MIDDLE AND LATE HOLOCENE MARITIME ADAPTATIONS ON NORTHEASTERN SAN MIGUEL ISLAND, CALIFORNIA

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ABSTRACT

In this paper, we provide detailed faunal data from Daisy Cave and Cave of the Chimneys, located on San Miguel Island. We report on marine vertebrate and shellfish remains from four archaeological components dated between about 4,500 and 2,500 radiocarbon years before present (RYBP). Nearshore and rocky intertidal fish and shellfish dominate the assemblages, providing most of the meat consumed by people at the caves. Shellfish, followed by fish, is the main food staple found in the deposits at Cave of the Chimneys. Sea mammals and birds appear to have been supplemental food sources. At Daisy Cave, fish, shellfish, and sea mammal each contribute roughly 30% of the edible meat represented, attesting to a more balanced economy. Our dietary reconstructions are generally consistent with models of subsistence for the Santa Barbara Channel, but provide important details on subsistence for a poorly known site type.

Keywords: San Miguel Island, maritime adaptations, faunal remains, dietary reconstructions.

INTRODUCTION

California's Channel Islands contain one of the most diverse and extensive records of maritime hunter-gatherers in the New World. During the Late Holocene, Chumash groups on the Northern Channel Islands and the adjacent mainland reached unusually high degrees of sociopolitical complexity for hunter-gatherers (Arnold 1987, 1992; Landberg 1965; King 1971; Colten 1993, Moss and Erlandson 1995). Recently, considerable research has focused on the development of complexity among the Island Chumash (e.g., Arnold 1992; Colten 1993; Lambert 1994; Arnold et al. 1997; etc.). Such research has been focused primarily on the last 1,500 years, with comparatively little work done on sites dating between 1,500 and 4,000 years ago. This time period, however, is crucial to understanding the development of Chumash society. During the Late Holocene (ca. 3,350 to 0 radiocarbon years before present (RYBP), in particular, numerous technological developments such as the plank canoe (Arnold 1995), the circular shell fishhook, the bow and arrow, a shell bead currency, and other changes in chipped and groundstone artifacts are thought to have occurred. With many of these technological changes, important shifts in human subsistence are believed to have happened, including an intensification of marine fishing.

At present, there are numerous gaps in the archaeological record of Island Chumash subsistence, including limited data from early Late Holocene assemblages, relatively few studies of site types other than villages, and relatively few integrated dietary reconstructions from San Miguel Island. In this paper, we address all three of these problems by presenting subsistence data from several archaeological components dating between about 4,500 and 2,500 RYBP at two San Miguel Island caves. Together, Cave of the Chimneys (CA-SMI-603) and Daisy Cave (CA-SMI-261) contain a rich record of archaeological materials spanning much of the Holocene, including excellent preservation of both faunal and floral remains. Here, we focus on general dietary patterns represented in samples recovered from components dating to the later part of the Middle Holocene and the early parts of the Late Holocene. First, however, we provide background data to contextualize the analyses and discussions that follow.

ENVIRONMENTAL SETTING

San Miguel Island, the westernmost of the Northern Channel Islands, contains an impoverished terrestrial flora and fauna compared to the adjacent California mainland and nearby islands. In contrast, the waters around the island are nourished by upwelling and nutrient-rich currents that support a diverse and highly productive marine ecosystem. Out of necessity, therefore, islanders appear to have been heavily dependent on marine resources since the earliest settlement of the Channel Islands (Erlandson 1994; Erlandson and Moss 1996).

Cave of the Chimneys and Daisy Cave are located along an isolated and rugged stretch of rocky coast on the northeast shore of San Miguel Island (Figure 1). Both caves appear to have been formed during the Pleistocene by marine erosion associated with a high interglacial sea stand. Cave of the Chimneys faces due east and is sheltered from the strong northwesterly winds that buffet San Miguel Island much of the year (Johnson 1972:63). Daisy Cave faces north and is more exposed, although the cave interior does provide shelter from the wind.

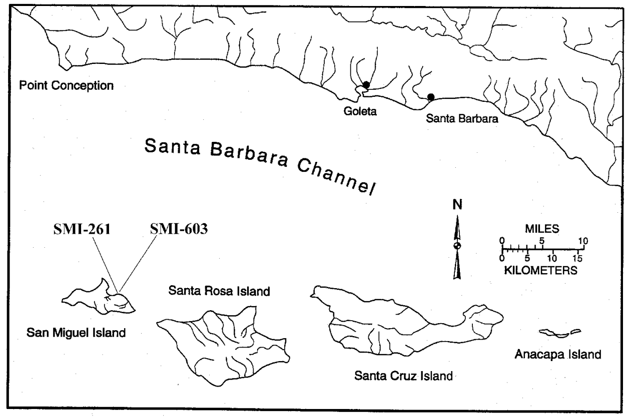

Figure 1. Location of SMI-261 and SMI-603

Cave of the Chimneys is a large rockshelter about 10 m deep and up to 12 m wide. The cave is situated 12 m above a rocky, wave-swept portion of coastline and can be accessed through a narrow ledge at the southeastern edge of the shelter. A skylight or "chimney" approximately 1.5 m in diameter and a large opening at the cave mouth provide ample light into most of the shelter. Although the floor of the cave slopes relatively steeply towards the ocean, archaeological deposits appear to be located beneath much of the cave floor. The deposits have been somewhat reduced by erosion and other natural disturbances.

Daisy Cave consists of a fissure about 11 m deep and 1.5 to 3 m wide, an outer rockshelter ca. 4 m x 5 m wide, and a stratified shell midden deposit on the slope in front of the cave and shelter (Erlandson et al. 1996). The cave is located about 10 m above sea level immediately above the shoreline near the base of a cliff of conglomerate. Archaeological and paleontological deposits have been found in all three site areas. The cave itself is divided into three narrow chambers separated by two low crawl spaces. The archaeological deposits at Daisy Cave once covered over 200 m^2, but this extent has been reduced somewhat by erosion and archaeological excavation (e.g., Rozaire 1978).

STRATIGRAPHY AND CHRONOLOGY

Although limited investigations have been conducted in Cave of the Chimneys, recent work documents at least four archaeological components, with up to two meters of midden accumulation. The deposits exhibit excellent preservation and stratigraphic integrity. Stratum 2, directly below a sterile soil is a ca. 20 cm thick gray-brown soil containing angular rock-fall, marine mollusks, and bird, fish, and sea mammal bone. Stratum 3 is a thin, dark, charcoal-laden soil with tightly clustered shell midden lenses that contain a variety of marine vertebrate and shellfish remains. The oldest deposit discussed here is Stratum 4, a 35 cm thick deposit with very little soil matrix. It is dry and extremely well-preserved, with abundant whole and broken sea urchin tests, other marine shells, as well as fish, bird, and sea mammal bones and delicate strands of sea grass. Other than a few chert flakes, an exhausted chert core, an *Olivella biplicata* barrel bead, and a bird bone hairpin or awl, no artifacts were recovered during our excavations in Strata 2, 3, and 4. Radiocarbon dates on single marine shells from these strata indicate that the deposits date to about 2,500, 3,800, and 4,000 RYBP, respectively (Table 1).

Although the archaeological components at Daisy Cave date back to the terminal Pleistocene, here we concentrate on Stratum A, the uppermost stratum remaining in front of the rockshelter at Daisy Cave. Stratum A has been radiocarbon dated between about 3,000 and 3,800 RYBP (Table 1). Inside the rockshelter, Rozaire excavated in relatively shallow Late Holocene deposits which are stratigraphically superior to, or contemporary with Stratum A (Erlandson et al. 1996:360). Artifacts found within these sediments include a "bead-maker's kit" containing *Olivella biplicata* shell bead blanks, shell fishhook blanks, small chert bladelets and bladelet drills used in bead-making, the remnants of a woven basketry bag and other artifacts (Rozaire 1993). The Late Holocene levels also contain abundant faunal remains, including sea mammals (cetaceans, pinnipeds, and sea otters), a diverse array of birds, marine fish and shellfish, and a few land mammals (mice, shrew, island fox, and skunk). Stratum A, once one of the major occupational strata in front of the rockshelter, has been largely lost to erosion. Recent excavations in Statum A yielded numerous faunal remains, an expedient chipped stone technology, but relatively few formal tools or other artifacts.

SUBSISTENCE PATTERNS AND DIETARY RECONSTRUCTIONS

A relatively diverse assemblage of shellfish and vertebrate faunal materials has been recovered from the Middle and Late Holocene strata at the two sites. Fifteen liters of excavated sediments from each stratum at Cave of the Chimneys and 18,000 cm^3 from Stratum A at Daisy Cave were analyzed for this paper. These samples were recovered from 1/8-inch mesh screen residuals. Numerous studies indicate the importance of using fine-screen samples to reveal information on more fragile site constituents (e.g., Erlandson 1994:94). Given the excellent preservation and low fragmentation at the sites, including numerous whole and articulated shells, fragile cordage, bones, and other perishable artifacts, the faunal samples obtained from the 1/8-inch mesh should be adequate for the purposes of our analysis. Nonetheless, future research using 1/16-inch materials will be valuable to affirm or correct our results.

Shellfish remains from these caves are dominated by rocky-shore species, which generally require a limited amount of technology for extraction and processing. The dominant shellfish taxa by weight for all three strata at Cave of the Chimneys include sea urchin (32.1%), California mussel (21.1%), red abalone (20.9%), black abalone (10.4%), turbans (5.0%) and several species of limpet, chiton, and other shellfish species (Table 2). Similarly, the Late Holocene shellfish assemblage at Daisy Cave consists of California mussel (53.3%), turbans (14.1%), red (8.1%) and

Table 1. A radiocarbon chronology for Middle and Late Holocene components at Cave of the Chimneys (CA-SMI-603) and Daisy Cave (CA-SMI-261), San Miguel Island, California.[1]

Site (SMI-1)	Provenience (Unit/Stratum)	Lab Number	Material Dated	Uncorrected ^{14}C age (RYBP)	^{13}C/^{12}C Adjusted	Calibrated Ag Range (CYBP)
603	Unit 1: Str. 2	Beta-115556	Marine Shell	2550± 60	2980± 60	2600(2440) 2340
603	Probe B:15-20 cm	Beta-14364A	Charcoal	--	3930± 60	4430(4410) 4280
603	Probe B: 35-40 cm	Beta-14367A	Charcoal	--	3940± 60	4440(4410) 4290
603	Unit 1: Str. 3	Beta-115557	Marine Shell	3830± 70	4270± 70	4280(4060) 3840
603	Probe B: 15-20 cm	Beta-12454	Marine Shell	--	4430± 60	4390(4280) 4180
603	Unit 1: Str. 4	Beta-115558	Marine Shell	4010± 70	4450± 70	4520(4320) 4070
603	Unit 1: Str. 5	Beta-115559	Marine Shell	4030± 60	4480± 60	4520(4370) 4150
603	Probe B: 35-40 cm	Beta-12455A	Marine Shell	--	4560± 60	4530(4430) 4380
261	Col. E-6: Str. A1	CAMS-8864	Charred twig	--	3220± 70	3360(3430) 3480
261	Col. E-6: Str. A1	Beta-49997	Marine Shell	3070± 80	3510± 80	2970(3110) 3230
261	Col. E-6: Str. A3	Beta-15619	Marine Shell	2990± 90	3430± 90	2860(2980) 3140
261	Col. E-6: Str. A3	CAMS-9095	Charred twig	--	3110± 60	3220(3350) 3380
261	Col. E-6: Str. A3	CAMS-14358	Marine Shell	--	3820± 80	3370(3460) 3580
261	Col. E-6: Str. A3	CAMS-14359	Marine Shell	--	3940± 70	3520(3620) 3700

[1] Compiled from Erlandson et al. (1996), Kennett (1998), Breschini et al. (1996), and other sources. Beta Analytic dates based on conventional (LSC) dating; CAMS dates on accelerator mass spectrometry. Rounded calendar ages include intercept (in parentheses) and age range at 1 sigma, calibration via Stuiver and Reimer s (1993) Calib 3.0.3 program.

black (6.0%) abalone, sea urchin (10.1%), chitons, limpets, and other rock-perching taxa.

The vertebrate faunal remains by weight from these two sites are composed of teleost fish (48.7%), followed by sea mammal (16.5%) and bird (4.0%), as well as small amounts of rodent and reptile bones. Of these five distinct classes only fish, sea mammal, and bird are treated as dietary resources. Due to an absence of evidence for burning or processing, the rodent and reptile remains are assumed to be of natural origin (e.g., Erlandson 1994). Only portions of the teleost fish remains have been analyzed in detail. A sample of fish remains from Stratum 4 at Cave of the Chimneys was analyzed using comparative collections housed at the University of Oregon. Similar to the shellfish assemblages, the fish remains are dominated by rocky-shore taxa, including *Sebastes* (rockfish), Embiotocidae (surfperch), Hexigraminidae (greenling family), and *Semicossyphus pulcher* (California sheephead). Although no formal fishing related artifacts were recovered at Cave of the Chimneys, the species identified could easily have been captured using a gorge/hook and line, with a dip net or seine, and/or by spearing. At Daisy Cave numerous complete and broken bone gorges along with their manufacturing debris were recovered in pre-3000 RYBP deposits (Rozaire 1978; Erlandson et al. 1996), indicating that gorge and line fishing was in use at the site during this time period.

DIETARY RECONSTRUCTIONS

To understand broad patterns of human subsistence at the two caves, we converted raw faunal data (dry shell and bone weights) into estimated meat yields with a series of conversion factors established by previous researchers. Dietary reconstruction using the weight method, like other zooarchaeological measures, is subject to a variety of problems (Erlandson 1994:57-58; Klein and Cruz-Uribe 1984:26-29; Lyman 1982:359-363). However, recently a number of archaeologists working on the southern California coast have used such methods to identify changes in faunal use patterns through time, making these studies highly useful for comparative analysis (e.g., Colten 1993, 1995; Erlandson 1991, 1994, 1997; Glassow 1992, 1993; Glassow and Wilcoxon 1988; Vellanoweth 1996; Vellanoweth and Erlandson 1998). Although the weight method is a useful tool for interpreting subsistence patterns, we emphasize that our dietary reconstructions for Cave of the Chimneys and Daisy Cave are general approximations of the nutritional yield of the major classes of faunal remains recovered from the sites, estimates subject to a variety of sources of error.

Despite such problems, our conversions effectively illustrate some methodological problems associated with traditional shell midden analysis. Different researchers often analyze different faunal classes (shell, fish, mammal, bird,

Table 2. Middle and Late Holocene midden constituents from SMI-603 and SMI-261.

Stratum	2		3		4		A	
Taxa	wt.	%	wt.	%	wt.	%	wt.	%
Acmaea digitalis	0.1	<0.01	--	--	--	--	--	--
Acmaea conus	0.2	<0.01	--	--	4.0	<0.01	--	--
Acmaea insessa	0.4	<0.01	--	--	0.1	<0.01	--	--
Acmaea limatula	--	--	--	--	59.6	0.7	--	--
Acmaea mitra	--	--	--	--	7.4	<0.01	<0.1	0.00
Acmaea pelta	3.5	0.1	--	--	2.0	<0.01	3.4	<0.01
Acmaea scabra	0.2	<0.01	--	--	12.6	0.1	2.3	<0.01
Acmaea sp.	--	--	--	--	--	--	1.4	<0.01
Amphissa bicolor	--	--	--	--	--	--	<0.1	0.00
Balanus sp.	15.2	0.6	105.1	1.6	51.2	0.6	94.1	1.8
Chiton sp.	69.8	2.9	98.5	1.5	303.5	3.4	117.7	2.3
Collisella ocracea	4.0	0.2	--	--	2.1	<0.01	--	--
Collisella strigatella	0.2	<0.01	--	--	12.8	0.1	--	--
Corallinecea sp.	0.3	<0.01	8.9	0.1	49.8	0.6	--	--
Crab sp.	3.2	0.1	37.7	0.6	51.5	0.6	7.4	0.1
Crepidula adunca	2.1	<0.01	--	--	--	--	1.5	<0.01
Diodora arnoldi	--	--	--	--	2.4	<0.01	--	--
Diodora aspera	--	--	--	--	5.8	<0.01	--	--
Fissurella volcano	1.6	<0.01	--	--	3.2	<0.01	0.5	<0.01
Gastropod undif.	--	--	0.9	<0.01	4.0	<0.01	0.8	<0.01
Haliotis cracherodii	71.1	3.0	1187.7	17.6	587.9	6.5	285.0	5.5
Haliotis rufescens	304.5	12.70	1634.3	24.2	1765.8	19.5	387.6	7.4
Haliotis sp.	45.6	1.9	169.9	2.5	141.1	1.6	71.5	1.4
Limpet sp.	1.8	<0.01	106.9	1.6	8.0	<0.01	3.0	<0.01
Littornia planaxis	--	--	--	--	--	--	0.3	<0.01
Littorina scutulata	--	--	--	--	--	--	<0.1	0.00
Lottia gigantea	7.3	0.3	--	--	48.7	0.5	16.0	0.3
Margariies sulcinctus	--	--	--	--	--	--	0.2	<0.01
Melobesia mediocris	--	--	--	--	40.3	0.4	--	--
Mytilus californianus	1061.7	44.3	1256.6	18.6	1427.1	15.8	2536.2	48.6
Pollicipes polymerus	2.6	0.1	2.3	<0.01	1.0	<0.01	28.6	0.5
Septifer bifurcatus	19.3	0.8	69.6	1.0	246.0	2.7	4.1	<0.01
Serpulorbis squamigerus	--	--	--	--	7.3	<0.01	1.8	<0.01
Strongylocentrotus sp.	459.6	19.2	1658.7	24.6	3573.7	39.5	479.5	9.2
Tegula brunnea	32.6	1.4	146.3	2.2	391.2	4.3	270.0	5.2
Tegula funebralis	--	--	72.0	1.1	118.5	1.3	315.9	6.1
Tegula sp.	42.3	1.8	18.0	0.3	64.7	0.7	83.1	1.6
Coral Unid.	--	--	--	--	--	--	1.8	<0.01
Land snail Unid.	6.7	0.3	14.4	0.2	2.3	<0.01	0.8	<0.01
Marine shell Unid.	--	--	7.6	0.1	--	--	43.7	0.8
Shellfish Subtotal	2155.9	89.9	6595.4	97.6	8995.6	99.4	4758.2	912.0
Fish	94.7	3.9	27.6	0.4	47.1	0.5	107.1	2.1
Bird	29.1	1.2	4.6	<0.01	2.1	<0.01	0.7	<0.01
Sea mammal	30.8	1.3	119.5	1.8	0.3	<0.01	80.1	1.5
Cetacean	--	--	--	--	--	--	262.9	5.0
Lizard	4.6	0.2	<0.1	<0.01	--	--	--	--
Rodent	83.2	3.5	8.3	0.1	2.8	<0.01	9.2	0.2
Bone undif.	--	--	--	--	--	--	0.8	<0.01
Vertebrate Subtotal	242.4	10.1	160.0	2.40	52.3	0.6	460.8	8.8
Total	2398.3		6755.4		9047.9		5219.0	

etc.) using different quantitative measures (minimum number of individuals, number of individual specimens, weights). Such studies are often not directly comparable and lack any integrated picture of the overall diet and economy from a given site. In contrast, integrated studies of faunal remains using the weight method provide general measures of the importance of various faunal classes within a single site, or between sites within a region. Following Erlandson (1994), we calculate the approximate meat yields of various faunal classes by converting the shell weights from the dominant taxa (abalone, mussel, etc.), and bone weights from fish, bird, and sea mammal (Table 3). The shell weights from non-dietary shellfish taxa, as well as the bone weights from reptile and rodent were excluded from the reconstruction.

A total of 21.6 kg of shell and bone was used to reconstruct the general patterns of faunal use at Cave of the Chimneys, and 7.3 kg were used from Daisy Cave (Table 2). Our dietary reconstruction from Stratum 4 at Cave of the Chimneys indicate that marine shellfish contributed roughly 83% of the edible meat in our sample and vertebrates contributed about 17% (Table 4). Red abalone (31.1%) and sea urchin (27.0%) provided the bulk of the estimated meat yield for Stratum 4, with other shellfish such as black abalone (7.2%), California mussel (5.5%), chiton (4.5%), and turbans (2.7%) contributing less meat. Although less than 18% of the human diet during this time period was made up of meat from vertebrates, fish (16.9%) provided the majority, while bird (0.4%) and sea mammal (<1.0%) were of relatively minor importance. In Stratum 3, shellfish contributed approximately 58% of the edible meat, with vertebrates contributing the other 42%. Shellfish meat was dominated by red (25.1%) and black (12.7%) abalone, with sea urchin (11.0%), and California mussel (4.2%) rounding out the rest. In contrast with the previous stratum, sea mammal provided as much as 32% of the meat yield, while fish (8.6%) decreased in importance and bird (0.8%) remained a supplemental dietary resource. In Stratum 2, shellfish contributed only 25% of the edible meat, while vertebrates, especially fish, contributed about 75%. Red abalone (8.2%), California mussel (6.3%), and sea urchin (5.3%) made up the majority of the meat provided by shellfish. Of the estimated vertebrate meat yield in Stratum 2, fish (51.9%) dominated the assemblage, with sea mammal and bird providing only about 14.7 and 8.6% of the edible meat, respectively. The utility of converting raw faunal weights into estimated edible meat weights is clearly illustrated with the Stratum 2 assemblage. Here, fish constitute only 3.9% of the total shell and bone weight, but provide more than half of the total estimated meat yield.

Our dietary reconstruction for Stratum A at Daisy Cave indicates that shellfish contributed about 32% and vertebrates about 68% of the total estimated meat yield for the faunal remains. California mussel (10.4%), red (7.3%) and black (3.7%) abalone, sea urchin (3.8%) and turbans (2.9%) contributed the majority of shellfish meat to the human diet. Of the vertebrates recovered, fish made up about 41% of the estimated edible meat yield, while sea mammal contributed roughly 27% and bird less than 1%. Once again, the dietary reconstruction clearly illustrates the usefulness of meat weight conversions as more realistic approximations of dietary importance than shell or bone weights alone. For instance, California mussel makes up about 49% of the total dry shell and bone weight, but contributed only about 10% of the meat to the human diet. Conversely, dry fish bone weight makes up only 2% of the total assemblage, but as much as 40% of the edible meat yields.

Table 3. Multipliers used in dietary reconstructions.

Faunal Taxon	Meat Multiplier	Primary Reference
Black abalone (*Haliotis cracherodii*)	0.944	Erlandson, unpublished notes
Red abalone (*Haliotis rufescens*)	1.36	Koloseike 1969
Abalone (average *H. rufescens*, *H. cracherodii*)	1.15	Average for red and black abalone
California mussel (*Mytilus californianus*)	0.298	*Erlandson 1994:59*
Chiton (*Nuttallina californica*)	1.15	Erlandson 1994:59
Owl limpet (*Lottia gigantea*)	1.36	Tartaglia 1976
Platform mussel (*Septifer bifurcatus*)	0.364	Erlandson 1994:59
Sea urchin (*Strongylocentrotus* sp.)	0.583	Kato and Schroeter 1985; Moss 1989
Turbans (*Tegula* sp.)	0.365	Erlandson 1994:59
Other shell*	0.298/0.308	Erlandson 1994:59; 1988
Fish	27.7	Tartaglia 1976
Bird	15.0	Ziegler 1975
Sea mammal	24.2	Glassow and Wilcoxon 1988

* Small shell fragments, mostly *M. californianus* for SMI-261; mostly Acmaeadae for Str. 2, SMI-603.

Table 4. Estimated meat yields for SMI-603 and SMI-261 faunal samples.

	Cave of the Chimneys (SMI-603)						Daisy Cave (SMI-261)	
Stratum	2		3		4		A	
Faunal Taxon	Meat	%	Meat	%	Meat	%	Meat	%
Black abalone	67.1	1.3	1121.2	12.7	555.0	7.2	269.0	3.7
Red abalone	414.1	8.2	2222.6	25.1	2401.5	31.1	527.1	7.3
Abalone	52.4	1.0	195.4	2.2	169.2	2.2	82.2	1.1
California mussel	316.4	6.3	374.5	4.2	424.3	5.5	755.8	10.4
Chiton	79.5	1.6	112.3	1.3	346.5	4.5	135.4	1.9
Limpet	--	--	33.0	0.4	37.0	0.5	--	--
Owl limpet	9.9	0.2	--	--	66.2	0.9	--	--
Platform mussel	7.0	0.1	25.3	0.3	89.6	1.2	--	--
Sea urchin	267.9	5.3	967.0	11.0	2083.5	27.0	279.6	3.8
Tegula	27.4	0.5	86.3	1.0	209.7	2.7	213.9	2.9
Other shell	9.7	0.2	--	--	--	--	87.9	1.2
Shellfish subtotal	1251.4	24.7	5137.6	58.2	6382.5	82.7	2350.9	32.4
Bird	436.5	8.6	69.0	0.8	31.5	0.4	10.5	0.1
Fish	2623.2	51.9	764.6	8.6	1304.7	16.9	2966.7	40.8
Sea mammal	745.4	14.7	2892.0	32.6	2.2	<0.1	1938.4	26.7
Vertebrate subtotal	3805.1	75.2	3725.6	42.0	1338.4	17.4	4915.6	67.6
Total	5056.5		8863.2		7720.9		7266.5	

DISCUSSION

As expected, our integrated dietary reconstructions for three components at Cave of the Chimneys and one at Daisy Cave suggest that the site occupants relied almost entirely on marine resources between about 4,500 and 2,500 calendar years before present (CYBP). By combining our reconstructions for both sites, a general picture emerges of the way humans adapted to the island environment during the latter portion of the Middle Holocene and the early part of the Late Holocene. Overall, shellfish, especially abalone, sea urchin, and mussel, were the most important sources of animal flesh, accounting for about 52% of all meat represented in the excavated samples. Of the total meat consumed at the two sites, fish contributed roughly 27%, sea mammal about 19%, and bird a meager 2%. Although birds were of minor dietary significance, their importance as raw material for tools (e.g., fishing gorges and awls) and as ornaments (including decorative feathers) should also be noted.

In many respects the dietary reconstructions for Cave of the Chimneys and Daisy Cave are consistent with general economic patterns identified at other sites from the southern California coast (see Glassow 1993:90; Walker and Erlandson 1986). In general, shellfish decline in dietary importance through time, while fish increase. Sea mammals fluctuate in importance, reflecting variations in site location, sample size, and the effects of butchering and transport (see Glassow 1993). Birds never contribute much meat to the diet, except for slightly elevated numbers for Stratum 2 at Cave of the Chimneys. This stratum appears to contain more natural rodent, lizard, and bird remains, however, which may have accumulated after the site was abandoned.

At about 4,500 BP, shellfish as a source of meat and protein continued to dominate the human diet of the islanders, approaching an economic pattern similar to that demonstrated for the Early Holocene (Erlandson 1994; Erlandson et al. 1998; Glassow 1993). By about 3,500 to 4,000 years ago, a more balanced economy is evident, with shellfish, sea mammal, and fish contributing more equal portions of edible meat to the diet. This pattern is well-demonstrated by our dietary reconstructions for Stratum 3 at Cave of the Chimneys and Stratum A at Daisy Cave. After about 3,000 RYBP, however, fish contributed the majority of meat to the diet of the site occupants. Not surprisingly, this is also about the time that the circular shellfish hook was invented in southern California, greatly enhancing the fishing capabilities of local peoples (Strudwick 1986).

SUMMARY AND CONCLUSIONS

For the most part, our dietary reconstructions follow the general pattern of economic development established for hunter-gatherers along the southern California coast over the past 10,000 years. Early Holocene coastal peoples relied heavily on shellfish meat as an economic staple, while fishing became the main focus during the Late Holocene. The subsistence data we presented suggest a gradual transition occurred during the latter part of the Middle Holocene, with shellfish being replaced by fish as the main source of edible meat and animal protein. Why this transition occurred is difficult to ascertain with the data available, but population growth, environmental change, and resource stress may have pushed people to develop a different subsistence balance. For now, our dietary reconstructions add to the general picture of emergent cultural complexity in coastal southern California and, in particular, to the specific economies associated with it. While our island cave data are important to filling out the regional pattern, it must be emphasized that they are from a unique site type not necessarily representative of the total economy. More research on a variety of site types, both large and small, dated to various time periods will help us understand more fully the unique developmental trajectories of Native southern California coastal peoples.

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