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Middle Holocene Subsistence and Land Use at Southeast Anchorage, Santa Rosa Island, California

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California's Channel Islands have a lengthy archaeological record, spanning roughly 13,000 calendar years. However, relatively little is known about cultural developments during the Middle Holocene, resulting in a substantial gap in our understanding of the prehistory of California. Our research at CA-SRI-667, a large dune site with three components dated between about 6,200 and 4,300 cal B.P., demonstrates significant environmental changes occurred through time. Faunal remains and artifacts from the site document the decline of a local estuary, intensive dune building episodes, and the presence of relatively mobile human settlement systems. These data illustrate the dynamic nature of Middle Holocene human settlement and subsistence strategies, and associated environmental changes on California's Channel Islands.

With one of the longest coastal occupations in the Americas, California's Channel Islands contain an outstanding archaeological record of hunter-gatherer evolution (Arnold 2001; Arnold et al. 2004; Erlandson et al. 1996; Kennett 2005; Raab and Yatsko 1992; Rick et al. 2005a). A research focus on the earliest and most recent parts of this record, however, has left a significant gap in our understanding of long-term human cultural developments in the region. This is particularly true for the northern islands, where relatively limited research has been conducted on Middle Holocene archaeological sites. This is surprising, since the Middle Holocene remains an important bridge between the initial colonization of the islands during the terminal Pleistocene and Early Holocene, and the complex hunter-gatherers that inhabited some of the islands in the Late Holocene.

Several recent studies have worked to fill this research gap. Some of the most comprehensive include Glassow's (1993a, 1993b, 2002, 2005a, 2005b; Glassow et al. 1994; see also Sharp 2000) analysis of Punta Arena and other sites on Santa Cruz Island. Perry (2005) and Kennett and Clifford (2004) have also presented data on Middle Holocene settlement, land use, and subsistence strategies on Santa Cruz Island, and Kennett et al. (2007) have provided an analysis of human responses to Middle Holocene climate change on the islands. Investigations on San Miguel (Braje 2007; Braje and Erlandson 2007; Braje et al. 2005; Erlandson et al. 2005a; Vellanoweth et al. 2002, 2006) and Santa Rosa islands (Rick et al. 2005b, 2006) have also increased, and include analyses of faunal remains and artifacts from cave and open-air sites. Despite these studies, we are just beginning to understand the diversity of human subsistence, land use, and cultural developments on the Channel Islands during the Middle Holocene.

Here we present archaeological data from CA-SRI-667, a multi-component Middle Holocene dune site on eastern Santa Rosa Island (Figure 1). Our analysis of faunal remains and artifacts from three of the site's components dated to ca. 6,200, 4,700, and 4,300 cal B.P. provides important diachronic information on cultural and environmental developments during this period of prehistory. When compared to other island sites of comparable antiquity, our research also illustrates the diversity of Middle Holocene human lifeways.

ENVIRONMENTAL BACKGROUND

The northern Channel Islands, located off the southern California coast, include San Miguel, Santa Rosa, Santa Cruz, and Anacapa islands. Santa Rosa is the second largest of these, with an area of roughly two hundred and seventeen square kilometers. It is located about 44 km. from the mainland coast of California, 5 km. east of San Miguel, and 9 km. west of Santa Cruz. Santa Rosa supports diverse flora and fauna, including distinct coastal beach and dune vegetation, island chaparral, oak and riparian woodland, and an island endemic species of Torrey pine (*Pinus torreyana insularis*), but these terrestrial environments are generally impoverished when compared to the adjacent mainland (Schoenherr et al. 1999). Several fresh water streams flow year-round.

The abundance of kelp beds, rocky and sandy near-shore habitats, and the upwelling of nutrient-rich currents make the marine environment of Santa Rosa and the other islands very productive. These marine environments

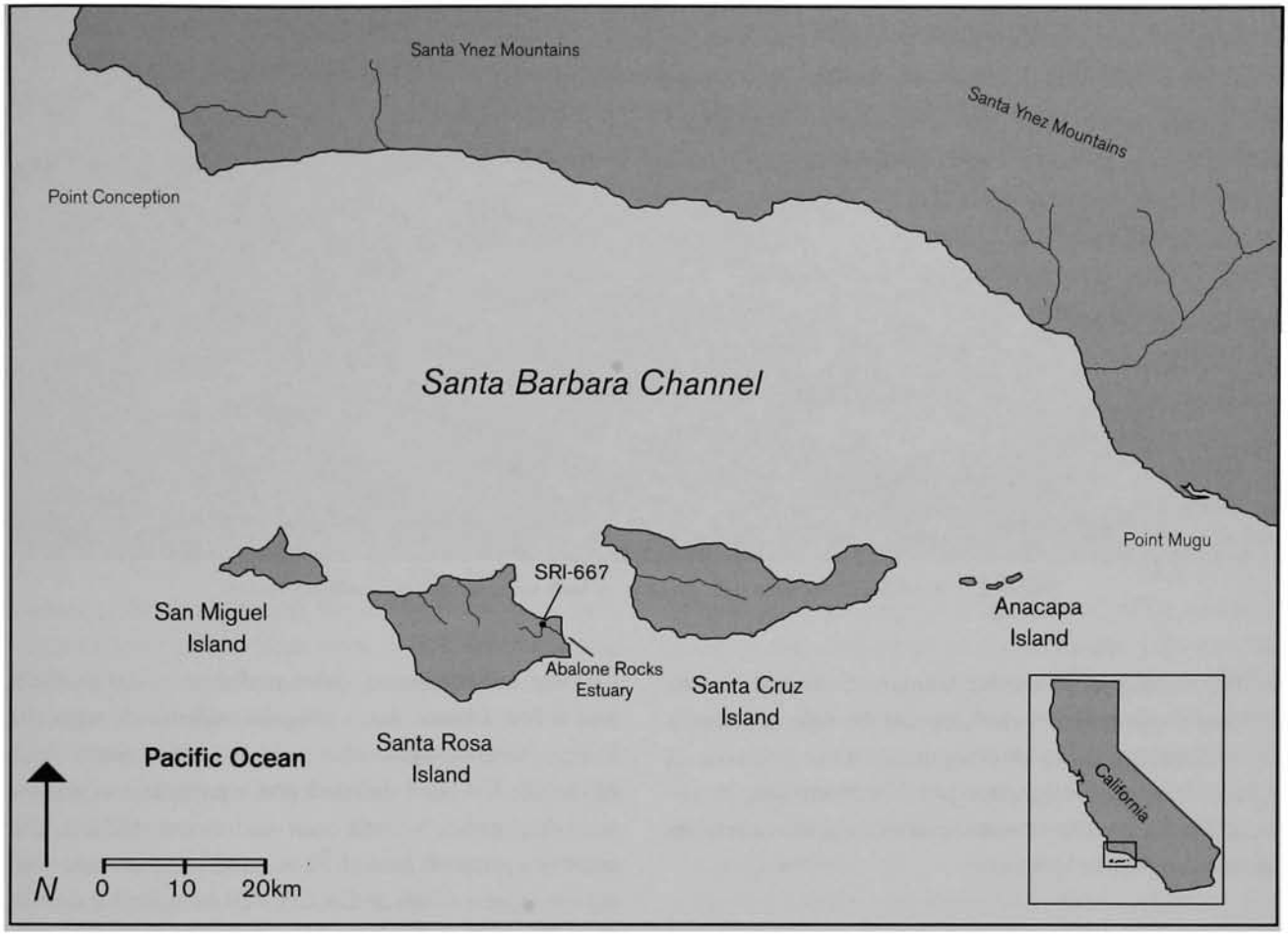

Figure 1. The Northern Channel Islands and Santa Barbara Channel (courtesy of Leslie Reeder).

support diverse (and often dense) populations of sea mammals, sea- and shorebirds, fishes, and shellfish. Marine resources were probably the primary attraction for early peoples and served to maintain a human population on the islands from the time of initial occupation during the terminal Pleistocene to the Historic Period.

Since the Last Glacial Period, Channel Islands environments have undergone significant changes. One of the most important environmental developments was the dramatic decline in island size, beginning with the break-up of Santarosae into the four islands of today (Porcasi et al. 1999). Rising sea levels also drastically reduced the amount of reef area on the northern islands and probably resulted in declines in kelp forest habitats from the terminal Pleistocene/Early Holocene to the Middle/Late Holocene (Graham et al. 2003; Kinlan et al. 2005). However, at the mouths of some drainages, particularly on the California mainland, productive estuaries were created by rising sea levels. As sea level rise slowed dramatically after about 5,000–6,000 years ago, these estuaries infilled and many of them disappeared (Erlandson 1994, 1997; Glassow 1997). While this pattern is well known for the mainland coast, only one estuary with viable shellfish habitats has yet to be identified on the Channel Islands (Rick et al. 2005b). This estuary occurred on eastern Santa Rosa Island and would have been about three kilometers from CA-SRI-667. Rising sea levels and other landscape changes also appear to correlate with several periods of intensive dune building, including a large number of dunes formed during the Middle Holocene on adjacent San Miguel Island (Erlandson et al. 2005b). Less is known about dune building on Santa Rosa than on San Miguel Island, but dunes appear to have been an important part of human settlement.

The residents of the Channel Islands utilized a variety of habitats for subsistence, and consequently island

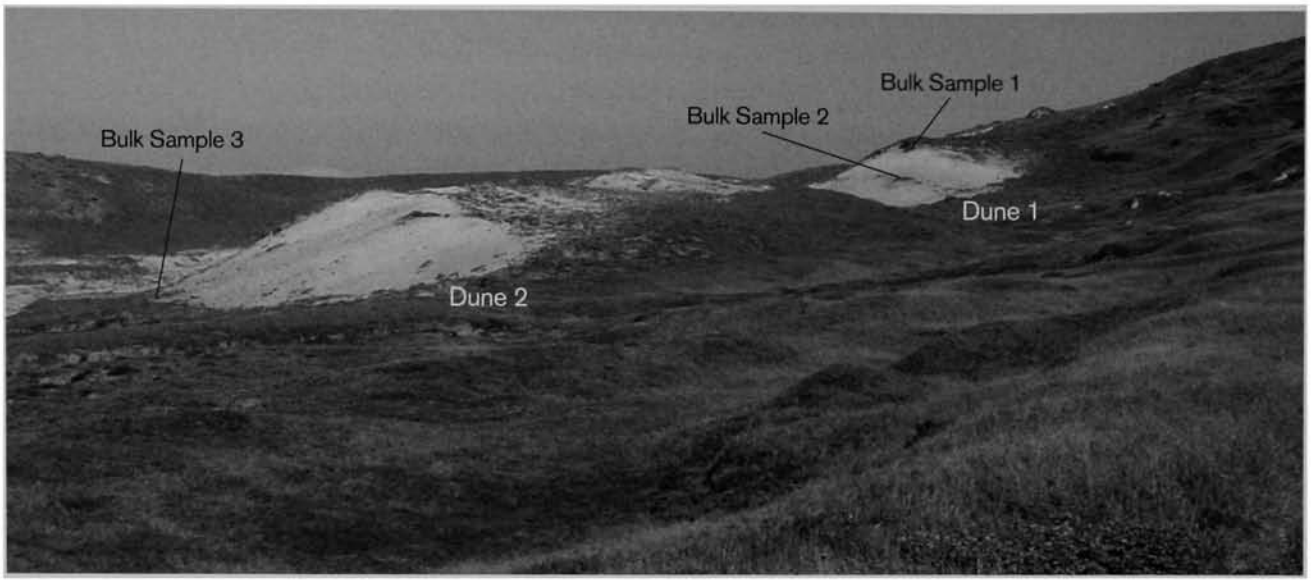

Figure 2. CA-SRI-667 site area with location of bulk samples and two primary dunes.

faunal remains are valuable sources of information on ancient environmental changes and the role of humans in influencing these developments. Our research at CA-SRI-667 was designed to provide information on the nature of local environmental and cultural developments during the Middle Holocene.

CA-SRI-667: DESCRIPTION AND CHRONOLOGY

CA-SRI-667 is located on the northeastern coast of Santa Rosa Island near Southeast Anchorage and Skunk Point. The site is a large (roughly 280 x 110 m.) shell midden situated in a dune complex with several cultural components (Figure 2). The site is bounded by an old dirt road and a steeply sloping hillside on the southern and western margins, and by the sea coast to the north. It sits on two large, partially vegetated dunes (Dunes 1 and 2) that are separated by a low-lying swale. Dune 1 is located on the eastern part of the site and Dune 2 is located to the west.

The site has at least three components, including intact deposits capping both dunes, a middle stratum about halfway down each dune, and a lower basal component underneath Dune 2. Several meters of sterile dune sand separate the three components, probably resulting from intensive dune building. The two upper components are largely composed of California mussel (*Mytilus californianus*), other rocky intertidal shellfish, and a few Pismo clams (*Tivela stultorum*), with the lowest site component containing estuarine shell. Much of the site has been deflated, and a pavement of eroded shell fragments, burned rock and stone artifacts, and small amounts of animal bone covers the surface. Our surface observations at CA-SRI-667 identified a diverse assemblage of shellfish remains at the site, with probable evidence for diachronic change in the constituents from one stratum to the next.

Five well-preserved marine and estuarine shells were selected for radiocarbon dating from the intact archaeological strata visible in the dune exposures (Table 1). These ^{14}C dates range from 6,260 to 4,200 cal. B.P. The upper component (Dune 1, Stratum 1) provided a calibrated age range of 4,370 to 4,200 cal. B.P. The middle component (Dune 1, Stratum 2) provided a calibrated age range of 4,800 to 4,640 cal. B.P. The basal deposit (Dune 2, Stratum 3) provided a calibrated age range of 6,260 to 6,130 cal. B.P. Two additional dates from Dune 2 overlap with each other and with the date from Stratum 1, Dune 1, suggesting chronological overlap with the occupations of the two dunes.

METHODS

Our field research at CA-SRI-667 was conducted in 2003, in association with a revegetation and site stabilization

Table 1

A RADIOCARBON CHRONOLOGY FOR SRI-667, SANTA ROSA ISLAND, CA

Provenience	Lab Number[a]	Material Dated	Conventional ^{14}C Age	Calibrated Age Range (cal BP, 1 Sigma)[b]
Dune 1: Stratum 1	OS-41892	*Mytilus californianus*	4,410 ± 40	4,370 - 4,200
Dune 2: Stratum 1	OS-48510	*Mytilus californianus*	4,510 ± 30	4,490 - 4,350
Dune 2: Stratum 2	OS-48515	*Mytilus californianus*	4,600 ± 35	4,580 - 4,430
Dune 1: Stratum 2	OS-41893	*Mytilus californianus*	4,730 ± 40	4,800 - 4,640
Dune 2: Stratum 3	OS-41894	*Chione undatella*	5,990 ± 45	6,260 - 6,130

[a]OS = National Ocean Sciences AMS Facility, Woods Hole, MA.

[b]All dates were calibrated using Calib 5.01 (Stuiver and Reimer 1993, 2005), applying a ΔR of 225 ± 35 years for all shell samples (Kennett et al. 1997). $^{13}C/^{12}C$ ratios were determined by the radiocarbon lab.

project conducted by Georganna Hawley of Channel Islands National Park. The site was revisited in 2005 to check the condition of the deposits and conduct a brief surface collection. During the 2003 field season, bulk samples were taken from each of the three cultural strata to better understand the subsistence and land use strategies of the site occupants. Bulk Sample 1, a 25-liter sample, was recovered from the roughly 15 cm. thick midden deposit (Stratum 1) that caps Dune 1. Bulk Sample 2, also 25 liters, was recovered from an approximately 40 cm. thick deposit (Stratum 2) located about two to three meters below Stratum 1 in Dune 1. Bulk Sample 3, with a volume of 30 liters, was recovered from a roughly 20 cm. thick deposit (Stratum 3) at the base of Dune 2, approximately five meters from the edge of the sea cliff. All of the bulk samples were poured over 1/16-inch mesh in the field and all residuals were retained.

All constituents were transported to Southern Methodist University for analysis. In the lab, each of the bulk samples was sorted through a series of nested sieves (1/4, 1/8, and 1/16-inch). All residuals from 1/4-inch and larger mesh were analyzed. Because of the volume of materials, samples from 1/8-inch mesh were weighed in bulk and 20% of each of the samples was randomly removed for complete analysis. The remaining 80% of the 1/8-inch sample was then sorted for diagnostic materials, including bone, chipped stone debitage, shell beads, and other artifacts that are generally less well represented in smaller sub-samples (see Kennett 1998; Moss 1989; Rick 2007 for similar procedures).

To quantify the faunal remains from the site, we used a combination of weight and Minimum Number of Individuals (MNI) for invertebrates, and Number of Identified Specimens (NISP), MNI, and weight for vertebrates. When calculating MNI, we relied on the maximum number of non-repetitive elements present in a sample (e.g., hinges and spires for shellfish, and long bones and cranial elements for vertebrates). To provide diachronic information on possible human predation pressure on shellfish populations, we also attempted to measure California mussels from the three strata. However, because of the fairly high fragmentation of the assemblage, few whole specimens were available. We used templates to measure specimens but came up with problematic and ambiguous results that are not reported here.

ARTIFACTS

Forty-four artifacts were recovered from CA-SRI-667, including 23 from our bulk samples and 21 from the site surface. The majority of these artifacts are chipped stone tools and debitage (72.7%), followed by ground stone (13.6%), and worked shell (13.6%) (Table 2). Of the chipped stone, 51.7% was chert that appears similar to cherts recently identified locally on eastern Santa Rosa Island, as well as from sources on Santa Cruz and San Miguel islands (see Rick 2007). Quartzite is present at the next highest frequency (34.5%), followed by quartz (6.9%), shale (3.4%), and chalcedony (3.4%).

Although we cannot be precise, the stratigraphic position of the artifacts recovered from the surface suggests that many of them date to the 4,700 and 4,200 cal. B.P. occupations of the site rather than the basal 6,200-year-old deposit. Only three of the 21 artifacts collected from the surface were bifaces. The first is

Table 2

LITHIC TOOLS FROM CA-SRI-667

Provenience	Type	Raw Material	Length (mm)	Width (mm)	Thickness (mm)
surface, Dune 1	doughnut stone	sandstone	72	72	23
surface, Dune 1	ground stone tool	siltstone	broken	30	13
surface, Dune 1	biface	chert	broken	64	14
surface, Dune 1	retouched flake	quartzite	45	24	7
surface, Dune 1	small blade	chert	55	13	4
surface, Dune 1	retouched core/scraper	chert	46	20	15
surface, Dune 1	flake tool/scraper	chert	32	27	7
surface, Dune 2	stemmed point	chert	50	26	7
surface, Dune 2	biface	metamorphic	84	26	12
surface, Dune 2	pick/scraper	chert	97	28	26
surface, Dune 2	doughnut stone	sandstone	85	85	36
surface, Dune 2	uniface	chert	128	93	35
surface, Dune 2	doughnut stone	sandstone	fragment	fragment	fragment
surface, Dune 2	flake knife	chert	60	37	10
surface, Dune 2	flake tool (perforator?)	chert	37	46	8
surface, Dune 2	flake tool (graver?)	chert	29	38	6
surface, Dune 2	flake tool	quartz	26	49	9
Stratum 1, Dune 1	doughnut stone	sandstone	49	49	18
Stratum 3, Dune 2	blade core	quartz	48	32	11

a single chert biface fragment that appears to have originally been a flake core that was later retouched and recycled as a chopper tool, as evidenced by the battering at one end. Another is a contracting stemmed point with a flat base, sharply angled shoulders, and straight lateral margins (Figure 3). It is made of a cryptocrystalline chert and appears to have been heat-treated before the final stages of production. The third is a lunate-shaped biface made from a lightweight metamorphic stone that has continuous retouch around its entire margin. We also recovered a chert polyhedral pick that is battered at both ends and has use wear along its margins that suggests it was also used as a scraper.

A small chert blade was also recovered from the surface (Figure 3). A core fragment that appears to have been used as a scraper or spokeshave late in its uselife, seven retouched flakes, and one tertiary flake, were also recovered from the surface. One of the retouched flakes may have been used as a thumbnail scraper. Another is a large, unifacially retouched flake that appears to have been used as a cleaver or adze. Its distal end is battered and the proximal end has been retouched and displays usewear consistent with scraping and cutting. The ventral surface also shows evidence that it was occasionally used as a hammerstone. The other retouched flakes appear to have been used as knives, perforators, and/or gravers.

Five ground stone artifacts were also recovered from the surface. One is a ground stone fragment of unknown use with a lenticular cross-section (Figure 3). It displays lengthwise striations on both of its surfaces. Additionally, three doughnut stones were recovered, one of which was broken. The unbroken stone displays indications of heat exposure and differed from the other doughnut stones in that it was flat on one side rather than convex. We also recovered a ground stone phallic artifact stratigraphically between Strata 1 and 2, but a short distance away from the excavated bulk samples. The artifact is made from off-white, fine-grained sandstone that has been ground into the approximate shape of a glans penis. Two perforated shells were also found on the surface and—other than the phallic artifact—were the only ornaments identified at the site. One is a *Trivia californiana* shell with a small perforation near the shell opening. The other is an *Olivella* barrel bead (Figure 3).

Figure 3. *Olivella* barrel bead, perforated *Trivia californiana* shell bead, spire-lopped bead, stemmed projectile point, small blade, unfinished doughnut stone, ground stone fragment, chert biface fragment (from upper left to lower right).

We recovered a single small, unfinished doughnut stone from Bulk Sample 1 (Figure 3). The outline of the object was ground into shape, but the opening on one side of the doughnut stone appears to have been completed and the artifact discarded before the opposite side was pecked deep enough to perforate the object. We also recovered one secondary chert flake, four tertiary flakes (one chert, three quartzite), and a single spire-lopped bead from Stratum 1 (Figure 3).

Five tertiary flakes (four quartzite, one chert) were the only artifacts recovered in Bulk Sample 2. Bulk Sample 3 also produced few artifacts; they included a single quartz core, two secondary flakes (one chert, one quartzite), one tertiary chert flake, four quartzite chips, and three pieces of Pismo clam that have been worked and appear to have been used as cutting tools.

The artifacts recovered from CA-SRI-667 suggest some continuity in artifact forms throughout the occupation. There are no clear changes in technology, although the small number of artifacts recovered makes it difficult to provide broad inferences about the site. However, these artifacts are generally similar to other assemblages recovered from Middle and Early Holocene sites from the Northern Channel Islands and along the Santa Barbara Channel mainland (Erlandson et al. 2005a, 2005c; Glassow 1997; Vellanoweth et al. 2006).

Table 3

INVERTEBRATE REMAINS FROM CA-SRI-667

Species	Stratum 1				Stratum 2				Stratum 3			
	Weight (g)	%Weight	MNI/ct	%MNI/ct	Weight (g)	%Weight	MNI/ct	%MNI/ct	Weight (g)	%Weight	MNI/ct	%MNI/ct
Invertebrates												
Abalone undiff.	18.34	0.5	3	0.1	0	0.0	-	-	0	0.0	-	-
Barnacle undiff.	227.82	5.7	-	-	55.15	1.8	-	-	261.66	4.1	-	-
Balanus spp. (large)	0	0.0	-	-	0	0.0	-	-	513.07	8.1	-	-
Calliostoma spp.	0.06	0.0	1	0.0	0	0.0	-	-	0	0.0	-	-
Chama pellucida	0	0.0	-	-	0	0.0	-	-	2.76	0.0	1	0.1
Chione fluctifraga	0	0.0	-	-	0	0.0	-	-	66.14	1.0	1	0.1
Chione undatella	0	0.0	-	-	0	0.0	-	-	258.12	4.1	10	0.7
Chiton undiff.	14.55	0.4	-	-	87.14	2.9	-	-	101.27	1.6	-	-
Clam undiff.	0	0.0	-	-	0	0.0	-	-	4.51	0.1	-	-
Crab undiff.	5.14	0.1	-	-	73.53	2.4	-	-	51.81	0.8	-	-
Crepidula fornicata	0.46	0.0	-	-	0	0.0	-	-	1.41	0.0	8	0.5
Crepidula spp.	0	0.0	-	-	0.68	0.0	-	-	0.60	0.0	5	0.3
Cryptochiton stelleri	13.59	0.3	-	-	0	0.0	-	-	0	0.0	-	-
Fissurella volcano	0.21	0.0	6	0.2	3.09	0.1	7	0.8	1.33	0.0	6	0.4
Gastropod undiff.	0	0.0	-	-	0.05	0.0	5	0.6	7.23	0.1	17	1.1
Haliotis cracherodii	4.70	0.1	1	0.0	0	0.0	-	-	0	0.0	-	-
Haliotis rufescens	13.74	0.3	1	0.0	7.25	0.2	1	0.1	82.33	1.3	6	0.4
Hinnites mulitrugosus	0	0.0	-	-	0	0.0	-	-	65.93	1.0	1	0.1
Land snail	0.88	0.0	7	0.3	0.50	0.0	5	0.6	0	0.0	-	-
Limpet undiff.	3.59	0.1	74	2.9	5.52	0.2	27	3.1	3.23	0.1	72	4.7
Megathura crenulata	0	0.0	-	-	0	0.0	-	-	0.25	0.0	5	0.3
Mytilus californianus	2,938.28	74.1	1,884	73.2	2,192.53	72.0	475	55.3	4,037.04	63.9	1,221	80.0
Nacre undiff.	79.65	2.0	-	-	52.93	1.7	-	-	0	0.0	-	-
Nucella spp.	0	0.0	-	-	19.20	0.6	-	-	0	0.0	-	-
Olivella biplicata	1.54	0.0	-	-	62.08	2.0	-	-	9.50	0.2	-	-
Ostrea lurida	0	0.0	-	-	0	0.0	-	-	10.36	0.2	5	0.3
Pholadidae	0	0.0	-	-	0	0.0	-	-	0.10	0.0	1	0.1
Pollicipes polymerus	17.79	0.4	-	-	5.07	0.2	-	-	25.70	0.4	-	-
Protothaca laciniata	0	0.0	-	-	0	0.0	-	-	39.31	0.6	2	0.1
Protothaca spp.	0	0.0	-	-	1.60	0.1	-	-	0	0.0	-	-
Protothaca staminea	0	0.0	-	-	0	0.0	-	-	32.51	0.5	7	0.5
Saxidomus nuttalli	0	0.0	-	-	0	0.0	-	-	416.14	6.6	13	0.9
Strongylocentrotus spp.	39.55	1.0	-	-	21.91	0.7	-	-	1.00	0.0	-	-
Septifer bifurcatus	338.24	8.5	575	22.3	236.05	7.8	313	36.4	106.68	1.7	82	5.4
Shell undiff.	3.75	0.1	-	-	7.41	0.2	-	-	0	0.0	-	-
Tegula funebralis	27.40	0.7	11	0.4	146.43	4.8	20	2.3	161.84	2.6	58	3.8
Thais spp.	12.23	0.3	10	0.4	65.20	2.1	6	0.7	13.83	0.2	4	0.3
Tivela stultorum	202.00	5.1	2	0.1	0	0.0	-	-	45.47	0.7	1	0.1
Shellfish Total	**3,963.82**		**2,575**		**3,043.32**		**859**		**6,321.13**		**1,526**	

FAUNAL REMAINS

A variety of faunal remains was recovered during our research at CA-SMI-667. The vast majority of the faunal assemblage consists of marine shellfish, particularly rocky intertidal species. However, a few fish, mammal, and bird bones were also identified, suggesting fairly diverse marine foraging strategies. All of the faunal remains reported here are from the three bulk samples and are from 1/8-inch screen residuals.

Shellfish and Invertebrates

Rocky intertidal/subtidal (88.1% by weight) species dominate the shellfish assemblage from the Stratum 3 Bulk Sample 3 (Table 3). Over 63% of the shellfish assemblage by weight is made up of California mussels, followed distantly by large barnacles at 8.1%. Although barnacles are not usually thought to be a food source for Channel Islanders, roughly 66.2 percent by weight of the barnacles in this assemblage appear to be from two large species, *Balanus nubilus* or *B. aquila*, and may have been collected for food. The estuarine species *Saxidomus nuttalli* (Washington clam) and *Chione undatella* (frilled Venus clam) are found at the next highest frequencies at 6.6% and 4.1% of the shellfish assemblage by weight, respectively. The other estuarine species, *Chione fluctifraga* (smooth Venus clam) and *Ostrea lurida* (oyster), combined to contribute only 1.2% of the shellfish assemblage. Stratum 3 contains the only evidence for the procurement of estuarine species of shellfish at CA-SRI-667, accounting for 11.9% of the shellfish assemblage by weight.

Estuarine species disappear in Stratum 2, Bulk Sample 2, probably correlating with limited marine input into the system following the relative stabilization of sea levels after about 5,000 years ago (see Rick et al. 2005b). Rocky intertidal/subtidal (99.1% by weight) species account for all identifiable shell species in this stratum. California mussels continue to dominate the faunal assemblage at 72.0% of the total shellfish weight, followed by *Septifer bifurcatus* (platform mussel) at 7.7%. *Tegula funebralis* (black turban snail) slightly increases in importance at 4.8% of the total shellfish weight, as do chitons and crabs at 2.8% and 2.4%, respectively.

As in Stratum 2, rocky intertidal/subtidal species are the most abundant identifiable shells in Stratum 1, Bulk Sample 1, accounting for 94.7% of the total shellfish weight. California mussels dominate this stratum as well at 74.1% of the total shellfish weight, followed by *S. bifurcatus* at 8.5%, *Tivela stultorum* at 5.1%, barnacles at 5.7%, and *Strongylocentrotus* spp. (sea urchins) at 1%. Estuarine shellfish species were not identified in this sample.

Vertebrates

Bone makes up less than one percent of the total weight of faunal remains in all three strata, suggesting vertebrate fauna were generally a supplementary part of the diet (see Table 4). The small size of our excavation units probably limited the recovery of some vertebrate remains, but

Table 4

VERTEBRATE REMAINS FROM CA-SRI-667

	Stratum 1						Stratum 2						Stratum 3					
Vertebrate Category	Weight (g)	% Weight	MNI/ct	% MNI/ct	NISP	% NISP	Weight (g)	% Weight	MNI/ct	% MNI/ct	NISP	% NISP	Weight (g)	% Weight	MNI/ct	% MNI/ct	NISP	% NISP
Bird	0.46	12.1	1	33.3	11	28.9	5.10	19.0	-	-	30	13.0	0.17	0.5	-	-	4	2.2
Bone undiff.	0.10	2.6	-	-	1	2.6	0.75	2.8	-	-	4	1.7	0.69	2.2	-	-	22	12.2
Damalichthys vacca	0	0.0	-	-	-	-	1.48	5.5	1	6.7	5	2.2	0	0.0	-	-	-	-
Embiotocidae	0.20	5.3	1	33.3	2	5.3	0.57	2.1	1	6.7	8	3.5	0	0.0	-	-	-	-
Fish undiff.	1.18	31.1	-	-	18	47.4	12.05	44.8	11	73.3	168	72.7	1.98	6.3	5	83.3	25	13.8
Mammal	1.85	48.8	1	33.3	6	15.8	3.93	14.6	-	-	7	3.0	28.33	89.7	-	-	130	71.8
Scorpaenichthys marmoratus	0	0.0	-	-	-	-	1	4.5	1	6.7	5	2.2	0.43	1.4	1	16.7	-	-
Sebastes spp.	0	0.0	-	-	-	-	1.78	6.6	1	6.7	4	1.7	0	0.0	-	-	-	-
Vertebrate Total	**3.79**		**3**		**38**		**26.88**		**15**		**231**		**31.60**		**6**		**181**	

nonetheless some interesting changes in their frequencies were noted through time. In Stratum 3, mammal bone dominates the vertebrate assemblage (69.9% of NISP), but in subsequent occupations mammal bone is negligible. Fish (65.5% of NISP) and birds (19.6% of NISP) are most abundant in Stratum 2 and are found only in low frequencies prior to and following that occupation. Fish, in particular, are more important during the occupation represented by Stratum 2 (82.3 % of NISP), with more than four times the amount of fish bone (17.1 g.) than in the other strata combined. Few diagnostic vertebrate bones were recovered in the samples, but these include pile perch (*Damalichthys vacca*), perch (Embiotocidae), cabezon (*Scorpaenichthys marmoratus*), and rockfish (*Sebastes* spp.). A nearly complete Risso's dolphin (*Grampus griseus*) cranium was recovered from the surface of Dune 1, but because this is the only cetacean bone from the site it is unclear if it was part of the site occupation, or was brought to the site recently by a visitor.

DISCUSSION

Our research at CA-SRI-667 provides important data on the subsistence-settlement strategies of hunter-gatherers on Santa Rosa Island, helping fill a significant gap in the prehistory of California. The faunal remains demonstrate that most subsistence activities at CA-SRI-667 consisted of shellfish gathering, primarily the procurement of rocky intertidal species (e.g., California mussels), supplemented by the exploitation of fish, mammals, and birds. Although research on Middle Holocene sites on the Northern Channel Islands has been limited, most studies have focused on the occurrence of red abalone middens, a distinct, largely Middle Holocene site type characterized by a high proportion of red abalone shells (Braje 2007; Glassow 1993a, 2002, 2005a; Rick et al. 2006; Vellanoweth et al. 2006). CA-SRI-667 is unique because it is one of the few sites to be reported on that is not a red abalone midden, and that contains multiple components dated to the Middle Holocene.

The earliest occupation of the site (Stratum 3) demonstrates a mix of shellfish gathering from rocky intertidal habitats, supplemented by the use of estuarine taxa. People appear to have been traveling approximately three kilometers to the Abalone Rocks Estuary to obtain these shellfish. This implies that CA-SRI-667 may have been a base camp, and that fairly mobile task groups were organized to collect resources from significant distances away, as Glassow (1997) has suggested for sites in the Goleta Slough on the mainland. This may have involved a logistically mobile settlement strategy, although a six-kilometer roundtrip would not be too far to travel in a single day. A number of researchers have noted fairly mobile subsistence strategies among Middle Holocene peoples on the Channels Islands (e.g., Kennett and Clifford 2004; Perry 2003, 2005), and Kennett et al. (2007) have recently linked this to Middle Holocene climatic developments.

The estuary does not appear to have supported viable shellfish habitats during the later site occupations represented in either Stratum 1 or 2. With the exception of the loss of estuarine taxa, however, subsistence strategies were comparable, emphasizing California mussel and other rocky shore shellfish. A small amount of Pismo clam (5.1% of shellfish weight) suggests an increase in the use of sandy shore habitats during the Stratum 1 occupation. This larger amount of Pismo clam may correspond with a decline in rocky reef productivity and an increase in sandy shore habitats related to the relative stabilization of local sea levels during the Middle Holocene (see Kinlan et al. 2005), but further research is needed to test this hypothesis. Although the relative abundance of some shellfish and other resources varied through time at CA-SRI-667, the subsistence-settlement system was fairly stable, a factor that may help explain the consistency of the lithic artifacts recovered from the site in all three components.

Although vertebrate faunal remains are limited in our sample, some interesting changes occur in the deposits. These include a decrease in mammal remains after the Stratum 3 occupation, an increase in fish in Stratum 2, and a decline in all vertebrates in Stratum 1 (Table 4). While these results may be influenced by sample size, the landscape changes noted at the site, including the decline of the nearby estuary, led the inhabitants of CA-SRI-667 to slightly modify their subsistence strategies. The decline of the estuary, and/or possible changes in the nature of the shoreline, may have altered the distribution of marine mammals, fishes, and birds. In some cases, these environmental changes may have reduced the accessibility of local resources. In others, it may have caused a shift towards the procurement of

species that were previously less important, such as fish and birds. The changes in bone frequencies, therefore, may be attributed to adaptations to a resource structure that had recently undergone significant transformation.

Detailed faunal and artifact data have been reported from relatively few Middle Holocene sites on Santa Rosa Island. Orr's (1968) analysis of several sites on the northwest coast demonstrated the presence of Middle Holocene burials and fairly diverse artifact assemblages, but the chronology of these sites is still relatively poor. Rick et al. (2006) recently reported data from CA-SRI-191, a Middle Holocene site with a red abalone component dated to ca. 6,000 cal B.P., and a deposit with large amounts of California mussel and urchin dated to around 4,300 cal B.P. The abundance of red abalone differs from CA-SRI-667, where red abalone makes up less than 2% of all three assemblages. This is surprising, since the Stratum 3 (ca. 6,200 cal B.P.) occupation of CA-SRI-667 occurred during a cold period of the Middle Holocene (ca. 6,300 and 5,800 cal B.P.) when red abalone may have been more accessible (see Glassow 2005a; Kennett et al. 2007; Rick et al. 2006). The focus on mussel in the 4,300-year-old deposit is similar to CA-SRI-667, but sea urchins, which make up about 21% of the CA-SRI-191 assemblage, contribute less than 1% of the assemblage at CA-SRI-667. These data demonstrate variability in human shellfish harvesting on Middle Holocene Santa Rosa Island, suggesting that people were probably focusing on taxa that were found in the greatest local abundance. This variability in human shellfish harvesting and subsistence in general is underscored by recent research on Santa Cruz Island, where Middle Holocene peoples targeted mussels, red abalone, and other taxa, and also harvested a variety of nearshore fishes and dolphins (Glassow 2005a, 2005b; Sharp 2000). Recent work on Middle Holocene San Miguel Island also suggests considerable diversity in human shellfish harvesting, a pattern probably strongly influenced by local environmental variability (see Braje 2007; Erlandson et al. 2005a; Vellanoweth et al. 2006).

Our analysis of CA-SRI-667 also provides important details on the nature of local dune building on the Channel Islands. Erlandson et al. (2005b) recently provided a trans-Holocene analysis of dune building on adjacent San Miguel Island. They noted an intensive period of dune building and associated human settlement on dunes during the Middle Holocene. This trend also appears to have been present at CA-SRI-667 and elsewhere on Santa Rosa Island (Orr 1968). At CA-SRI-667 the roughly seven to ten meter-high dunes were formed in just a 2,000-year period. Like adjacent San Miguel Island, human deposition of refuse (e.g., shells, bones, and stones) on top of the dunes helped to stabilize the landscape and lead to the formation of the large dunes that characterize the site. In this sense, the dune landscape at CA-SRI-667, and elsewhere on the Channel Islands, is both anthropogenic and natural.

Finally, the dearth of beads and ornaments, and the abundance of expedient chipped stone tools at CA-SRI-667, is similar to many Middle and Early Holocene Channel Island sites (Erlandson et al. 2005a, 2005c; Glassow 1997; Rick et al. 2005a; Vellanoweth et al. 2006). These patterns differ from Late Holocene sites in the area, which contain an abundance of beads, ornaments, and other exchange and wealth items (Arnold 2001; Rick et al. 2005a). The limited number of such items at CA-SRI-667 and other sites suggests that Middle Holocene peoples generally had less formal social hierarchies and exchange systems than later peoples.

CONCLUSIONS

The Middle Holocene was a relatively exciting and dynamic time period in the prehistory of California. Middle Holocene peoples, representing an important link between the earliest occupants of the Channel Islands and the diverse array of peoples documented during the historic era, adapted to a variety of cultural and environmental variables. At CA-SRI-667, people appear to have responded to significant environmental changes, including the decline of an estuary with previously abundant shellfish populations, as well as significant dune building episodes. They also adapted to a variety of changes in sea surface temperatures, including one of the warmest episodes of the Holocene, with a brief cold snap, and possibly reduced El Niño frequencies (Kennett et al. 2007). Although environmental variables of the Middle Holocene influenced the nature of human settlement and subsistence strategies, our data from CA-SRI-667 emphasize that people also played an important role in the structure and function of Channel Island ecosystems (see also Erlandson et al. 2004, 2005b). Working in concert

with natural environmental changes, human activities contributed to the formation of the large dunes at the site, and probably placed predation pressure on local intertidal and estuarine shellfish stocks. This predation pressure was probably mediated by relatively low population densities and the ability to relocate to other areas of the island, a strategy that became increasingly difficult later in time as human populations grew (Erlandson et al. 2004; Rick 2007). While we are just beginning to understand the cultural and environmental variables of the Middle Holocene, the available data point to diverse lifeways and subsistence strategies, as well as interesting patterns of tool production and procurement; in addition, significant similarities and differences existed in comparison with ethnographically-described peoples in the area. These are all patterns that we expect will become clearer and more complex with additional research.

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