals. Somewhat surprising, given the modern productivity of pinnipeds on the northern Channel Islands, is the fact that no evidence has yet been found at CA-SRI-6 or other early island sites for any economic emphasis on sea mammal hunting. The small sample from CA-SRI-6 and its distance from the coast during the Early Holocene may account for the virtual absence of sea mammal bone, as it seems unlikely that people would have transported such heavy carcasses roughly 2 km inland. Even at Daisy Cave, however, where the shoreline was never far from the site, sea mammals appear to have been no more than supplemental resources. Thus, the dearth of sea mammal bone at CA-SRI-6 is consistent with evidence from other early coastal sites in southern California where hunting appears

to have been limited, and shellfish and plant resources appear to have dominated the diet (Erlandson 1994).

Finally, our subsistence reconstruction for the Early Holocene component contrasts sharply with evidence for Late Holocene subsistence patterns from Component V at CA-SRI-6, dated to about 1250 calendar years B.P. Here, faunal remains recovered from column samples suggest that shellfish (primarily California and platform mussels) provided a relatively small proportion (6.9%) of the edible meat represented, while fish provided almost 61%. Sea mammal bone is also much more common than in the 9300 year old component, providing over 30% of the edible meat represented. Birds and land mammals are both minimally represented in the Late Holocene samples. These patterns, too, are consistent with evidence for a general intensification of marine fisheries by Late Holocene peoples along the southern California coast (Colten 1993; Glassow 1993; Kennett 1998).

Summary and Conclusions

The large site complex known as CA-SRI-6 contains a deeply buried shell midden occupied about 9300 years ago. Our midden samples provide the first quantitative data for the site constituents, demonstrating that the earliest occupants collected shellfish and fished in rocky littoral and nearshore habitats. Black abalone dominates the midden constituents, with California mussel, red abalone, sheephead, rockfish, and an array of other minor shellfish, fish, birds, and mammals also taken. According to our reconstructions, shellfish contributed roughly 85% of the diet, fish about 14%, and birds and mammals less than 1% each.

Marine resources comprise at least 98% of the edible meat represented, leaving no doubt about the economic importance of the sea. Terrestrial plant foods, however, may represent a largely invisible but highly significant aspect of the site economy. Artifacts are rare, probably because of the heavy reliance on shellfish collecting and the lack of small edible seed resources that require milling. Our work at CA-SRI-6 reinforces the interpretations from Daisy Cave, Eel Point, and other early Channel Island sites that maritime hunter-gatherers had effectively adapted to a variety of Pacific Coast habitats at a very early date.

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