Journal of California and Great Basin Anthropology
Vol. 22, No. 2, pp. 295-320 (2000).

Trans-Holocene Subsistence Strategies and Topographic Change on the Northern California Coast: The Fauna from Duncans Point Cave

THOMAS A. WAKE, Zooarchaeology Laboratory, Cotsen Institute of Archaeology, Univ. of California, Los Angeles, CA 90095-1510.
DWIGHT D. SIMONS, Archaeological Research Center, California State Univ., Sacramento, CA 95819.

There has been considerable debate in recent years concerning the nature and consequences of prehistoric marine mammal exploitation along the Pacific coast of North America. Preliminary data from the vertebrate faunal assemblage from the northern California coastal site of Duncans Point Cave (CA-SON-348/H) has been included in this debate. Detailed analysis of the mammal remains from Duncans Point Cave indicates a high frequency of juvenile seals and sea lions, suggesting that rookeries were accessible to the prehistoric inhabitants of the site. Changes in the shellfish assemblage suggest that profound environmental and topographic changes have occurred there. With little evidence supporting intensification or diet breadth expansion, an understanding of topographic changes, such as coastal erosion, is necessary to explain the patterns seen in this faunal assemblage.

RECENTLY, there has been considerable debate regarding the evolution of marine mammal hunting and general subsistence along the northern California and Oregon coasts. Much of this debate concerns the effects humans have had on marine mammals along the Pacific coast, and how changing distributions and abundances of these important resources influenced cultural development in this region. Some have suggested that overexploitation and local extirpation of mainland marine mammal rookeries and haulouts resulted in the development of more refined hunting technologies, including far-reaching innovations such as watercraft (Jobson and Hildebrandt 1980; Hildebrandt 1981, 1984; Hudson 1981; Hildebrandt and Jones 1992; Arnold 1995; Jones and Hildebrandt 1995; Hildebrandt and Levulett 1997). In contrast, Lyman (1988, 1989, 1995) pointed to an apparent lack of specific evidence for rookery overexploitation or utilization at all, but did not doubt the important effects human exploitation had on marine mammal distributions.

Marine mammal remains recovered from Duncans Point Cave (CA-SON-348/H) on the south-central Sonoma County coast (Fig. 1) have been included in this debate (e.g., Hildebrandt and Jones 1992:381; Jones and Hildebrandt 1995:85-86). However, researchers who have referred to the Duncans Point Cave fauna have not included discussions of age class representation, since such data were unavailable until now. Presentation of the age class data for Duncans Point allows for a more accurate interpretation of marine mammal exploitation, provides more fine-grained information useful for paleoenvironmental reconstruction, and raises additional questions regarding the roles of topographic and other environmental changes.

In this article, a detailed analysis of the entire mammal assemblage from Duncans Point Cave is presented. Included is new information on age class representation of marine mammals in this assemblage, showing that a significant number of juveniles were brought to the cave. The shell-

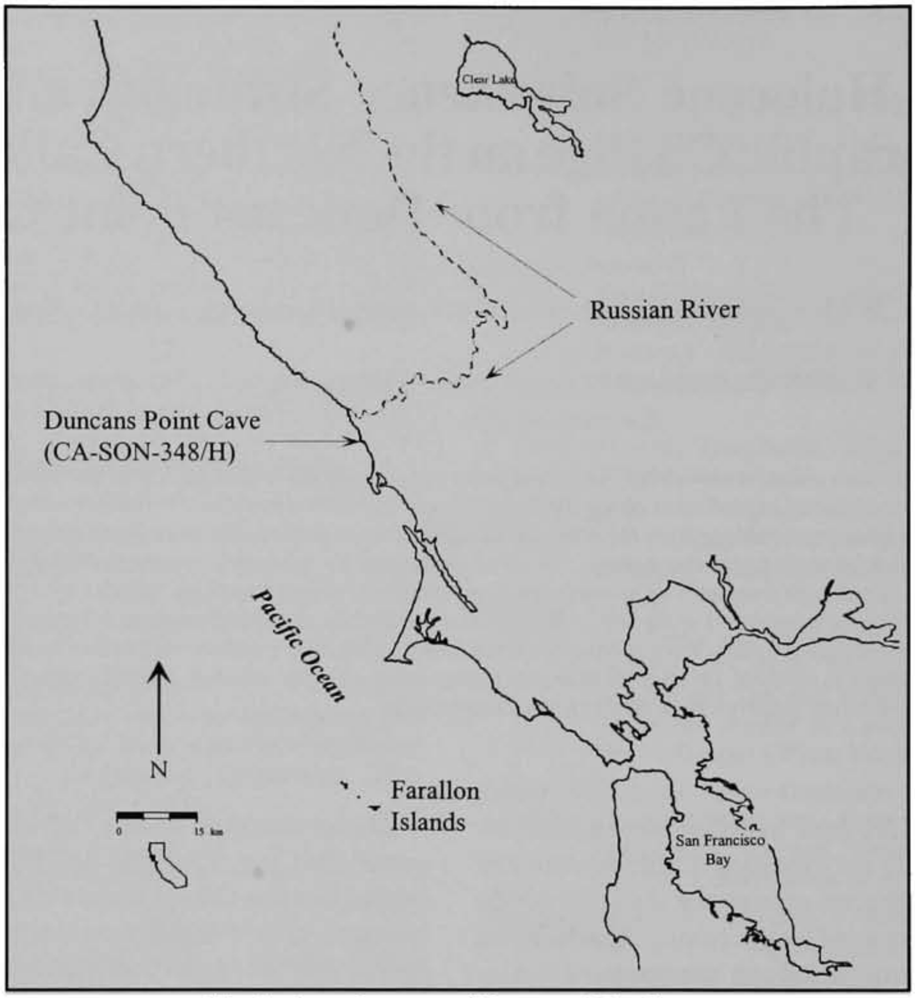

Fig. 1. Location map of Duncans Point Cave.

fish, fish, and bird remains from Duncans Point Cave are then reviewed to provide a more complete perspective on subsistence and environment.

DUNCANS POINT CAVE

Duncans Point (Duncans Landing) Cave (CA-SON-348/H) is located on a promontory along the south-central Sonoma County coast, approximately eight km. south of the mouth of the Russian River. On this promontory is a large outcrop of sandstone bedrock containing several small overhangs and an ancient sea-arch cave known as Duncans Point Cave. This 12-m.-deep natural cavern was formed during the mid-Pleistocene, ca. 500,000 years ago, when a marine terrace roughly 25 m. above the current shoreline was cut, and wave action completely eroded through the exposed bedrock. Currently, the interior of the cave is almost completely filled with debris, and has a midden deposit nearly three m. deep. The midden is found both within and outside the cave, and covers almost all of Duncans Point. The site is quite large, and has not been fully mapped. During August 1989, a 1.5-m.^{2} test unit was excavated to a depth of 280 cm. by California Department of Parks and Recreation personnel and volunteers, directed by Rae Schwaderer (1992).

In 1907, Duncans Point was first surveyed archaeologically by Nels Nelson (Nelson 1909), followed shortly thereafter by Peter (1923) between 1911 and 1913 (also see Fredrickson 1984). The site was formally recorded in 1949 by Arnold Pilling and Franklin Fenenga and given the permanent trinomial 4-Son-348/H, subsequently changed to CA-SON-348/H. In 1971, Duncans Point was listed on the National Register of Historic Places (Schwaderer 1992:56).

Duncans Point Cave is anthropologically important for several reasons. In Coast Miwok mythology, the cave is known as *lupu-lama* (Rock Hole), the place Coyote made and lived at after being spurned by Crab Woman (Kelly 1978a:24). The cave is called *kabe'mali* (Rock Place) by the Kashaya Pomo (Barrett 1908:232-233). The outcrop was a historic boundary marker between the Kashaya Pomo and Coast Miwok (Merriam 1907; Barrett 1908:Map 1, 1952; Kroeber 1925: 274, 356; Loeb 1926:Plate 1; Stewart 1943:49; Kelly 1978b:415; McLendon and Oswalt 1978: 278). In addition to Barrett (1908:232-233), Kniffen (1939:382, Map 3) and Gifford (1967: 10) also listed Duncans Point as an old Pomo village site.

The Duncans Point archaeological site is one of the largest prehistoric coastal sites located between the mouth of the Russian River and Bodega Head. Currently, it is the only known large cave site on the northern California coast between San Francisco and Cape Mendocino. The antiquity of human occupation at Duncans Point Cave is attested to by a suite of seven uncorrected radiocarbon dates (Schwaderer 1992:57). These range sequentially from 8,210 $\pm$ 110 to 3,210 $\pm$ 100 RCYBP. A possible Lake Mojave style Annadel obsidian projectile point was recovered from the 240 to 250 cm. level, dated at 8,210 $\pm$ 110 RCYBP (Beta-34844). This point has a relatively thin hydration band (3.5 microns), which suggests a more recent attribution (Schwaderer 1992:61). Another important aspect of Duncans Point Cave is the presence of abundant, well-preserved vertebrate faunal remains, which represent the local biota over the last 8,000 years.

MAMMAL REMAINS FROM DUNCANS POINT CAVE

In the following discussion of subsistence and topographic change, the focus is on the mammal remains from Duncans Point Cave. With respect to sample size, these remains form the largest component of vertebrate skeletal elements recovered from the site. When analyzed from a temporal perspective, the mammal bones display more obvious, coherent patterns of change through time than do either the fish or bird remains. Shellfish, another important animal resource exploited at Duncans Point Cave, also exhibit changes apparently related to subsistence and topographic change (discussed below; also see Schwaderer 1992:65; Erlandson 1994:247-248; Erlandson and Moss 1996:294).

Materials and Methods

Summarizing Schwaderer (1992:57), a single 1.5-m.^{2} excavation unit was placed in the cave, roughly five m. from the southwest opening. The unit was excavated in arbitrary 10-cm. levels. Sediment from the northeast quadrant of each level was passed through three-mm. (1/8-in.) mesh. The remainder was passed through six-mm. (1/4-in.) mesh. A 10% volumetric sample from each screen size fraction from each level was taken to the laboratory for wet screening. The entire unit was excavated to a depth of 280 cm. Excavation in the north quadrant continued to a depth of 310 cm. Processing methods below the 270-cm. level were altered due to a decrease in shell and an increase in clay, so all excavated material below that level was wet screened. The volume of material from these lowest levels is not comparable to that from overlying levels. However, specimens identified from these levels are included in the tables below to provide as complete a record of the archaeofauna as possible.

Vertebrate faunal remains from Duncans Point Cave were first sorted and separated by class (Pisces, Amphibia, Reptilia, Aves, Mammalia). Elements assigned to these classes were then identified. Mammal remains were further sorted into identifiable and unidentifiable components for each excavation level. Identified bones were assigned to the most specific taxonomic level possible. Primary determination of taxonomic affiliation was facilitated by use of comparative osteological collections maintained by the Museum of Vertebrate Zoology, University of California, Berkeley, the California Academy of Sciences, San Francisco, and the Zooarchaeology Laboratory, University of California, Los Angeles.

Concurrent with identification, a variety of other data was recorded for each skeletal element. These included taxonomic category, skeletal element, body side, element configuration (complete, proximal, distal, medial, or fragment thereof), estimated age, and modifications (burning, gnawing, fragmentation, butchering marks, purposeful modification). Number of identified specimens (NISP) was determined for each vertebrate taxon on the basis of the number of separately identified specimens assignable to that taxonomic category. Minimum numbers of individuals (MNI) were computed by counting the most abundant paired or unique skeletal element for each taxonomic category present within a given cultural component. The age of individual specimens was taken into account in determining MNIs. Analytical groupings followed Schwaderer's (1992:57-59) postulation of six distinct stratigraphic and cultural components (see Table 1).

Results

A total of 1,415 identified mammal bones (73.4% of all identified vertebrate remains) was recovered from Duncans Point Cave, along with 203 fish (10.4%), five amphibian (0.3%), one reptile (0.1%), and 309 bird (15.8%) elements. These were arrayed by cultural component in Schwaderer (1992:66-67, Table 3.4). Table 2 presents numbers of identified specimens of the mammal taxa for the site as a whole, and for each cultural component. Minimum numbers of individuals for the mammal taxa are also provided for the entire site and its cultural components (see Table 3).

A total of 35 mammal taxa was recovered from Duncans Point Cave. These include size-classed remains, as well as those of insectivores (shrew [*Sorex vagrans*]; mole [*Scapanus latimanus*]), lagomorphs (jackrabbit [*Lepus californicus*]; cottontail [*Sylvilagus* cf. *bachmani*]), rodents (mountain beaver [*Aplodontia rufa*]; ground squirrel [*Spermophilus beecheyi*], western gray squirrel [*Sciurus griseus*], gopher [*Thomomys bottae*], woodrat [*Neotoma fuscipes*], deer mouse [*Peromyscus maniculatus*], harvest mouse [*Reithrodontomys megalotis*], meadow vole [*Microtus californicus*], porcupine [*Erethizon dorsatum*]), whale (Balaenopteridae), carnivores (dog/coyote [*Canis* sp.], raccoon [*Procyon lotor*], weasel [*Mustela frenata*], badger [*Taxidea taxus*], skunk [*Mephitis mephitis*], sea otter [*Enhydra lutris*], bobcat [*Lynx rufus*], fur seal [*Callorhinus ursinus*], sea lion [*Zalophus californianus*], harbor seal [*Phoca vitulina*]), and artiodactyls (deer [*Odocoileus hemionus*]). Rodents (n = 1,078; 75.1%) were by far the most abundant order of mammals. Dominant rodent species included pocket gophers (*Thomomys bottae* [n = 672; 46.8%]), and California voles (*Microtus californicus* [n = 281; 19.6%]). They were followed at some distance by carnivores (n = 165; 11.5%), lagomorphs (n = 107; 7.5%), and size-classed bones (n = 61; 4.3%). Small numbers of artiodactyls (n = 16; 1.1%), insectivores (n = 7; 0.5%), and cetaceans (n = 1; 0.1%) completed the mammal assemblage.

Economically insignificant mammals (insectivores, weasels, and most of the rodent taxa [n = 1,026; 77.8%]) far outnumbered economically significant taxa (rabbits, most of the carnivores, mountain beaver, gray squirrel, porcupine, deer

Table 1
CULTURAL COMPONENTS AT DUNCANS POINT CAVE[a]

Cultural Component	Associated Strata	Approximate Depths (in cm.)	Radiocarbon Age B.P.	Calibrated Dates[b] (2 Sigma, > 0.99 Prob.)
1 (noncultural)	IX	260-280	None	None
2	VII and VIII	210/220-260	8,620 ± 420 8,210 ± 110	10,740-8,635 B.P. 8,975-8,491 B.P.
3	VI	160-210/220	7,850 ± 110 6,260 ± 120	8,585-8,141 B.P. 7,474-6,934 B.P.
4	IV	85/95-140/160	4,640 ± 90	5,182-4,635 B.P.
5	III	60-85/95	3,400 ± 120	3,975-3,432 B.P.
6 (mixed)	I and II	0-60	3,210 ± 100	3,309-2,825 B.P.

[a] From Schwaderer (1992).
[b] Stuiver and Reimer (1993) and Stuiver et al. (1998:CALIB 4.2).

[n = 293; 22.2%]), and may represent intrusive individuals or possible intermittent use of the cave by predators, such as owls or coyotes. Mammals from Duncans Point Cave that are considered economically significant include taxa exploited for food and/or other raw materials (skin, bone, sinew), for which a relatively high rate of return measured against hunting costs is generated (cf. Hildebrandt 1981, 1984; Winterhalder and Smith 1981; Stephens and Krebs 1986; Simons 1992; Broughton 1994a, 1994b; Janetski 1997) and if they are noted as important in applicable ethnographic reports (Barrett 1952; Gifford 1967). No historic period domestic, commensal, or introduced wild taxa occur. All of the mammal taxa are currently found within the immediate vicinity of Duncans Point, or were present during the historic past, with the possible exception of the mountain beaver (Ingles 1965; Hall 1981).

The overall sample size from Duncans Point Cave was relatively small, and the focus on the economically significant mammals further reduced the size of the sample. A larger sample might provide a wider array of identified species and perhaps more robust numbers of individual species from each respective cultural component (Grayson 1984). However, the importance of the time depth represented by this sample and the information it can provide about coastal occupation along the Sonoma County coast during much of the Holocene merits analysis of a relatively small sample.

DISCUSSION

Faunalturbation

The remains of burrowing insectivores and rodents (mole, ground squirrel, gopher, and vole) comprised a significant portion of the mammalian assemblage from Duncans Point Cave (n = 682; 47.5%), and occurred throughout the deposits. The abundance of these species most likely is a consequence of the location of the site within a grassland/coastal scrub mosaic, prime habitat for these animals, a situation also observed along the central Mendocino County coast (Simons 1990). Various researchers have commented on mammalian faunalturbation in archaeological and natural contexts in California (Erlandson 1984; Bocek 1986, 1992; Erlandson and Rockwell 1987; Johnson 1989). These studies have shown that gopher burrowing apparently produces stratigraphic distribution of materials within archaeo-

Table 2
NUMBER OF IDENTIFIED SPECIMENS (NISP) FOR MAMMALS BY CULTURAL COMPONENT AT DUNCANS POINT CAVE

		Cultural Component						
Common Name	**Scientific Name**	**1**	**2**	**3**	**4**	**5**	**6**	**Total**
vagrant shrew	*Sorex vagrans*	--	--	--	1	--	--	1
broad-footed mole	*Scapanus latimanus*	1	--	1	1	--	2	5
dog	*Canis* sp.	--	--	1	1	--	1	3
coyote	*Canis latrans*	--	--	--	5	--	1	6
sea otter	*Enhydra lutris*	--	3	8	4	4	14	33
striped skunk	*Mephitis mephitis*	--	--	1	--	--	4	5
long-tailed weasel	*Mustela frenata*	--	--	2	--	1	1	4
badger	*Taxidea taxus*	--	4	1	--	--	--	5
raccoon	*Procyon lotor*	--	--	--	--	--	1	1
bobcat	*Lynx rufus*	--	--	2	--	--	--	2
carnivore	--	--	--	--	--	--	3	3
small carnivore	--	--	1	2	2	--	--	5
northern fur seal	*Callorhinus ursinus*	--	--	6	17	3	19	45
California sea lion	*Zalophus californicus*	--	1	1	2	5	2	11
harbor seal	*Phoca vitulina*	--	--	--	18	2	2	22
seals	Pinnipedia	--	--	2	4	--	2	8
eared seals	Otariidae	--	1	2	2	2	6	13
baleen whale	Balaenopteridae	--	--	--	--	--	1	1
black-tailed deer	*Odocoileus hemionus*	--	--	2	5	7	2	16
mountain beaver	*Aplodontia rufa*	--	--	--	2	3	3	8
Beechey's ground squirrel	*Spermophilus beecheyi*	--	--	--	--	--	4	4
gray squirrel	*Sciurus griseus*	--	--	--	2	--	1	3
pocket gopher	*Thomomys bottae*	40	52	205	136	74	164	671
dusky-footed woodrat	*Neotoma fuscipes*	--	--	--	2	4	3	9
white-footed mice	*Peromyscus* sp.	--	3	--	15	9	13	40
deer mouse	*Peromyscus maniculatus*	1	--	--	--	--	--	1
harvest mouse	*Reithrodontomys megalotis*	--	--	--	1	3	3	7
vole	*Microtus californicus*	26	13	16	87	44	95	281
porcupine	*Erethizon dorsatum*	--	--	1	4	--	--	5
rodent	--	--	3	1	3	--	11	18
small rodent	--	--	7	--	2	1	1	11
jackrabbit	*Lepus californicus*	--	--	--	--	--	4	4
cottontail rabbit	*Sylvilagus bachmani*	1	15	40	21	5	21	103
large mammal	--	--	1	9	6	2	6	24
medium mammal	--	--	--	8	1	3	--	12
small mammal	--	--	4	8	13	--	--	25
Totals		69	108	319	357	172	390	1,415

logical sites entirely unrelated either to prehistoric human behavior, or to natural alluvial, colluvial, or aeolian processes. The frequency of burrowing mammal remains at Duncans Point Cave suggests that mammalian faunalturbation may have affected site structure, as is probably the case at other sites along the northern California coast (see Simons 1990:38-39). This is supported by independent obsidian hydration data (Schwaderer 1992:60), which suggest that mixing of cultural materials has occurred within the deposits.

The upper levels of the site (Component 6) have been churned due primarily to looters and

Table 3
MINIMUM NUMBER OF INDIVIDUALS (MNI) FOR MAMMALS BY CULTURAL COMPONENT AT DUNCANS POINT CAVE

		Cultural Component						
Common Name	**Scientific Name**	**1**	**2**	**3**	**4**	**5**	**6**	**Total**
vagrant shrew	*Sorex vagrans*	--	--	--	1	--	--	1
broad-footed mole	*Scapanus latimanus*	1	--	1	1	--	1	3
dog	*Canis* sp.	--	--	1	1	--	1	1
coyote	*Canis latrans*	--	--	--	1	--	1	1
sea otter	*Enhydra lutris*	--	2	2	1	1	2	2
striped skunk	*Mephitis mephitis*	--	--	1	--	--	2	3
long-tailed weasel	*Mustela frenata*	--	--	1	--	1	1	2
badger	*Taxidea taxus*	--	1	1	--	--	--	1
raccoon	*Procyon lotor*	--	--	--	--	--	1	1
bobcat	*Lynx rufus*	--	--	1	--	--	--	1
northern fur seal	*Callorhinus ursinus*	--	--	2	4	2	3	4
California sea lion	*Zalophus californianus*	--	1	1	1	1	1	1
harbor seal	*Phoca vitulina*	--	--	--	2	2	1	2
black-tailed deer	*Odocoileus hemionus*	--	--	1	2	2	1	2
mountain beaver	*Aplodontia rufa*	--	--	--	1	2	1	3
Beechey's ground squirrel	*Spermophilus beecheyi*	--	--	--	--	--	1	1
gray squirrel	*Sciurus griseus*	--	--	--	1	--	1	2
pocket gopher	*Thomomys bottae*	4	12	33	18	16	17	95
dusky-footed woodrat	*Neotoma fuscipes*	--	--	--	1	2	1	3
white-footed mouse	*Peromyscus sp.*	--	1	--	4	3	5	11
deer mouse	*Peromyscus maniculatus*	1	--	--	--	--	--	1
harvest mouse	*Reithrodontomys megalotis*	--	--	--	1	2	1	4
vole	*Microtus californicus*	4	2	4	11	8	13	33
porcupine	*Erethizon dorsatum*	--	--	1	2	--	--	2
jackrabbit	*Lepus californicus*	--	--	--	--	--	1	1
cottontail rabbit	*Sylvilagus bachmani*	1	2	8	3	1	3	8

others disturbing the site. In fact, ongoing looting and ultimate protection of the site were the prime motivating factors that resulted in excavation of the cave. Keeping in mind the possibility of pre-excavation stratigraphic mixing by people and possibly rodents, the stratigraphic integrity of the site is quite good. Well-defined stratigraphic breaks were recorded in the profile drawing of the excavation unit (Schwaderer 1992:58). Photographs of the profile (in possession of the authors) include close-up shots of finely laminated shellfish remains lying together in the same horizontal plane and a hearth with a series of well-defined ash layers within it. Neither of these situations would occur in a site that had been seriously disturbed by rodents.

Two important observations suggest secondary introduction of many of the small mammal remains into the cave. The first is the fact that finely stratified, undisturbed features such as hearths were observed in cross section in the walls of the single excavation unit. Such features do not preserve well in an environment subjected to extensive bioturbation. Secondly, there is little reason for small mammals to burrow into the cave sediments, especially in the area of the excavation unit, well behind the dripline in an area where no plants grow. Both pocket gophers and California voles eat plants, gophers preferring roots and tubers and voles preferring new shoots. There is no food or cover to attract these species into the cave, reducing the likelihood that they would enter the cave to forage or burrow. The cave does provide potential roosts and shelter for owls, coyotes, and other predators that could introduce rodent remains into the site. The possibility of the introduction of rodent remains into the cave sediments by predators, and not necessarily by the rodents themselves, makes it difficult to determine the exact postdepositional impact of faunalturbation on the site.

Past Environments

While pocket gophers were ubiquitous throughout the cave deposits, remains of California voles increased in the upper, more recent, levels and components. This trend indicates recent expansion of grassland habitats in the region after the Middle Holocene. Interestingly, California ground squirrels and black-tailed jackrabbits occurred only in the uppermost levels of Component 6, implying relatively recent expansion of more open, arid habitats in the area. Some might view the occurrence of these two species at Duncans Point Cave as indicative of diet breadth expansion. However, this does not appear to be the case, as they occurred in such low numbers (NISP of four each) and the specimens were not modified in any way, other than wear that could be construed as representing carnivore gnawing.

Pertinent palynological data from North Coast localities suggest that development of a more or less modern climatic regime occurred ca. 10,000 to 7,500 years B.P. on the Point Reyes Peninsula (Rypins et al. 1989). Drier summers led to the disruption and demise of closed-canopy, coniferous forests, which were replaced by a mosaic of grassland and coastal scrub vegetation. Russell (1983) noted that during the last millennium, major vegetation changes have taken place at Wildcat Lake on the Point Reyes Peninsula. Changes in the relative abundance of grass and shrub pollen indicate that proportions of such vegetation were not constant. Exact causes of these changes are unknown, but likely sources include localized factors, such as fire and topographic disturbances (landslides and slumps), as well as more general factors, such as climatic change (i.e., the Mediaeval Warm Epoch/Drought; see Graumlich 1993; Stine 1994).

Economically Significant Mammals

Economically significant mammals represented in the Duncans Point Cave archaeofauna include lagomorphs (jackrabbits, cottontails); rodents (mountain beaver, western gray squirrel, porcupine); terrestrial carnivores (dog/coyote, coyote, raccoon, badger, striped skunk, bobcat); marine mammals (sea otter, northern fur seal, California sea lion, harbor seal, whale); and artiodactyls (deer). Table 4 groups economically significant mammals from Duncans Point Cave by component, and for the site as a whole. Marine and terrestrial mammals first occur in numbers in Component 2, dated between 8,200 and 8,600 B.P. Similar antiquity for marine mammal hunting along the southern California coast is evidenced at the Eel Point site, on San Clemente Island (Erlandson 1994:214-216; Porcasi 1995), as well as at other Channel Island sites and coastal mainland sites from San Luis Obispo County south (Erlandson and Colton 1991; Hildebrandt and Jones 1992; Erlandson 1994; Jones and Hildebrandt 1995).

Lagomorphs. Lagomorphs, primarily cottontail rabbits, occurred throughout the deposits, but jackrabbits were present only in the uppermost levels (Component 6). The frequencies of the two lagomorph genera reflect their current abundance. Cottontails are common but jackrabbits are rarely seen on the coast. The relatively high abundance of lagomorph bones (n = 107; 7.5% of all mammal remains, 35.4% of economically significant mammals), and their presence in all cultural components, indicate that rabbits and hares were an important, perhaps "coharvested," terrestrial resource (Yesner 1981:162; Simons

Table 4
ECONOMICALLY SIGNIFICANT MAMMALS BY CULTURAL COMPONENT AT DUNCANS POINT CAVE (NISP/%NISP)

	Cultural Component						
Taxa	**1**	**2**	**3**	**4**	**5**	**6**	**Totals**
whale	0	0	0	0	0	1 (1%)	1 (0.3%)
sea otter	0	3 (12%)	8 (12%)	4 (4%)	4 (13%)	14 (16%)	33 (11%)
pinnipeds	0	2 (8%)	11 (16%)	43 (48%)	12 (39%)	31 (36%)	99 (33%)
rabbits	1 (100%)	15 (60%)	40 (58%)	21 (24%)	5 (16%)	25 (29%)	107 (35%)
rodents	0	0	1 (1%)	8 (9%)	3 (10%)	4 (5%)	16 (5.3%)
carnivores	0	5 (20%)	7 (10%)	8 (9%)	0	10 (11%)	30 (10%)
deer	0	0	2 (3%)	5 (6%)	7 (22%)	2 (2%)	16 (5.3%)
Totals	1	25	69	89	31	87	302
marine	0	5 (20%)	19 (28%)	47 (53%)	16 (52%)	46 (53%)	133 (44%)
terrestrial	1 (100%)	20 (80%)	50 (72%)	42 (47%)	15 (48%)	41 (47%)	169 (56%)
Totals	1	25	69	89	31	87	302

1992:87-88). As defined by Yesner (1981:162), coharvesting "is a type of optimal foraging when additional species are obtained as part of the same general hunting procedure." The point is that hunters, when presented with prey other than their intended quarry, will not pass it by for a variety of possible reasons, including easy opportunity and insurance against returning empty-handed. Lagomorphs in general could also be an important source of pelts for use in cloaks and other clothing (Barrett 1952; Gifford 1967). Compared to Duncans Point Cave, lagomorphs are not usually as well represented at other coastal sites from the San Francisco Bay area and farther north, and appear to have been relatively unimportant economically (Hildebrandt 1979, 1981; Levulett and Hildebrandt 1987; White 1989; Simons 1990, 1992; Broughton 1994a, 1999; Wake 1994, 1997a, 1997b).

Hildebrandt and Levulett (1997:147-148) noted that lagomorphs make up about 3% of remains comprising pooled faunal assemblages from important sites along California's north coast. This increases to 15% in the pooled sample from central California coastal sites (including Duncans Point Cave), reaching an overwhelming 95% at sites along the southern California coast. This north-south increase in lagomorph remains is seen as resulting directly from changing distributions and abundance of critical animal resources (salmonid fishes, large land mammals, small game) along the California coast as a consequence of latitudinal variation in habitat.

Rodents. Economically significant rodents (mountain beaver, gray squirrel, porcupine) were found in small numbers (n = 16; 5.3% of economically significant mammals) in Components 3 through 6. These small game mammals probably were sporadically taken for their meat and pelts (Gifford 1967).

Carnivores. Terrestrial carnivores include dog/coyote, raccoon, badger, striped skunk, and bobcat (N = 30; 9.9%of economically significant mammals). They occurred in all components, except Components 1 and 5. These animals typically are found in archaeofaunas from sites along California's north coast in relatively small numbers (Hildebrandt 1979, 1981; Levulett and Hildebrandt 1987; Simons 1990, 1992; Broughton 1994a; Wake 1997a, 1997b). Their frequency of occurrence at Duncans Point Cave suggests that sporadic hunting of terrestrial carnivores occurred at this site. Terrestrial carnivores would provide meat, pelts, and raw material for bone tools (see Schwaderer 1992: 64).

Cervids. Typically, deer and/or elk are the most common large terrestrial mammals found at northern California coastal sites (Hildebrandt 1979, 1981, 1984; Lyman 1988, 1989, 1995; White 1989; Simons 1990, 1992; Hildebrandt and Jones 1992; Jones and Hildebrandt 1992; Broughton 1994a; Wake 1997a, 1997b). Due to their size, amount of meat, and other products that they provide (hides, bones, sinew, bone grease), cervids generally are presumed to be the most economically important terrestrial mammals available during the Holocene in northern coastal California. This does not appear to be the case at Duncans Point Cave, however. Elk were absent, and deer remains occurred in relatively small numbers (n = 16; 5.3% of economically significant mammals) in Components 3 through 6.[1]

The apparent lack of elk at Duncans Point Cave is surprising. Elk remains are recovered, often in abundance, at many coastal archaeological sites in northern California (Hildebrandt 1979, 1981, 1984; Lyman 1989; Simons 1990, 1992; Hildebrandt and Jones 1992; Broughton 1994a; Jones and Hildebrandt 1995; Wake 1997a, 1997b). McCullough (1969:9-23) observed that elk were present along the Sonoma County coast and adjacent areas, and were relatively abundant. The absence of elk remains at Duncans Point Cave therefore seems most likely a product of the relatively small sample size.

Cetaceans. One whale bone was present in Component 6 (0.33% of economically significant mammals). The juvenile ulna fragment was assigned to the Family Balaenoptyeridae (rorqual whales), which includes fin, sei, Minke, blue, and humpback whales. Historically, members of this family have become stranded along the California coast (Norris and Prescott 1961; Roest 1970; Sullivan and Houck 1979). The specimen from Duncans Point Cave probably represents such an individual, butchered at the site of its grounding. While it is possible that the whale specimen may have been brought to the site as raw material for tools, its low relative density and small size limit its potential utility.

Sea Otters. Sea otter elements were present in all cultural components, except Component 1. Their remains are moderately abundant (n = 33; 10.9% of economically significant mammals). Sea otter bones are frequently found in some abundance at sites along the northern California coast (Hildebrandt 1979, 1981, 1984; Lyman 1988, 1989; White 1989; Simons 1990, 1992; Hildebrandt and Jones 1992; Jones and Hildebrandt 1992; Broughton 1994a; Lyman 1995; Wake 1997a, 1997b). These relatively large animals would have provided meat and luxurious pelts. Harvesting probably occurred year-round, availability permitting.

Pinnipeds. Pinniped remains present at Duncans Point Cave included those of northern fur seals, California sea lions, and harbor seals. They occurred in abundance (n = 99; 32.8% of economically significant mammals) in all components, except Component 1. Since harbor seals and fur seals were the most numerous pinnipeds, and as both had high frequencies of juvenile elements, this discussion focuses primarily on these species. Both taxa first appeared in Component 3, and both were found in all subsequent components (Figs. 2 and 3).

Harbor seal bones first appeared in Level 16, and peaked in Component 4 (Fig. 2). They were present, but much less common, in Components 5 and 6. Bones from juveniles constituted 68% (n = 15) of the harbor seal bone specimens. Four of the specimens had cut marks, and none was burned. When compared to Lyman et al.'s (1992) phocid seal meat utility index, the harbor seal remains were dominated by low utility elements (nine distal and three proximal limb bones; see Table 5). High utility elements (five rib cage bones and one pelvic bone) were present, and several medium utility elements (three vertebrae and one cranial bone) also occurred.

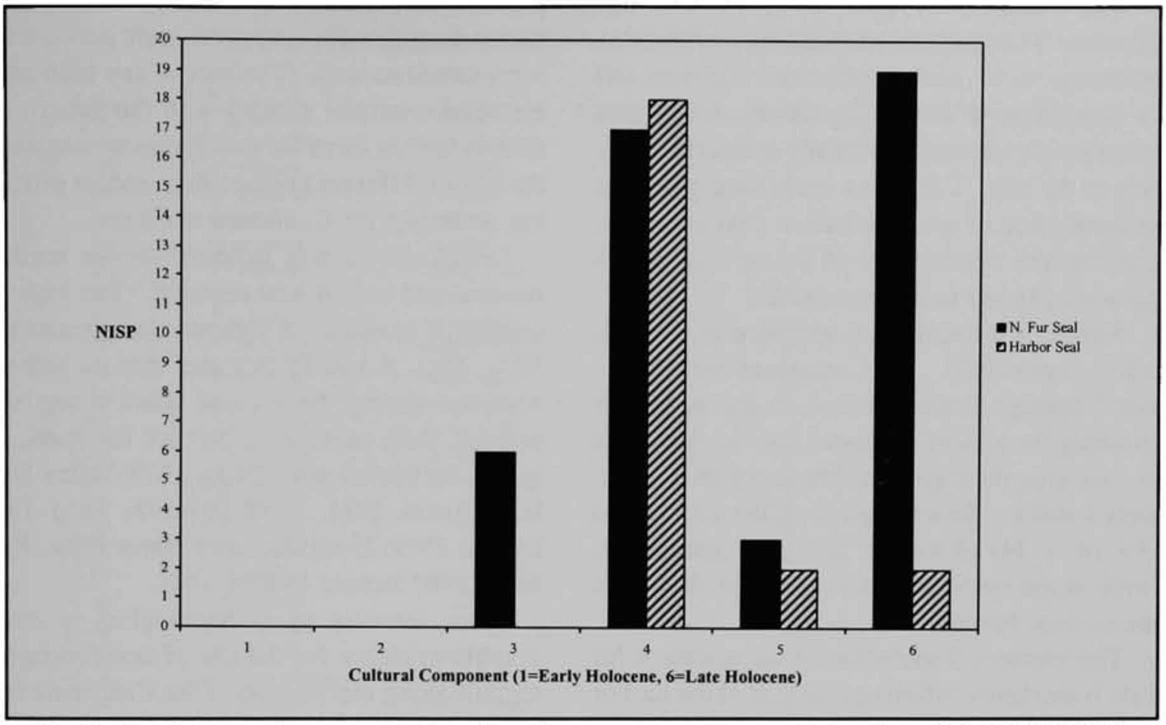

Fig. 2. Dominant marine mammals by cultural component at Duncans Point Cave (CA-SON-348/H).

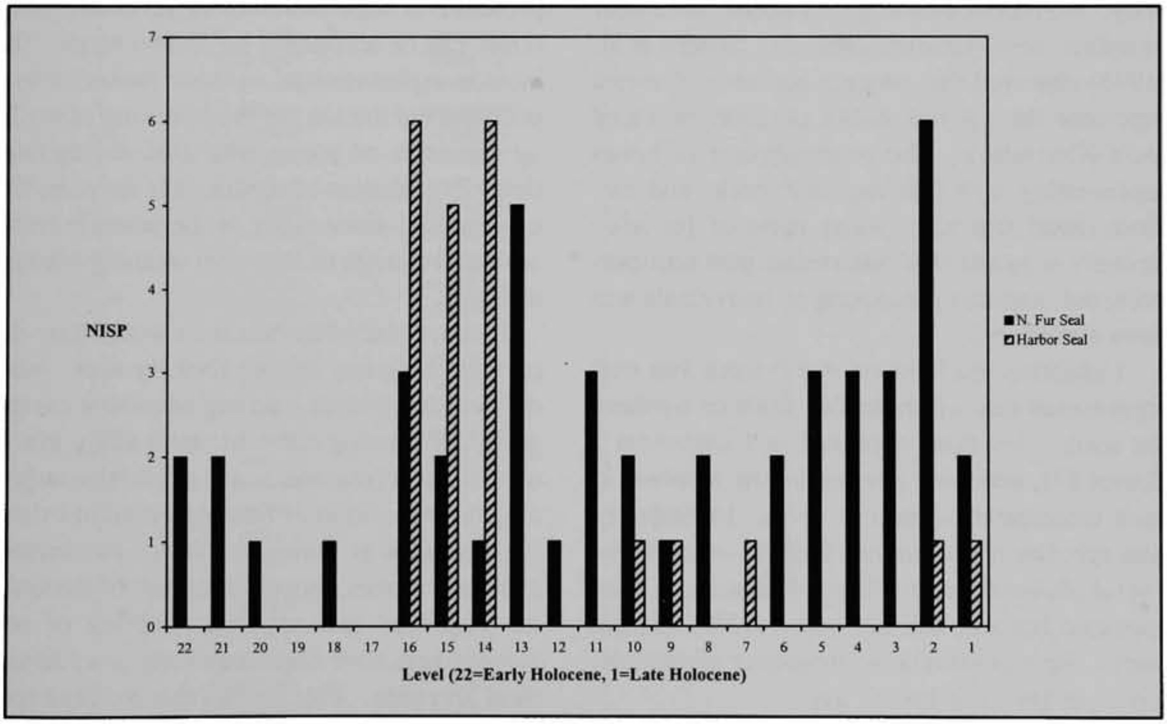

Fig. 3. Dominant marine mammals by level at Duncans Point Cave (CA-SON-348/H).

Differential body part distribution is not apparent. The presence of elements representing the cranial, axial, and appendicular skeleton, and the dominance of low utility elements, suggests transport of complete or partially eviscerated animals to the site. This is not surprising given the predominance of juvenile harbor seal elements, implying the exploitation of young individuals that are light and easily transported.

Northern fur seals first appeared in Component 3 (Level 22). They remained well represented through Components 4, 5, and 6, always occurring in greater numbers than harbor seals do, reaching their greatest frequency in Components 4 and 6. Bones from juveniles constituted 53% (n = 24) of the fur seal bone specimens. Three of the specimens had cut marks, and three others were burned.

The element distribution of the northern fur seals is markedly different than that of the harbor seals. The fur seal assemblage was dominated by skeletal elements representing the head and upper body. No flipper elements, leg bones, or lumbar vertebrae were present (Table 5). Savelle et al. (1996) observed that rib cage and neck elements represent the highest utility portions of eared seals (Otariidae). The predominance of bones representing high (rib cage and neck) and medium (head and arm) utility parts of fur seals strongly suggests that differential part transport occurred, and that processing of individuals was done elsewhere.

California sea lions (n = 11) were less well represented than either harbor seals or northern fur seals. Sea lions appeared in Component 2 (Level 25), and were present in low numbers in each subsequent cultural division. Juvenile sea lion specimens constituted 18% (n = 2) of the overall *Zalophus* assemblage. One sea lion bone appeared burned, and six bones (55%) had cut marks, the highest relative frequency among pinnipeds at Duncans Point Cave.

None of the 11 California sea lion bones represented high utility portions (e.g. Savelle et al. 1996). Rib cage (n = 4) and flipper (n = 5) elements were the most common, with pelvic bones represented as well. The lack of any high utility elements contrasts sharply with the pattern evident in the northern fur seal remains, suggesting the use of different procurement and/or processing strategies for California sea lions.

Seasonality is best indicated by the northern fur seal and harbor seal remains. The high frequency of juveniles of both species (greater than 60%; Figs. 4 and 5) indicates that the site was occupied during the seasons when young were present; early to midsummer for fur seals, and spring for harbor seals (Bigg 1969; Haley 1978; Hildebrandt 1981, 1984:191-193; King 1983; Lyman 1989:75-82; Orr and Helm 1989; Riedman 1990; Simons 1990:41-44).

Since there is no archaeological or ethnographic evidence for the use of oceangoing watercraft along this portion of the California coast (Heizer and Massey 1953; Jobson and Hildebrandt 1980; Hudson 1981; Arnold 1995), the presence of high numbers of juvenile pinniped bones can be accounted for in two ways. These include exploitation of onshore rookeries by the occupants of the site, or the gathering of washed-up carcasses of young who died during migration. Exploitation of rookeries is the most likely explanation, since many of the juvenile remains are small enough to represent weaning young-of-the-year.

It is not likely that carcasses would have drifted from currently known rookery sites, such as the Farallon Islands. Strong nearshore currents, generally running north to south along this part of the California coast, are especially unfavorable for deposition of floating Farallon-originating juveniles at Duncans Point. Furthermore, abundant sharks plying the waters of the Gulf of the Farallons and adjacent stretches of ocean would likely have disposed of any stray living or dead juveniles. This implies that readily exploitable fur seal and harbor seal rookeries were located in the vicinity of Duncans Point Cave.

Table 5
IDENTIFIED PINNIPED SPECIMENS FROM DUNCANS POINT CAVE

Level	Taxon	Element	Count	Side[a]	Portion[b]	Burned	Cut	Age[c]
16	*Phoca vitulina*	cervical vertebra	1	m	a	--	--	j
16	*P. vitulina*	cranium	1	r	f	--	--	j
10	*P. vitulina*	femur	1	l	c	--	--	j
14	*P. vitulina*	fibula	1	l	c	--	--	j
16	*P. vitulina*	ilium	1	r	c	--	--	j
16	*P. vitulina*	manubrium	1	m	c	--	1	--
2	*P. vitulina*	metacarpal	1	l	p	--	1	a
14	*P. vitulina*	metacarpal	1	r	c	--	--	j
1	*P. vitulina*	metacarpal	1	--	p	--	--	--
14	*P. vitulina*	metacarpal	1	--	c	--	--	j
15	*P. vitulina*	metacarpal	1	--	c	--	1	j
15	*P. vitulina*	metacarpal	1	--	c	--	--	j
14	*P. vitulina*	metatarsal	1	--	c	--	--	j
14	*P. vitulina*	phalanx 2	2	--	c	--	--	--
7	*P. vitulina*	rib	1	r	c	--	--	a
14	*P. vitulina*	rib	1	r	p	--	--	j
9	*P. vitulina*	sternum	1	m	c	--	--	j
16	*P. vitulina*	thoracic vertebra	1	m	a	--	--	j
16	*P. vitulina*	ulna	1	r	c	--	1	j
15	*P. vitulina*	centrum	1	m	c	--	--	j
15	*P. vitulina*	centrum	1	m	c	--	--	--
12	*Callorhinus ursinus*	atlas	1	r	f	--	--	j
22	*C. ursinus*	auditory bulla	1	r	f	--	--	--
3	*C. ursinus*	canine	1	l	c	--	--	j
15	*C. ursinus*	canine	1	l	c	--	--	--
3	*C. ursinus*	cervical vertebra	1	m	f	--	--	j
13	*C. ursinus*	humerus	1	l	m	--	--	j
3	*C. ursinus*	humerus	1	r	c	--	1	j
8	*C. ursinus*	humerus	1	r	c	--	--	j
13	*C. ursinus*	humerus	1	r	m	--	--	j
1	*C. ursinus*	innominate	1	r	d	--	--	--
22	*C. ursinus*	mandible	1	l	p	--	1	--
2	*C. ursinus*	maxilla	1	l	c	--	--	j
2	*C. ursinus*	maxilla	1	r	c	--	--	j
18	*C. ursinus*	maxilla art.	1	l	p	--	--	--
1	*C. ursinus*	maxilla art.	1	r	p	--	--	--
20	*C. ursinus*	maxilla art.	1	r	p	--	--	--
10	*C. ursinus*	occipital c.	1	l	c	--	--	--
11	*C. ursinus*	occipital c.	1	l	c	--	--	--
14	*C. ursinus*	occipital c.	1	l	f	--	--	--
3	*C. ursinus*	occipital c.	1	r	c	1	--	j
13	*C. ursinus*	parietal	1	l	p	--	--	--
13	*C. ursinus*	parietal	1	r	p	--	--	--
3	*C. ursinus*	premolar	2	l	c	--	--	j
11	*C. ursinus*	premolar	1	--	c	--	--	--
21	*C. ursinus*	premolar	1	--	c	--	--	j
21	*C. ursinus*	premaxilla	1	r	f	--	--	--
3	*C. ursinus*	premaxilla	1	l	c	--	--	j
3	*C. ursinus*	premaxilla	1	l	c	--	--	j
2	*C. ursinus*	premaxilla	1	r	c	--	--	j
2	*C. ursinus*	radius	1	l	c	1	--	j
2	*C. ursinus*	radius	1	r	c	1	--	a
3	*C. ursinus*	rib	1	l	c	--	--	a
16	*C. ursinus*	rib	1	l	c	--	--	j
16	*C. ursinus*	rib	1	r	c	--	--	j
16	*C. ursinus*	scapula	1	l	c	--	--	j
15	*C. ursinus*	scapula	1	r	p	--	--	a

Table 5 (continued)
IDENTIFIED PINNIPED SPECIMENS FROM DUNCANS POINT CAVE

Level	Taxon	Element	Count	Side[a]	Portion[b]	Burned	Cut	Age[c]
6	*C. ursinus*	sternum	1	m	m	--	--	j
8	*C. ursinus*	sternum	1	m	c	--	1	--
6	*C. ursinus*	thoracic vertebra	1	m	m	--	--	j
11	*C. ursinus*	thoracic vertebra	1	m	f	--	--	j
9	*C. ursinus*	upper canine	1	l	f	--	--	j
10	*C. ursinus*	upper incisor	1	l	f	--	--	--
2	*C. ursinus*	zygomatic arch	1	l	p	--	--	--
13	*C. ursinus*	zygomatic arch	1	l	c	--	--	j
8	*Zalophus californicus*	calcaneum	1	l	c	--	1	j
7	*Z. californicus*	ilium	1	r	c	--	--	a
11	*Z. californicus*	lumbar vertebra	1	m	c	--	1	j
6	*Z. californicus*	phalanx 2	1	l	c	--	--	--
18	*Z. californicus*	phalanx 2	1	--	c	--	--	--
3	*Z. californicus*	rib 1	1	r	c	1	1	a
2	*Z. californicus*	rib 2	1	r	m	1	1	--
12	*Z. californicus*	sternum 2	1	m	c	--	--	--
8	*Z. californicus*	tarsal	1	l	c	--	--	a
8	*Z. californicus*	tarsal	1	l	d	--	1	--
25	*Z. californicus*	thoracic vertebra 4	1	m	d	--	1	a

[a] l = left; r = right; m = medial.
[b] a = neural arch; f = fragment; c = complete; p = proximal; d = distal; m = midshaft.
[c] j = juvenile; a = adult.

Given the local shoreline topography between the Russian River and Bodega Head, which currently is characterized by the presence of many offshore rocks, islets, and a few isolated beaches, it seems highly likely that given proper conditions, fur seals and harbor seals could have established rookeries. Supporting this conclusion is a large, active harbor seal haulout and rookery currently located near Jenner, at the mouth of the Russian River (Blunt 1980). Small groups of harbor seals can also be seen hauled out and resting on rocks all along the Sonoma and Marin county coasts, especially in the vicinity of Point Reyes, the Gulf of the Farallons, and in San Francisco Bay (Blunt 1980; Allen et al. 1989).

In contrast, no local mainland fur seal rookeries are currently known, or mentioned historically (Starks 1922; Evermann 1923; Grinnell et al. 1937:626-628; Hall 1940; Kenyon and Wilke 1953; Orr and Helm 1989; Hanni et al. 1997). During historic times, the nearest fur seal rookery apparently was located on the Farallon Islands, approximately 80 km. southwest of Duncans Point Cave. It was heavily impacted first by American and then Russian-American Company seal hunters who, during the early nineteenth century, established an outpost on the islands and harvested over 200,000 fur seal skins (Scammon 1874; Ogden 1941; Riddell 1955; Khlebnikov 1976, 1990; Tikhmenev 1978; White 1995). The Farallon rookery was so heavily impacted by sealing that fur seals only began breeding there again in 1996 (Snyder 1996). Hall (1940) implied that fur seals probably hauled out along the mainland coast more often prior to their commercial exploitation during the 1700s and 1800s (see Lyman 1989:81-82). Hildebrandt and Jones (1992:361) and Jones and Hildebrandt (1995:94) argued that onshore migratory fur seal rookeries along the California coast were decimated by prehistoric hunters. Erlandson et al. (1998) suggested, however, that predation by

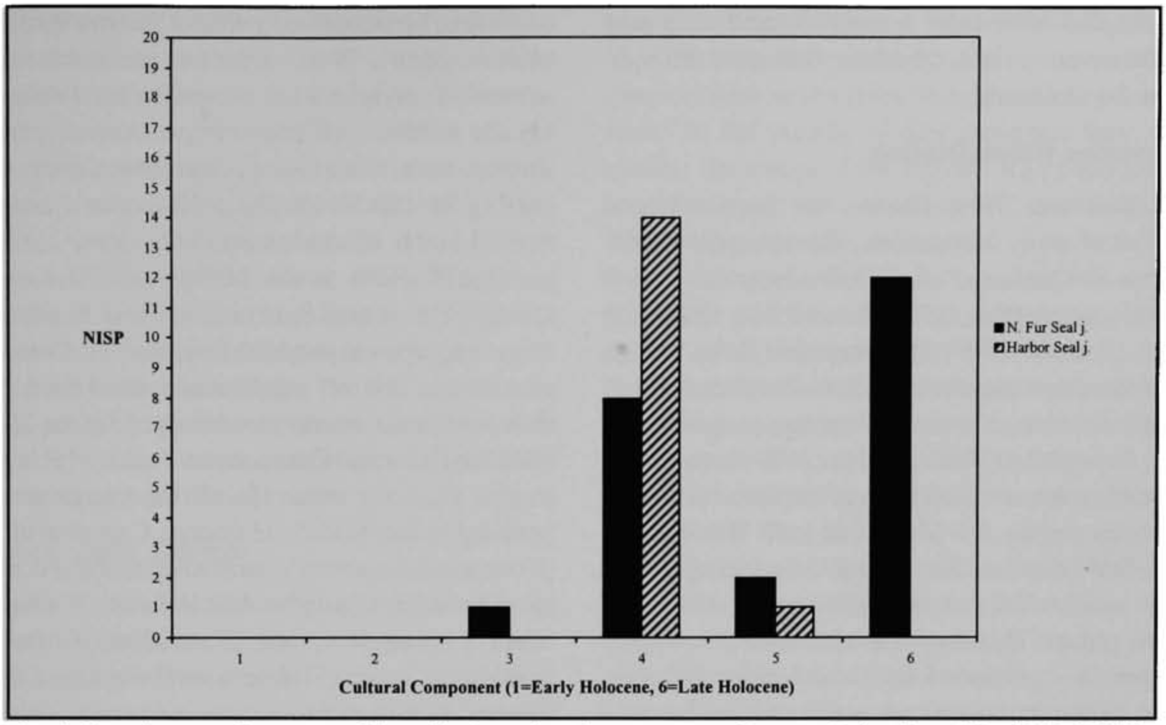

Fig. 4. Dominant marine mammal juveniles by cultural component at Duncans Point Cave (CA-SON-348/H).

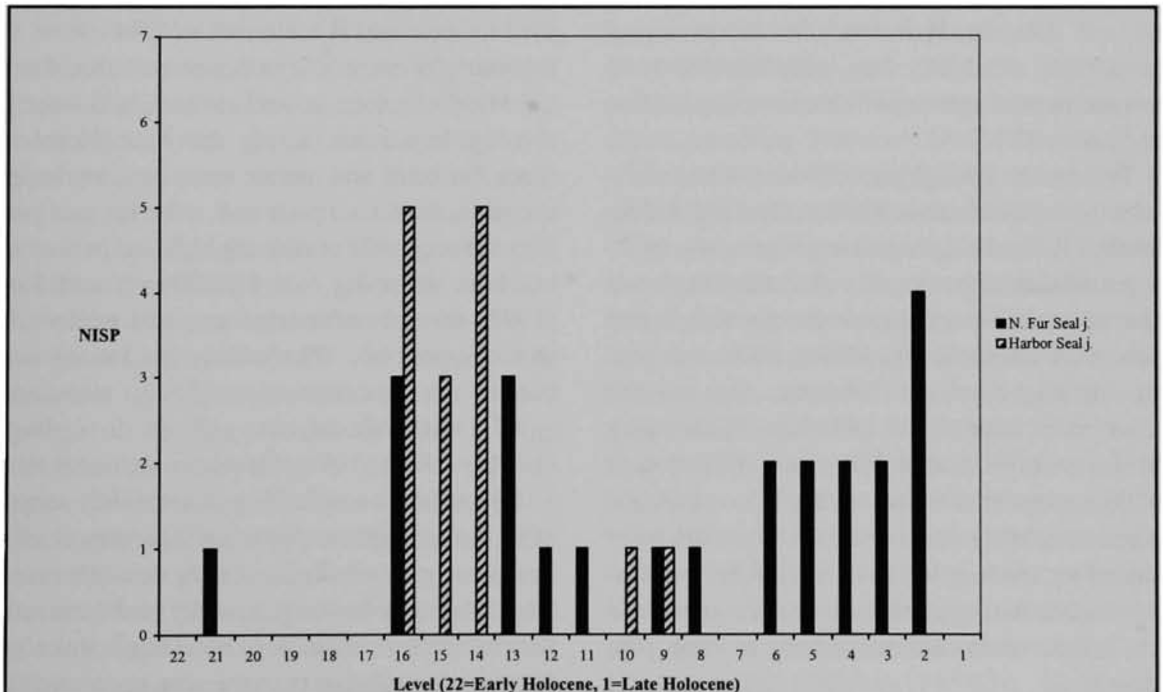

Fig. 5. Dominant marine mammal juveniles by level at Duncans Point Dave (CA-SON-348/H).

bears and other large terrestrial carnivores may have severely limited onshore rookeries throughout the Holocene.

Resource Intensification

Resource intensification has been a central focus of many discussions of prehistoric subsistence in California (e.g., Erlandson and Colten 1991; Jones 1992, 1996; Raab 1996; Erlandson and Glassow 1997; Hildebrandt 1997a). With respect to mammalian exploitation, several potentially testable scenarios have been proposed.

Broughton (1994a, 1994b, 1999) argued that consumption of increasingly smaller vertebrate species during the Middle to Late Holocene in the San Francisco Bay area and Sacramento Valley indicates that a loss of foraging efficiency took place. This drop was attributed to resource depression produced by central place foraging and human population growth (also see Janetski 1997:1075-1076). In the San Francisco Bay area, this most strikingly manifests itself as a dramatic decrease in the relative frequency of artiodactyls, especially deer, accompanied by an increase in the representation of sea otters (also see Simons 1992).

To counter Broughton (1994a, 1994b), McGuire and Hildebrandt (1994; also see Hildebrandt 1997a; Hildebrandt and Levulett 1997) suggested that in many parts of California, small game species, especially rabbits, provided most of the meat consumed by Middle Holocene peoples. During the Late Holocene, deer hunting increased in importance. Further, Hildebrandt and Jones (1992) and Jones and Hildebrandt (1995) contended that during the Holocene, high-ranked migratory sea lions and fur seals were reduced by overexploitation of rookery populations, necessitating pursuit of smaller, more elusive harbor seals and sea otters as time progressed.

Data on economically significant mammals from Duncans Point Cave come from cultural components spanning much of the Holocene, providing an opportunity to test the merit of the above models. With respect to particular taxa, several observations can be made (see Table 4): (1) the numbers of sea otter remains fluctuate through time, with their greatest abundances occurring in the Middle/Late Holocene Components 3 and 6; (2) fur seal remains occur in their greatest amounts in the Middle/Late Holocene Components 4 and 6; (3) harbor seal bones are most numerous in the Middle Holocene Component 4, and fall off significantly thereafter; (4) deer reach their maximum abundance in the Middle/Late Holocene Components 4 and 5; (5) lagomorph elements occur in all the components, peaking in the Middle Holocene Component 3; (6) terrestrial mammals (primarily rabbits) dominate the earlier (Early/Middle Holocene) Components 1 through 3; and (7) marine mammals dominate the later (Middle/Late Holocene) Components 4 through 6.

Temporal trends for mammals at Duncans Point Cave provide a limited degree of support for McGuire and Hildebrandt's (1994) thesis that lagomorphs were a significant resource during the Middle Holocene (and earlier), with deer becoming important during the Late Holocene. Since fur seals and harbor seals both attain peak abundances in Component 4, with fur seal numbers subsequently remaining high and harbor seal numbers dropping, the Hildebrandt and Jones (1992) scenario of marine mammal exploitation is not supported. The widely fluctuating numbers of sea otter bones through time also argues against their model, as well as Broughton's (1994a, 1994b, 1999) deer-sea otter reversal.

Resource intensification models thus seem to offer limited explanatory value regarding changes in frequencies of mammal taxa through time at Duncans Point Cave. Culturally based causative factors include technological change and social factors affecting the considerable preoccupation with trade and exchange displayed by prehistoric Californians. Environmental variables include the distribution and abundance of animal resources present within the Duncans Point Cave site catchment, and interannual shifts in resource availability (cf. Simons 1992:82-84). Recently, the impact of long-term climatic/habitat change on subsistence adaptations in California has provoked lively debate (Raab et al. 1995; Raab 1996; Arnold 1997; Arnold et al. 1997; Hildebrandt 1997a, 1997b; Jones 1997; Raab and Bradford 1997; Raab and Larson 1997). At Duncans Point Cave, topographic change resulting from Holocene sea level rise and coastal erosion probably produced habitat changes within the catchment of the site, affecting exploitation of mammalian taxa through time.

Topographic Change

An important factor often mentioned only briefly in the debate on Californian marine mammal hunting is the potential effect of gradual or rapid topographic change on the distribution and abundance of marine resources. Erlandson and Moss (1996:282) pointed out that the archaeological record of coastal California and much of Pacific North America is complicated by sea level rise, inundation, subsidence, isostatic rebound, and tectonic activity. In California, great earthquakes tend to occur every few hundred years along the northern San Andreas Fault (Prentice 1989; Niemi and Hall 1992). For example, recent tectonic uplift of 1.0 to 1.5 m. in the Cape Mendocino area produced extensive die-offs of local mussel beds (Fitzgerald and Ozaki 1994). In contrast to episodic tectonic events, coastal erosion is an ongoing process, directly affecting the distribution and availability of a variety of resources (Williams and Bedrossian 1977; Ritter 1978; Lyman 1991; Erlandson 1994). It is highly probable that during the Holocene, erosional processes along the west coast of North America profoundly affected the distribution of habitats suitable for marine mammal haulouts and rookeries along the mainland shoreline, as well as on offshore rocks and islands.

Over the past 15,000 years, the California coastline has undergone considerable reshaping. This has been due primarily to an interaction between Holocene sea level change and coastal erosion. In the vicinity of San Francisco Bay, including the mouth of the Russian River and Duncans Point, Atwater et al. (1977) and Atwater (1979:41) proposed sea levels of -8 m. at 5,000 B.P., -55 m. at 10,000 B.P., and -100 m. at 15,000 B.P. They noted an average sea level rise of about two cm. per year between 11,000 B.P. and 8,000 B.P. During the last 6,000 years, the rate of sea level rise has slowed considerably to an average of 0.1 to 0.2 cm. per year. When correlated with the early archaeology of the San Francisco Bay Area (Bickel 1978:13; Moratto 1984:219-222) and the Mendocino County coast (Simons et al. 1985:264), Holocene sea level rise is viewed as having profound environmental and archaeological consequences. As for Duncans Point Cave, at 15,000 B.P. the shoreline may have been approximately 14 km. west; by 10,000 B.P., it was about five km. west, and at 5,000 B.P., ca. one km. west (Atwater 1979:41).

During the last 6,000 years, as coastal inundation resulting from sea level rise has eased, shoreline retreat along the California coast has primarily been due to coastal erosion. The rate of erosion varies, according to coastal geology and geomorphology, degree of exposure to wave action, and water depth (e.g., Williams and Bedrossian 1977). Along the Santa Barbara coast, for example, shoreline erosion progresses at a mean annual rate of up to 15 cm. or more per annum (Norris 1968; Shepard and Wanless 1971). Erosion rates greater than 15 cm. per year are typical along much of the central California coast (Gordon 1979). Sedimentary rocks near Santa Cruz erode an average of approximately 30 cm. per year, as do formations on the San Mateo County coast (Sullivan 1975:31; Griggs and Johnson 1979:76). Sedimentary rocks around Fort Ross on the Sonoma County coast tend to erode at a rate of nine cm. per year or less (Ritter 1978:536). Consequently, 6,000 years ago, subsequent to much of the period of Early Holocene sea level rise, the shoreline at Fort Ross could have been more than 0.5 km. farther west of its present location.

Given its apparent antiquity, the ramifications of Holocene sea level rise and coastal erosion for prehistoric peoples living at Duncans Point Cave are noteworthy. During human occupancy of the site, it is an absolute certainty that the topography of the shoreline near the point has been profoundly affected by sea level change, inundation, and erosion. These processes would have affected littoral habitats, leading to changes in the distributions and abundances of marine plant and animal resources, especially shellfish, fish, birds, and marine mammals. For example, some of the rocks barely visible offshore today were probably larger and perhaps could have served as haulouts or rookeries 2,000 years ago.

Evidence suggesting changes in the physical environment in the Duncans Point area is provided when relative abundances of wide-ranging, habitat-specific shellfish species are computed. Citing work conducted at Franchthi Cave in southern Greece, Shackleton (1988:19) suggested that reconstruction of inshore marine environments through study of shellfish distributions within a stratigraphic column "permits a more detailed monitoring of the past use of resources than has often previously been attempted."

The shellfish assemblage characterizing the earlier components (Components 1 through 3) at Duncans Point Cave is composed of species typically found in protected, sandy or muddy estuarine habitats (Fig. 6). Numbers of these species greatly diminish in Components 4 through 6. Rocky intertidal species, such as mussels, occur in large numbers in all of the cultural components (Fig. 7). While it is possible that estuarine mollusk species could have been carried the 10 km. to Duncans Point Cave from where they currently occur at Bodega Bay, it is unlikely, especially when abundant shellfish resources were located just offshore. Furthermore, if people were importing such species, why would they stop relatively suddenly roughly 6,000 years ago? Schwaderer (1992:65) and Erlandson (1994:247-248) suggested that during the Early Holocene, estuarine habitats were present close to Duncans Point, and were subsequently drowned by sea level rise (see also Erlandson and Moss 1996:294). These estuarine habitats may have been associated with the former mouth of the Russian River, which may have discharged into the Pacific Ocean at a different location than at present, or with a smaller estuary formed at the mouth of a local drainage just south of Duncans Point.

Fish are present in the Duncans Point Cave cultural components, usually in lower numbers than birds or mammals (Schwaderer 1992:66). Fish reach their highest numbers in Components 3 and 4. None of the identified fish species can be classed as estuarine. In fact, most are found along rocky shorelines. The relatively low numbers and species diversity of fish suggest that fishing was not as important to the protein subsistence economy as collecting shellfish or hunting birds and mammals.

The avifaunal assemblage from Components 2 and 3 is dominated by birds preferring the protected waters of bays, inlets, and estuaries (loons, western grebes, geese, ducks, and coots). Subsequent cultural components (4 through 6) contain a mixture of bird taxa favoring protected waters and those principally occurring along the outer, rocky coast (albatross, fulmar, cormorant, gull, murre) (Grinnell and Miller 1944; Miller 1951; Small 1974; Cogswell 1977). Marine mammal remains first appear in abundance in Component 3, subsequently dominating assemblages in Components 4 through 6 (Table 4; Fig. 2). Juvenile marine mammals become more common in Component 4 (Fig. 4).

Shellfish, bird, and marine mammal data from Duncans Point Cave suggest that changes in the exploitation of marine resources may have oc-

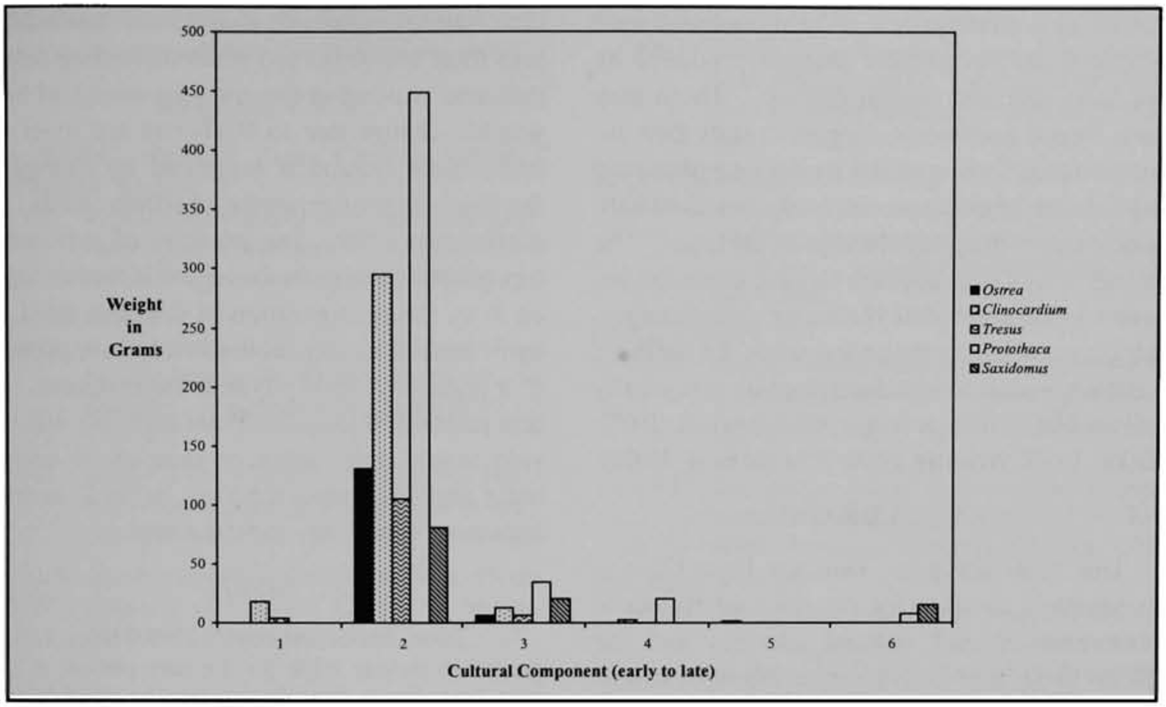

Fig. 6. Soft bottom-dwelling mollusks by cultural component from Duncans Point Cave (CA-SON-348/H) (data from Schwaderer 1992).

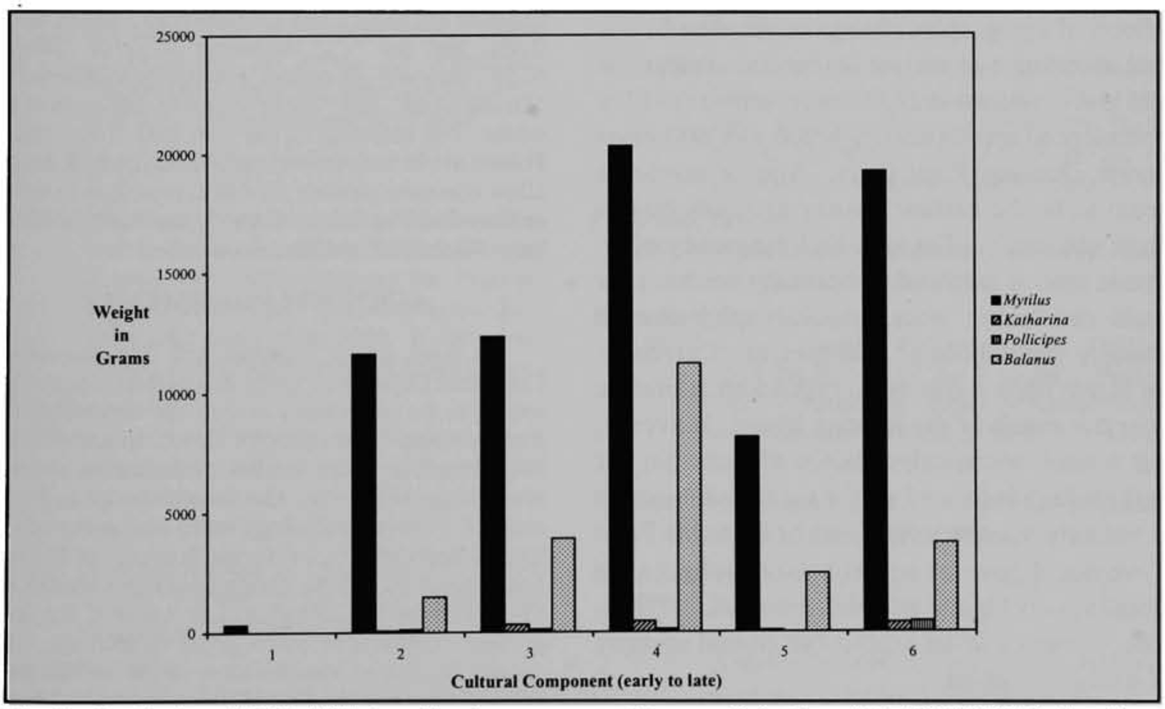

Fig. 7. Rocky intertidal shellfish by cultural component at Duncans Point Cave (CA-SON-348/H) (data from Schwaderer 1992).

curred as a consequence of habitat changes resulting from topographic changes produced by sea level rise and coastal erosion. These may have forced prehistoric peoples to shift their resource focus from a mixed strategy emphasizing exploitation of estuarine and rocky intertidal habitats to one principally fixed upon the latter. The timing of this shift appears to have occurred between 6,300 and 4,600 years ago. Interestingly, this corresponds to the period when the northern California coast attained much of its historically known configuration (e.g., Atwater et al. 1977; Bickel 1978; Atwater 1979; Simons et al. 1985).

CONCLUSIONS

Due to its antiquity, Duncans Point Cave is an excellent location for the study of Holocene environmental and cultural change, and the effects these have had on procurement of animal resources. Topics of particular concern include the antiquity of marine mammal hunting, terrestrial and marine resource intensification, and the effects of topographic change on the distribution and abundance of marine resources. Terrestrial and marine mammal exploitation appears to have commenced approximately 8,200 to 8,600 years ago at Duncans Point Cave. Marine mammals seem to be the earliest, most commonly hunted large mammals. The very high frequency of juvenile marine mammals, especially northern fur seals and harbor seals, implies exploitation of rookery populations of both species. Currently, an active harbor seal rookery/haulout is present near the mouth of the Russian River. However, the nearest historically known and current fur seal rookery is located on the Farallon Islands. It is unlikely that the inhabitants of Duncans Point Cave could have or would have traveled to the Farallons to obtain juvenile fur seals. Therefore, presence of an exploitable coastal rookery is strongly implied.

Since Duncans Point Cave appears to have been occupied during much of the Holocene, the effects of sea level rise and coastal erosion on the distribution of available rookery and haulout habitats must be considered when discussing marine mammal hunting at the site. Evidence of topographic change due to Holocene sea level rise and coastal erosion is suggested by changes in the frequency of estuarine shellfish, birds, and marine mammals. The intensity of past coastal topographic change in the region is further attested to by the configuration of the cave itself and by its natural setting, both of which are products of a highly dynamic physical environment. Future research at Duncans Point certainly will provide larger, time-sensitive samples of invertebrate and vertebrate remains, as well as other important classes of cultural remains.

NOTE

1. Jones and Hildebrandt (1995:Tables 2-3) neglected to include NISP for the deer present at Duncans Point Cave, even though they have columns labeled "Deer/elk NISP." Numbers of deer remains represented during both temporal periods are available in Schwaderer (1992:Table 3.4). The "Deer/elk NISP" columns in Tables 2 and 3 should read 7 and 9, respectively, and not "-". Inclusion of these "Deer/elk NISP" data will, of course, change the numbers in the "Grand Total" and "Total" columns and rows in both tables. The omission of the deer data from Duncans Point Cave in both tables is problematic, as it does not allow adequate grounds for full comparison to the other sites listed in Tables 2 and 3, especially those that have "Deer/elk" remains enumerated.

ACKNOWLEDGEMENTS

We thank Breck Parkman and Rae Schwaderer, California Department of Parks and Recreation, for allowing us the opportunity to study the vertebrate faunal remains from Duncans Point Cave. In addition, Rae Schwaderer provided valuable information about the archaeology of the site. Our thanks also go to the Museum of Vertebrate Zoology at the University of California, Berkeley, the California Academy of Sciences, San Francisco, and the Zooarchaeology Laboratory at the University of California, Los Angeles, for access to their comparative osteological collections, which greatly facilitated identification of the vertebrate remains from Duncans Point Cave. We thank Mark Q. Sutton, Jon Erlandson, anonymous reviewers, and the staff of the *Journal* for their assistance in editing and production of this paper. We also thank Christina

Campbell and Nona Simons for their encouragement. The opinions expressed here are entirely our own.

REFERENCES

Allen, Sarah G., Harriet R. Huber, Christine A. Ribic, and David G. Ainley
1989 Population Dynamics of Harbor Seals in the Gulf of the Farallones, California. California Fish and Game 75(4):224-232.

Arnold, Jeanne E.
1995 Transportation Innovation and Social Complexity Among Maritime Hunter-Gatherer Societies. American Anthropologist 97(4): 733-747.

1997 Bigger Boats, Crowded Creekbanks: Environmental Stresses in Perspective. American Antiquity 62(2):337-339.

Arnold, Jeanne E., Roger H. Colton, and Scott Pletka
1997 Contexts of Cultural Change in Insular California. American Antiquity 62(2):300-318.

Atwater, Brian F.
1979 Ancient Processes at the Site of Southern San Francisco Bay: Movement of the Crust and Changes in Sea Level. In: San Francisco Bay: The Urbanized Estuary, T. John Conomos, ed., pp. 31-45. San Francisco: Pacific Division of the American Association for the Advancement of Science.

Atwater, Brian F., Charles W. Hedel, and Edward J. Helley
1977 Late Quaternary Depositional History, Holocene Sea Level Changes, and Vertical Crustal Movement, Southern San Francisco Bay, California. U.S. Geological Survey Professional Paper 1014. Washington: United States Government Printing Office.

Barrett, Samuel A.
1908 The Ethnogeography of the Pomo and Neighboring Indians. University of California Publications in American Archaeology and Ethnology 6(1).

1952 Material Aspects of Pomo Culture, Parts 1 and 2. Bulletin of the Public Museum of the City of Milwaukee 20(1-2).

Bickel, Polly McW.
1978 Changing Sea Levels Along the California Coast: Anthropological Implications. The Journal of California Anthropology 5(1):6-20.

Bigg, Michael A.
1969 Clines in the Pupping Season of the Harbor Seal, *Phoca vitulina*. Journal of the Fisheries Research Board of Canada 26(2):449-455.

Blunt, Clarkson E., Jr. (coord.)
1980 Atlas of California Coastal Marine Resources. Sacramento: State of California, The Resources Agency, Department of Fish and Game.

Bocek, Barbara
1986 Rodent Ecology and Burrowing Behavior: Predicted Effects on Archaeological Site Formation. American Antiquity 51(3):589-603.

1992 The Jasper Ridge Reexcavation Experiment: Rates of Artifact Mixing by Rodents. American Antiquity 57(2):261-269.

Broughton, Jack M.
1994a Declines in Mammalian Foraging Efficiency During the Late Holocene, San Francisco Bay, California. Journal of Anthropological Archaeology 13(4):371-401.

1994b Late Holocene Resource Intensification in the Sacramento Valley, California: The Vertebrate Evidence. Journal of Archaeological Science 21(4):501-514.

1999 Resource Depression and Intensification During the Late Holocene, San Francisco Bay: Evidence from the Emeryville Shellmound Vertebrate Fauna. University of California Anthropological Records 32.

Cogswell, Howard L.
1977 Water Birds of California. Berkeley: University of California Press.

Erlandson, Jon M.
1984 A Case Study in Faunalturbation: Delineating the Effects of the Burrowing Pocket Gopher on the Distribution of Archaeological Materials. American Antiquity 49(4): 785-790.

1994 Early Hunter-Gatherers of the California Coast. New York: Plenum Press.

Erlandson, Jon M., and Roger H. Colten (eds.)
1991 Hunter-Gatherers of Early Holocene Coastal California. University of California, Los Angeles, Institute of Archaeology, Perspectives in California Archaeology, Vol. 1.

Erlandson, Jon M., and Michael A. Glassow (eds.)
1997 Archaeology of the California Coast During the Middle Holocene. University of

California, Los Angeles, Institute of Archaeology, Perspectives in California Archaeology, Vol. 4.

Erlandson, Jon M., and Madonna L. Moss
1996 The Pleistocene-Holocene Transition Along the Pacific Coast of North America. In: Humans at the End of the Ice Age: The Archaeology of the Pleistocene-Holocene Transition, Lawrence G. Straus, Berit V. Eriksen, Jon M. Erlandson, and David R. Yesner, eds., pp. 277-301. New York: Plenum Press.

Erlandson, Jon M., and Thomas K. Rockwell
1987 Radiocarbon Reversals and Stratigraphic Discontinuities: Natural Formation Processes in Coastal Californian Archaeological Sites. In: Natural Formation Processes and the Archaeological Record, David Nash and Michael Petraglia, eds., pp. 51-73. BAR International Series 352.

Erlandson, Jon M., Mark A. Tveskov, and R. Scott Byram
1998 The Development of Maritime Adaptations on the Southern Northwest Coast of North America. Arctic Anthropology 35(1):6-22.

Evermann, Barton W.
1923 The Conservation of the Marine Life of the Pacific. The Scientific Monthly 16(5): 521-538.

Fitzgerald, Richard, and Vicki Ozaki
1994 Splish, Splash, and Crash: Geological Implications on the Coastal Archaeological Record of Northwest California. Proceedings of the Society for California Archaeology 7:95-103.

Fredrickson, David A.
1984 The North Coastal Region. In: California Archaeology, by Michael J. Moratto, pp. 471-527. Orlando: Academic Press.

Gifford, Edward W.
1967 Ethnographic Notes on the Southwestern Pomo. University of California Anthropological Records 25.

Gordon, Burton L.
1979 Monterey Bay Area: Natural History and Cultural Imprints (2nd ed.). Pacific Grove, CA: The Boxwood Press.

Graumlich, Lisa J.
1993 A 1000-Year Record of Temperature and Precipitation in the Sierra Nevada. Quaternary Research 39(2):249-255.

Grayson, Donald K.
1984 Quantitative Zooarchaeology: Topics in the Analysis of Archaeological Faunas. Orlando: Academic Press.

Griggs, Gary B., and R. E. Johnson
1979 Coastline Erosion: Santa Cruz County. California Geology 32(4):67-75.

Grinnell, Joseph, and Alden H. Miller
1944 The Distribution of the Birds of California. Berkeley: Cooper Ornithological Club, Pacific Coast Avifauna No. 27.

Grinnell, Joseph, Joseph S. Dixon, and Jean M. Linsdale
1937 Fur-Bearing Mammals of California: Their Natural History, Systematic Status, and Relations to Man. Berkeley: University of California Press.

Haley, Delphine (ed.)
1978 Marine Mammals of Eastern North Pacific and Arctic Waters. Seattle: Pacific Search Press.

Hall, E. Raymond
1940 Pribilof Fur Seal on California Coast. California Fish and Game 26(1):76-77.

1981 The Mammals of North America (2nd ed.). New York: John Wiley and Sons.

Hanni, Krista D., Douglas J. Long, Robert E. Jones, Peter Pyle, and L. E. Morgan
1997 Sightings and Strandings of Guadalupe Fur Seals in Central and Northern California, 1988-1995. Journal of Mammalogy 78(2): 684-690.

Heizer, Robert F., and William C. Massey
1953 Aboriginal Navigation Off the Coasts of Upper and Baja California. Bureau of American Ethnology Bulletin 151:285-312.

Hildebrandt, William R.
1979 Vertebrate Faunal Analysis. In: Report of the Archaeological Investigations of Shelter Cove, Valerie A. Levulett, ed., pp. 212-242. Report on file at the Northwest Information Center, Sonoma State University, Rohnert Park, California.

1981 Native Hunting Adaptations on the North Coast of California. Ph.D. dissertation, University of California, Davis.

1984 Late Period Hunting Adaptations on the North Coast of California. Journal of California and Great Basin Anthropology 6(2): 189-206.

1997a The Relative Importance of Lacustrine and Estuarine Resources to Prehistoric Hunter-Gatherer Populations: A View from Southern Santa Clara Valley, California. Journal of California and Great Basin Anthropology 19(2):197-225.

1997b Late Holocene Use of Wetland Habitats in Central California: A Reply to Jones. Journal of California and Great Basin Anthropology 19(2):288-293.

Hildebrandt, William R., and Terry L. Jones
1992 Evolution of Marine Mammal Hunting: A View from the California and Oregon Coasts. Journal of Anthropological Archaeology 11(4):360-401.

Hildebrandt, William R., and Valerie A. Levulett
1997 Mid-Holocene Adaptations on the North Coast of California: A Study of Terrestrial Resource Productivity and Its Influence on the Use of Marine Foods. In: The Archaeology of the California Coast During the Middle Holocene, Jon M. Erlandson and Michael A. Glassow, eds., pp. 143-150. University of California, Los Angeles, Institute of Archaeology, Perspectives in California Archaeology, Vol. 4.

Hudson, Travis
1981 To Sea Or Not To Sea: Further Notes on the "Oceangoing" Dugouts of North Coastal California. Journal of California and Great Basin Anthropology 3(2):269-282.

Ingles, Lloyd G.
1965 Mammals of the Pacific States: California, Oregon, and Washington. Stanford, CA: Stanford University Press.

Janetski, Joel C.
1997 Fremont Hunting and Resource Intensification in the Eastern Great Basin. Journal of Archaeological Science 24(12):1075-1088.

Jobson, Robert W., and William R. Hildebrandt
1980 The Distribution of Oceangoing Canoes on the North Coast of California. Journal of California and Great Basin Anthropology 2(2):165-174.

Johnson, Donald L.
1989 Subsurface Stone Lines, Stone Zones, Artifact-Manuport Layers, and Biomantles Produced by Bioturbation Via Pocket Gophers (*Thomomys bottae*). American Antiquity 54(2):370-389.

Jones, Terry L. (ed.)
1992 Essays on the Prehistory of Maritime California. Davis: Center for Archaeological Research at Davis, Publication No. 10.

1996 Mortars, Pestles, and Division of Labor in Prehistoric California: A View from Big Sur. American Antiquity 61(2):243-264.

1997 Lakes and Estuaries Reconsidered: A Comment on Lacustrine Resource Intensification in the Southern Santa Clara Valley, California. Journal of California and Great Basin Anthropology 19(2):281-288.

Jones, Terry L., and William R. Hildebrandt
1995 Reasserting a Prehistoric Tragedy of the Commons: Reply to Lyman. Journal of Anthropological Archaeology 14(1):78-98.

Kelly, Isabel
1978a Some Coast Miwok Tales. The Journal of California Anthropology 5(1):21-41.

1978b Coast Miwok. In: Handbook of North American Indians, Vol. 8, California, Robert F. Heizer, ed., pp. 414-425. Washington: Smithsonian Institution.

Kenyon, Karl W., and Ford Wilke
1953 Migration of the Northern Fur Seal, *Callorhinus ursinus*. Journal of Mammalogy 34(1):86-98.

Khlebnikov, Kyrill T.
1976 Colonial Russian America: Kyrill T. Khlebnikov's Reports, 1817-1832, Basil Dmytryshyn and E. A. P. Crownhart-Vaughan, eds. and trans. Portland: Oregon Historical Society.

1990 The Khlevnikov Archive. Journal (1800-1837) and Travel Notes (1820, 1822, and 1824), Leonard Shur, ed., J. Bisk, trans. University of Alaska, Fairbanks, Rasmuson Library Historical Translation Series, Vol. 5.

King, Judith E.
1983 Seals of the World (2nd ed.). Oxford: Oxford University Press.

Kniffen, Fred B.
1939 Pomo Geography. University of California Publications in American Archaeology and Ethnology 36(6).

Kroeber, Alfred L.
1925 Handbook of the Indians of California. Bureau of American Ethnology Bulletin 78.

Levulett, Valerie A., and William R. Hildebrandt
1987 The King Range Archaeological Project: Results of the 1984 Field Season. Report

on file at the Bureau of Land Management, Ukiah, California.

Loeb, Edwin M.
1926 Pomo Folkways. University of California Publications in American Archaeology and Ethnology 19(2).

Lyman, R. Lee
1988 Zoogeography of Oregon Coast Marine Mammals: The Last 3,000 Years. Marine Mammal Science 4(3):247-264.
1989 Seal and Sea Lion Hunting: A Zooarchaeological Study from the Southern Northwest Coast of North America. Journal of Anthropological Archaeology 8(1):68-99.
1991 Prehistory of the Oregon Coast: The Effects of Excavation Strategies and Assemblage Size on Archaeological Inquiry. San Diego: Academic Press.
1995 On the Evolution of Marine Mammal Hunting on the West Coast of North America. Journal of Anthropological Archaeology 14(1):45-77.

Lyman, R. Lee, James M. Savelle, and Peter Whitridge
1992 Derivation and Application of a Meat Utility Index for Phocid Seals. Journal of Archaeological Science 19(4):531-555.

McCullough, Dale R.
1969 The Tule Elk: Its History, Behavior, and Ecology. University of California Publications in Zoology 88.

McGuire, Kelly R., and William R. Hildebrandt
1994 The Possibilities of Women and Men: Gender and the California Milling Stone Horizon. Journal of California and Great Basin Anthropology 16(1):41-59.

McLendon, Sally, and Robert L. Oswalt
1978 Pomo: Introduction. In: Handbook of North American Indians, Vol. 8, California, Robert F. Heizer, ed., pp. 274-288. Washington: Smithsonian Institution.

Merriam, C. Hart
1907 Distribution and Classification of the Mewan Stock in California. American Anthropologist 9(2):338-357.

Miller, Alden H.
1951 An Analysis of the Distribution of the Birds of California. University of California Publications in Zoology 50(6):531-644.

Moratto, Michael J.
1984 California Archaeology. Orlando: Academic Press.

Nelson, Nels C.
1909 Site Survey, Russian River to Golden Gate Mounds. Berkeley: University of California Archaeological Survey Manuscripts No. 351.

Niemi, Tina M., and N. Timothy Hall
1992 Late Holocene Slip Rate and Recurrence of Great Earthquakes on the San Andreas Fault in Northern California. Geology 20(3):195-198.

Norris, Kenneth S., and John H. Prescott
1961 Observations on Pacific Cetaceans of Californian and Mexican Waters. University of California Publications in Zoology 63(4):291-402.

Norris, R.
1968 Sea Cliff Retreat Near Santa Barbara, California. California Division of Mines and Geology Information Service Circular No. 21.

Ogden, Adele
1941 The California Sea Otter Trade: 1784-1848. University of California Publications in History 26.

Orr, Robert T., and Roger C. Helm
1989 Marine Mammals of California. Berkeley: University of California Press.

Peter, Jesse
1923 Survey of Tomales Bay, Bodega Bay, and Sonoma County Sites. Berkeley: University of California Archaeological Survey Manuscripts No. 436.

Porcasi, Judith F.
1995 Identification and Analysis of Mammalian and Avian Remains Recovered from 1994 Excavations at Eel Point, San Clemente Island. Pacific Coast Archaeological Society Quarterly 31(3):39-66.

Prentice, Carol S.
1989 Earthquake Geology of the Northern San Andreas Fault Near Point Arena, California. Ph.D. dissertation, California Institute of Technology, Pasadena.

Raab, L. Mark
1996 Debating Prehistory in Coastal Southern California: Resource Intensification Versus Political Economy. Journal of California and Great Basin Anthropology 18(1): 64-80.

Raab, L. Mark, and Katherine Bradford
1997 Making Nature Answer to Interpretivism: Response to J. E. Arnold, R. H. Colton,

and S. Pletka. American Antiquity 62(2): 340-341.

Raab, L. Mark, and Daniel O. Larson
1997 Medieval Climatic Anomaly and Punctuated Cultural Evolution in Coastal Southern California. American Antiquity 62(2):319-336.

Raab, L. Mark, Katherine Bradford, Judith F. Porcasi, and William J. Howard.
1995 Return to Little Harbor, Santa Catalina Island, California: A Critique of the Marine Paleotemperature Model. American Antiquity 60(2):287-308.

Riddell, Francis A.
1955 Archaeological Excavations on the Farallon Islands, California. Berkeley: Reports of the University of California Archaeological Survey No. 32.

Riedman, Marianne
1990 The Pinnipeds: Seals, Sea Lions, and Walruses. Berkeley: University of California Press.

Ritter, Dale F.
1978 Process Geomorphology. Dubuque, IA: William Brown and Company.

Roest, Aryan I.
1970 *Kogia simus* and Other Cetaceans from San Luis Obispo County, California. Journal of Mammalogy 51(2):410-417.

Russell, Emily W. B.
1983 Pollen Analysis of Past Vegetation at Point Reyes National Seashore, California. Madroño 30(1):1-11.

Rypins, Steven, Steven L. Reneau, Roger Byrne, and David R. Montgomery
1989 Palynologic and Geomorphic Evidence for Environmental Change During the Pleistocene-Holocene Transition at Point Reyes Peninsula, Central Coastal California. Quaternary Research 32(1):72-87.

Savelle, James M., Max T. Friesen, and R. Lee Lyman
1996 Derivation and Application of an Otariid Utility Index. Journal of Archaeological Science 23(5):705-712.

Scammon, Charles M.
1874 The Marine Mammals of the Northwestern Coast of North America. San Francisco: J. H. Carmany and Sons.

Schwaderer, Rae
1992 Archaeological Test Excavation at the Duncans Point Cave, CA-SON-348/H. In: Essays on the Prehistory of Maritime California, Terry L. Jones, ed., pp. 55-71. Davis: Center for Archaeological Research at Davis, Publication No. 10.

Shackleton, James C.
1988 Reconstructing Past Shorelines as an Approach to Determining Factors Affecting Shellfish Collecting in the Prehistoric Past. In: The Archaeology of Prehistoric Coastlines, Geoff Bailey and John Parkington, eds., pp. 11-21. Cambridge: Cambridge University Press.

Shepard, Francis P., and Harold R. Wanless
1971 Our Changing Coastlines. New York: McGraw Hill.

Simons, Dwight D.
1990 Vertebrate Remains from the Albion Sites. In: Western Pomo Prehistory: Excavations at Albion Head, Nightbird's Retreat, and Three Chop Village, Thomas N. Layton, ed., pp. 37-51. University of California, Los Angeles, Institute of Archaeology, Monograph No. 32.
1992 Prehistoric Mammal Exploitation in the San Francisco Bay Area. In: Essays on the Prehistory of Maritime California, Terry L. Jones, ed., pp. 73-104. Davis: Center for Archaeological Research at Davis, Publication No. 10.

Simons, Dwight D., Thomas N. Layton, and Ruthann Knudson
1985 A Fluted Point from the Mendocino County Coast, California. Journal of California and Great Basin Anthropology 7(2):260-269.

Small, Arnold
1974 The Birds of California. New York: Winchester Press.

Snyder, George
1996 Fur Seal Birth on Farallones Raises Hopes. San Francisco Chronicle (newspaper) 167: 230.

Starks, Edwin C.
1922 Records of the Capture of Fur Seals on Land in California. California Fish and Game 8(3):155-160.

Stephens, David W., and John R. Krebs
1986 Foraging Theory. New York: Princeton University Press.

Stewart, Omer C.
1943 Notes on Pomo Ethnogeography. Univer-

sity of California Publications in American Archaeology and Ethnology 40(2).

Stine, Scott
1994 Extreme and Persistent Drought in California and Patagonia During Mediaeval Time. Nature 369(6481):546-549.

Stuiver, Minze, and Paula J. Reimer
1993 Extended 14C Database and Revised CALIB Radiocarbon Calibration Program. Radiocarbon 35:215-230.

Stuiver, Minze, Paula J. Reimer, Edouard Bard, J. Warren Beck, G. S. Burr, Konrad A. Hughen, Bernd Kromer, F. Gerry McCormac, Johannes v.d. Plicht, and Marco Spurk
1998 INTCAL98 Radiocarbon Age Calibration 24,000-0 Cal BP. Radiocarbon 40:1041-1083.

Sullivan, Raymond
1975 Geological Hazards Along the Coast South of San Francisco. California Geology 28(2):27-33.

Sullivan, Robert M., and Warren J. Houck
1979 Sightings and Strandings of Cetaceans from Northern California. Journal of Mammalogy 60(4):828-833.

Tikhmenev, Petr Aleksandrovich
1978 A History of the Russian American Company, Richard A. Pierce and Alton S. Donnelly, eds. and trans. Seattle: University of Washington Press.

1994 Social Implications of Mammal Remains from Fort Ross, California. Proceedings of the Society for California Archaeology 7:19-32.

1997a Mammal Remains from the Native Alaskan Neighborhood. In: The Archaeology and Ethnohistory of Fort Ross, California, Vol. 2, The Native Alaskan Neighborhood, A Multiethnic Community at Colony Ross, Kent G. Lightfoot, Ann M. Schiff, and Thomas A. Wake, eds., pp. 279-309. Berkeley: University of California Archaeological Research Facility, Contributions No. 55.

1997b Subsistence, Ethnicity, and Vertebrate Exploitation at the Ross Colony. In: The Archaeology of Russian Colonialism in the Northern and Tropical Pacific, Peter R. Mills and Antoinette Martinez, eds., pp. 84-115. Berkeley: Kroeber Anthropological Society Papers No. 81.

White, Greg
1989 A Report of Archaeological Investigations at Eleven Native American Coastal Sites, MacKerricher State Park, Mendocino County, California. Report on file at the California Department of Parks and Recreation, Sacramento.

White, Peter
1995 The Farallon Islands: Sentinels of the Golden Gate. San Francisco: Scottwall Associates.

Williams, James W., and Trinda L. Bedrossian
1977 Coastal Zone Geology Near Gualala, California. California Geology 30(2):27-34.

Winterhalder, Bruce, and Eric A. Smith (eds.)
1981 Hunter-Gatherer Foraging Strategies: Ethnographic and Archaeological Analyses. Chicago: University of Chicago Press.

Yesner, David R.
1981 Archaeological Applications of Optimal Foraging Theory. In: Hunter-Gatherer Foraging Strategies: Ethnographic and Archaeological Analyses, Bruce Winterhalder and Eric A. Smith, eds., pp. 148-170. Chicago: University of Chicago Press.