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Journal

Journal of California and Great Basin Anthropology, 21(1)

ISSN

0191-3557

Author

Porcasi, Judith F.

Publication Date

1999-07-01

Peer reviewed

REPORTS

Prehistoric Exploitation of Albatross on the Southern California Channel Islands

JUDITH F. PORCASI

Zooarchaeology Laboratory, Institute of Archaeology,
Univ. of California, Los Angeles, CA 90095-1510.

Archaeological excavations in coastal California and on the offshore Channel Islands customarily produce scant evidence of the prehistoric presence or cultural use of the three species of albatross that visit the area. However, recent investigations on San Clemente Island reveal dense concentrations of two species of albatross that are dated to a narrow Middle Holocene time period. At nearby San Nicolas Island, a similar concentration of the same two species was dated later in the Holocene. This report describes these unique avian archaeofaunas and suggests that concentrations of the remains of these birds in an area where they are rarely recovered may reflect attempts by immigrant birds to colonize the Channel Islands. The vulnerability of breeding albatrosses to intense predation by early hunter-gatherers is also discussed.

THREE species of albatross visit coastal California on their annual eastward migration across the Pacific: *Diomedea albatrus* Pallas, the short-tailed albatross; *D. nigripes* Audubon, the black-footed albatross; and *D. immutabilis* Rothschild, the Laysan albatross (Fig. 1).¹ Since albatrosses have been intensively hunted for the past two centuries, these birds were probably more numerous prehistorically than they are today. Yet California coastal and Channel Island archaeological sites rarely produce more than a few albatross bones.²

So it came as a great surprise when three southern California Channel Island archaeological sites revealed unusually dense concentrations of

albatross remains. At a 1994 excavation at Eel Point (CA-SCLI-43) on San Clemente Island off the coast of San Diego, hundreds of albatross bones were recovered from a single cultural stratum, which produced a calibrated radiocarbon date of 3,609 to 3,819 calendar years before present (B.P.), dendrocalibrated with a one-sigma age range and mean intercept of 3,693 B.P. (calculated by Calib rev. 3.0.3 [Stuiver and Reimer 1993]).

Subsequent to the 1994 excavations, another site on San Clemente Island (CA-SCLI-152), located near the northern tip of the island, yielded an albatross concentration that rivals the one from Eel Point and is similarly dated to the Middle Holocene. No less than five albatrosses were recovered from a single unit with only 0.2 m.³ of matrix. This material was radiocarbon dated to 3,520 ± 40 B.P. (Beta-105603) (D. R. Gallegos, personal communication 1997). A 1977-1979 excavation at the Thousand Springs Site (CA-SNI-11) on nearby San Nicolas Island also produced a dense deposit of albatross bones attributed to a single cultural stratum radiocarbon dated to the Late Holocene (Bleitz-Sanburg 1987; Bleitz 1993).

While albatross is not unknown in the prehistoric Channel Islands (e.g., Guthrie 1980, Walker et al. 1987) or in the more northern Aleutian Islands (Yesner 1976), these southern California archaeofaunas are unique in the quantity of albatross bone, as well as in their secure dating to specific prehistoric occupations on these islands. The majority of identified albatross bone at these sites is the short-tailed albatross, consistent with other reported finds of albatrosses on the islands and mainland coast. The remainder is the black-footed albatross. The Laysan albatross was not found at any of these sites. This report considers the question of why so many albatross bones were deposited on these islands during two well-defined, relatively brief periods.

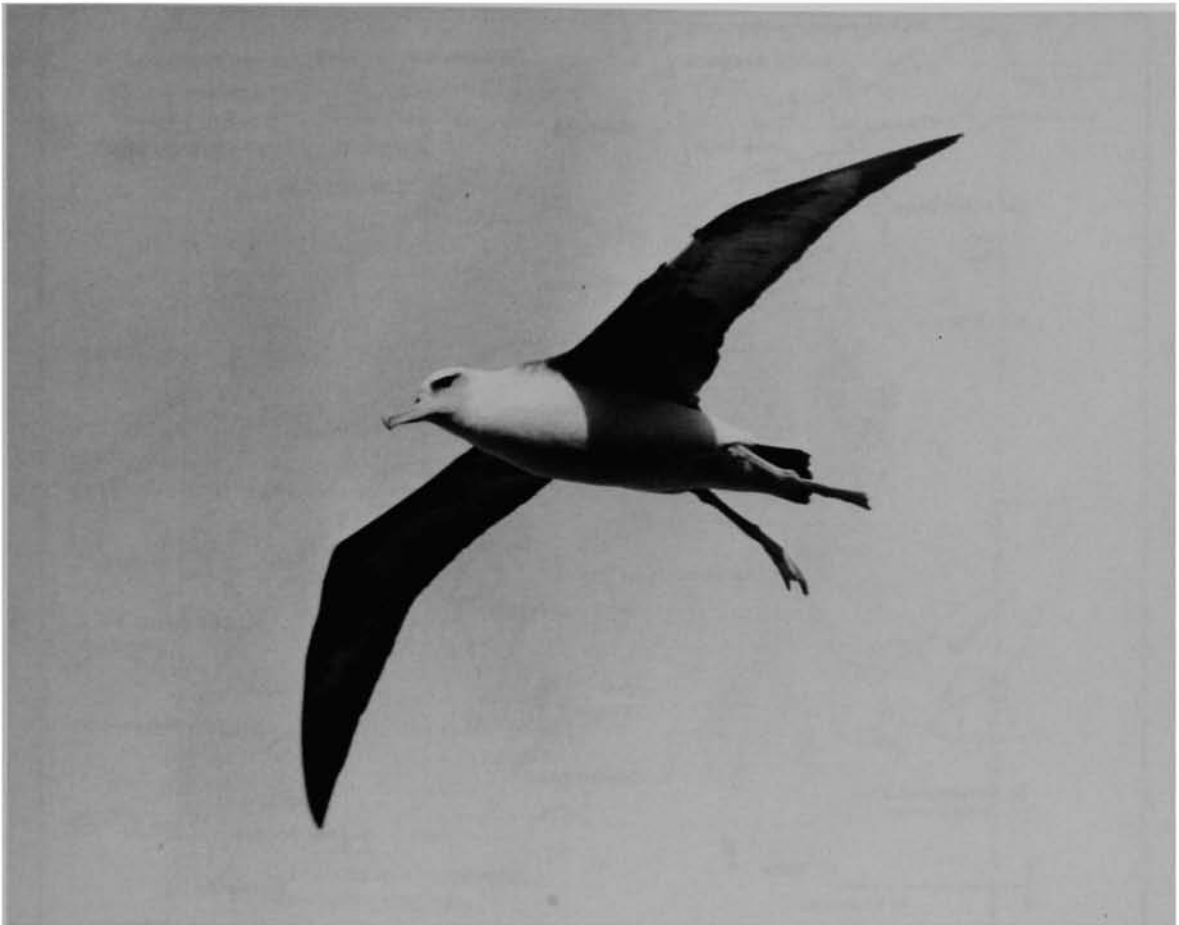


Fig. 1. Albatross in flight. (Photograph by Harvey I. Fisher, courtesy of the Natural History Museum of Los Angeles County.)

THE 1994 EXCAVATIONS AT EEL POINT

San Clemente Island is the southernmost and fourth largest (148 km.²) of the California Channel Islands (Fig. 2). It is 61 km. from the mainland, and its nearest island neighbors are Santa Catalina and San Nicolas, approximately 39 and 97 km. distant, respectively. Stratigraphy is extraordinarily well preserved on San Clemente Island because there are no burrowing animals and most of the island is an undeveloped military preserve.

Eel Point is a rocky headland jutting seaward from the western coast of the island. The resil-

ience of this shoreline has played a major role in protecting the site from erosion by the sea. The site itself (Fig. 3) is an expansive knoll capping intact cultural deposits more than 300 cm. deep. Previous research has demonstrated that this site was occupied by maritime-adapted people from about 9,000 to 500 B.P. (Axford 1978; Meighan 1986; Salls 1988, 1992; Raab and Yatsko 1992; Porcasi 1995; Raab et al. 1995).

The 1994 excavations at Eel Point were conducted by California State University, Northridge, in conjunction with the Navy's Office of Natural Resources, and were designed to develop a detailed chronological structure of the site and a

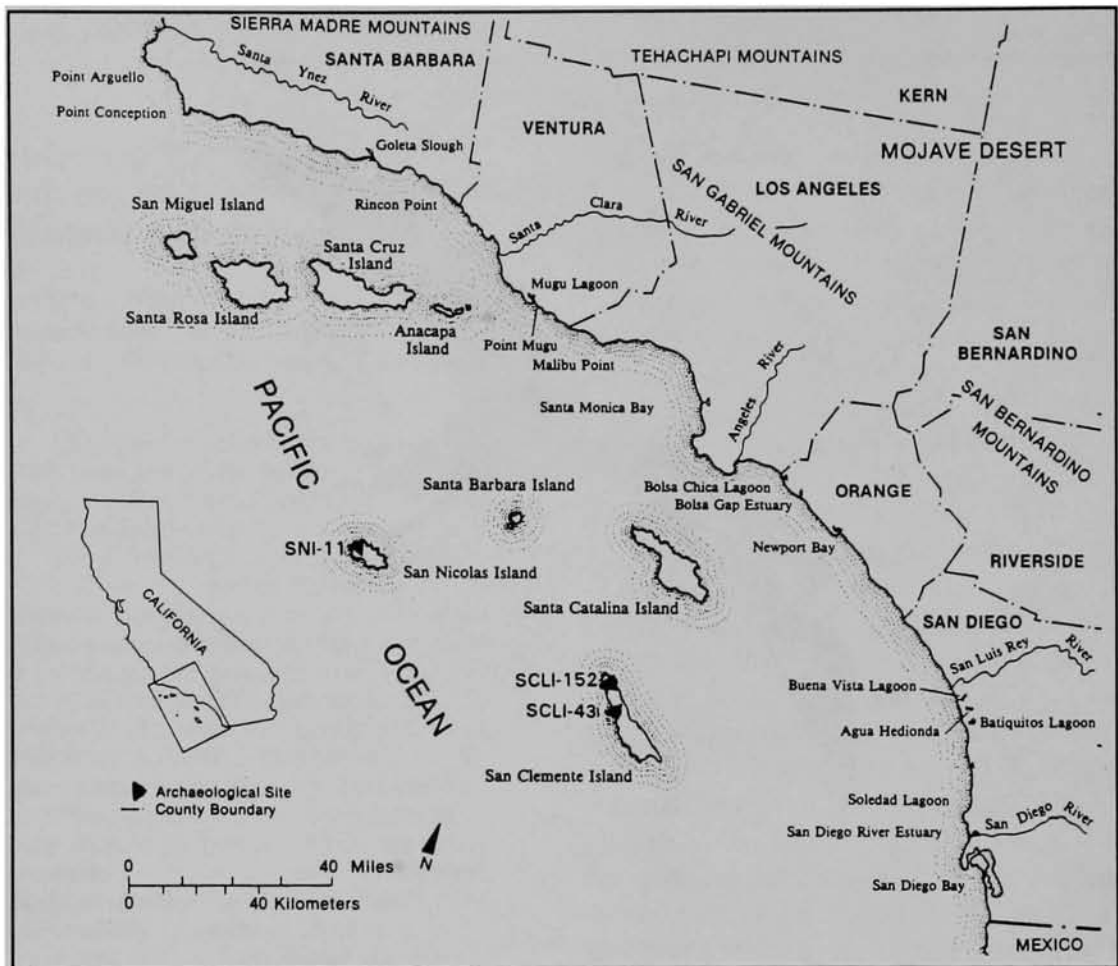


Fig. 2. The southern California Bight showing the northern group of islands (San Miguel, Santa Rosa, Santa Cruz, and Anacapa) and the southern group of islands (San Clemente, Santa Catalina, and San Nicolas).

carefully controlled sample of both artifacts and faunal materials. Five units (four 1 x 2 m. and one 1 x 1 m.) were excavated in natural strata to varying depths until sterile soil or bedrock was reached. All material was screened through 1/8-in. mesh. A large quantity of fish bone was recovered, along with 4,239 bird and mammal bones (pinnipeds, sea otters, and cetaceans), weighing 5,782.32 g.³ Shell was not collected, except for samples paired with charcoal for radiocarbon dating and some complete mussel valves for use in isotopic analyses.

Thirty natural strata were radiocarbon dated to

produce a chronological sequence for the site. Using 15 sequential dates bracketing 24 strata across the site, a nearly continuous timeline of site occupation from about 8,332 to 544 B.P. was constructed (Porcasi 1995).⁴ This timeline is the chronological foundation for analysis of the site and provides essential control for assessing changes over time in the assemblage.

THE EEL POINT ALBATROSS CONCENTRATION

The Eel Point excavation produced 922 bird bones (912.73 g.) accounting for nearly 22% of

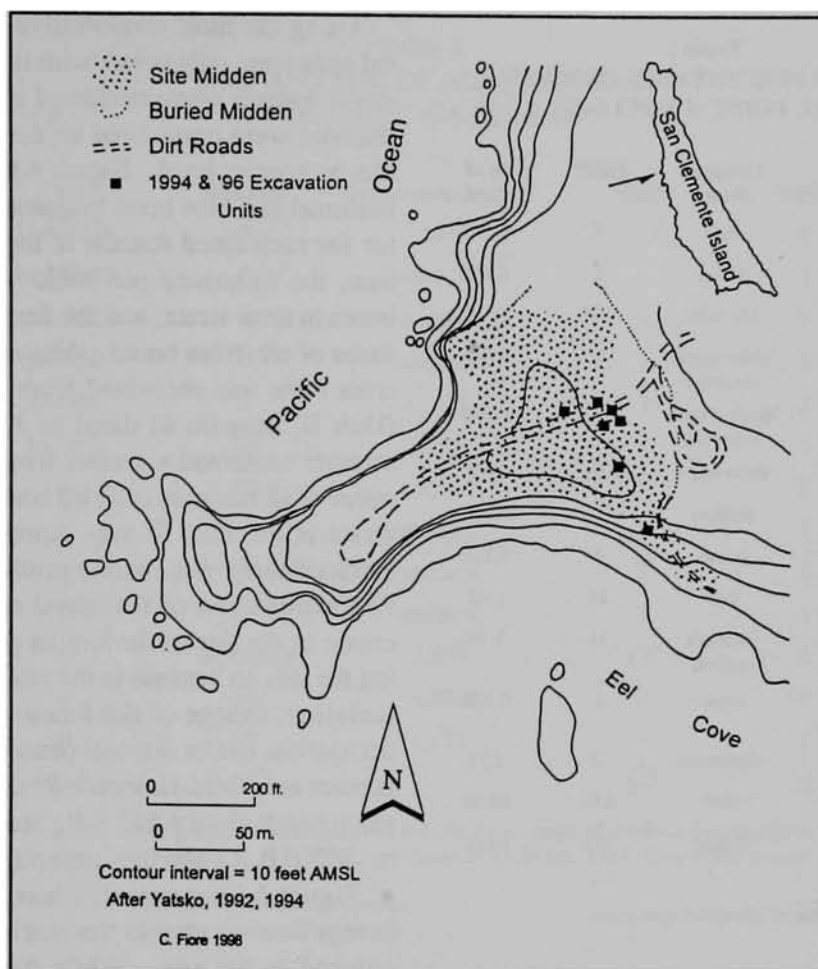


Fig. 3. The Eel Point site (CA-SCLI-43) on San Clemente Island showing location of the midden and the five units excavated in 1994. Nearly all of the albatross bone was collected from Unit B.

the total nonpiscine collection. Some 290 bird bones were identified to genus and/or species (Table 1). Of these, 205 bones are albatross. Thus, albatross accounts for 4.8% of the nonpiscine archaeofauna and the vast majority (71%) of the identified bird remains. Table 2 presents the number of identified specimens (NISP) and minimum number of individuals (MNI) of albatross for each dated cultural deposit (stratum) that produced albatross bone. The NISP is a count of the number of specimens identified to genus or species. The MNI is the index described by White (1953), Krantz (1968), Bökönyi (1970), and Gray-

son (1973, 1984) in which identified elements for a taxon are further categorized by part of element, side, and, when possible, the age and/or sex of the animal to determine the minimum number of individual animals of a taxon represented by the identified specimens. Since each natural stratum represents a single deposit (aggregation), the MNIs are based on the number of identifiable albatrosses in each stratum. This is Grayson's (1973:432-438) "maximum distinction method."

Recognizing the limitations of the NISP or MNI in faunal analysis (e.g., Grayson 1973, 1984; Lyman 1979, 1994; Klein and Cruz-Uribe

Table 1
NISP AND PERCENTAGES OF BIRDS
AT EEL POINT (CA-SCLI-43)

Taxa	Common Name	NISP ^a	% of Bird
<i>Gavia</i> sp.	loon	6	0.649
<i>Aechmophorus</i> sp.	grebe	2	0.216
<i>Diomedea</i> sp.	albatross	195	21.15
<i>D. albatrus</i>	short-tailed albatross	8	0.866
<i>D. nigripes</i>	black-footed albatross	2	0.216
<i>Puffinus</i> sp.	shearwater	23	2.49
<i>Pelecanus</i> sp.	pelican	2	0.216
<i>Anser</i> sp.	goose	1	0.108
<i>Larus</i> sp.	gull	14	1.52
<i>Ptychoramphus aleuticus</i>	Cassin's auklet	11	1.19
<i>Corvus brachyrhynchos</i>	crow	1	0.108
<i>Phalacrocorax</i> sp.	cormorant	25	2.71
unidentified aves	bird	632	68.56
	Totals	922	100%

^a NISP = number of identified specimens.

1984; Hesse and Wapnish 1985; Brewer 1992), bone frequency per cubic meter in each stratum was used to indicate the quantity of bone deposited in each aggregation. While not solving all the quantitative limitations of the NISP and MNI, nor addressing depositional rate or other taphonomic concerns, this method controls for variation of volume (i.e., each aggregation) and provides a relative measure of bone quantity in each natural level. The undisturbed stratigraphy of the site indicates that relative frequencies of bone within the deposits have not been altered taphonomically. In addition, the stratum that produced the albatross concentration (Stratum 6) is bordered by adjacent natural levels dated at 2,273 and 4,202 B.P., respectively (Porcasi 1995:53), helping to bracket the depositional period of the stratum.

Using the most conservative zooarchaeological technique, only bones with unequivocal diagnostic features were considered identified; the remainder were considered unidentified to the genus or species level. Figure 4 presents the total mammal and bird bone frequency per cubic meter for each dated stratum in the Eel Point timeline, the frequency per cubic meter of all bird bones in these strata, and the frequency per cubic meter of albatross bones. Almost all of the albatross bone was recovered from a single deposit (Unit B, Stratum 6) dated to 3,693 B.P. This stratum contained a greater frequency per cubic meter of all mammal and bird bone than any other strata at the site. It may represent a period of extraordinarily rich marine productivity, intensified exploitation of the island resources, an increase in the size of the human population utilizing the site, an increase in the rate of matrix accumulation, change of site function or duration of occupation, and/or disposal patterns. The stratum appears as a "Mid-Holocene Peak" of bone deposition begun about 4,547 B.P., reaching its climax ca. 3,700 B.P., and then abruptly "crashing."

Figure 5 illustrates the increase in bird bone across time relative to the marine mammals recovered at the site. While the Mid-Holocene Peak involved increases in all these food resources, no other animal experienced an escalation in relative abundance equivalent to the birds, the majority of which was albatross (Table 3). No more than three albatross bones were recovered from any other dated stratum during the 9,000-year occupation of the site. The strata immediately preceding and following this peak produced only one or two albatross bones (Porcasi 1995), yet the single peak stratum produced 187 albatross bones from only 0.4 m.³ of excavated matrix. Half of this concentration of albatross bone was contained in a small pit-like feature within the stratum, clearly a single deposition of tightly intermingled bones.

The predominance of albatross in the bird bone concentration is illustrated in Figure 6. One-third

Table 2
NISP AND MNI OF ALBATROSS AT
EEL POINT (CA-SCLI-43)

Unit	Stratum	Radiocarbon Date ^a	NISP ^b	MNI ^c
24.5S/77E	3	544	2	1
24.5S/77E	6	544-1,709	1	1
2N/35E	3	undated	1	1
2N/35E	4	undated	1	1
2N/35E	7	2,566	3	1
2N/35E	10	3,504	2	1
A	4B	undated	1	1
B	3	undated	1	1
B	4	undated	2	1
B	5A	undated	1	1
B	6/Feature	3,693	187	8
B	6A	4,202	2	1
B	6B	4,421	1	1
Totals			205	20

^a Dates shown are the mean intercept of the one-sigma range of dendrocalibrated age in years B.P. (present = A.D. 1950), calculated by Calib rev. 3.0.3 (Stuiver and Reimer 1993).

^b NISP = number of identified specimens.

^c MNI = minimum number of individuals.

(32.6%) of the bird bone in this stratum was identified as albatross. It is likely that most of the unidentified bird bones in this stratum are also albatross because of their large size and direct association with the identified albatross bone. Without diagnostic features, however, these bones could not be unequivocally identified as albatross, as they could represent another large species, such as eagle. While most of the strata at Eel Point produced albatross NISPs of one or two and MNIs of one, the unique concentration in Stratum 6 of Unit B yielded a conservatively derived NISP of 187 and an MNI of eight individuals, all deposited at one time within a small area and volume.

Table 4 presents the content of the albatross concentration by anatomical portion and element. While all portions of the skeleton are represented,

the frequencies of the various elements suggest how these birds might have been used by the island people. The axial skeleton is well represented, but there are few fragments of the relatively fragile ribs. Despite the fact that the forelimb is well represented by humeri, there are few ulnae. There are few femur fragments, while the nearly fleshless distal leg elements (tarsometatarsi and phalanges) are numerous. The meager presence of the robust femur and ulna relative to other elements in this concentration is unexplained in terms of natural taphonomic processes (see Guthrie 1993a:155; also see Table 1).

This brief anatomical analysis suggests that certain parts of the body of an albatross may have been put to special use. The fleshiest portions of the bird (e.g., torso and legs) may have

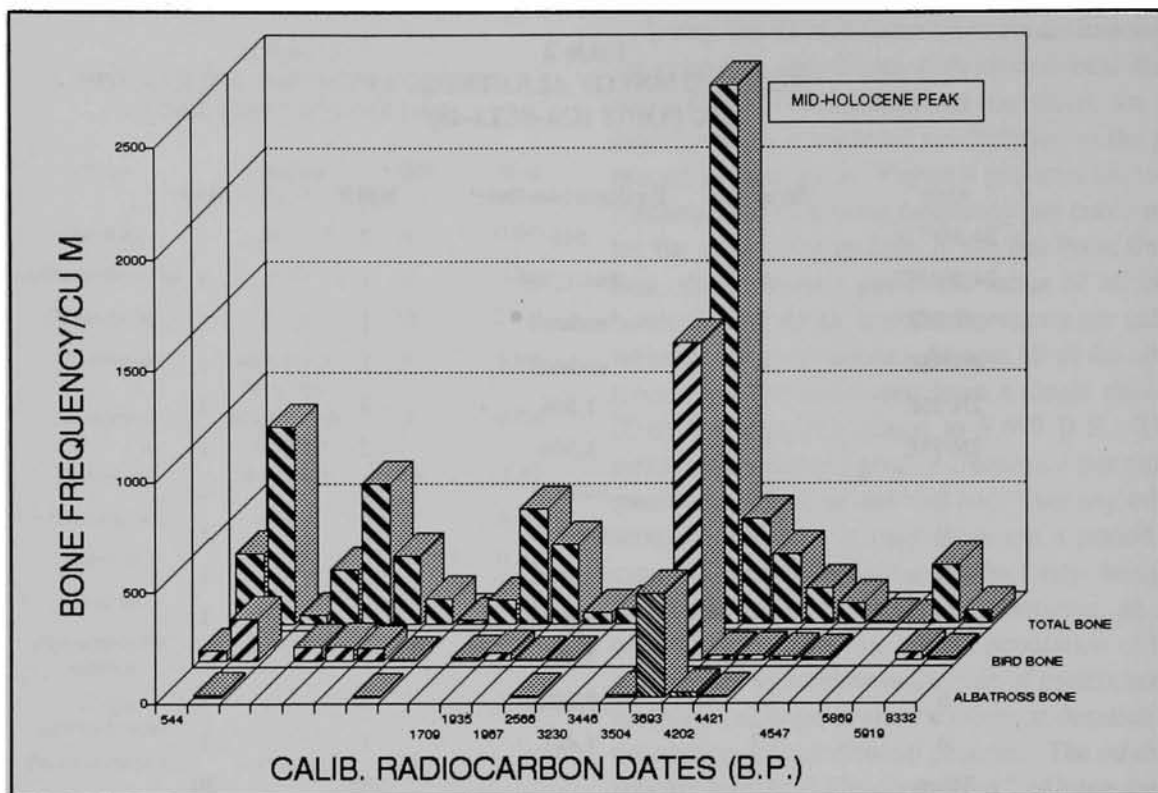


Fig. 4. Frequency per cubic meter of bone recovered in the 1994 Eel Point (CA-SCLI-43) excavations shown over the site timeline. The frequency per cubic meter of the entire osteological assemblage is shown along with total avian bone and albatross bone. The graph reveals a cyclic pattern of bone deposition over time with a notable "Mid-Holocene Peak" at 3,693 B.P. The timeline was constructed on the basis of radiocarbon dated strata from the five excavated units, which provided a continuous chronology of the site.

been selectively separated for food. Whistles and beads, which are common California artifacts (Gifford 1940:180, 182), could have been fashioned from the ulnae, and the large feathers (primaries) found along the length of this bone could have been removed for decorative uses.

None of the albatross bone found in the concentration was burned, nor was there any evidence of butchering. However, birds can be cooked without direct exposure to fire (boiled or steamed), and cooked bird carcasses are easily pulled apart rather than cut (Brown 1989:15-16). Few bones recovered from Eel Point have demonstrated direct evidence of butchering, including large marine mammal bones, which

would have required extensive butchering for consumption.

During a second season of excavation at Eel Point in 1996, eight new units (total volume 14.04 m.³), produced an additional 7,562 mammal and bird bones, but only 17 albatross elements. This second collection represents the more typical deposition of a few scattered albatross remains usually found on these islands.

THE SAN NICOLAS ISLAND ALBATROSS CONCENTRATION

San Nicolas Island lies northwest of San Clemente Island and is the outermost island of the

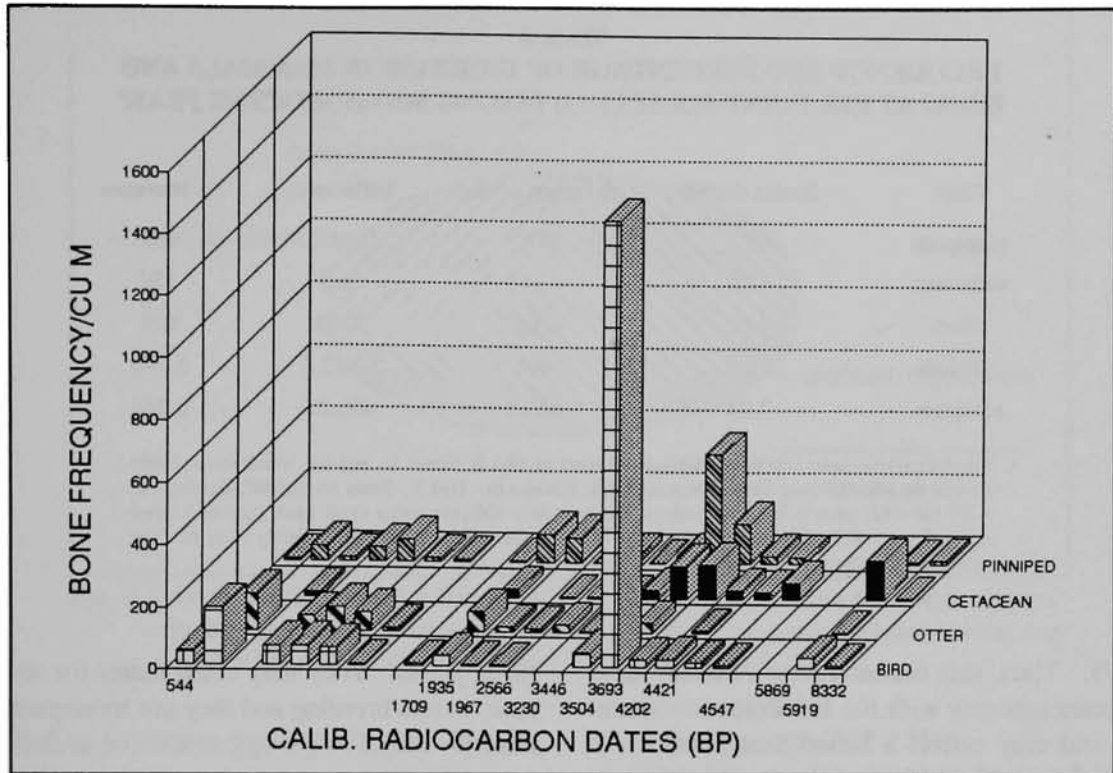


Fig. 5. Relative frequency per cubic meter of marine mammals and birds over time at Eel Point (CA-SCLI-43). The Mid-Holocene Peak shown at 3,693 B.P. contains large increases in deposition of all these resources. However, the increase in bird bones is most dramatic, especially since this increase is primarily albatross bone (Fig. 6). No bone is indicated between 4,547 and 5,869 years B.P. and just after 1,709 B.P. because the small quantities of bone recovered from these levels was unidentified.

southern archipelago. It is much smaller and lower in elevation than San Clemente Island, and strong northwesterly winds continually buffet the island, deflating sites and redepositing archaeological materials (Salls 1988:423-424). As a result, the stratigraphy of many San Nicolas Island sites is disturbed, so the chronology is enigmatic.

Bleitz-Sanburg (1987) described mammalian and avian remains recovered from 1977-1979 excavations at the Thousand Springs Site on the northwestern coastal terrace of the island. This is a widespread dune site with an extensive shell midden in which three cultural levels were defined on the basis of artifact typology and radiocarbon dates (Reinman and Lauter 1981; Reinman 1982; Bleitz-Sanburg 1987:62).

Bleitz-Sanburg identified both short-tailed and black-footed albatross bone from each of the excavated mounds and tabulated them within the three cultural strata (Table 5). A majority of the albatross bone is from Stratum I, originally dated between 270 B.C. and A.D. 1377 (Bleitz-Sanburg 1987), or about 2,220 to 573 B.P. (dendrocalibrated). This places the majority of the San Nicolas Island albatross bone later in the Holocene than the Eel Point bone. Because of the disturbed stratigraphy at the site and possible contamination of the original radiocarbon samples, a new suite of radiocarbon dates was derived in 1997, bracketing Stratum I even later in the Holocene, between about 1,600 and 600 B.P. (dendrocalibrated) (P. Martz, personal communication

Table 3
FREQUENCY AND PERCENTAGE OF INCREASE IN MAMMALS AND BIRDS AT EEL POINT (CA-SCLI-43) DURING MID-HOLOCENE PEAK^a

Taxa	Strata 6A/6B	Stratum 6 (m. ³)	Difference	% Increase
pinnipeds	48.2	377.5	329.3	683
cetaceans	41.0	102.5	61.5	150
otters	4.82	35.0	30.18	626
all birds	24.1	1,407.5	1,383.4	5,740
albatross	7.23	467.5	460.27	6,366

^a The comparison shown is between combined content of Unit B, Strata 6A and 6B, which immediately precede the Mid-Holocene Peak stratum (Unit B, Stratum 6). Unit B, Strata 6A and 6B, are dated to 4,202 and 4,421 years B.P., respectively (or approximately 600 years prior to the peak Stratum 6 dated to 3,693 years B.P. The combined volume of Strata 6A and 6B is .415 m.³, slightly more than the volume of Stratum 6 (.4 m.³).

1997). Thus, this concentration of albatross is not contemporary with the Eel Point concentration and may reflect a subsequent presence of these birds in the California islands, although this Late Holocene presence has not been found on San Clemente Island. At both island sites, the strata yielding the albatross concentrations were exceptional and unlike other strata dated before or after.

THE ALBATROSS AS A "SITTING DUCK"

Maritime people commonly harvest sizable seabirds, particularly when they can be taken in large numbers while congregated on or near land to breed (Brothwell et al. 1981; Serjeantson 1988:211-214). The life history and breeding practices of albatross make them especially vulnerable to such predation, as evidenced by the historic near-extirpation of the short-tailed albatross by Asian feather collectors (Hasegawa and DeGange 1982).

Among birds, albatross are classic K-strategists (Pianka 1970; Stearns 1976; Estes 1979). They are large (up to 10 kg.), long-lived, and slow to attain reproductive maturity (about six or

seven years). They may court mates for several years before breeding and they are monogamous. They lay only a single egg a year (or in alternate years); if an egg is lost, it is rarely replaced during the same breeding cycle (Palmer 1962:119). If one of the mated pair is lost during the incubation period, the egg probably will not survive. Similarly, both parents are needed to feed the nestling.

It is pivotal to the hypothesis herein that albatross do not normally congregate in substantial numbers on or near land. As Guthrie (1980:159) noted, these birds are seldom seen—at least in a healthy condition—within a mile of shore, except during the breeding season. Albatross spend most of their lives riding air currents over the open ocean, skimming food from the surface. They can soar for weeks, crossing thousands of miles of ocean without a landfall; however, they must land to breed. When breeding, incubating an egg, or tending a chick, adult birds will not flee and can be easily captured. Several researchers have directly approached, touched, and tagged breeding albatrosses (e.g., Dunlap 1988; Jouventin et al. 1989). Thus, even though this bird is a pelagic aerialist, it can only be de-

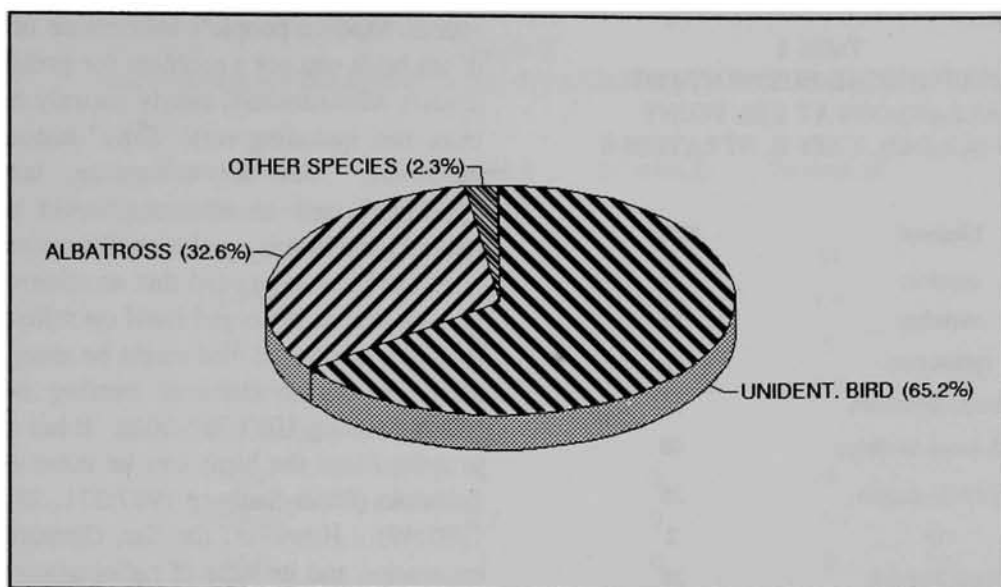


Fig. 6. Avian constituents at Eel Point (CA-SCLI-43), Unit B, Stratum 6. "Other Species" include cormorants, shearwaters, gulls, and crows. It is estimated that at least one-third of the unidentified bird bone is probably albatross.

scribed as a "sitting duck" during the breeding season.

There are two other conditions under which albatross sometimes congregate. They will cluster over upwellings of cold water to partake of an enriched marine ecosystem (Palmer 1962:117, 127). At such times, they could fall prey to nearshore maritime fisher/hunters, especially if they were rafting on the ocean surface. Latest findings on sea surface temperature (SST) from the Santa Barbara channel region (Kennett 1998) indicate extremely cool waters beginning about 3,700 B.P., immediately following a precipitous decline from a period of extremely high SSTs that began about 4,250 B.P. Cool water temperatures would prompt the kelp forests off the shore of Eel Point to flourish, and kelp forests are among the world's most highly productive ecosystems (Strahler and Strahler 1997:526). Such an enriched ecosystem would support increases in all marine taxa, including large marine birds. The later Holocene period during which the San Nicolas Island albatross bones were deposited is characterized by the coolest SST phase

recorded (Kennett 1998:123).

While it is possible that the albatross found at Eel Point and Thousand Springs congregated near these islands to feed from an enriched marine ecosystem, the cool water scenario does not adequately explain the increased presence of the birds. For example, evidence from the west coast of British Columbia suggests that albatross may gather over areas with higher-than-normal ocean temperatures and that these gatherings sometimes occur during months when the bird is not expected to be present (see Gaston 1994: 373).

Another condition in which albatrosses may collect on or near land is to scavenge human refuse (Palmer 1962:126). They will sometimes gorge themselves to the point where they are slow to take flight from land or the sea surface. Palmer (1962:129) reported that it takes nearly 100 yards of "runway" for an albatross to get off the ground. While this scavenging is most common in the wake of watercraft, it might also occur at sites where blubbery marine mammals are butchered and consumed. However, many sites

Table 4
ANATOMICAL ELEMENTS OF
ALBATROSS AT EEL POINT
(CA-SCLI-43), UNIT B, STRATUM 6

Element	NISP ^a
cranium	21
vertebra	33
synsacrum	3
sternum/furculum	11
Total Axial Skeleton	68
coracoid/scapula	26
rib	2
Total Thorax	28
humerus	14
ulna	4
radius	1
carpometacarpus	8
phalanx	8
Total Forelimb	35
femur	2
fibula	1
tibiotarsus	9
tarsometatarsus	13
phalanx	44
Total Hindlimb	74

^a NISP = number of identified specimens.

have been found in the islands where marine mammals had been butchered for hundreds (if not thousands) of years, yet few albatross bones have been found there.

ALBATROSS CAPTURE

If a substantial number of albatrosses had visited the inhabited islands of southern California for even a brief time in prehistory, it is certain that they would have been a prized food re-

source. Modern people's abhorrence of the taste of sea birds was not a problem for prehistoric islanders who subsisted nearly entirely on marine resources, including very "fishy" tasting marine mammals. An easy-to-capture, large meat "package" such as albatross would be highly ranked prey in this insular environment.

It has been suggested that an albatross could be captured as it gorged itself on refuse on land or at sea, or that the bird might be snared in nets used for marine mammal hunting or fishing (Bleitz-Sanburg 1987:298-301). It has also been proposed that the birds can be taken on baited fishhooks (Bleitz-Sanburg 1987:271, 299; Safina 1995:49). However, the San Clemente Island excavation and its suite of radiocarbon dates reveal that fishhooks were not utilized at this site until about 3,300 B.P., some 400 years after the albatross concentration was deposited. This date is consistent with the appearance of circular fishhooks at other coastal and island sites (Koerper et al. 1988, 1995; Raab et al. 1995).

If the use of hooks enhanced exploitation of albatross, there should be an increased quantity of albatross bones in Eel Point strata dated after the Mid-Holocene Peak. Yesner (1976:275) also stated that hooks might have been used to capture albatrosses, but no hooks were recovered at the Aleutian sites he reported. It is possible that the same hypothetical capture scenario could be applied to the bi-pointed fish gorge used extensively prior to development of the circular fishhook (Salls 1989:194). On San Nicolas Island, the albatross concentration was found in association with both fishhooks and fish gorges. But as noted above, the cultural materials at that site have been mixed chronologically and stratigraphically. The question remains open as to whether the use of gorges could account for the concentrations of albatross bone. Furthermore, if albatrosses had been captured opportunistically during fishing, we would expect to find more evenly distributed evidence of these birds over time, with most in the later years when fishing

Table 5
SAN NICOLAS ISLAND (CA-SNI-11) ALBATROSS NISP and MNI^a

Taxon/Measure	Stratum I	Stratum II	Stratum III
Short-tailed albatross			
NISP	119	17	14
NISP/m. ³	7.6	2.7	1.6
MNI	24	9	6
MNI/m. ³	1.5	1.4	0.7
Black-footed albatross			
NISP	3	0	0
NISP/m. ³	0.2	0	0
MNI	2	0	0
MNI/m. ³	0.1	0	0

^a NISP = number of identified specimens; MNI = minimum number of individuals (from Bleitz-Sanburg 1987:224).

intensified. This is not what was found at Eel Point.

Yesner (1976:274, 277) felt that the albatross found in the Aleutian Islands were captured during interisland flights, presupposing some form of pelagic fishing/hunting technology. Neither of the California island sites discussed here has produced evidence of open-ocean hunting or fishing technology during the Middle Holocene. While some form of watercraft was certainly used for travel to and from the mainland and between the islands (probably tule [*Scirpus* sp.] reed canoes or dugouts), the archaeofaunal and artifact collections from both Eel Point and Thousand Springs reflect a heavy reliance on nearshore waters and onshore marine mammal (pinniped) rookeries (Bleitz-Sanburg 1987:289-290; Porcasi 1995).⁵ It is most likely that during the Middle Holocene and into the Late Holocene, albatross were captured by the simplest and most expedient method; i.e., grabbing them while they were on the ground or possibly stoning or netting them as they tried to take flight. This capture would be

especially easy if the birds had congregated to breed and nest.

WHAT CONSTITUTES A PREHISTORIC NESTING SITE?

The generally accepted biological criteria for identification of a nesting site, other than direct or historical observation of breeding activity, include the presence of nests, eggs/eggshell, or juvenile birds. While these criteria may be appropriate biologically or historically speaking, in an archaeological context they may not apply. For example, dozens of avian species are year-round residents or breeders on the California coast and its islands (Peterson 1990; Lehman 1994), yet nestling birds, culturally deposited eggshell, or nest remains are unreported in the archaeological literature, with rare exceptions (e.g., Howard 1929:379-380).

The nest of an albatross is a shallow basin scooped into the surface of a relatively flat, usually windswept and barren landscape (Palmer 1962). Such a structure would be extremely dif-

difficult to identify in archaeological deposits that are thousands of years old. Most eggshell is highly perishable, easily displaced, and virtually invisible in a dense shell midden (Sidell 1993:5). Exceptions to this are known, such as those involving the extremely thick shell of giant, flightless birds (Higham 1994), undisturbed, naturally deposited Pleistocene fossil eggshell (Guthrie 1993b:408), or relatively recent (historical) depositions (Brothwell et al. 1981; Keepax 1981; Serjeantson 1988; Sidell 1993). Since only certain shells were collected for study at Eel Point, any eggshell that might have been in the midden was discarded, along with hundreds of kilograms of shell fragments.

No young (hatchling) albatross was identified, as juvenile bones lack the osteological details that permit unequivocal identification (Guthrie 1993a:157). While older juvenile birds (e.g., fledglings) attain near-adult size before they can fly, their bones are not fully ossified and fragment easily into unidentifiable pieces. This is especially true of the epiphyses of limb bones, which are primary diagnostic elements. Therefore, only adults with fully formed bones were identified. As mentioned above, while the albatross concentrations from both islands contain large quantities of fragmented large bird bones that are probably albatross, many were not identified as albatross bone. Furthermore, if breeding adults and nests were being raided before juveniles hatched, no nestling bones would have been present.

In these archaeological sites, it is the concentrated presence of numerous adult albatross in an area where they are rarely found that may be the best criterion for recognizing attempted colonization. At both the San Clemente and San Nicolas island sites, the narrowly time-bracketed presence and remarkable frequencies of albatross bone suggest that this bird was present in numbers far in excess of solitary migratory individuals or small groups of seasonal visitors, and that they were intensively harvested by humans.

WHY A CALIFORNIA NESTING SITE?

All albatrosses breed on oceanic islands. The albatrosses that visit California are historically known to breed on islands no further east than Hawaii (Palmer 1962:117-130; Yesner 1976:266; Hunt et al. 1980; Hasegawa and DeGange 1982:807). After fledging, the birds are solitary fliers, usually congregating only to breed. So why would large numbers of these birds be present in California island middens for brief periods in an area where they are rarely found?

One possible answer may be that they were forced to abandon their ancestral nesting locations, attempting to colonize a new area. Until recently, there had been no direct evidence of breeding populations anywhere near the North American mainland. However, in recent years a colony of Laysan albatross has established itself on Guadalupe Island offshore of western Baja California (Dunlap 1988). This illustrates the apparent ability of albatrosses to extend or modify their breeding range when conditions prompt such action.

The primary prehistoric nesting area of the short-tailed albatross in the far western Pacific was the Japanese Izu archipelago. These islands are part of an extremely active volcanic cluster with a geological pattern of frequent and violent eruptions. Eruptions occur at approximate 100-year intervals and often last for months at a time (Oki et al. 1978). The Izu Islands are situated directly on what is identified as the "Volcanic Front of the East Japan Volcanic Zone" (for quaternary volcanoes) (Soda 1996:38). For example, numerous eruptions on Torishima Island have completely buried albatross nesting grounds. During historically recorded eruptions (e.g., in 1939 and 1941), the entire short-tailed albatross population of Torishima was forced to flee, and any breeding that was possible during those years occurred elsewhere (Hasegawa 1979:24; Hasegawa and DeGange 1982:807-808). If similar and prolonged disturbances occurred during the

Middle and Late Holocene, as indicated by Oki et al. (1978), short-tailed albatross breeding populations might have been forced to migrate eastward on more than one occasion to search for other suitable nesting grounds.

The black-footed albatross breeds in both the western and the central Pacific (Peterson 1990:74), so volcanic activity in the western Pacific may not have affected their central Pacific breeding islands. This could explain the minor presence of this species on San Clemente and San Nicolas islands. On the other hand, the Laysan albatross breeds as far east as Hawaii and may not have been disturbed by volcanic activity in the western Pacific, thus explaining its absence on the California islands. A number of nineteenth century naturalists claimed to have observed albatross nesting in the Aleutian Islands, where both adults and eggs were exploited (see Yesner 1976:266; Hasegawa and DeGange 1982:807). Yesner (1976:266) dismissed these accounts as misidentification of the species, especially since the breeding behavior was reportedly at the wrong time of year. Strangely, though, Aleut folktales also tell of albatross nesting (Murie 1959:35). These native tales may be a record of a similar atypical migration by a displaced albatross population attempting to establish a new breeding range.

Although there is no direct evidence, this report has hypothesized the existence of a prehistoric California nesting site for albatross. There are other possible causes for sudden, anomalous aggregations of dead or dying birds that might be deposited in a cultural midden. Large quantities of marine birds can be wiped out by exposure to natural toxins developed in the marine organisms upon which they feed. For example, tens of thousands of crazed shearwaters crashed to the shores of Monterey Bay in August 1961 after eating anchovies that had fed on a local algae that produced a poisonous toxin (McClatchy News Service 1995). But if this were true for the Eel Point albatross, one would expect to find abnormally

large quantities of other marine bird species in the midden, such as shearwaters. This was not the case at Eel Point.

Severe climatic events (e.g., El Niños) may have affected the marine ecosystem to such an extent that the birds were driven off their normal migration path. Certainly, sea birds are affected by such conditions. For example, Gantenbein (1998:16) reported that during the 1998 El Niño, "rafts of dead seabird chicks" washed ashore. On the other hand, he reported that several species of marine birds modified their ranges and appeared far north of their normal habitats (Gantenbein 1998:16). Since El Niños occur relatively frequently, separated by decades rather than centuries or millenia, it does not follow that a single event at about 3,700 years B.P. would result in a unique albatross concentration while other El Niños produced no similar evidence.

SUMMARY AND CONCLUSIONS

These alternative hypotheses for explaining the albatross concentrations should be studied further, especially in the light of newly emergent paleoclimatic data. For the time being, the following conclusions are made based on the existing archaeological record.

First, while the prehistoric presence of albatross in the Channel Islands is known, the sites discussed in this report produced concentrations of albatross bones unique in California, indeed unique in all of coastal North America. Second, both the Eel Point and Thousand Springs concentrations occurred during discrete, although different, time periods. Thus, it is hypothesized that two cycles of albatross immigration may have occurred. Third, since albatross occasionally colonize new areas when their normal breeding grounds are disturbed, these birds may have attempted to breed on the west coast of North America because their northwestern Pacific island breeding grounds had been severely disturbed by prolonged volcanic activity. Finally, the bone concentrations in these rich cultural

middens provide evidence of intensive and immediate exploitation of albatross during an atypically large visitation of these birds to the Channel Islands.

NOTES

1. The genus of these species has recently been changed to *Phoebastria*; only the wandering albatross (*Diomedea exulans*) retains the genus *Diomedea* (American Ornithologists' Union 1998:xvii).

2. For example, Brown (1989:23) reported two albatross elements from three sites in Marina Del Rey, Los Angeles County, and Colten (1995:106) recovered three albatross bones from four sites on Santa Cruz Island. Guthrie (1980) listed six albatross elements from nine sites on San Miguel Island and a few from Vandenberg Air Force Base (Guthrie 1990), and stated that albatross are seldom seen in a healthy condition within a mile of shore (Guthrie 1993a:159). Howard (1949:23) reported only seven albatross bones from seven southern California sites, while Meighan (1959:400) found "relatively limited evidence of bird utilization" at Little Harbor on Santa Catalina Island. Schwaderer (1992: 66) listed three albatross elements from a coastal cave in Sonoma County, and Simons (1986, 1990) reported small numbers of albatross bones from 27 coastal sites. Guthrie (in Walker et al. 1987) reported a large number of albatross bones representing some 22 individuals from one San Miguel Island site, but these were scattered throughout the site, as well as various stratigraphic levels, and do not constitute a single deposition.

3. Fish bone has not yet been quantified or analyzed except for overall weight, which totals about 10.6 kg.

4. An occupational hiatus is found between 8,332 and 5,919 B.P., but this may be the result of small sample bias.

5. Preliminary analysis of new data from both San Clemente and Santa Catalina islands (Porcasi 1999; Porcasi et al. n.d.) now indicates that large quantities of dolphins were being taken there throughout the Middle Holocene. Although the technology for pelagic hunting and fishing is open to question, the presence of the dolphin bone argues that the early islanders had attained a certain level of pelagic hunting skill or specialized methods for capturing dolphin.

ACKNOWLEDGEMENTS

My thanks to Kimball Garrett of the Natural History Museum of Los Angeles County, Paul Collins of the Santa Barbara Museum of Natural History, Tom

Wake of the University of California, Los Angeles (UCLA), Institute of Archaeology Zooarchaeology Laboratory, and Fritz Hertel of the UCLA Dickey Biological Collection. These scientists gave me unlimited access to the comparative collections under their care. Daniel Guthrie of the Claremont Colleges and Dwight Simons provided essential research guidance. Special gratitude is due to Mark Raab of California State University, Northridge, and Andrew Yatsko of the Naval Air Station Natural Resources Office, for permitting me to participate in the 1994 and 1996 Eel Point excavations and for guiding my research derived from that project. The revised radiocarbon dates for San Nicolas Island were furnished by Steven Schwartz of the Point Mugu Naval Air Weapons Station and Patricia Martz of California State University, Los Angeles. Christine Fiore prepared the Eel Point site map, and Figure 2 is based on work by Rusty Van Rossman. Dennis Gallegos of Gallegos & Associates provided data and dates from CA-SCLI-152. Dana Bleitz's thesis provided the San Nicolas Island faunal data. I also thank the reviewers of this manuscript, especially R. Lee Lyman, who helped bring it to publication quality.

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Archaeological Investigations at Tucker Hill, Lake County, Oregon

JAMES HUTCHINS and DWIGHT D. SIMONS

Kautz Environmental Consultants, Inc., 5200 Neil Rd., Ste. 200, Reno, NV 89502.

Tucker Hill is located in the Lake Abert-Chewaucan Marsh Basin in Lake County, Oregon. In 1995, as part of the requirements associated with the permitting process for a mining company to conduct a perlite quarrying operation, the authors conducted a cultural resources inventory of the upper slopes and top of Tucker Hill (Hutchins 1995), as well as a program of archaeological testing for 13 sites located on and around Tucker Hill (Hutchins et al. 1996). Evidence derived from archaeological survey and site testing provided what the authors believe to be a representative view of the types of sites occurring on the Tucker Hill landform. Studies of lowland sites in the Lake Abert-Chewaucan Marsh Basin have been conducted by Oetting and Pettigrew (1985, 1987), Pettigrew (1985), and Oetting (1988, 1989,

1990a, 1990b), but this investigation of Tucker Hill is one of very few archaeological studies of upland sites in this vicinity.

TUCKER HILL is a peninsula extending into the wetlands formed by the upper Chewaucan Marsh (now drained) and the lower Chewaucan Marsh (Fig. 1). Both of these shallow basins are remnants of pluvial Lake Chewaucan, a Pleistocene lake which left wave-cut terraces on the Tucker Hill landform at elevation levels of 4,370 ft., 4,460 ft., and 4,520 ft., the high water stand for Lake Chewaucan (Allison 1982). The summit of Tucker Hill is 4,984 ft. above mean sea level, well above the high water stand. Studies of paleomagnetic variation in fine-grained lake sediments have shown that the most recent high water stand (i.e., 4,520 ft.) of Lake Chewaucan occurred no earlier than 16,800 years ago (Grayson 1993:100). Since then, the oscillating lake levels have trended steadily downward, isolating smaller bodies of water, and leaving Summer Lake, Lake Abert, and the Chewaucan marshes as remnants which have persisted—perhaps with occasional periods of complete desiccation—from the Early Holocene (ca. 11,000 to 6,900 years B.P.) to the present (Allison 1982). Wetland environments can be especially productive in terms of food resources (plants, waterfowl, etc.), so the Tucker Hill landform is well situated to have accumulated cultural deposits associated with aboriginal settlement and subsistence activities from the Early Holocene until recent reclamation and agricultural activities disrupted these patterns.

ARCHAEOLOGICAL INVESTIGATIONS AT TUCKER HILL

The cultural resources inventory conducted in 1995 covered 570 acres on the upper slopes and top of Tucker Hill, as well as a corridor 18 feet wide for a haul road that connects Tucker Hill to State Route 31 (Hutchins 1995). A total of 30 archaeological sites and five isolated finds was re-