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# A trans-Holocene archaeological record of Guadalupe fur seals (*Arctocephalus townsendi*) on the California coast

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Guadalupe fur seals (*Arctocephalus townsendi*) were decimated by 19th century commercial sealers in the northeastern Pacific and thought to be extinct until 1928 when commercial fishermen caught two adult males at Isla de Guadalupe from a group of up to 60 adults and pups (Wedgeforth 1928, Huey 1930). These two animals were brought to the San Diego Zoo, prompting several zoological expeditions to Isla de Guadalupe in the 1930s and 1940s, but none successfully located Guadalupe fur seals. In 1949, a single male was seen on San Nicolas Island, California (Bartholomew 1950), and in 1954, a small breeding group of animals was found in a cave at Isla de Guadalupe (Hubbs 1956). The population had grown to at least 500 animals in 1967, to about 7,400 animals in 1993, and to 12,176 in 2003, with breeding populations currently confined to Mexico's Islas de Guadalupe and San Benito (Peterson *et al*. 1968, Gallo-Reynoso 1994, Gallo-Reynoso *et al*. 2005, Carretta *et al*. 2007). Although small numbers of Guadalupe fur seals haul out on the California Channel Islands today, including a female and single pup born on San Miguel Island in 1997, they are vastly outnumbered by California sea lions (*Zalophus californianus*), northern elephant seals (*Mirounga angustirostris*), northern fur seals (*Callorhinus ursinus*), and harbor seals (*Phoca vitulina*), all of which currently breed on San Miguel Island (Stewart *et al*. 1993, Melin and DeLong 1999, DeLong and Melin 2002). Archaeological and genetic data suggest, however, that the modern distribution and abundance of Guadalupe fur seals are very different from prehistoric distributions (Walker and Craig 1979, Colten 2002, Etnier 2002*a*, Walker *et al*. 2002, Weber *et al*. 2004).

Because *Arctocephalus townsendi* was not described as a new species until 1897 after historical commercial sealing had devastated the population, questions remain about its biogeography, natural history, and range (Merriam 1897, Hanni *et al*. 1997, Melin and DeLong 1999, Etnier 2002*a*). Although a few fur seals identified in historical accounts from the Farallon Islands were thought to be Guadalupe fur seals, the best estimate of the historical northern range for Guadalupe fur seals is likely the northern Channel Islands (Repenning *et al*. 1971). Fur seals on the Farallon Islands, which were extirpated by commercial sealers in the early 1800s, were originally identified as *A. townsendi* (Starks 1922), and bones from commercial sealing middens were also reported to be *A. townsendi* (Riddell 1955). The bone collection was reexamined by J. Schonwald of the California Academy of Sciences and found to be *C. ursinus* (Repenning *et al*. 1971, Pyle *et al*. 2001). Archaeological data and modern strandings, however, indicate that Guadalupe fur seals at least occasionally occur in northern California, Oregon, and Washington (Lyon 1937:165, Hanni *et al*. 1997, Etnier 2002*a*, Moss *et al*. 2006). In this note, we provide the first synthesis of Guadalupe fur seal remains from archaeological sites in coastal California, supplying information on their past distributions, ecology, natural history, and management (Fig. 1).

We performed a systematic literature review of published accounts of Guadalupe fur seals from California archaeological sites, and also compiled a number of additional identifications from unpublished reports. We were cautious when compiling the archaeological occurrences of Guadalupe fur seals and only included specimens identified by a reputable specialist (see Lyman 2002 for a review). We included

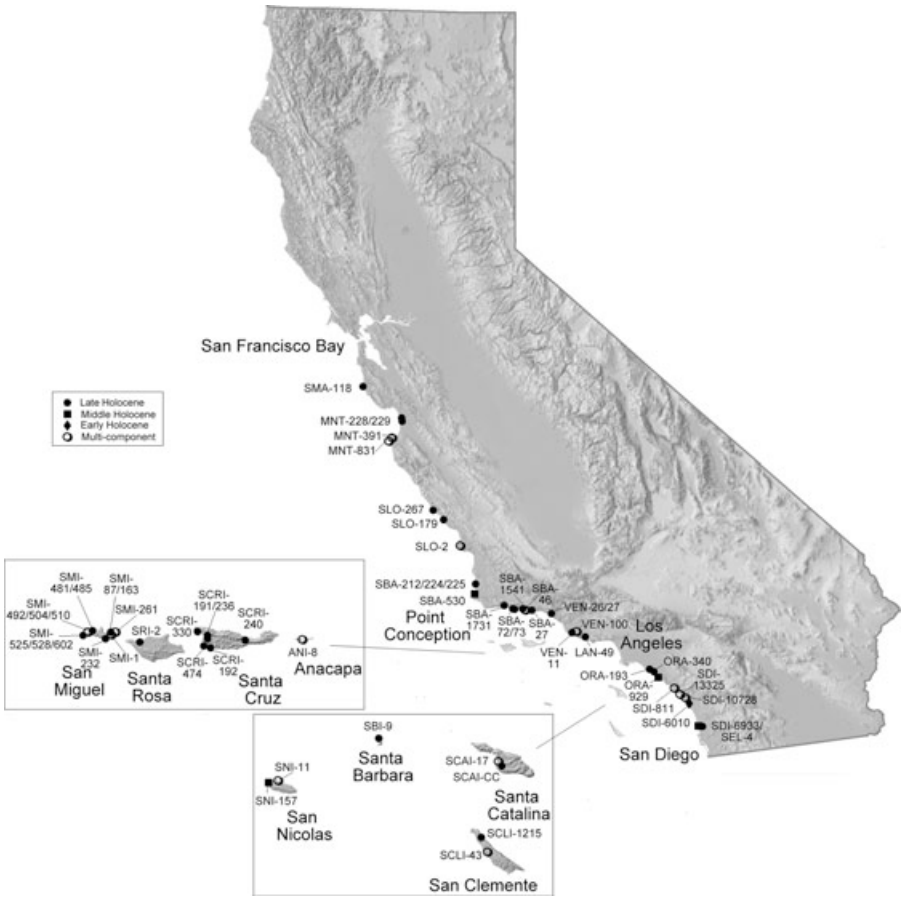


*Figure 1.* Location of archaeological sites containing Guadalupe fur seal remains in California.

specimens identified to species, excluding those that were identified solely as fur seal. We recorded bone and teeth counts and minimum number of individuals (MNI), an estimate of the total number of animals based on the frequency of non-repetitive elements (Grayson 1984, Lyman 2008). When available, we also included age and sex estimates.

Guadalupe fur seals have been identified in at least 60 archaeological sites on the California Coast, including 32 on the mainland and 28 from the Channel Islands (Table 1). At least 3,478 Guadalupe fur seal bones or teeth have been identified with 1,601 from the Channel Islands and 1,877 from the mainland. Many researchers did not report MNI, but a conservative estimate indicates that there are at least 576 individuals represented: 306 from the islands and 270 from the mainland. San Miguel Island contains 13 sites, the largest concentration in our data set, followed

*Table 1.* Archaeological occurrences of Guadalupe fur seals in California.

| Site number[a] | Age (cal B.P.)[b] | Count[c] | MNI | Comment | References |
|---|---|---|---|---|---|
| *Mainland assemblages* | | | | | |
| SDI-SEL-4 | middle Holocene | 2 | 1 | Site is located near San Elijo Lagoon. | Wake, unpublished data |
| SDI-811 | 4150–1050 | 2 | n/a | These are the only two pinniped bones id'd at the site. | Wake 1999 |
| SDI-6010 | 8000–7200 | 1 | 1 | Only pinniped bone id'd. | Cairns and Altschul 1993 |
| SDI-6933 | late Holocene | 1 | 1 | Small sample like other San Diego sites. | Wake, unpublished data |
| SDI-10728a | 8000–5000 | 1 | 1 | 1 of only 2 pinniped bones id'd. | Wake 1999 |
| SDI-13325 | 5000–1000 | 1 | 1 | California sea lions dominate assemblage with 20 bones. | Wake 1999 |
| ORA-193 | 1330–410 | 2 | 2 | 1 juvenile and 1 baculum, along with 4 harbor seal bones are only pinniped remains at site. | Langenwalter 1981 |
| ORA-340 | 3100 –700 | 1 | 1 | Only pinniped species id'd at site. | Langenwalter 1991 |
| ORA-929 | 6300–4300 | 4 | 1 | Only pinniped species id'd at site. | Langenwalter 1991 |
| LAN-49 | late Holocene | 15 | 2 | Only specimens known from LA County. | Wake 2004 |
| VEN-11 | 350–Historic | 1557 | 152 | 67% of all pinnipeds and sea otters. | Lyon 1937 |
| VEN-26 | 1600–1100 | 8 | 4 | Mix of adults and juveniles and all adults are female. | Walker, unpublished data |
| VEN-27 | 1500–Historic | 145 | 63 | Mix of adults and juveniles and all adults are female. | Walker, unpublished data |
| VEN-100 | multi-component? | 4 | 2 | Along with 1 California sea lion bone are only pinniped bones at site. | Simons 1979 |
| SBA-27 | 1000–500 | 32 | 9 | Mix of adults and juveniles | Hudson 1993*a* |
| SBA-46 | 4000–150 | 2 | 2 | 3 additional bones from undifferntiated fur seal. | Langenwalter n.d. |
| SBA-72 | 1950–1230 | 30 | 6 | 85% of marine mammal count id'd to species, includes a pup and juvenile. | Erlandson *et al.* 2008 |

| | | | | | |
|---|---|---|---|---|---|
| SBA-73 | 1990–410 | 8 | 3 | Only marine mammal id'd to species, includes juvenile, adult, and pup remains. | Erlandson *et al*. 2008 |
| SBA-212 | 500–240 | 2 | 1 | Probable Guadalupe fur seal. | McKim *et al*. 2007 |
| SBA-224 | 1070–Historic | 3 | n/a | 21% of id'd pinniped bones. | Hudson 1993*b* |
| SBA-225 | 3250–Historic | 1 | 1 | Only id'd pinniped species. | Hudson 1993*b* |
| SBA-530 | 7650–6320? | 1 | 1 | 11% of pinniped bones id'd to species. | Lebow *et al*. 2007 |
| SBA-1541 | 1000–700 | 3 | 1 | Only pinniped id'd to species. | Moore *et al*. 1988 |
| SBA-1731 | 800–400 | 20 | n/a | 18 bones from lower strata. | Michals 1993 |
| SLO-2 | 10,300–200 | 5 | 4 | 3% of pinniped bone count id'd to species. | Jones *et al*. 2008, Jones, unpublished data |
| SLO-179 | 950–700 | 2 | n/a | 7% of pinniped bone count id'd to species. | Jones and Ferneau 2002 |
| SLO-267 | 3250–950 | 1 | 1 | 5% of pinniped bone count id'd to species. | Jones and Ferneau 2002 |
| MNT-228 | 2600–950 | 1 | 1 | 4% of pinniped bone count id'd to species. | Jones *et al*. 1996, Jones and Ferneau 2002 |
| MNT-229 | 2600–700 | 8 | n/a | 20% of pinniped bone count id'd to species. | Dietz *et al*. 1988, Jones and Ferneau 2002 |
| MNT-391 | 5500–2500 | 12 | n/a | 38% of pinniped bone count id'd to species. | Cartier 1993, Jones and Waugh 1997 |
| MNT-831 | 7100–1200 | 1 | 1 | 3% of pinniped bone count id'd to species. | Porcasi 2006 |
| SMA-118 | 710–460 | 1 | 1 | 1% of pinniped bone count id'd to species. | Hylkema 2002 |
| *Channel Island assemblages* | | | | | |
| SCAI-1 | 5920–880 | n/a | n/a | Thought to be fairly common in deposits but no counts given. | Porcasi 2002 |
| SCAI-CC | 1450–430 | 45 | 6 | 87% of pinniped bone count id'd to species. | Bickford and Martz 1980 |
| SCLI-43B[d] | Trans-Holocene | 69 | n/a | Adults and juveniles are present. Eleven bones from Garlinghouse: 2 = early Holocene, 9 = late Holocene. 1 bone and 1 MNI in Goldberg are from late Holocene. | Porcasi *et al*. 2000, Garlinghouse 2000, Goldberg 1993 |
| SCLI-1215 | late Holocene | 1 | 1 | Adult remains. | Goldberg 1993 |
| SBI-9 | 2680–2110 | 5 | 2 | 33% of pinniped bone count id'd to species. | Walker 1978, Colten 2002 |
| SNI-11 | 6980–510 | 428 | 104 | 61% of pinniped bone count id'd to species. 149 bones could be as old as 6900–4500 cal B.P. | Bleitz 1993 |

*(Continued)*

*Table 1 (Continued)*

| Site number[a] | Age (cal B.P.)[b] | Count[c] | MNI | Comment | References |
|---|---|---|---|---|---|
| SNI-157 | 4240–3720 | n/a | 1 | 1 of 3 pinniped species id'd. | Martz 2005 |
| ANI-8 | 5020–540 | 1 | 1 | Small sample of faunal remains. | Sandefur 1978 |
| SCRI-191 | 1980–300 | 11 | n/a | 79% of bone count id'd to species. | Colten 2002 |
| SCRI-192 | 790–Historic | 62 | n/a | 86% of pinniped bone count id'd to species in Colten ($n = 31$), 60% of bone count id'd to species in Noah ($n = 31$). | Colten 2002, Noah 2005 |
| SCRI-236 | Historic | 2 | n/a | 2 bones from 2 different houses. | Noah 2005 |
| SCRI-240 | 3210–130 | 622 | >66 | 79% of pinniped bone count id'd to species in Colten ($n = 115$), 35% in Noah ($n = 29$). Walker's ($n = 478$) MNI = 66 contains all adult females. | Colten 2002, Noah 2005, Walker, unpublished data |
| SCRI-330 | 790–Historic | 3 | n/a | 50% of pinniped bone count id'd to species. | Colten 2002 |
| SCRI-474 | 1530–540 | 3 | n/a | 27% of pinniped bone count id'd to species. | Colten 2002 |
| SRI-2 | 260–Historic | 4 | 2 | 80% of pinniped bone count id'd to species (all females). | Rick 2004 |
| SMI-1 | 7140–3250 | 33 | 4 | 26% of pinniped bone count id'd to species. | Walker 1978 |
| SMI-87 | 3200–2340 | 4 | 2 | 22% of pinniped bone count id'd to species. | Rick 2007 |
| SMI-163 | 320–Historic | 3 | 1 | 60% of pinniped bone count id'd to species. | Rick 2007 |
| SMI-232 | 1290–1070 | 84 | 35 | 86% of pinniped bone count id'd to species. | Braje and DeLong 2008[1] |
| SMI-261 | trans-Holocene | 4 | 2 | Two female bones and 1 immature. | Walker 1978 |
| SMI-481 | 1260–920 | 49 | 14 | 45% of pinniped bone count id'd to species by Rick. 2 bones and 2 MNI from Walker and Snethkamp. | Walker and Snethkamp 1984, Rick 2007 |
| SMI-485 | 570–480 | 2 | 2 | Found on site surface. | Walker and Snethkamp 1984 |
| SMI-492 | 5580–1250 | 20 | 6 | 4 females, no males, including 3 immature, and 1 adult. | Walker and Snethkamp 1984 |
| SMI-504 | 3050–2850 | 1 | 1 | From stratum 16. | Walker and Snethkamp 1984 |
| SMI-510 | 1260–1130 | 1 | 1 | Immature individual. | Walker and Snethkamp 1984 |

| | | | | | |
|---|---|---|---|---|---|
| SMI-525 | 3230–520 | n/a | 46 | 18 adults, 28 subadults, 46% of total pinniped MNI. | Walker and Craig 1979 |
| SMI-528 | 1570–1120 | 85 | n/a | 50% of total sea mammal assemblage. | Walker *et al*. 2002 |
| SMI-602 | 540–Historic | 56 | n/a | 42% of total sea mammal assemblage. | Walker *et al*. 2002 |

[a]All sites organized by county or island and site number designations: SDI = San Diego, ORA = Orange, LAN = Los Angeles, VEN = Ventura, SBA = Santa Barbara, SLO = San Luis Obispo, MNT = Monterey, SMA = San Mateo, SCLI = San Clemente Island, SCAI = Santa Catalina Island, SNI = San Nicolas Island, SBI = Santa Barbara Island, ANI = Anacapa Island, SCRI = Santa Cruz Island, SRI = Santa Rosa Island, SMI = San Miguel Island.

[b]All ages obtained from original reports and are generally calibrated age ranges, but in a few cases it was not clear if the dates being reported were calibrated or uncalibrated dates or if site chronologies were based on artifact associations. Northern Channel Island dates were obtained from the Radiocarbon Database on File, Department of Anthropology, University of Oregon, Eugene, Oregon. For some sites, few dates have been obtained, and ages should be treated as approximations rather than absolute ages.

[c]If count or MNI (minimum number of individuals) were unknown, they were assumed to be 1.

[d]Garlinghouse (2000) also reported Guadalupe fur seal remains from three San Clemente Island sites. Because some of the data from all three sites were reported by time period but not site, we have omitted 32 bones from the middle Holocene that could be from SCLI-34, -847, and -1215.

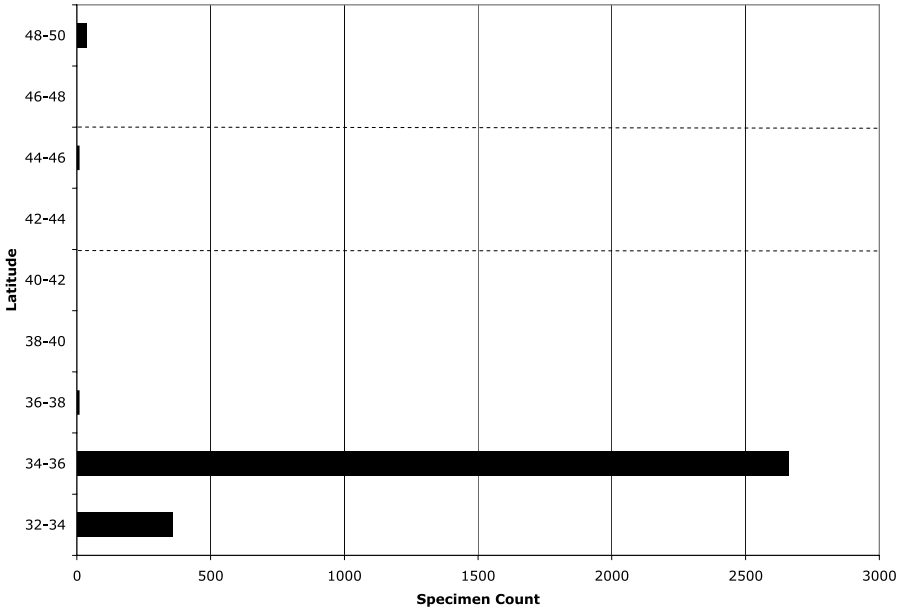


*Figure 2.* Plot of the total number of late Holocene (3500 cal B.P. to present) Guadalupe fur seal bones found in archaeological sites by approximate latitude in California (Table 1), Oregon (Lyon 1937:165, Moss *et al*. 2006), and Washington (Etnier 2002*a*). The dashed lines represent approximate location of California–Oregon border (bottom) and Oregon–Washington border (top).

by 10 in Santa Barbara County, and six each on Santa Cruz Island and in San Diego County.

The highest density of sites and individuals occurs on the Channel Islands and southern parts of the mainland, with the density declining north of Point Conception and none currently identified in California north of San Mateo County. Figure 2 presents the total specimen count for all late Holocene (3500 cal B.P. [calendar years before present, where present = 1950] to present) samples broken up by approximate latitude. More than 98% of the specimens come from south of 36° of latitude, demonstrating a much higher concentration of animals in southern California with smaller frequencies to the north.

The number of pinniped bones recovered from individual sites is governed by the extent of excavation, the intensity of pinniped hunting, bone preservation, recovery and analytical methods, and other variables. The largest count and MNI for a single site were from VEN-11 located at Point Mugu on the mainland, where Lyon (1937) reported 1,557 bones and 152 MNI. All other mainland sites have much lower counts and MNI—the next highest being 145 and most sites with fewer than 10. For the Channel Islands, the highest count comes from SCRI-240 on Santa Cruz Island where 622 specimens from more than 66 animals have been identified (Walker, unpublished data, Colten 2002, Noah 2005) and SNI-11 on San Nicolas Island where 428 specimens and 104 individuals were identified (Bleitz 1993). This is

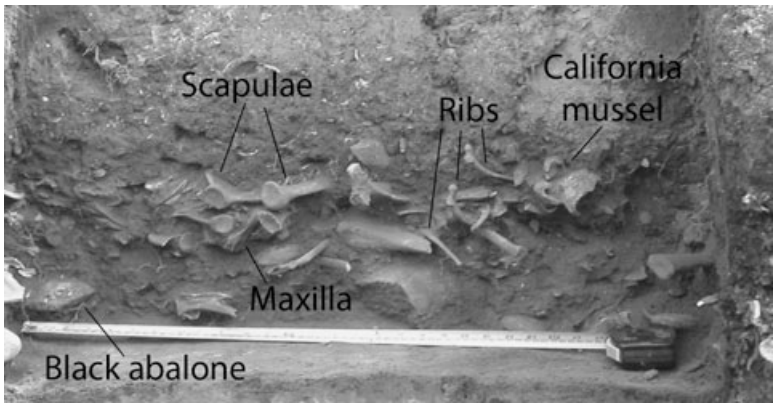


*Figure 3.* Closeup of a roughly 25 cm cross-section of an archaeological deposit rich in Guadalupe fur seal and other pinniped bones at CA-SMI-232, San Miguel Island (Photo by Todd Braje).

followed by SMI-528 with 85 specimens and SMI-232 with 84, both on San Miguel Island (Fig. 3; Walker *et al*. 2002, Braje and DeLong 2008[1]).

A variety of other pinnipeds were identified in many of the assemblages reported in Table 1, including California sea lions, northern fur seals, northern elephant seals, Steller sea lions (*Eumetopias jubatus*), and harbor seals, as well as sea otters (*Enhydra lutris*). At many of these sites, Guadalupe fur seal remains are relatively rare with just a few identified, particularly at mainland sites. However, at sites on the Channel Islands and at VEN-11 on the Ventura County mainland, Guadalupe fur seals are often the most abundant pinniped. These include SNI-11 on San Nicolas, SCAI-CC on Santa Catalina, SCRI-191, -192, -240, and -330 on Santa Cruz, SRI-2 on Santa Rosa, and SMI-163, -232, -481, -528, and -602 on San Miguel where Guadalupe fur seals contributed 40%–80% of the pinniped bones.

Chronological data for many of the specimens in our study are limited by a variety of factors, including small numbers of radiocarbon dates available for some sites, insufficient reporting of data, and site disturbances. California mainland sites are often heavily affected by bioturbation and historical disturbances that have mixed deposits of different ages. These problems are generally minimized on the Channel Islands. The oldest specimens in the sample date to the early Holocene (~11,000 to 7500 cal B.P.), including two bones reported by Garlinghouse (2000) from SCLI-43 on San Clemente Island and a single specimen from SDI-6010 in San Diego County associated with several dates between about 8000 and 7200 cal B.P. Specimens from SMI-1, SNI-11, and SCA-17 on the Channel Islands and SDI-10728a and MNT-391 on the mainland may also date to the early or middle (7500 to 3500 cal B.P.) Holocene, but these sites also contain younger components. Most of the Guadalupe fur seal remains come from sites with components dating to the late Holocene

[1]Braje, T. J., and R. L. DeLong. 2008. Ancient sea mammal exploitation on the south Coast of San Miguel Island. In Proceedings of the Seventh California Islands Symposium. (unpublished).

($n > 45$), with the highest concentration of bones coming from sites dated to the last 2,500–1,500 yr (*e.g.,* SMI-232, -481, -528, -602, and VEN-11). The abundance of Guadalupe fur seals in late Holocene archaeological sites is in part related to sampling, since younger sites tend to be larger, denser, and better preserved than older sites. However, the late Holocene development of the plank canoe (tomol), a seaworthy form of watercraft used in parts of southern California, may have facilitated taking animals from offshore rocks, caves, the water, and other more difficult to access areas (Kennett 2005, Rick 2007).

Age and sex data were rarely reported, with the best data coming from sites on San Miguel (SMI-232, -481, -525, and -528), Santa Cruz (SCRI-240), and San Clemente (SCLI-43) islands and three sites on the Santa Barbara and Ventura County mainland (SBA-72, -73, and VEN-11). The archaeological samples are all dominated by adult or subadult females, with some juveniles and small numbers of pups (<1 yr old). At SMI-232, 53 adults, 9 subadults, 16 juveniles, and 6 pups, with 53 females and 5 males were identified (Braje and DeLong 2008[1]). Similarly, SMI-481 produced 37 adults or subadults, 2 juveniles, 40 females, and 2 males (Rick 2007). Eighty-five Guadalupe fur seal bones dominated by adult females and some immature males and females were present at SMI-528 (Walker *et al*. 2002). Although the samples are relatively small, Walker (1978, Walker and Craig 1979, Walker and Snethkamp 1984) reported Guadalupe fur seals from SMI-525, -492, -485, -261, and -504 that were dominated by females and included adults, subadults, and immature specimens. Walker (unpublished data) also identified the remains of 66 Guadalupe fur seals at SCRI-240, all of which were from adult females. At SCLI-43, Porcasi *et al*. (2000:213) identified 39 adult and 18 juvenile Guadalupe fur seals. They also indicated that mostly female and some neonate and fetal material suggest a pinniped rookery may have been nearby, though they did not specify the exact species associated with these remains (Porcasi *et al*. 2000:215). On the mainland, SBA-72 and -73 contain 38 bones, with juveniles, adults, and a few pups (Erlandson *et al*. 2008). Finally, at VEN-11 Lyon (1937) reported 1,337 adult females, 24 adult males, and 190 juveniles.

Determining the presence of a rookery using archaeological data requires the remains of pre-weaned pups, usually based on the estimated age of skeletal elements, and ideally adult male and female remains (Lyman 1988, Etnier 2002*b*). The abundance of female Guadalupe fur seal remains in California archaeological sites is consistent with the harvest of a breeding population of reproductive females that alternate time ashore for nursing pups and marine feeding for 8–10 mo of each year (Rice *et al*. 1965, Pierson 1987). Because adult Guadalupe fur seal females reproduce annually, most females of reproductive age would visit rookeries. While it remains possible that Guadalupe fur seals were breeding on the Channel Islands (see also Repenning *et al*. 1971:26), the dearth of pups, males, and definitive evidence for pre-weaned pups makes it impossible to determine if rookeries were present on the Channel Islands or elsewhere in California at this time.

Guadalupe fur seals and other pinnipeds may have been hunted or scavenged by Native Americans on land or at sea. A variety of hunting technologies have been identified in the region, including a distinctive type of stone projectile called Channel

Islands Barbed (a.k.a Arena) points that date between about 10,000–8,000 yr ago and may have been used to hunt sea mammals (Erlandson and Braje 2007). Unfortunately, few of these have been found in clear association with marine mammal or other faunal remains. Other projectile points from across the Holocene may have also been used to hunt Guadalupe fur seals and other pinnipeds, and some individuals could have been clubbed while hauled out. As noted earlier, the plank canoe, thought to be developed around 1,500 yr ago, roughly corresponds with significant increases in Guadalupe fur seal and other pinniped remains, suggesting that people may have intensified efforts to acquire these animals from offshore rocks, caves, and the water (Kennett 2005, Rick 2007, Braje and DeLong 2008[1]).

Several researchers have suggested that Guadalupe fur seal abundance in California and more northerly waters may be influenced by El Niño, with animals moving northward following warmer El Niño conditions (Hanni *et al*. 1997, Melin and DeLong 1999, Etnier 2002*a*). A single pup born on San Miguel Island in 1997 occurred during an El Niño year (Melin and DeLong 1999) and strandings in northern California are also correlated with El Niño events (Hanni *et al*. 1997). Most of the Guadalupe fur seals in our database date to the last 4,000 yr, a time when El Niño frequency was thought to increase (Kennett *et al*. 2007), suggesting a possible correlation between the prehistoric abundance of Guadalupe fur seals in California and El Niño. Modest numbers of Guadalupe fur seal remains also occur during the middle Holocene when the frequency of El Niño events may have been reduced (see Kennett *et al*. 2007). The small number of specimens from the California mainland north of Point Conception may be from animals that stranded during El Niños. However, it remains possible that Guadalupe fur seals in prehistoric southern California, were not as tightly correlated with El Niño, especially if breeding Guadalupe fur seal populations were considerably larger and more geographically dispersed than today. Stable isotope analyses could help determine how strongly the role of El Niño influenced ancient Guadalupe fur seal abundance and ecology.

Archaeological data indicate that Guadalupe fur seals were considerably more common in California, especially south of Point Conception, than they are today. The abundance of Guadalupe fur seals in southern California archaeological sites contrasts with the modern abundance of northern elephant seals, northern fur seals, and to a lesser extent California sea lions. The significant growth of Guadalupe fur seal populations over the last three decades, including recent strandings in northern California, Oregon, and Washington suggests that Guadalupe fur seals may be moving towards a distribution more consistent with their Holocene distribution, especially the last 3,500 yr. Based on the archaeological data, as the population of Guadalupe fur seals continues to grow in Mexico, they should become resident on the Channel Islands and frequent visitors at other hauling areas south of about 36° of latitude, with animals present to the north, but probably in smaller numbers. Our analysis underscores the potential of archaeological data to help understand the historical ecology, biogeography, natural history, and management of pinnipeds and other marine organisms around the world (see Walker and Craig 1979, Lyman 1988,

Etnier 2002*a*, Hildebrandt and Jones 2002, Moss *et al*. 2006, Braje and DeLong 2008[1]).

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