The Prehistoric Exploitation of Marine Mammals and Birds at San Nicolas Island, California

Dana E. Bleitz
Department of Anthropology, California State University
Los Angeles, CA 90032

Abstract - Research on San Nicolas Island prehistory currently describes an aboriginal maritime adaptation which appeared about 6,800 years ago. Faunal data from the stratified site of SNI-11 indicate an early procurement strategy dominated by shellfish gathering and supplemented by fish, sea-mammal and bird resources. This economy evolved into a broader-based strategy which focused upon the diverse range of species foraging and inhabiting the kelp beds and in which smaller pinniped and cetacean species played an important role.

Introduction

Model Proposed for San Nicolas Island: San Nicolas Island, the outermost of the California Channel Islands, was occupied by an aboriginal people who adopted a maritime subsistence base and arrived, according to calibrated radiocarbon dates by about 6,800 years ago (Table 1) [UCLA-2559D: 5,955±120 radiocarbon years = 6,800 cal B.P. (calibrated date)] (Bleitz-Sanburg 1987; Bryan 1970; Reinman 1964; Reinman & Lauter 1981; Stuiver 1982; Suess 1979).

Reinman (1964) speculated on the maritime development of the Nicoleños in comparison with the prehistoric economy of the Santa Catalina Islanders reported by Meighan (1959). The exploitation of San Nicolas Island by the Nicoleños was postulated by Reinman as evolving from a subsistence strategy dominated by shellfish gathering and supplemented by sea-mammal and fish protein into a broader-based and more stable economy, an economy in which fishing and the procurement of sea mammals became increasingly important in relation to shellfish harvesting.

Subsequent excavations on San Nicolas Island at SNI-11, a site situated almost at the northernmost point on the island and containing three distinct occupational strata, enabled Reinman to define a chronological sequence of early, intermediate and late. Within the artifact assemblage of SNI-11, a discrete change is demonstrated in the fishing technology, where the sole presence of the bone gorge from the earlier two occupations almost exclusively is replaced by the occurrence of the circular shell fishhook during the late period (Reinman & Lauter 1981).

Changing Exploitation/Procurement: Although a model of Nicoleño maritime adaptation was proposed by Reinman (1964), no systematic analysis of the faunal remains recovered from San Nicolas Island had previously been conducted to verify these tentative conclusions. Of the entire faunal collection from SNI-11, only the mammal and bird remains are focused upon at this time. Comparable assemblages of sea-mammal and bird remains preserved in large numbers have been reported from relatively few of the sites which have been excavated on the California Islands and the adjacent southern California coast (Bleitz-Sanburg 1987).

In conjunction with the general paucity of systematic faunal analyses dealing with sea-mammal and bird bones excavated from sites along the southern California coast and California Islands, there is a general lack of comparative ethnographic and archaeological data concerning methods for hunting these animals by the aboriginal people of the Southern California Bight. Reinman & Lauter (1981) were able to define changes in the fishing tackle employed by the inhabitants of San Nicolas Island, but no well-defined hunting toolkit has been distinguished for marine mammals and birds exploited at SNI-11.

The characteristic behavior, biology and distribution of an animal species affect the strategy designed for its procurement (Earle 1980). The analysis of the modern characteristics for the mammalian and avian species identified from the SNI-11 faunal assemblage, as well as the methods employed by biologists to capture these animals, may allow for a new interpretation of the general absence of a specialized hunting toolkit and the presence of a well-defined fishing tool assemblage from SNI-11.

Methods

Dietary Significance: The procurement of animal resources initially may be studied through two variables – the range of species targeted and the desired range of products (Earle 1980). The objective yield of animal products may vary from protein (meat) to calories (fat) and raw materials (bone and hide).

The analysis of osteological residues resulting from the cultural processing of animal species into usable constituents generally has been viewed through two perspectives. The processed raw materials have been studied as artifacts, while the protein contribution has been derived through reconstructions of meat weights from residue-bone weights or from counts of the Minimum Number of Individuals (MNI) represented for each species identified within the faunal assemblage.

The "Wiegemethode," or weight method, attempts to determine the relative dietary contribution of animals within the faunal assemblage by calculating the meat weights of each taxon from the respective weights of preserved bones identified from each species. On the assumption that bone weight correlates linearly to meat weight in vertebrate fauna, the sampled bone-weights are multiplied by a derived conversion factor in order to obtain a proportional measure of meat weight (Cook & Treganza 1950; Reed 1963; Uerpmann 1973).

The linear relationship of bone weight to meat weight was disputed by Casteel (1978). His research demonstrated that bone and meat weights are related curvilinearly. In addition, this curvilinear relationship may be applied

Table 1. Radiocarbon dates from the Thousand Springs site (SNI-11) by stratum and mound.

Laboratory No.	Stratum	Mound	Unit	Level (cm)	C_{14} yrs (B.P.)	Calibrated Age (B.P.)
IVC-45	I (Upper)	Md D	1.5N/39E	20-30	**573±109**	**600**
Gak-8205	I (Upper)	Md B	1.5S/3E	10-20	(3,820±120)	(4,100-4,450)
IVC-81	I (Upper)	Md B	1.5S/3E	20-30	**650±45**	**700**
IVC-82	I (Upper)	Md B	4.5S/22.5E	10-20	**960±46**	**960**
IVC-44	I (Upper)	Md C	3N/64.5E	60-70	**1,559±120**	**1450**
UCLA-2559A	I (Upper)	Md A	3S/1.5E	30-40	(3,725±80)	(4,100)*
UCLA-2559B	I (Upper)	Md A	3S/1.5E	70-80	(2,460±100)	(2,450-2,750)*
UCLA-2559C	I (Lower)	Md A	3S/1.5E	130-140	(4,330±120)	(4,000-5,350)*
Gak-8204	I (Lower)	Md A	3S/1.5E	150-170	**2,220±110**	**2,250**
Gak-8206	II	Md B	0N/31.5W	10-20	**3,430±130**	**3,650-3,950**
UCLA-2559E	II	Md B	7.5S/3E	60-70	**3,930±125**	**4,150-4,450***
UCLA-2559D	III	Md B	0N/31.5W	140-150	**5,955±120**	**6,800***
Gak-8207	III	Md B	0N/31.5W	170-190	**4,160±140**	**4,500-4,900**

All radiocarbon samples submitted for dating were charcoal.
Dates in **boldface** follow the depositional sequence of the three-tiered midden at SNI-11.
* = calibrated ages determined from tables by Stuiver (1982) and Suess (1979).

only to actual individuals identified within each taxon as opposed to composite collections of analyzed faunal remains. Due to the greater inaccuracies of the bone-weight index as a basis for reconstructing meat weights, the index was rejected in favor of the MNI method (Casteel 1978; Chaplin 1971; Daly 1969; Grayson 1984; Klein & Cruz-Uribe 1984; Lyman 1979).

The Minimum Number of Individuals (MNI) method proposed by White (1953) involves multiplying the average live-weight of a given species by the percent of usable meat available from that species. The usable meat-weight is then multiplied by the MNI to determine that species' total available meat-weight represented in the faunal assemblage. White's formula may be expressed, therefore, in the following manner: (average live-weight of species x percentage of meat weight from live weight x MNI) = Total meat-weight per taxon.

The calculations of live weight and percentages of usable meat for species of sea mammals in White's report (1953) were limited to otters and pinnipeds and were derived from maximum-size individuals. Stewart & Stahl (1977) included only one marine mammal - the ringed seal (*Phoca hispida*) - in their discussion of edible meat-poundage figures. Neither report, however, included seabird species within the research.

Although the contribution of meat to the human diet was investigated by White, the dietary significance of fat and blubber (calories) was overlooked, and no proportions of available fat/blubber-weights to live weights were computed. Based upon botanical surveys of San Nicolas Island to date (Junak 1992), the percentage of plant-derived carbohydrates (calories) in the diet of the Nicoleños would have been limited due both to the Island's small size and restricted range of edible vegetation.

Experiments by Vilhjalmut Stefansson and Karsten Anderson, two arctic explorers, provided information relating to the viability of subsisting on a diet devoid of plant foods (Speth 1983). It was determined recently that Stefansson and Anderson were able to ward off the development of scurvy during their study by consuming bone marrow, an apparent repository for significant quantities of vitamin C (Field 1976; Speth 1983). In addition, nitrogen loss and starvation, due to a lack of carbohydrates and calories in their diet, were remedied by the consumption of fat, which Stefansson (1944) considered to be "the most important ingredient of an arctic ration" (Speth 1983:150-155).

Speth (1983) emphasized the importance of dietary fat to hunter-gatherer societies by proposing four strategies they might have applied to prevent caloric insufficiency. Two primary remedies might have included the killing of large numbers of lean-muscled animals and subsequent gorging on the meat or a selected killing of fat individuals and the processing of fat-abundant carcass parts. A third strategy might have emphasized the hunting of species which normally maintain a high quantity of body fat. A long-term remedy would have included the augmentation of stored foods with preserved fats and bone grease.

The superabundance of resources represented by the procurement of large marine mammals may have been dealt with by a sharing and/or storage of the excess products (Smith 1981). Data on the method and duration of fat and meat preservation may be derived from ethnographic and historic accounts concerning the aboriginal capture and utilization of sea mammals in southern California.

In his study of the Nunamiuts, Binford (1978) details the meat-drying techniques applied by a group of Eskimos to caribou and sheep carcasses. The average daily consumption of meat by humans and dogs is presented in terms of pounds (live-animal weight). This daily rate of food consumption by the Nunamiut Eskimos was averaged at 1.33 kg (2.94 lbs) of meat and 0.004 kg (0.01 lbs) of plants per person.

By applying the figure of 1.33 kg as a maximum average for daily meat consumption to the Nicoleños dietary habits, an idealized rate for the consumption of sea-mammal meats may be inferred. As Stewart & Stahl (1977:269) caution, "It is doubtful that each carcass was subjected to...a full utilization in prehistoric times." Although varying degrees of carcass exploitation may have been employed between species, the idealized quantity of available meat and fat may be calculated from live-animal weights recorded by marine zoologists. In addition, the potential dietary significance of marine-mammal resources may be projected and compared by dividing Binford's figure for the Nunamiuts' daily rate of meat consumption into the average meat and fat weights documented for each species (Table 2).

Projections for the dietary significance of sea mammals in terms of the weight consumed are difficult to assess from the archaeological record. Due to differential butchering practices most likely employed upon large pinnipeds and cetaceans, a low incidence of bone, in contrast to the bulk portions of meat and fat, would be "schlepped" back to the living site from the kill locality (Daly 1969; Smith & Kinahan 1984). Sea-mammal remains, especially the porous cetacean bones, tend to be under-represented in archaeological sites due both to preservation and also to the "Schlepp-Effect" discrimination favoring meat transportation over bone conveyance. Data supporting calculations of consumed-meat ratios per species as opposed to available marine-mammal meat tend, therefore, to be obscured in the archaeological faunal assemblage.

Excavation Techniques: The excavation of SNI-11 was conducted under the direction of Fred M. Reinman of the California State University, Los Angeles, with the cooperation of the U.S. Navy, Pacific Missile Test Center, Point Mugu. Between November 1977 and August 1978, 15 test units were excavated at the Thousand Springs site in order to examine and define the temporal relationships of the different strata exposed on each of the four mounds.

The fifteen 1.5 x 1.5 m test pits were excavated in arbitrary levels of 10 cm increments. All artifacts, stone, bone and charcoal were saved for analysis, while a portion of molluscan species was sampled from each level. Within each arbitrary 10 cm level, the midden constituents were bagged separately according to their association with differing natural strata and features. The depths of the test units ranged from 30-210 cm below unit datum. A total volume of 33.075 m^3 of soil was excavated from SNI-11 and passed through 1/4 inch mesh screen.

Of the three strata defined from the Thousand Springs Site, a total volume of 15.75 m^3 of midden was excavated from the uppermost Stratum I. Four units comprised the sample of Stratum II with a total volume of 6.3 m^3, while five units were set in the earliest Stratum III with a test volume of 8.775 m^3 of midden. A total volume of 30.825 m^3 of midden was removed from between the sterile dune-sand strata of SNI-11.

Six column samples were collected from the excavation pits on Mound B. Two columns were cut in arbitrary 10 x 10 x 10 cm increments, while the other four were 10 x 10 cm columns excavated following the natural stratigraphy of their units. The columns of arbitrary 10 cm^3 samples were collected from the two deepest units on Mound B - 1.5S/58.5W and 0N/31.5W. Each of these two units exposed both Strata II and III. The column samples taken by natural stratigraphy were removed from units excavated into only a single stratum (1.5S/3E - Stratum I; 7.5S/3E - Stratum II; 19.5S/3E and 28.5N/9E - Stratum III).

Radiocarbon Dates: Thirteen radiocarbon readings were processed through three different laboratories - the Imperial Valley College Radiocarbon Laboratory (IVC), the Gakushain Laboratory (Gak) of Japan and the University of California at Los Angeles Radiocarbon Laboratory (UCLA) - using charcoal excavated from units that tested each of the mounds and strata on SNI-11 (Table 1). The three tiers of strata on Mound B were designated by Reinman (from upper to lower) as Stratum I, Stratum II and Stratum III. Similarities in the artifact assemblages from the strata of Mounds A, C and D with that of the

Table 2. Potential human rate of consumption for marine mammals from SNI-11 (after Bleitz-Sanburg 1987)

Taxa	Mean Live Weight (lbs)			Usable Meat (lbs)			Fat Weight (lbs)			Days of Food for 30 People			Days of Food for One Person		
	M	F	J	M	F	J	M	F	J	M	F	J	M	F	J
Sea Otter (*Enhydra lutris lutris*)	72	47	26^{w}	50	33	18^{w}	-	-	-	0.6	0.4	-	17.0	11.2	6.0
California Sea Lion (*Zalophus californianus*)	864	243	19^{p}	403	170	13^{p}	31.5 gal. of oil from 3-4 indiv.s			4.6	1.9	-	137.1	57.8	4.4
Northern Elephant Seal (*Mirounga angustirostris*)	5,940	1,980	348^{w}	1485	495	87^{w}	210 gal. of oil			6.8	5.6	1.0	505.1	168.4	29.6
Guadalupe Fur Seal (*Arctocephalus townsendi*)	350	100	11^{nb}	245	70	7.7^{nb}	-	-	-	2.8	0.8	-	83.3	23.8	2.6
Northern Fur Seal (*Callorhinus ursinus*)	300-615	65-150	35^{5m}	140-300	46-105	25^{5m}	^{a}60-100	-	-	1.6-3.4	0.5-1.2	0.3	47.6-102	15.6-35.7	8.5
Harbor Seal (*Phoca vitulina*)	191	14	44^{w}	133	100	31^{w}	-	-	-	1.5	1.1	0.4	45.0	34.0	10.5
Pacific Bottlenose Dolphin (*Tursiops truncatus*)	*560	-	-	*140	-	-	*251	-	-	*1.6	-	-	*47.6	-	-
Risso's Dolphin (*Grampus griseus*)	*515-770	-	-	*129-192	-	-	*232-346	-	-	*1.5-2.2	-	-	*43.9-65.5	-	-
Minke Whale (*Balaenoptera acutorostrata*)	*13,200	-	550^{nb}	*5,940	-	249.5^{nb}	*3,300	-	137.5	*67.4	-	2.8	*2,020.4	-	84.2
Gray Whale (*Eschrichtius robustus*)	-	69,212	5525	-	17,615	1381	-	20,020	1,602	-	199.7	15.7	-	5,991.5	469.7
Common Dolphin (*Delphinus delphis*)	*114	*109.6	-	*28.5	*27.4	-	*51.3	*49.3	-	*0.3	*0.3	-	*9.7	*9.3	-
Pacific White-sided Dolphin (*Lagenorhynchus obliquidens*)	*165-198	-	-	*41-50	-	-	*74-89	-	-	*0.5-0.6	-	-	*14.0-17.0	-	-
Northern Right Whale Dolphin (*Lissodelphis borealis*)	*110	*242	-	*28	*60.5	-	*49	*108.9	-	*0.3	*0.7	-	*9.4	*20.6	-
Spinner Dolphin (*Stenella* sp.)	*123	-	-	*31	-	-	*55	-	-	*0.4	-	-	*10.5	-	-
Harbor Porpoise (*Phocoena phocoena*)	*118	-	-	*29	-	-	*53	-	-	*0.3	-	-	*9.9	-	-

Pounds of meat /day calculated at 2.94 lbs of meat/person/day (Binford 1978).
Mean live weights derived from Bigg (1981), Daugherty (1979), Fiscus (1978), Gaskin (1982), Gihr & Pilleri (1969), Kanwisher & Ridgeway (1983), Kenyon (1969), Leatherwood & Reeves (1978), Leatherwood & Walker (1979), Lluch-Belda (1969a; 1969b), McGinnis & Schusterman (1981), Nishiwaki (1972), Norris & Prescott (1961), Perrin (1975), Walker (1975), White (1953).
M = male; F = female; J = juvenile; w = weaned juvenile; p = pup; nb = newborn; * = mean weight for adult animal; ^{5m} = 5 month old calf.

uppermost Stratum I on Mound B indicated a temporal unity and allowed for their designation as Stratum I loci.

Of the 13 carbon samples submitted for dating, the initial eight radiocarbon dates obtained for SNI-11 were tested at the Imperial Valley College Radiocarbon Laboratory (IVC) and the Gakushain Laboratory (Gak). Six of these radiocarbon dates were obtained for Stratum I. One carbon sample was processed from each Stratum I location on Mounds A, C and D (Md A: Gak-8204 = 2,220±110 years B.P.; Md C: IVC-44 = 1,559±120 years B.P.; Md D: IVC-45 =573±109 years B.P.), while three dates were obtained for the uppermost stratum on Mound B (IVC-81 = 650±45 years B.P.; IVC-82 = 960±46 years B.P.; and Gak-8205 = 3,820±120 years B.P.). The latter date of 3,820 radiocarbon years was rejected as out of sequence and therefore too early. On Mound B, a single carbon sample each was dated from Stratum II (Gak-8206 = 3,430± 130 years B.P.) and Stratum III (Gak-8207 = 4,140±140 years B.P.).

Five subsequent radiocarbon dates, processed through the Radiocarbon Laboratory at UCLA, suggest that the depositional record of the Thousand Springs site is quite complex and is older than the IVC and Gak series of dates indicate. The calibrated date for Stratum III was extended from 4,500-4,900 years B.P. (Gak-8207) to 6,800 years B.P. (UCLA-2559D). Although the 6,800 cal B.P. date is from a shallower level (140-150 cm) than the Gak-8207 of 4,500-4,900 cal B.P., these depths reflect the 10° slope of the Stratum III deposit exposed in unit 0N/31.5W. Stratum II's calibrated date-range was increased from 3,650-3,950 years B.P. (Gak-8206) to include 4,150-4,450 years B.P. (UCLA-2559E). The three Stratum I charcoal samples [UCLA-2559A = 3,725±80 years B.P.; UCLA-2559B = 3,725±80 years B.P.; UCLA-2559C = 3,725±80 years B.P.] are significantly out of sequence, however, and are rejected. Nine radiocarbon dates do align with the serial stratigraphy preserved at the Thousand Springs site, and the temporal order of the three strata on SNI-11 may be organized as follows:

Stratum I	(Mounds A, B, C and D)	A.D. 1,250-300 B.C.
Stratum II	(Mounds B)	1,700-2,500 B.C.
Stratum III	(Mounds B)	2,550-4,850 B.C.

Faunal Remains: Osteological remains of fish, marine and terrestrial mammal, bird and reptile species were recovered during the

Table 3. Gross bone weights of the taxonomic classes by mound and stratum from the Thousand Springs site (SNI-11).

	Stratum I								
	Upper Component			Lower Component			Total Mound A		
Class	gm	gm/m³	%	gm	gm/m³	%	gm	gm/m³	%
Mammalia*	1,862.8	752.6	41.0-	1,188.5	240.1	23.4	3,051.3	410.9	31.8
Aves	131.3	53.0	2.9	112.9	22.8	2.2	244.2	32.9	2.5
Pisces	2,545.3	1,028.4	56.1	3,768.8	761.4	74.3	6,314.1	850.4	65.7
Reptilia									
Total Bone Weight	4,539.4	1,834.1	100.0	4,070.2	1,024.3	100.0	9,609.6	1,294.2	100.0
Column Samples									
Total Bone Weight									
Total Shell Weight									

* Weight does not include the minke whale scapula in Stratum II.
gm = total weight in grams; gm/m3 = total weight in grams/m³; % = percent of total weight/component, mound or stratum. The gm/m³ figure for the column samples is a projected measure for a m³ of midden.

excavation of the Thousand Springs site (SNI-11). Although the reptile bone and a 20% sample of the fishes have been identified, only the analysis of the mammalian and avian remains is discussed in this report.

The vertebrate faunal collection available for study from SNI-11 represents only that bone recovered during the excavation of each test unit, as well as all of the non-artifactual and non-human osteological midden constituents which failed to pass through the 1/4 inch mesh screens. The resulting faunal assemblage was transported to the Archaeology Laboratory, California State University, Los Angeles, for curation and analysis.

The faunal specimens from each unit and level initially were sorted into their general class of Mammalia, Aves, Pisces and Reptilia. Within each arbitrary 10 cm level, the natural stratigraphic provenience of the faunal remains was retained during this sorting by class. The gross bone-weight of each class sample (recorded by unit and level) is presented in Table 3 by stratigraphic provenience.

The skeletal specimens within each class sample were categorized to the most specific taxonomic level possible by using the comparative osteological collections at the Los Angeles County Natural History Museum. The mammal bone was identified by the author at the museum's Marine Laboratory, while the bird specimens were identified by Delmer E. Sanburg, Jr. in the Ornithology Laboratory of the Museum. Each faunal element was identified as to taxon, skeletal element, side (right, left, axial), bone portion (proximal, shaft, distal, body, complete), state of fusion, age size (small, medium, large) and qualitative condition (burned, mineralized, weathered and/or cut).

The Minimal Number of Individuals (MNI) represented in the mammalian and avian faunal remains from the Thousand Springs site was calculated by using a modified technique from that suggested by White (1953) and Krantz (1968).

> "The actual number of individual animals represented by a pile of bones of one species is ordinarily determined by maximum bone count: the number of bones found of a particular kind (right humerus, for example) may be taken as the *minimum* number of individuals of that species butchered in that particular deposit. A variation on this method is possible when right and left bones of the same kind can be accurately paired off as

Table 3. (continued)

Stratum I (cont.)									Stratum II			Stratum III		
Total Mound B/C			Total Mound D			Total			Total			Total		
gm	gm/m³	%	gm	gm/m³	%	gm	gm/m³	%	gm	gm/m³	%	gm	gm/m³	%
610.7	118.0	15.4	494.1	156.9	23.6	4,156.1	263.9	26.5	1,650.3	262.0	39.0	3,121.8	355.8	49.0
189.5	366	48	313.8	99.6	15.0	747.5	47.4	4.8	287.9	45.7	6.8	441.1	50.3	6.9
3,155.5	609.8	79.8	1,284.2	407.7	61.4	1,0753.8	682.8	78.7	2,289.3	363.4	54.2	2,694.9	307.1	42.3
												112.8	12.8	1.8
3,955.7	764.4	100.0	2,092.1	664.2	100.0	1,5657.4	994.1	100.0	4,227.5	671.0	100.0	6,370.6	726.0	100.0
									53.9	17,966.7	116.0	9666.7	158.6	6100.0
									707.2	235,733.3	2,178.6	1,81550.0	2,507.1	9,6426.9

having come from the same individual. In this case the minimum number of individuals is equal to the number of pairs of a given bone, plus the unpaired rights, plus the unpaired lefts. This method usually yields a higher total and is thus closer to the actual number of individuals originally involved" (Krantz 1968:286).

In the case of the mammalian and avian faunal remains from SNI-11, few duplications of skeletal elements of the same side occurred for each species from a given level. In determining the MNI for each species from skeletal element and side, the additional criteria of age and age size were included in the calculations. The two right humeri of large-adult sea otters would be distinguished from the left femur of a small adult of the same species for a minimum number of three individuals rather than two.

The faunal assemblage from SNI-11 was divided into sample sizes for the determination of MNI according to the "maximum distinction approach". As opposed to treating the site as a single aggregate or its three strata as aggregate units following the "minimum distinction approach" discussed by Grayson (1984), the maximum distinction method separates the faunal collection into smaller clusters based upon both the horizontal (excavation unit) and vertical (level) provenience. The minimum distinction method eliminates the possibility of misrepresenting the scattered remains from a single individual as an MNI of more than one. In calculating the MNI from the most common paired or axial skeletal element, however, distinctions between individuals exhibiting the same osteological characteristics, while lacking in duplicated elements, would be obscured or minimally distinct. The faunal clusters used to determine MNI at the Thousand Springs site were determined by the proveniences of the natural stratigraphy within the arbitrary levels of each excavation unit.

Results

Mammals: Of the 4,570 mammal bones analyzed from the Thousand Springs site, 2,270 specimens (49.7%) were identified to the taxonomic level of species. The remaining 2,300 mammal bones (50.3%) were classified by their size categories of large or small Pinnipedia or Cetacea (Table 4).

The greatest diversity of species occurs in Stratum I, the uppermost tier of occupation midden. Two species of canids and 14 marine-mammal species were identified from this stratum. The mammalian faunal assemblage recovered from the 15.75 m^3 of midden excavated from Stratum I totaled 2,072 specimens, and a density of 132 mammal bones/m^3 of midden was recorded.

Stratum II yielded nine marine-mammal species as well as a mammal-bone density of 224 bones/m^3. The volume of midden excavated from Stratum II totaled 6.3 m^3. The apparent increase of bone density in this stratum is principally caused by the 691 fragmented remains of a Minke whale (*Balaenoptera acutorastrata*) scapula. The fact that bone-density figures are only quantifications of specimen numbers per volume of midden and do not imply an indication of bone mass or weight becomes apparent when dealing with whale bones. Cetacean bone is characteristically porous and, when degreased, has a comparatively lower weight-to-mass ratio than that found in terrestrial mammal bone. As a midden constituent, cetacean bone also is more friable than the bones from species belonging to other mammalian orders. The 691 fragments of bone comprising the Minke whale scapula may be treated as a single element within Stratum II and thus reduce the total mammal-bone count from 1,410 specimens to 720 bones. The density of bone calculated for this intermediate stratum may be revised from 224 specimens/m^3 to 114 bones/m^3. Rather than an increase in density, this revised density-figure reflects a decrease in the frequency of mammal bone

from Stratum II in comparison to the density of mammalian faunal remains found within the later Stratum I.

The 8.775 m^3 of midden excavated from Stratum III yielded a total of 1,088 mammal bones. One Indian dog (*Canis familiaris*) and nine species of marine mammals were identified from the Stratum III faunal assemblage. The mammal-bone density in this lowermost stratum numbered 124 specimens/m^3 of midden.

Table 4. Mammalian taxa by strata at the Thousand Springs site (SNI-11).

	Site Total			Total Stratum I					Total Stratum II					Total Stratum III				
Taxa	E	B	MNI	E	E/m³	B	MNI	MNI/m³	E	E/m³	B	MNI	MNI/m³	E	E/m³	B	MNI	MNI/m³
Fissipedia																		
Dog *Canis familiaris*	39	1	5	37	2.3	0	3	0.2						2	0.2	1	2	0.2
San Nicolas Island Fox *Urocyon littoralis dickeyi*	2	0	1	2	0.1	0	1	0.1										
Sea Otter *Enhydra lutris lutris*	619	369	124	325	20.6	201	61	3.9	188	29.8	121	32	5.1	106	12.1	74	31	3.5
Pinnipedia (Large)	**213**	**92**	**40**	**44**	**2.8**	**39**	**11**	**0.7**	**51**	**8.1**	**30**	**13**	**2.1**	**122**	**13.9**	**23**	**16**	**1.8**
California Sea Lion *Zalophus californianus*	126	24	27	12	0.8	5	7	0.4	8	1.3	4	5	1.0	106	12.1	15	15	1.7
Elephant Seal *Mirounga angustirostris*	14	1	4	1	0.1	1	1	0.1	2	0.3	0	1	0.2	11	1.2	0	2	0.2
Pinnipedia (Small)	**1,268**	**711**	**111**	**615**	**39**	**392**	**61**	**3.9**	**224**	**35.6**	**92**	**24**	**3.8**	**429**	**48.9**	**227**	**26**	**3.0**
Guadalupe Fur Seal *Arctocephalus townsendi*	428	176	104	197	12.5	82	53	3.4	72	11.4	22	19	2.9	149	18.1	72	32	3.5
Northern Fur Seal *Callorhinus ursinus*	102	39	18	94	6.0	36	15	1.0	7	1.0	3	2	0.3	1	0.1	0	1	0.1
Harbor Seal *Phoca vitulina richardsi*	27	8	12	14	0.9	3	5	0.3	7	1.0	1	3	0.5	6	0.7	4	4	0.5
Cetacea (Large)	**346**	**230**	**40**	**188**	**11.9**	**158**	**14**	**0.9**	**110**	**17.5**	**22**	**13**	**2.1**	**48**	**5.5**	**22**	**13**	**1.5**
Pacific Bottlenose Dolphin *Tursiops truncatus*	5	3	3	5	0.3	3	3	0.2										
Risso's Dolphin *Grampus griseus*	3	1	3	2	0.1	1	2	0.1						1	0.1	0	1	0.1
Minke Whale *Balaenoptera acutorostrata*	691	19	1						691	109.7	19	1	0.2					
Gray Whale *Eschrichtius robustus*	1	0	1	1	0.1	0	1	0.1										
Cetacea (Small)	**469**	**193**	**66**	**333**	**21.1**	**130**	**41**	**2.6**	**47**	**7.5**	**26**	**11**	**1.4**	**89**	**10.1**	**37**	**14**	**1.7**
Common Dolphin *Delphinus delphis*	11	5	2	11	0.7	5	2	0.1										
Pacific White-Sided Dolphin *Lagenorhynchus obliquidens*	108	10	14	100	6.3	9	9	0.6	2	0.3	0	1	0.2	6	0.7	1	4	0.5
Northern Right Whale Dolphin *Lissodelphis borealis*	90	9	17	87	5.5	7	15	1.0	1	0.2	1	1	0.2	2	0.2	1	1	0.1
Spinner Dolphin *Stenella longirostris*	1	0	1	1	0.1	0	1	0.1										
Harbor Porpoise *Phocoena phocoena*	3	0	2	3	0.4	0	2	0.3										

E = total number of elements/taxon; E/m^3 = number of elements/m^3; B = number of burned elements; MNI = minimum number of individuals; MNI/m^3 = minimum number of individuals/m^3.

Birds: Fifteen species of medium- to large-sized birds were identified from the middens of SNI-11. Eight taxonomic orders are represented by these species: Gaviformes (loons); Podicipediformes (grebes); Procellariiformes (tubenoses); Pelecaniformes (pelicans and allies); Ciconiiformes (herons and allies); Anseriformes (goose-like birds); Falconiformes (vultures, hawks and falcons) and Charadriiformes (gulls, alcids and shorebirds). Three of these orders – the Procellariiformes, Pelecaniformes and Charadriiformes – were the most heavily exploited throughout the three occupations of the Thousand Springs site (Table 5).

Foster & Schiel (1985:76) define three habitats used by birds feeding around the kelp forests of California: 1) Kelp Forest – living, attached kelp in association with rocky substrata; 2) Drift Kelp – detached kelp that may be found floating far out to sea in the pelagic zone and 3) Kelp Wrack – detached kelp deposited on the beach by water motion.

Within the kelp-forest habitat, they distinguish three subhabitats and provide an initial listing of avifauna utilizing each zone. Their three distinct subhabitats are: 1) the surface canopy; 2) the midwater and bottom substrata beneath the canopy and 3) the seaward fringe of the forest.

Foster & Schiel (1985) caution that their list, based primarily upon personal communication and secondarily on the very few published accounts, is an incomplete summary of avian-species clusters in relationship to the substrata of the kelp forest. Based upon this study, however, the species of birds from the Thousand Springs site may be organized by their association with these subhabitat categories. A fourth subhabitat – the inshore fringe of the kelp bed – mentioned by Foster & Schiel is included for the Thousand Springs site avifauna-assemblage. The birds identified from SNI-11 and associated with the kelp-bed environment are as follows: 1) Surface Canopy - western gull and great blue heron; 2) Midwater and Bottom – eared grebe and Brandt's cormorant; 3) Seaward Fringe - Brandt's cormorant and auklets and 4) Inshore Fringe - loons, grebes and cormorants.

The bird most closely associated with the subhabitats of the kelp beds off California is the Brandt's cormorant (Foster & Schiel 1985). Within the middens at SNI-11, the Brandt's cormorant ranks as the third most-abundant species both in frequency and MNI.

The avian species which occur throughout each of the three strata at SNI-11 are all marine birds inhabiting offshore waters. Three of these species - the Brandt's cormorant, western gull and Cassin's auklet - also are associated with the surface canopy and seaward fringe of the kelp-bed habitat. The northern fulmar and the short-tailed albatross are the two truly pelagic representatives of this offshore avian assemblage. The habitat associations of these birds reflect a persistent targeting by the Nicoleños of the seaward portion of the kelp-forest environment during each period of tenancy at the Thousand Springs site.

Discussion

The faunal assemblage excavated from the stratified Thousand Springs site (SNI-11) diachronically exhibits a shift in the proportional exploitation of animal classes (Table 3) which increasingly stressed the procurement of fish species. The consistent emphasis in the faunal collection of avian species which forage the kelp beds and offshore waters indicates a persistent exploitation of the zones throughout the occupations of SNI-11. The general decline in the specialized procurement of pinnipeds, following the earliest occupation period at the Thousand Springs site, especially was marked with respect to large pinnipeds. Conversely, a diversification in cetacean species, as well as an increased harvesting of toothed Cetacea, is notable during the late Stratum I period (Table 4). This exchange - from the targeting of large pinnipeds during the initial residency at SNI-11 to an expanded exploitation of cetacean species in the latest occupation - reflects the Nicoleños' increased and predominantly generalized exploitation of their offshore environs through time.

Specialized strategies for the capture and utilization of pinnipeds and sea otters are indicated within the faunal assemblage from SNI-11 as well as reconstructions from earlier accounts concerning the procurement of these animals. Pinnipeds would have been exploited most readily through shore-based forays at their rookery sites by aboriginal hunting parties. The large pinnipeds (California sea lion and northern elephant seal), as well as the smaller harbor seal, could have been stampeded inland from the beach by the hunters and readily dispatched with clubs or spearing weapons. Although no spear foreshafts were excavated from SNI-11, barbed-bone fish-spear and harpoon points have been documented from San Nicolas Island by way of early collectors during the later 1800s (Bennyhoff 1950; Hoover 1973; Hudson & Blackburn 1982). The fur seals (Guadalupe fur seal and northern fur seal) also could be hunted in this

Table 5. Avian taxa by stratum at the Thousand Springs site (SNI-11).

	Stratum I				Stratum II				Stratum III			
Taxa	E	E/m³	MNI	MNI/m³	E	E/m³	MNI	MNI/m³	E	E/m³	MNI	MNI/m³
Pacific Loon *Gavia arctica pacifica*					2	0.3	1	0.2				
Eared Grebe *Podiceps nigricollis californianus*	3	0.2	2	0.1					5	0.6	3	0.3
Short-tailed Albatross *Diomedea albatrus*	119	7.6	24	1.5	17	2.7	9	1.4	14	1.6	6	0.7
Black-footed Albatross *Diomedea nigripes*	3	0.2	2	0.1								
Northern Fulmar *Fulmarus glacialis rogersii*	13	0.8	9	0.6	35	5.6	8	1.3	131	14.9	18	2.0
Double-crested Cormorant *Phalacrocorax auritus albociliatus*					12	1.9	4	0.6				
Brandt's Cormorant *Phalacrocorax penicillatus*	29	1.8	15	1.0	6	1.0	4	0.6	30	3.4	8	0.9
Great Blue Heron *Ardea herodias herodias*									2	0.2	1	0.1
Lesser Canada Goose *Branta canadensis parvipes*					1	0.2	1	0.1				
Peregrine Falcon *Falco peregrinus anatum*					4	0.6	1	0.2				
California Gull *Larus californicus*	4	0.2	4	0.2	4	0.6	2	0.3	2	0.2	2	0.2
Glaucous-winged Gull *Larus glaucescens*	1	0.1	1	0.1	7	1.1	5	0.8	3	0.3	1	0.1
Western Gull *Larus occidentalis*	12	0.8	9	0.6	11	1.7	5	0.8	11	1.2	4	0.5
Cassin's Auklet *Ptychoramphus aleuticus*	8	0.5	5	0.3	10	1.6	4	0.6	5	0.6	3	0.3
Rhinoceros Auklet *Cerorhinca monocerata*	5	0.3	2	0.1								

E = total number of elements/species; E/m³ = number of elements/m³; MNI = minimum number of individuals; MNI/m³ = minimum number of individuals/m³.

cooperative manner. The fur-bearing pelts of these species, however, were an important product, and weapons which would have torn or pierced a hide probably were avoided in favor of clubs.

Kroeber & Barrett's (1962) study of the seal-hunting strategies practiced among the coastal northwestern Californians (Yurok, Tolowa, Wiyot, Bear River, Mattole and Sinkyone) describes the hunting of pinnipeds as centering around these animals' haul-out locations. One or more canoes of five to six men each would approach a pinniped rookery or rocky haul-out, and three to four men per canoe would disembark to procure the animals with clubs and harpoons. The other hunters would wait in their boats to finish off any injured animals attempting to escape from shore to the water.

The Yurok considered the morning hours to be the proper time to initiate a pinniped hunt, because a large animal might take as long as half a day to kill. The offshore killing of wounded or injured animals was a more arduous task than the shore-based forays. Accounts of canoes being towed out to sea by large pinnipeds before the hunters could dispatch the fatigued mammal were cited by Yurok and Bear River informants (Kroeber & Barrett 1962).

That the harpoons and canoes employed by the Channel Islanders were equal to the stresses of offshore sealing as practiced by the coastal northwestern California Indians is suggested by a similar Chumash canoe trek as noted by John P. Harrington. This account involved three Chumash fishermen who would embark in the early morning hours to go fishing. On one recorded occasion, after harpooning a giant sea bass (a fish which may weigh over 227 kg and measure 226 cm in length), they were towed from Los Pitos, Ventura County, nearly to Santa Cruz Island (Hudson & Blackburn 1982; Hudson *et al.* 1978).

The resources of blubber and meat, as well as the pelts or hides from pinnipeds, required rendering prior to use. Unless restraint was practiced with regard to the quantities of these mammals to be killed, the surpluses of blubber and meat would mandate the immediate processing of these resources to avoid a loss of their net yield. Kroeber & Barrett (1962:120) stated that for the Mattole "a hunting party would, with luck, succeed in taking a number of seals, even ten to twenty, in a day." The preparation of a large catch necessitated an aggregate of people to participate in the time-consuming tasks of skinning, butchering, tanning, meat curing and processing of the blubber before flies and time rotted the animals beyond chemical and cultural acceptability.

Regular forays by the Nicoleños into rookery sites, which would have disturbed the pinnipeds enough to cause the abandonment of the haul-out site, may not have occurred. The decreasing frequency of large-pinniped remains over time within the Thousand Springs middens may indicate the increasing displacement of their rookery sites away from the locality of SNI-11. If a sufficiency of surplus resources could by processed and stored, the intervals between these hunting forays may have been prolonged enough to mollify the disturbance of the rookery herds. The more tenacious Guadalupe fur seal may have maintained its rookery location, despite human predators, at the cost of a general decrease in the herd's population.

The increased exploitation of sea otters during the Stratum II occupation of SNI-11 followed by the Stratum I increase in the procurement of northern fur seal resources proportionally offset the exploitive pressure on Guadalupe fur seals. These alterations in the targeting of species affected by the Nicoleños may have forestalled the elimination of relatively local Guadalupe fur seal rookeries as well as reducing the frequency of disturbance at these haul-out sites.

The sea otter was principally hunted by the Nicoleños within its kelp-bed habitat (Bleitz-Sanburg 1987). The specialized targeting of this marine mammal for its fur and meat would not have required the larger hunting units organized for capturing pinnipeds. Instead, these diminutive mammals could be procured by single canoes containing two or three men. Sea otters fleeing under water may achieve speeds up to 5 kts as opposed to only 1.5 kts at the water's surface. The animals could have been overtaken by a canoe such as the *tomol*, which accomplished speeds of 6-8 kts (Hudson *et al.* 1978).

Nets or special snares probably were employed to capture the sea otter in preference to weapons which might have damaged this fur-bearing mammal's pelt. Kroeber (1925) suggests that sea-otter furs may have constituted the chief item of export from San Nicolas Island. The preponderance of harpoon points recovered from San Nicolas Island in comparison to the relative scarcity of this artifact from the other Channel Islands indicated to Bennyhoff (1950) a special emphasis on marine-mammal hunting and a particular focus on the fur-bearing sea otter due to the Nicoleños' isolated and restricted insular environment. He also considered the use of this weapon by the Channel Islanders to be a late development. Utilization of harpoon arrows, as described by Bennyhoff (1950) and Robinson (1933) for hunting sea otters, is indicated by the existence of a possible barbed harpoon-arrow foreshaft which was found on San Nicolas Island in 1882 (Nelson 1936).

The fortuitous strandings of whales upon the shores of San Nicolas Island were, as with the coastal Chumash and northwestern California Indians (Kroeber & Barrett 1962; Yates 1957), occasions for festivity which required the community's involvement in order to harvest and process the superabundance of meat, blubber and bones. The process of defleshing one of these mammoth animals may have followed the same basic pattern used by the northwestern California Indians. Among the Chumash, as well as the northwest Californians, the family or village who owned the beach upon which the whale washed ashore also owned the carcass (Blackburn 1975; Kroeber & Barrett 1962). The individual and village ownership of resource privileges to coastal sites for food procurement, as was recorded for the Luiseños (Bean & Shipek 1978; Sparkman 1908), may have generally pertained for the Indians of the Southern California Bight. This code of beach and carcass ownership may have prevailed on San Nicolas Island as well. The orderly distribution of whale portions may not have gone without violent disputes as reported by Yates (1957) in reference to the Barbareño Chumash and by Waterman (1920) for the Yurok.

Butchering of whales involved the use of a cutting tool such as a bone, flint or slate knife, or a meat saw. A serrated slate blade found in 1882 on San Nicolas Island is described by Nelson (1936). Deep parallel cuts were made into the whale, and tumplines were tied into holes pierced into the ends of these strips. Men generally did the cutting, while the women pulled on the tumplines to aid in separating the blubber or meat away from the carcass. If men were not available, the women would assume the task of cutting. The blubber was removed in strips first by cutting through this thick layer and separating it from the interfacing muscle layer. These blocks of fat were then dragged by the women to the water to wash off the blood prior to "trying out" the oil. The sheets of muscle also were removed in blocked strips. A greater amount of stress on the tumplines was required in order to tear the meat as the cutter made his/her incisions. People who lived farthest from the beached carcass dried and cooked their portions of meat and blubber at the "kill site" by using driftwood fires; whereas, those who lived closest returned to their campsite to cure and "try out" their cuts of whale. Steatite dishes or turtle shells were used to catch the oil as it dripped out from the cooking blubber. The oil was generally stored in the paunches and bladders of pinnipeds (Kroeber & Barrett 1962).

An aggregation of people was mobilized to participate in butchering whales whenever a beached animal was sighted by the Nicoleños. The episodic frequency of whale beachings would require an opportunistic harvesting and apportionment of the superabundant meat and blubber if large cetacean resources were to constitute a significant contribution to the Nicoleños' diet.

The characteristic behaviors of the avian and small cetacean species identified within the faunal assemblage of SNI-11 delineate a procurement strategy for these species which was generalized and opportunistic. The upper swimming speeds of healthy dolphins and porpoises range between 10-15 kts and, with the possible exception of the slower Risso's dolphin (average speed = 5 kts), could easily outdistance a *tomol* which will only reach speeds of up to 6-8 kts (Hudson *et al.* 1978). Unless these cetaceans were sick or injured, it is unlikely that they could be pursued and harpooned from a canoe. Aside from the procurement of randomly beached specimens, the small cetaceans probably would have been captured by drowning them in nets and secondarily capturing them on baited fishing lines (Bleitz-Sanburg 1987).

The increase in fishing during the late occupation of the Thousand Springs site is demonstrated by a near doubling in weight of fish bone/m^3 of midden as well as a proportional rise in relative mass per stratum of 14.5% (Table 3). This marked alteration in the targeting of piscine fauna in Stratum I coincides with the increase and diversification of cetacean species within the Stratum I faunal assemblage. The expansion of fishing activities by the Nicoleños most likely led to an increase in the entrapment of small cetaceans within the fishing nets and provided an attraction for these piscivores which lured them more frequently into the areas of offshore fishing.

Remains of the Pacific white-sided dolphin (*Lagenorhynchus obliquidens*), as well as of its rarer relative - the distinctive northern right whale dolphin (*Lissodelphis borealis*), occur in all three strata of the Thousand Springs site. The frequency of these remains, however, increased dramatically during the late occupation. Populations of *L. obliquidens* are resident around San Nicolas Island, and *L. borealis* schools frequently intermix with herds of "lags". The feeding habits of *L. obliquidens* would bring it into the vicinity of the insular kelp forests when shoals of Clupeiform fish (herrings, sardines, anchovies) were chased. This cetacean, therefore, easily could become enmeshed in or hooked on the Nicoleños' fishing equipment. The dolphin, if not drowned in the net, would be contained or, if hooked, would become exhausted enough to the point where a harpooner could attempt to dispatch the animal. The northern right whale dolphin, which tends to become less easily disturbed when schooling with "lags," will flee danger by swimming just below the water's surface. This characteristic greatly would increase the chances of the northern right whale dolphin's entanglement in fishing nets while schooling near the insular kelp beds with Pacific white-sided dolphin herds.

These opportunistically procured small cetaceans would have required few people for processing the carcass, since individual animals were probably sporadically captured. The carcass could subsequently be "schlepped" to the site.

The marine birds represented within the Thousand Springs faunal assemblage do not indicate an exploitation of these species at their breeding sites, which are easily disrupted by human predators. Instead, adult specimens more likely were procured as an opportunistic by-product of fishing the kelp beds. The preponderance of avian species preserved from SNI-11 falls within three taxonomic orders - Procellariiformes, Charadriiformes and Pelecaniformes. The albatrosses, northern fulmar (Procellariiformes) and gulls (Charadriiformes) are the dominant genera which were captured by the Nicoleños at the Thousand Springs site (Table 5). These genera share the common behavior of being surface-feeding, offshore-marine birds which will snatch and swallow hooks baited with fish or fats. In addition, these birds, especially the Procellariiformes, are noted for glutting on fats and blubber to the point of flightlessness and thus would be easy prey for capture by hand.

The cormorants (Pelecaniformes) and auklets (Charadriiformes) share, with the less frequently procured Pacific loon (Gaviiformes) and eared grebe (Podicipediformes), the behavior of pursuing their prey by swimming or "flying" underwater. These swim-pursuit species would have been most vulnerable to capture by drowning in fishing nets. Cormorants, as well as albatrosses, have been captured by contemporary fishermen in this manner (Robbins & Rice 1974; Sowls *et al.* 1980).

Although no net remains or weights were excavated from the Thousand Springs site, net weights have been recovered from other sites on San Nicolas Island which equate in time with each of the three occupation strata at SNI-11 (Lauter 1982). The grooved and perforated net-weights from San Nicolas Island are nearly identical to those used by the Indians of northwestern California on their flat, gill or set nets and seines (Kroeber & Barrett 1962). Perforated shaped-stone rings from San Nicolas Island, which are attributed as digging-stick weights, probably also were used as net weights (Hudson & Blackburn 1982; Putnam 1879a).

Fragments of nets from San Nicolas Island also have been reported by Hoover (1973) and Rozaire (1957) and recently were excavated from SNI-38 (pers. obs. 1992). The capture of a marine bird in one of these nets may not have disrupted the fishing operation. The entanglement of a marine mammal, such as a cetacean or a pinniped, would most likely have damaged the net and at least disrupted the fishing. A similar problem is described for the Tolowa fisherman of northwestern California. "[The gill net] was watched very carefully, chiefly because a seal or sea lion, following the fish, might tangle in the net and ruin it in a very few minutes. The repair of a torn net might consume at best two or three days" (Kroeber & Barrett 1962:52).

Birds, as with cetaceans, probably were captured sporadically by fishermen. Few people would have been required to process these avian species into their constituent resources of feathers, skin meat and bone. Marine birds were undoubtedly an important aspect within the Nicoleños' fishing strategy. The presence of flocks of birds feeding around the kelp-forest perimeters would have signaled to the fishermen the location of schooling fishes. Kroeber & Barrett (1962:89) reported just such a practice employed by the ocean-fishing northwestern California Indians. "The fishermen could always keep track of the spots where the fish were thus congregating by noting where the gulls, cormorants, pelicans, and other birds were hovering as they fed on these fish."

Conclusion

The mammalian and avian marine fauna from the Thousand Springs site may be grouped into Heffley's (1981) model of species distribution in order to gain an insight concerning the Nicoleños' exploitation patterns. Evenly-spaced and stable species include resident and common marine-vertebrates, such as fishes, sea otter, short-tailed albatross, northern fulmar, Brandt's cormorant, western gull and Cassin's auklet. Mobile, clumped and unpredictable species include cetaceans, elephant seals, northern fur seals (prior to rookery establishment) and non-resident wintering birds. Clumped and predictable animals would be represented by populations of essentially resident California sea lions, fur seals, and harbor seals.

The procurement of clumped species may have resulted in superabundances of food resources which could be cached. Storage of food would have allowed for aggregations of family units to coexist at central semi-permanent locations, such as the Thousand Springs site. Ethnographic accounts concerning the processing of cetacean and pinniped species by the coastal Indians of northwestern California indicate that cooperative efforts were needed to render these mammals into the desired constituent resources (Bleitz-Sanburg 1987).

Within the earlier component of Stratum I, a proportional decline in the weight of mammal bone occurs in conjunction with the distinct increase by weight of fish bone (Table 3). Abatement from the hunting of pinnipeds and sea otters during this period indicates a procurement-strategy change toward low-risk, evenly-spaced and stable species which allows for smaller aggregates of people to be involved in butchering and caching tasks. The expanded diversity in small cetacean species from the narrower range of these animals noted in the earlier two strata (II and III) reflects this increased targeting of the offshore habitat for the reliable piscine fauna.

The intensified exploitation of fishes continues throughout both the earlier and later components of Stratum I. Within the later component of Stratum I, however, the targeting of sea otters and fur seals is reintensified. In addition, an expansion in both the diversity and quantity of cetacean, as well as pinniped species procured, is evident in this upper component of Stratum I. The continued heavy exploitation of low-risk, evenly-spaced and stable species coincides during the latest occupation period with a reinvestment in the procurement of both clumped and predictable, as well as mobile clumped and unpredictable, species. This expanded procurement of a more diverse range of vertebrates, which includes both evenly-spaced types and clumped species, indicates an increase in the size of the resource-sharing groups centered at the Thousand Springs site.

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