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ANCIENT SEA MAMMAL EXPLOITATION ON THE SOUTH COAST OF SAN MIGUEL ISLAND

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Abstract—Archaeological evidence suggests that pinnipeds and sea otters have long been important dietary and raw material resources for Channel Islanders. Excavations at a village site on the south coast of San Miguel Island, CA-SMI-232, provide evidence of sea mammal hunting at about 1200 cal BP. Detailed analysis demonstrates that Guadalupe fur seals were the focus of Late Holocene hunters, with lesser numbers of California sea lions, harbor seals, and sea otters. Since federal protection and the subsequent rebound in populations after historic over-hunting, tens of thousands of pinnipeds haul out each year on San Miguel Island beaches and rocky outcrops. Today, breeding populations are dominated by northern elephant seals, California sea lions, northern fur seals, and harbor seals with occasional visits by Steller's sea lion and Guadalupe fur seals. The archaeological record suggests a complex picture of local pinniped population dynamics that has been severely altered by historic exploitation, and perhaps by large-scale prehistoric hunting. In this paper, we present zooarchaeological evidence of pinniped hunting from CA-SMI-232 and document significant changes between prehistoric and modern pinniped communities on San Miguel Island.

INTRODUCTION

Beginning in the eighteenth and nineteenth centuries, commercial hunting substantially reduced Pacific Coast populations of seals (family Phocidae) and sea lions (family Otariidae). History is replete with stories of commercial hunting ships from Russia, Britain, America, and elsewhere slaughtering hundreds to thousands of sea mammals at a time for voracious consumer markets. Along with well-documented impacts on whale populations, some of the most dramatic examples may be the hunting of sea otters (*Enhydra lutris*), Guadalupe fur seals (*Arctocephalus townsendii*), northern fur seals (*Callorhinus ursinus*), California sea lions (*Zalophus californianus*), elephant seals (*Mirounga angustirostris*), and others in the New World. European and American commercial interests discovered vast populations of sea mammals from Alaska south to the Antarctic and frantically competed for animal skins and oil (Ellis 2003, 161–178). Despite surviving millennia of predation by Aleut, Chumash, and other Native hunters, many sea mammal species were brought to the brink of extinction within a few decades of commercial hunting.

Since the passing of the Marine Mammal Protection Act of 1972, pinniped and sea mammal populations have made a dramatic recovery despite significant historic population size reductions (population bottlenecks) and in some cases, decreases in genetic variability (genetic bottlenecks). Today, the Channel Islands are home to abundant pinniped and cetacean (dolphins, whales, etc.) populations. Point Bennett, located at the west end of San Miguel Island, is one of the largest and most diverse pinniped rookeries in the world occupied by over 150,000 animals yearly (DeLong and Melin 2000). Six different pinniped species regularly visit the island with breeding populations dominated by northern elephant seals, California sea lions, northern fur seals, and harbor seals (*Phoca vitulina*) with occasional visits by Steller's sea lion (*Eumetopias jubatus*) and Guadalupe fur seals. Sea otters were reintroduced to San Nicolas Island but have not been allowed to establish populations at other islands in an effort to reduce impacts by this voracious shellfish predator

on sea urchin and other fisheries in areas south of Point Conception.

In this paper, we present zooarchaeological evidence of pinniped hunting from CA-SMI-232, a large Late Holocene village site on the south coast of San Miguel Island, and use these data and other archaeological assemblages to compare against the modern composition of sea mammals. We argue that modern communities of pinnipeds are a product of severe historic over-hunting, their subsequent protection, and the recovery of seal and sea lion populations in a demographic vacuum. The large, diverse rookery on western San Miguel Island has probably not existed for a large part of the last 13,000 years following the initial colonization of the northern Channel Islands by maritime peoples.

ENVIRONMENTAL AND CULTURAL CONTEXT

San Miguel Island is located approximately 42 km off the Santa Barbara Coast, and the 37 km^2 island is comprised of rolling hills, sprawling dune sheets, tablelands, and marine terraces (Schoenherr et al. 1999). Terrestrial habitats on the island are relatively impoverished, lacking many of the plants and animals common on the mainland. However, a rich and ecologically diverse marine environment surrounds the island, with strong deep-water upwelling and nutrient-rich kelp forests supporting sizeable populations of shellfish, fish, sea mammals, and seabirds.

At historic contact, these extensive marine resources supported dense populations of maritime hunter-gatherers, the Chumash Indians. Spanish chroniclers described large villages and towns, led by hereditary chiefs scattered along the mainland coast and island perimeters. Goods and services were regularly traded between the islands, mainland, and interior with purple olive snail (*Olivella biplicata*) beads serving as the medium of exchange (Arnold 1991, 1992, 2001; Kennett 2005; King 1990; Rick 2007; Rick et al. 2005).

Scientific archaeological investigations have been conducted on San Miguel and the other Channel Islands for over a century and have yielded a dynamic picture of island subsistence strategies. While considerable temporal and spatial variation has been identified, islanders seem to have focused on intertidal shellfish gathering during the Early Holocene. Less accessible resources such as fish, sea mammals, and seabirds gradually contributed a greater percentage of the dietary meat, as

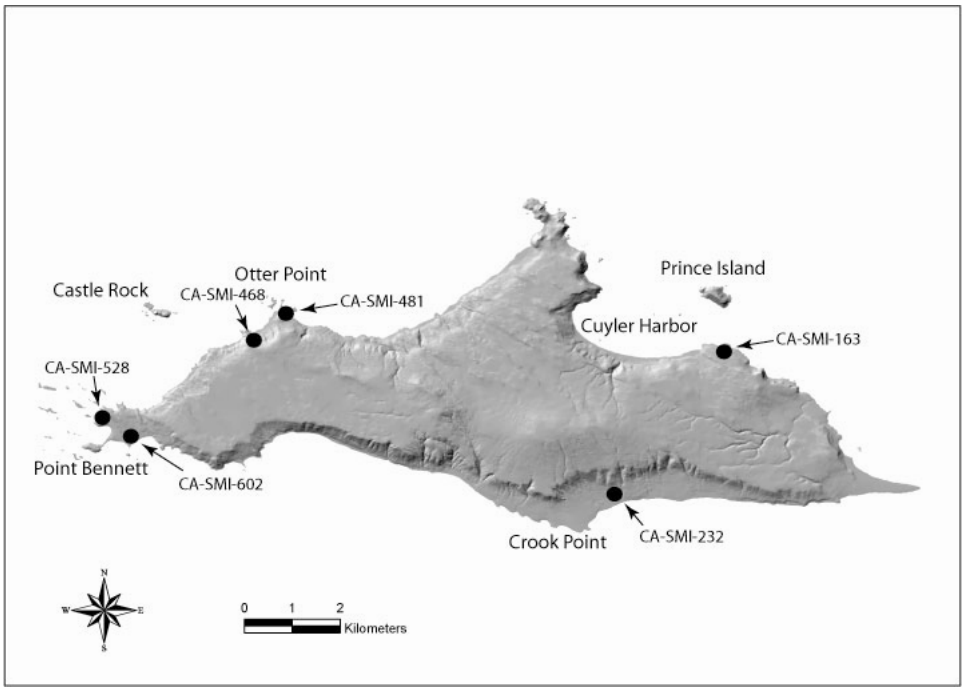

Figure 1. Location of San Miguel Island, the Santa Barbara Channel region, and the archaeological sites mentioned in the text.

populations expanded and anthropogenic impacts affected the availability of local resources (Braje 2007; Braje et al. 2007; Erlandson 1994; Kennett 2005; Rick 2007; Rick et al. 2005). Pinniped hunting experienced an abrupt increase beginning about 1500 cal BP (Braje 2007; Kennett 2005; Rick 2007; Walker et al. 2002). Three sites on San Miguel Island dating to this time period have undergone archaeological sampling and detailed faunal analysis, and contain abundant pinniped remains—CA-SMI-481 at Otter Point (Rick 2007), CA-SMI-528 at Pt. Bennett (Kennett 2005; Walker et al. 2002), and CA-SMI-232 on the south-central coast (Braje 2007). In the following section, we present zooarchaeological data on marine mammal remains from excavations at CA-SMI-232. Our analysis provides a broader understanding of the nature of sea mammals available to San Miguel islanders during the Late Holocene, the technological and economic context of sea mammal hunting, and the impacts of growing populations on marine ecosystems.

METHODS

CA-SMI-232 is a large shell midden positioned on the south coast of San Miguel Island, near the base of the southern escarpment, northeast of Crook Point (Fig. 1). The site was first recorded in the 1960s by Rozaire and Kritzman (Rozaire 1978), who mismapped the locality approximately one km to the east. During an archaeological survey project of the south coast, Braje and colleagues relocated, mapped, and described the locality (Braje et al. 2005). The site has a commanding view of the Crook Point area and its relatively protected harbor, sandy beaches, dense offshore kelp forests, and the southern coastal plain. The site deposits are exposed in two actively eroding gullies approximately 150 m west of Forney's Canyon, a large canyon with seasonal freshwater (Fig. 2).

The West Gully contains a 20 to 30 cm thick shell midden deposit, abundant in rocky shore shellfish remains, especially mussel, small red and black abalone, and sea urchin shells. This deposit is exposed for approximately 50 m in the eastern wall and, while not continuous, the midden seems to represent a single occupation based on the similar stratigraphic location and cultural constituents of the deposits. The East Gully contains midden deposits between 30 and 60 cm thick and relatively continuous intact deposits are exposed for roughly 80 m in its eastern and western walls. Deposits are notable for their size, thickness, and density and all contain abundant shellfish, fish, and marine mammal remains. Visual inspection of the deposits, however, suggests that two distinct types of deposits are eroding from this gully. In the northeast site area, the midden exposed in the western wall is dominated by shellfish remains; fish and marine mammal bone are present but significantly less abundant than shell. Two pockets of midden dominated by marine mammal bones are also present—one approximately 10 m south of the shell lens in the western wall and one opposite the shell lens eroding from the eastern wall. These "bone bed" loci contain dense aggregations of articulated and disarticulated skeletal remains of fish and sea mammal, including many juvenile pinnipeds and some cetacean remains.

Research at CA-SMI-232 focused on the shell and bone lenses exposed in the East Gully exposure, but radiocarbon samples were collected from the midden deposit in the West Gully. Two columns, a 75 L sample from the bone bed lens (Column 1) and a 100 L sample from the shell lens (Column 2), were excavated from the gully wall exposures and water-screened over 1/16-inch mesh (Fig. 2). In addition, a 2.0 m by 1.0 m excavation unit (Unit 1) was excavated through the bone bed lens with the long axis running east-west, perpendicular to the gully.

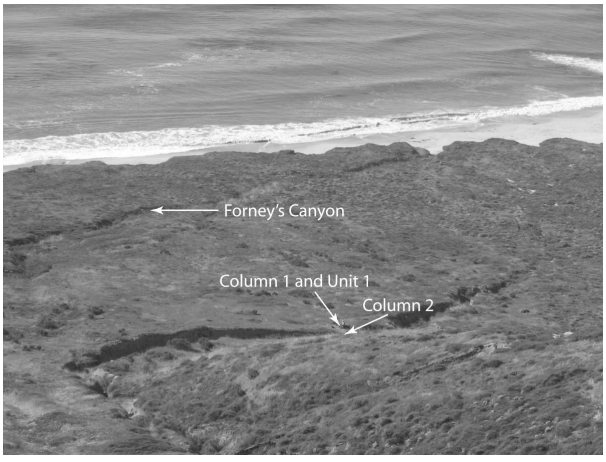

Figure 2. Photograph of the East Gully at CA-SMI-232 and locations of excavation units.

To quantify the various sea mammal remains, a variety of zooarchaeological measures were used, including number of identified specimens (NISP), minimum number of individuals (MNI), and bone weights. NISP is the count of whole and fragmentary elements for each individual taxon. MNI values are an estimate of the lowest possible number of individuals present in the assemblage and are derived from the frequency of non-repetitive elements. While each of these methods has associated problems, taken together they offer an excellent measure of the relative importance of faunal classes.

Excavated samples produced numerous complete or nearly complete sea mammal elements, but many of these were vertebrae and flipper elements that are difficult to positively identify to species. We identified marine mammal bone to the most specific taxon possible, but limited our analysis to elements for which we had access to large comparative collections (e.g., humeri, femurs, mandibles, maxilla, and cranial elements) or those that are distinctive to family, genus, or species (e.g., cetacean vertebrae). Due to these limitations, the three excavated samples are reported as a single assemblage. The ages and sexes of the pinniped bones were determined using the research osteological collection at the National Marine Mammal Laboratory in Seattle. Sea otter bones were excluded from this analysis because of the small sample size and limited sexual dimorphism in the skeletal remains.

RESULTS

Four radiocarbon dates define the site chronology (Table 1). From the East Gully exposures, three radiocarbon dates were obtained from single, well-preserved marine shells, one from the top of the bone lens, one from the top of the shell lens, and one from the base of the shell lens. These dates suggest that the East Gully midden was deposited between about 1290 and 1070 cal BP. Since stratigraphic profiles show no evidence of a hiatus in the cultural strata, these deposits probably date to a relatively narrow window of time and reflect discrete activity areas.

A single radiocarbon sample was run from the West Gully shell midden deposit—an *Olivella* wall bead collected from the middle of the shell deposit in the eastern wall, yielding a one sigma age range of 600 to 490 cal BP. This suggests that the area was occupied at least 500 years after the East Gully occupation. Surface collections from the West Gully produced several *Olivella* callus cup beads, a hallmark of the Late Period and consistent with the radiocarbon chronology (see King 1990). No diagnostic Late Period artifacts were found in the East Gully site area, suggesting that the material corresponds with the end of King's (1990) Middle Period.

Based on the two column samples (total = 175 L), sea mammal bone density at CA-SMI-232 was extremely high at 32.7 g/L, often less than 10 g/L at other Late Holocene sites (see Braje 2007; Rick

Table 1. Radiocarbon dates from CA-SMI-232.

Provenience	Material[1]	Lab #	Measured ^{14}C age	Conventional ^{14}C age	Age range (cal BP)[2]
East Gully, Column 1, level 1	*Mc*	OS-44639	N/A	1910±30	1290-1190
East Gully, Column 2, level 1	*Ol*	OS-59576	N/A	1880±30	1265-1170
East Gully shell lens, near base	*Hr*	Beta-180770	1370±60	1810±60	1220-1070
West Gully wall, near base	*Ol* wall	OS-51542	N/A	1160±40	600-490

[1]*Hr=Haliotis rufescens*, *Mc=Mytilus californianus*, *Ol*=partial *Olivella* cup bead, *Ol* wall=*Olivella* wall bead.

[2]Calibrated using the CALIB 5.0.1 program and a local reservoir correction of –225 ± 35 years (Stuiver and Reimer 1993, 1999); age ranges at one sigma.

Table 2. Identified marine mammal remains from Columns 1 and 2 and Unit 1 at CA-SMI-232.

	Wt. (g)	Wt.%	NISP	NISP%	MNI	MNI%
Carnivora						
Otariidae						
Arctocephalus townsendii (Guadalupe fur seal)	3518.4	82.6	84	84.8	35	85.4
Zalophus californianus (California sea lion)	537.1	12.6	5	5.1	2	4.9
Phocidae						
Phoca vitulina (Harbor seal)	18.5	0.4	2	2	1	2.4
Mustelidae						
Enhydra lutris (Sea otter)	25.5	0.6	2	2	2	4.9
Cetacea						
Small/Medium Cetacean	162.5	3.8	6	6.1	1	2.4
Total	4262	100	99	100	41	100

2007). Table 2 shows that most of the identified sea mammal remains were from otariids (89.9% of NISP), including 84 from Guadalupe fur seals (84.8%) and five from California sea lions (5.1%). Phocids and sea otter bones were relatively rare in the samples, with only two harbor seal bones (2.0%) and two sea otter bones (2.0%). Six small to medium cetacean bones were identified—probably dolphin or porpoise bones—comprising 6.1% of the total NISP. MNI values reflect similar patterns (Table 2), with otariids comprising 90.3% of the total MNI, phocids 4.8%, and sea otters 4.9%. Guadalupe fur seal was the most abundant marine mammal by MNI, comprising 85.4%, followed by California sea lions and sea otters each at 4.9%. Harbor seals and small and medium cetaceans each accounted for 4.8% of the sample.

Of the 84 Guadalupe fur seal elements identified by age and sex, most (n=49) were adult females. Two were from adult males, three from subadult females, and two from subadult males (Table 3). Sex determinations could not be made on 26 elements due to a lack of comparative collections or sexually dimorphic characteristics. The two identified harbor seal elements were from a pup, which could not be sexed. Finally, five California sea lion bones were identified, four adult males and one subadult male (Table 3). In total, the assemblage is dominated by adult or subadult Guadalupe fur seals with only eight of the identified

Table 3. Age and sex determinations of pinniped bones at CA-SMI-232 identified to species (NISP)

Species	Adult	Subadult	Juvenile	Pup	Male	Female	Sex Undif.
Guadalupe fur seal	53	9	16	6	5	53	26
Harbor seal	--	--	--	2	--	--	2
California sea lion	4	1	--	--	5	--	--

elements from pups, six from Guadalupe fur seals, and two from harbor seals. These pup elements consisted of four humeri, two femurs, one tibia, and one mandible.

DISCUSSION AND CONCLUSIONS

The late Middle Period (ca. 1300–800 cal BP) seems to be a time when Channel Islanders underwent remarkable social, political, economic, and physiological changes. Data suggest that islanders congregated in large coastal villages, increased the production and trade of goods between the islands and mainland, and diversified their subsistence economies (Arnold 2000, 2001; Kennett 2005; Rick 2007; Rick et al. 2005). This also seems to be a time when islanders underwent remarkable declines in human health and increases in disease and lethal conflict (see Hollimon 1990; Lambert 1993). Lambert (1993) and Lambert and Walker (1991) implicated growing population densities, increased territorial circumscription, and climate change as possible causal factors, but shortages of and anthropogenic impacts on local subsistence resources were likely important factors (Braje 2007). Islanders also increased their reliance on marine fishing and expanded their subsistence economies. Data from each of the three late Middle Period sites with abundant pinniped remains on San Miguel Island (CA-SMI-232, CA-SMI-481, and CA-SMI-528) suggest that islanders focused more heavily on marine mammal hunting. At each of these sites, Guadalupe fur seals dominate the samples, comprising between 36% and 85% of the assemblages by NISP (Table 4). At CA-SMI-481 where age and sex data were reported (Rick 2004, 153), nearly all the Guadalupe fur seal remains were identified as adult females. At CA-SMI-232, we found a similar pattern with a heavy reliance on adult female Guadalupe fur seals.

Kennett (2005), relying on behavioral ecological principles and optimal foraging theory, suggested that the increased hunting of pinnipeds at about 1500 cal BP is related to the introduction of the bow-and-arrow and development of the plank canoe (*tomol*) which made marine mammal hunting a more energy-efficient strategy to feed growing island populations. These technologies probably increased the effectiveness of pinniped exploitation because modern behavioral observations suggest that human hunters on the island would quickly force otariid (fur seals and sea lions) and phocid (harbor seals and elephant seals) populations to Toffshore rocks and outcrops (Allen et al. 1971; DeLong, field observations; Gerrodette and Gilmartin 1990; Riedman 1990; Wilkinson and Bester 1988), where access would be more difficult. Hunting may have only been possible from stable watercraft for in-water or hauled out prey. Landing on offshore rocks such as Castle Rock and Prince Island today is difficult, even with rubberized boats, due to heavy wave energy and the dearth of protected landings. The combination of *tomols* and highly accurate, maneuverable, and powerful bow-and-arrow technology probably allowed hunters better access to easily frightened offshore pinnipeds. The general lack of pup and juvenile remains from island archaeological sites suggests that the large, breeding pinniped populations on San Miguel today (especially at Point Bennett) were not present 1500 years ago. Rather, populations were likely restricted to offshore rocks, and the Channel Islands and western San Miguel only became a breeding and haulout area after the removal of the Chumash during the historic period. Commercial over-hunting and subsequent population recovery seems to have created significant changes in species composition from the prehistoric to modern periods. This seems particularly clear in the near absence of elephant seals, the second most abundant pinniped on San Miguel Island today, in prehistoric assemblages, which are dominated by Guadalupe fur seals that are rare on the island today.

While evidence of a heavy reliance on sea mammals has been documented at the Punta Arena site (CA-SCRI-109) on western Santa Cruz Island (Glassow 2005) and the Eel Point site (CA-SCLI-43) on San Clemente Island (Porcasi et al. 2000) during the Early and Middle Holocene, these sites are located near submarine canyons, which may have allowed for greater access to dolphins and sea mammals. Sea mammal bones also have been recovered in small numbers from many Channel Islands sites predating 1500 cal BP, especially on San Miguel Island where the largest populations are found today (Rick et al. 2005). However, quantification of faunal remains from sites and components older than approximately 1700 cal BP suggests that marine mammals were not the focus of

Table 4. Summary of other San Miguel Island late Middle Period sites with abundant sea mammal bone. Data from Rick 2007 and Walker et al. 2002.

	NISP	NISP%	MNI	MNI%	Adult/ Subad.	Subad./ Juv.	Pup	Male	Female
CA-SMI-481 — 1260–920 cal BP									
Otariidae									
Guadalupe fur seal	47	36.4	12	34.3	37	2	0	2	41
Northern fur seal	23	17.8	8	22.9	21	2	0	0	21
Steller's sea lion	1	0.8	1	2.9	0	0	1	1	0
California sea lion	29	22.5	7	20.0	24	6	0	28	0
Phocidae									
Elephant seal	1	0.8	1	2.9	N/A	N/A	N/A	N/A	N/A
Harbor seal	4	3.1	1	2.9	N/A	N/A	N/A	N/A	N/A
Carnivora									
Sea otter	24	18.6	5	14.3	N/A	N/A	N/A	N/A	N/A
Total	129	100	35	100	82	10	1	31	62
CA-SMI-528 — 1570–1120 cal BP									
Otariidae									
Guadalupe fur seal	85	49.1	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Northern fur seal	28	16.2	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Steller's sea lion	4	2.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A
California sea lion	20	11.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Phocidae									
Elephant seal	1	0.6	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Harbor seal	3	1.7	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Carnivora									
Sea otter	32	18.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	173	100	N/A	N/A	N/A	N/A	N/A	N/A	N/A

the subsistence economy (Kennett 2005,197–198; Walker et al. 2002).

Interestingly, both Rick (2004) and Walker et al. (2002) report decreases in sea mammal remains in Late Period sites on San Miguel Island at CA-SMI-163, CA-SMI-468, and CA-SMI-602. At each of these sites, there seems to be a shift away from a marine mammal to a fish-based economy during the

Late Period (Rick 2007, 136, Figure 7.5; Walker et al. 2002, 631). While only speculative, the decrease in pinniped hunting during the Late Period may be the result of human impacts on and the anthropogenic reduction of marine mammal populations that began about 1500 cal BP. This may suggest that the composition of modern pinniped populations on the Channel Islands are the result of not only commercial over-hunting during the eighteenth and nineteenth centuries but also intensive human utilization that began at least 1500 years ago.

Determining the mechanism that triggered compositional changes from prehistoric to modern pinniped communities on the Channel Islands is of central importance. Cold water episodes during the recovery period after historic over-hunting may have given cold water adapted species such as elephant seals and northern fur seals an advantage over warm water adapted Guadalupe fur seals (Walker et al. 2002, 631). Processes of competitive exclusion or other complex ecological interactions also need to be addressed and will take the cooperative efforts of a variety of scientists including biologists, ecologists, historians, and archaeologists. The first step, however, will be the recognition of the anomalous nature of historic pinniped populations and that their reintroduction to local ecosystems may not have followed "natural" trajectories.

Fascinating new evidence is beginning to emerge, however, that Paleocoastal peoples on San Miguel, Santa Rosa, and Santa Cruz islands may have hunted sea mammals during the earliest occupations of the islands, when human populations were small and sea mammals had little to no fear of human hunters. Recent discoveries at several Early Holocene sites suggest that a finely made, bifacial projectile point technology—Channel Islands Barbed or Punta Arena points—may be evidence of intensive Paleocoastal sea mammal hunting (Braje 2007; Erlandson and Braje 2007; Erlandson et al. 2005; Glassow et al. 2008). Faunal evidence to support this conclusion is currently lacking, perhaps the combined result of rising sea levels, coastal erosion, and the "Schlepp Effect," where sea mammals were butchered on local beaches and not transported to base camps and incorporated into the archaeological record. Ultimately, the question of when sea mammal hunting on the Channel Islands first began and how ancient populations were affected will require continued analysis of faunal and technological evidence from a variety of archaeological sites, isotopic studies from human remains, and DNA investigations from ancient and modern sea mammal bones.

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