Faunal Remains from CA-LAN-2630, California State University, Long Beach

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Abstract

Analysis of faunal remains recovered from CA-LAN-2630 on the campus of California State University, Long Beach, revealed a composite prehistoric/historic archaeofauna signifying long-term mixed usage of large and small land mammals, waterfowl, aquatic fauna such as marine mammals, turtles, and frogs, and marine and estuarine fish. A large quantity of shellfish remains attests to the intensive use of both the marine and estuarine environments. The diversity of taxa in the prehistoric context suggests that LAN-2630 was primarily a residential camp at which a wide range of food resources from the immediate vicinity was consumed. The prehistoric archaeofauna is overlain by and partially intermixed with a historic archaeofauna including many of the same species found in the prehistoric archaeofauna as well as domestic livestock.

Introduction

CA-LAN-2630 is a deeply buried site on the campus of California State University, Long Beach. Details of excavation methods, units, and screening are fully documented in Boxt and Dillon (2013) and are only partly reiterated here. The site had an estimated area of 15,700m^2, and a total of 121.29m^3 of midden was excavated. This yielded bone, shell, charcoal, pottery, and artifacts made from stone, shell, and bone. Radiocarbon dates range between AD 1150 to 1700 and cluster in the Late Prehistoric period between AD 1400 and 1600 (Boxt and Dillon 2013). However, a number of reversals and mixed historic and prehistoric dates and faunal remains suggest that stratigraphy had been disturbed to some extent by bioturbation, flood episodes, and agricultural activities. The upper 60 cm of the site is deemed to be mixed (Boxt and Dillon 2013) and based on recovery of domestic bone, separation of the historic and prehistoric deposits is established at 60 cm.

The site's vertebrate archaeofauna consists of 44,416 specimens weighing more than 9,090 g. It consists of large and small land mammals, waterfowl, aquatic fauna such as turtles and frogs, and marine and estuarine fish. Marine mammals are also present in small quantities. The faunal specimens are highly fragmented, and many are stained, probably by waterborne minerals. Nearly half of the small mammal bone is burrowing rodentia, much of which appears to be intrusive.

In addition to the vertebrate archaeofauna, an enormous quantity (1.25 metric tons) of subsistence-related shellfish remains was recovered. Miller and Boxt (2009, 2010) present the ecological and nutritional considerations of the invertebrate archaeofauna, and Boxt and Hale (2016) present shellfish depositional data and shellfish artifacts. Eighty-nine percent of the shellfish was recovered above the 60-cm separation level (Boxt and Hale 2016:5).

Methods

All vertebrate faunal material was water screened through 1/8-in mesh and identified by the staff of the Zooarchaeology Laboratory of the Cotsen Institute of Archaeology at UCLA. Identifications were made to the most detailed taxonomic level possible using the laboratory's comparative osteological collection. In addition to taxonomic identification, recorded data includes skeletal element, part of element, anatomical side, age, weight, and modification such as burning, butchering, gnawing, or evidence of tool manufacture.

Specimens that could not be identified to genus or species were identified to class (e.g., mammal, bird) and size (e.g., small, medium, large). Size distinctions for mammals are: small (animals of jackrabbit size or smaller); medium (animals larger than jackrabbit but smaller than deer); and large (animals of deer size or larger). For birds, “large” was used for birds larger than a duck, “medium” was used for duck-size birds, and “small” was used for birds smaller than a duck, such as crows, blackbirds, and sparrows.

Quantitative Summary of the Collection

Table 1 presents the LAN-2630 vertebrate archaeofauna in terms of frequency (i.e., Number of Identified Specimens, NISP) and weight. In this collection 59 species and 22 genera were identified. Some 39 broader taxonomic categories (orders/suborders, families, and classes/sizes) were also identified. Some 11 percent of the collection was identified to the species level, and another 1.9 percent was identified to the genus level. About 43 percent was identified to the broader taxonomic categories. Some 43.7 percent of the bone was unidentifiable except as undifferentiated vertebrata.

Table 2 summarizes weights and NISPs of the different vertebrate categories. Figure 1 presents the proportions by NISP and weight of each category. In terms of bone weight (and presumably associated meat yield), large mammals predominate. While this reflects the actual nature of the archaeofauna, it places undue emphasis on the historic component of the site in which large domestic animals (cattle, horse, sheep, pig, and goat) contributed most bone weight. There is no counterpart large mammal in the prehistoric diet except a small quantity of deer and marine mammal bone. On the other hand, the proportions shown for NISPs present a more realistic picture of the relative abundances of different faunal categories at the site. These data show that in terms of abundance many more small animals were present than large mammals.

Table 3 presents the LAN-2630 vertebrate archaeofauna based on the 60-cm separation described previously. It is important to note, however, that a considerable quantity of historic bone was recovered from the prehistoric context. Figure 2 compares the proportion of historic bone (recovered above 60 cm) and prehistoric bone (recovered below 60 cm) in terms of NISPs, and Figure 3 presents proportions of historic and prehistoric bone in terms of weights. The huge quantity of large mammal bone in the historic archaeofauna (above 60 cm) is primarily domestic livestock. There is a minor quantity of large and medium mammal (either terrestrial or marine) in the prehistoric collection, and a reliance on small mammals is apparent. Fishing is highest in the prehistoric period, suggesting that this was an important food source for the indigenous population.

Two tests can be applied to determine the comparative species richness (*sensu* Magurran 2004) and the extent of fragmentation (*sensu* Lyman 2008) of the prehistoric and historic vertebrate archaeofaunas. Species richness is tested by the Margalef Diversity Index (Magurran 2004:77). Results of this test were 6.18 for the prehistoric nonpiscine archaeofauna and 4.03 for historic nonpiscine taxa. These are both high values and indicate a highly diverse nonpiscine archaeofauna overall. The Margalef index for prehistoric fish was 3.20, and it was 1.63 for historic fish. These data indicate that the fishing harvest was more diverse during the prehistoric period.

Fragmentation is calculated by dividing the weight of a category of bone by the NISP. This test yielded a fragmentation value of 0.056 for prehistoric fish and 0.04 for fish from the historic context. Fragmentation of nonpiscine bone in the prehistoric context is 0.23

Table 1. CA-LAN-2630 Vertebrate Taxa.

Common Name	Taxon	NISP	Wt. (g)
Large Terrestrial Mammals			
Pig	*Sus scrofa*	1	.71
Cattle	*Bos taurus*	65	2,039.79
Domestic Sheep	*Ovis aries*	2	58.15
Sheep	*Ovis* spp.	33	406.33
Goat	*Capra hircus*	17	64.63
Deer, Black-tailed	*Odocoileus hemionus*	10	109.05
Hoofed Mammal—Even-toed	Artiodactyla	212	778.76
Horse	*Equus* spp.	4	115.19
Large Mammal—Undif.	Mammalia, lg	1769	2,206.17
Total		2113	5,778.77
Medium Terrestrial Mammals			
Gray Fox	*Urocyon cinereoargentus*	1	.42
Coyote	*Canis latrans*	3	2.90
Dog or Coyote.	*Canis* spp.	50	38.62
Carnivore	Carnivora	13	1.54
Raccoon	*Procyon lotor*	3	4.15
Skunk—Striped	*Mephitis mephitis*	12	12.35
Medium Mammal—Undif.	Mammalia, md	111	45.29
Total		193	105.27
Small Terrestrial Mammals			
Blacktailed Jackrabbit	*Lepus californicus*	13	1.35
Hare	*Lepus* spp.	30	4.95
Rabbit—Cottontail	*Sylvilagus auduboni*	1	.10
Rabbit	*Sylvilagus* spp.	23	3.73
Hare/Rabbit	Leporidae	13	.97
Weasel—Long Tailed	*Mustela frenata*	11	1.49
Squirrel—Western Gray	*Sciurus griseus*	58	15.17
Squirrel—California Ground	*Spermophilus beecheyi*	270	46.81
Squirrel—Ground	*Spermophilus* spp.	42	6.63
Squirrel—Tree	*Sciurus* spp.	5	3.54
Squirrel/Chipmunk	Sciuridae	80	21.94
Mole	*Scapanus latimanus*	10	1.07
Gopher—Pocket	*Thomomys bottae*	3775	446.23
Merriam's Kangaroo Rat	*Dipodomys merriami*	71	3.20
Mouse—Little Pocket	*Perognathus longimembris*	5	.06

Table 1. Continued.

Common Name	Taxon	NISP	Wt. (g)
Mouse—Pocket	*Perognathus* spp.	21	.42
Woodrat	*Neotoma* spp.	17	1.27
Mouse—Southern Grasshopper	*Onychomys torridus*	6	.10
Mouse—Parasitic	*Peromyscus californicus*	2	.06
Mouse—Deer	*Peromyscus maniculatus*	2	.02
Mouse—White-footed	*Peromyscus* spp.	15	.36
Vole—California	*Microtus californicus*	155	6.09
Vole	*Microtus* spp.	8	37
Muskrat	*Ondatra zibethicus*	1	.03
Mice/Rats/Voles	Cricetidae	1	.01
Rodent	Rodentia	37	110.78
Small Mammal – Undif.	Mammalia, sm	11628	529.89
Total		18,506	1,206.64
Marine Mammals			
Sea Lion—California	*Zalophus californianus*	3	17.37
Sea Lion & All Seals	Pinnipedia	8	14.05
Dolphin/Porpoise	Delphinidae	1	1.49
Otter—Sea	*Enhydra lutris*	42	95.93
Total		54	128.84
Unidentified Mammal Bone			
Mammal—Undif.	Mammalia	1258	199.51
Birds			
Hawks & Eagle	Accipitridae	1	.10
Blackbird—Tricolored	*Agelaius tricolor*	36	1.89
Jay—Scrub	*Aphelocoma coerulescens*	3	.08
Robin	*Turdus migratorius*	34	1.59
Crow—Common	*Corvus brachyrhynchos*	1	.08
Vulture—Turkey	*Cathartes aura*	1	.35
Albatross—Short-tailed	*Diomedea albatrus*	1	6.52
Albatross	*Diomedea* spp.	1	.04
Cormorant –Double-crested	*Phalacrocorax auritus*	1	4.94
Duck—Pintail	*Anas acuta*	1	.22
Duck—Cinnamon Teal	*Anas cyanoptera*	4	.65
Duck—Mallard	*Anas platyrhynchos*	17	6.68
Duck—Unid	*Anas* spp.	6	1.13

Table 1. Continued.

Common Name	Taxon	NISP	Wt. (g)
Goose—White-fronted	*Anser albifrons*	1	.61
Goose—Canada	*Branta canadensis*	2	6.11
Goose—Unid	*Anser* spp.	7	7.82
Goose Subfamily	Anserinae	1	.80
Bird—Perching	Passeriformes	8	.52
Bird—Unid	Aves	156	14.12
Bird—Large	Aves, large	17	4.96
Bird—Medium	Aves, medium	28	4.27
Bird—Small	Aves, small	105	6.33
Total		432	69.70
Reptiles/Amphibians			
Frog	*Rana* spp.	4	.22
Frog or Toad	Salientia	9	.52
Amphibian	Amphibia	4	.07
Turtle—Western Pond	*Clemmys marmorata*	63	18.22
Turtle	Testudinidae	11	5.22
Lizard—Coast Horned	*Phrynosoma coronatum*	28	.66
Lizard – Western Whiptail	*Cnemidophorus tigris*	1	.01
Lizard—Southern Alligator	*Elgaria multicarinatus*	6	.06
Lizard—Alligator	*Elgaria* spp.	5	.05
Lizard—Western Fence	*Sceloporus* spp.	6	.06
Iguana—Family	Iguanidae	6	.16
Lizard	Lacertilia	37	.63
Boa—Rosy	*Lichanura trivirgata*	1	.02
Boa	*Lichanura* spp.	5	.10
Long-nosed Snake	*Rhinochelius* spp.	1	.02
Garter Snake	*Thamnophis* spp.	81	1.79
Racer	*Masticophis* spp.	25	3.66
King Snake—California	*Lampropeltis* spp.	25	.96
Gopher Snake	*Pituophis melanoleucus*	210	21.19
Snake—Nonvenomous	Colubridae	148	5.03
Rattlesnake—Western	*Crotalus viridis*	1	.19
Rattlesnake	*Crotalus* spp.	105	.45.15
Viper	Viperidae	1	.06
Snake Suborder	Serpentes	115	3.36

Table 1. Continued.

Common Name	Taxon	NISP	Wt. (g)
Reptile/Amphibian	Reptilia/Amphibia	10	.31
Total		908	107.75
Unidentified Vertebrata			
Vertebrate – Undif.	Vertebrata	19,396	1,423.82
Fish—Elasmobranchi			
Smoothhounds	Triakididae	11	1.87
Ray—Bat	*Myliobatis californica*	24	1.78
Ray—Thornback	*Platyrhinoidis triseriata*	33	.87
Guitarfish—Shovelnose	*Rhinobatos productus*	44	2.78
Sharks & Rays	Elasmobranchi	73	1.99
Total		185	9.29
Fish—Osteichthyes			
Jacksmelt	*Atherinops californiensis*	20	.64
Silversides	Atherinidae	17	.18
Blacksmith	*Chromis punctipinnis*	2	.02
Herring—Family	Clupeidae	5	.05
Perch—Pile	*Damalichthys vacca*	2	.06
Surfperch—Family	Embiotocidae	396	11.29
Anchovy—Family	Engraulididae	1	.01
Corvina—California	*Menticirrhus undulatus*	3	.35
Croaker—Yellowfin	*Umbrina roncador*	26	4.99
Croaker—Black	*Cheilotrema saturnum*	2	.21
Croaker—White	*Genyonemus lineatus*	1	.12
Croaker—Spotfin	*Roncador stearnsii*	17	5.06
Croaker—Family	Sciaenidae	22	1.68
Shortfin corvina	*Cynoscion parvipinnis*	2	1.01
Flounder/Flatfish Order	Pleuronectiformes	122	2.04
Halibut—California	*Paralichthys californica*	8	.95
Mackerel—Pacific	*Scomber japonicus*	23	1.63
Jackmackerel	*Trachurus symmetricus*	1	.07
Midshipman	*Porichthys* spp.	49	1.82
Rockfish	*Sebastes* spp.	7	.57
Bass	*Paralabrax* spp.	2	.18
Sheephead—California	*Semicossyphus pulcher*	13	1.05
Bony Fish—Undif.	Osteichthyes	630	27.23
Total		1371	61.21
Site Totals		44,416	9,090.80

Table 2. CA-LAN-2630 Bone Weight and Frequency by Faunal Group.

Faunal Group	Wt. (g)	NISP
Large mammal	5778.77	2113
Medium mammal	105.27	193
Small mammal	1206.64	18506
Marine mammal	128.84	54
Undif. mammal	199.51	1258
Reptile/Amphibian	107.75	908
Bird	69.70	432
Shark/ray	9.29	185
Bony fish	61.21	1371
Vertebrata	1423.82	19396

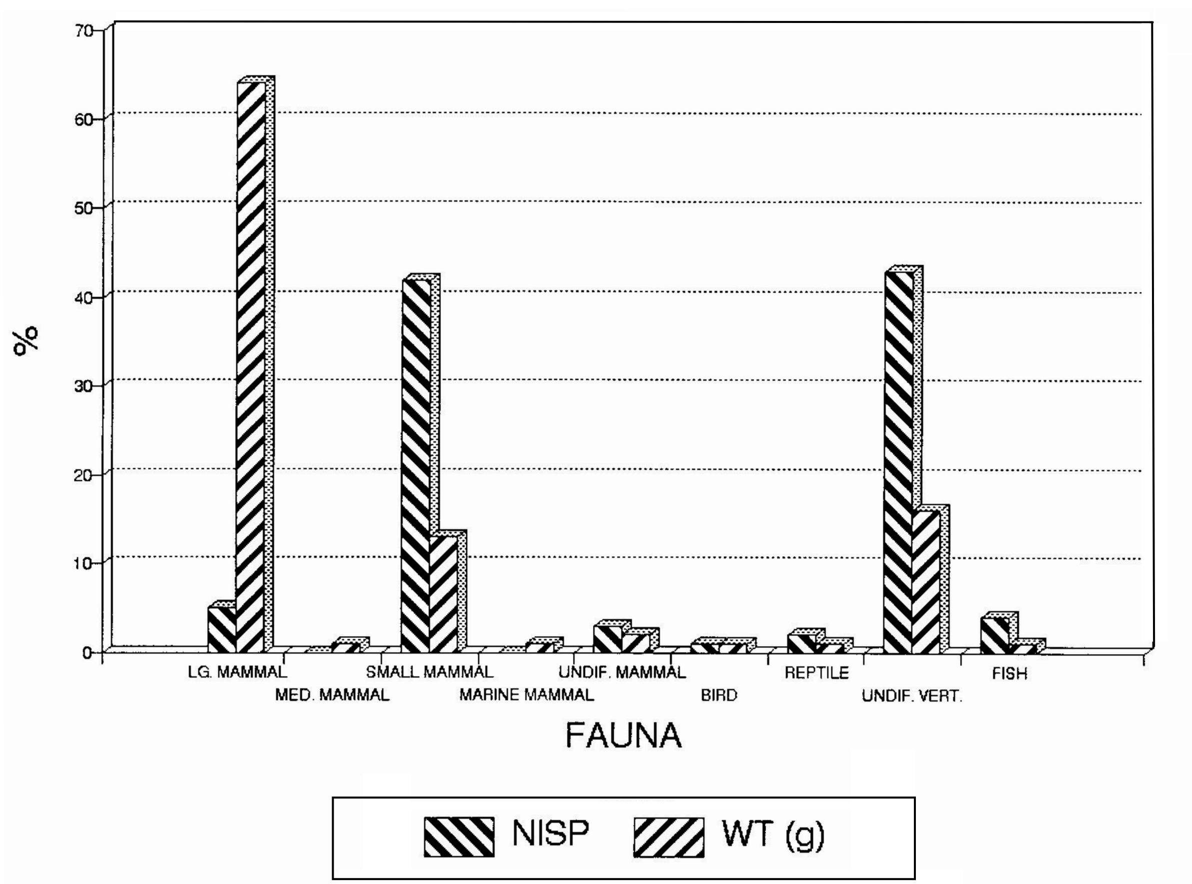

Figure 1. Proportion of NISPs and weight by faunal category.

Table 3. CA-LAN-2630 Vertebrate Taxa Based on 60-cm Separation of Domestic Bone (>60 cm = Prehistoric; <60 cm = Historic).

Taxon	Common Name	>60 cm NISP	> 60 cm Wt. (g)	<60 cm NISP	<60 cm Wt. (g)
Sus scrofa	pig	0	0	1	.71
Bos taurus	cattle	3	16.57	62	2,023.22
Ovis aries	sheep	35	464.48	0	0
Capra hircus	goat	17	64.63	0	0
Equus spp.	horse/donkey	4	115.19	0	0
Odocoileus hemionus	black-tailed (mule) deer	10	109.05	0	0
Artiodactyla	artiodactyla	5	7.64	207	771.12
Large Mammal	undif. large mammal	67	74.61	1702	2,131.56
Canis latrans	coyote	3	2.90	0	0
Canis spp.	dog/coyote	44	33.54	6	5.08
Carnivora	carnivore	2	.15	11	1.39
Urocyon cinereoargentus	gray fox	1	.42	0	0
Procyon lotor	raccoon	3	4.15	0	0
Mephitis mephitis	striped skunk	1	.78	11	11.57
Medium Mammal	undif. mam.	18	6.75	93	38.54
Lepus californicus	hare	36	4.95	7	1.35
Sylvilagus spp.	rabbit	20	3.42	3	.31
Sylvilagus auduboni	cottontail rabbit	1	.10	0	0
Leporidae	hare/rabbit	2	.14	11	.83
Mustela frenata	weasel	11	1.49	0	0
Sciurus griseus	gray squirrel	54	12.84	4	2.33
Spermophilus beecheyi	California ground squirrel	266	44.68	46	8.76
Sciuridae	squirrel/chipmunk	71	18.80	9	3.14
Sciurus spp.	tree squirrel	4	3.19	1	.35
Scapanus latimanus	mole	10	1.07	0	0
Thomomys bottae	pocket gopher	1008	117.48	2767	328.75
Neotoma spp.	woodrat	1	.01	16	1.26
Onychomys torridus	southern grasshopper mouse	6	.10	0	0
Peromyscus californicus	parasitic mouse	2	.06	0	0
Peromyscus spp.	white-footed mouse	14	.33	1	.03
Peromyscus maniculatus	deer mouse	2	.02	0	0
Perognathus spp.	pocket mouse	16	.31	5	.11
Perognathus longimembris	little pocket mouse	5	.06	0	0
Dipodomys spp.	kangaroo rat	52	2.05	5	.21
Dipodomys merriami	Merriam's kangaroo rat	14	.94	0	0

Table 3. Continued.

Taxon	Common Name	>60 cm NISP	> 60 cm Wt. (g)	<60 cm NISP	<60 cm Wt. (g)
Microtus californicus	California vole	48	2.29	115	4.17
Ondatra zibethicus	muskrat	1	.03	0	0
Cricetidae	mouse/rat/vole	1	.01		
Rodentia	rodent	453	27.26	1790	83.52
Small mammal	undif. small mammal	1812	69.81	9816	460.08
Pinnipedia	pinniped	1	3.37	7	10.68
Enhydra lutris	sea otter	11	15.63	31	80.30
Delphinidae	dolphin/porpoise	0	0	1	1.49
Zalophus californianus	California sealion	3	17.37	0	0
Mammalia	undif. mammal	50	13.74	1208	185.77
Agelaius tricolor	tricolored blackbird	2	.14	34	1.75
Accipitridae	hawk/eagle	1	.10		
Aphelocoma coerulescens	scrub jay	1	.04	2	.04
Turdus migratorius	robin	7	.31	27	1.28
Corvus brachyrhynchos	crow	1	.08	0	0
Diomedea albatrus	short-tailed albatross	1	6.52	0	0
Diomedea spp.	albatross	1	.04	0	0
Phalacrocorax auritus	double-crested cormorant	1	4.94	0	0
Cathartes aura	turkey vulture	1	.35	0	0
Anas cyanoptera	cinnamon teal	4	.65	0	0
Anas platyrhynchos	mallard	8	2.32	9	4.36
Anas spp.	duck	1	.10	5	1.03
Anas acuta	pintail duck	0	0	1	.22
Branta canadensis	Canada goose	0	0	2	6.11
Anser spp.	goose	8	8.62	0	0
Anser albifrons	white-fronted goose	1	.61	0	0
Passeriformes	perching bird	2	.06	6	.46
Aves	unid. bird, all sizes	247	24.25	59	5.32
Salientia	frogs/toads	1	.01	8	.51
Amphibia	amphibian	0	0	4	.07
Rana spp.	frog	4	.22	0	0
Clemmys marmorata	western pond turtle	56	15.34	28	8.13
Phrynosoma coronatum	coast horned lizard	0	0	28	.66
Cnemidophorus tigris	whiptail lizard	0	0	1	.01
Elgaria multicarinatus	southern alligator lizard	5	.05	1	.01

Table 3. Continued.

Taxon	Common Name	>60 cm NISP	> 60 cm Wt. (g)	<60 cm NISP	<60 cm Wt. (g)
Elgaria spp.	alligator lizard	2	.02	0	0
Sceloporus spp.	western fence lizard	4	.04	8	0.09
Lacertilia	lizard	14	.08	23	.55
Iguanidae	Iguanidae—family	0	0	6	.16
Lampropeltis spp.	king snake	14	.45	11	.51
Lichanura spp.	boa	1	.01	4	.09
Lichanura trivirgata	rosy boa	1	.02	0	0
Rhinochelius spp.	long-nosed snake	1	.02	0	0
Masticophis spp.	racer	5	3.05	20	.61
Pituophis melanoleucus	gopher snake	9	.92	201	20.27
Thamnophis spp.	garter snake	68	1.53	13	.26
Colubridae	nonvenomous snake	19	1.50	129	3.53
Crotalus spp.	rattlesnake	82	43.63	25	1.77
Serpentes	snake	11	.31	104	3.05
Reptilia/amphibia	reptile/amphibian	0	0	10	.31
Vertebrata	undif. vertebrate	1944	130.30	17,452	1,293.52
Triakididae	smoothhounds	3	.80	8	1.07
Myliobatis californica	bat ray	22	1.64	2	.14
Platyrhinoidis triseriata	thornback ray	30	.79	3	.08
Rhinobatos productus	guitarfish -shovelnose	6	.17	38	2.61
Elasmobranchi	sharks/rays	9	.18	64	1.81
Atherinops californiensis	jacksmelt	3	.06	17	.58
Atherinidae	silversides	4	.05	13	.13
Chromis punctipinnis	blacksmith	0	0	2	.02
Clupeidae	herring family	5	.05	0	0
Damalichthys vacca	pile perch	2	.06	0	0
Embiotocidae	surfperch family	82	2.21	314	9.08
Menticirrhus undulatus	California corvina	0	0	3	.35
Umbrina roncador	yellowfin croaker	4	.70	22	4.29
Cheilotrema saturnum	black croaker	2	.21	0	0
Roncador stearnsii	spotfin croaker	17	5.06	0	0
Sciaenidae	croaker family	19	1.01	3	.21
Pleuronectiformes	flounder/flatfish	15	.26	107	1.78
Paralichthys californica	California halibut	8	.05	0	0
Scomber japonicus	Pacific mackerel	23	1.63	0	0

Table 3. Continued.

Taxon	Common Name	>60 cm NISP	> 60 cm Wt. (g)	<60 cm NISP	<60 cm Wt. (g)
Porichthys spp.	midshipman	10	.35	39	1.47
Engraulididae	anchovy family	1	.01	0	0
Genyonemus lineatus	white croaker	1	.12	0	0
Cynoscion parvipinnis	shortfin corvina	2	1.01	0	0
Trachurus symmetricus	jackmackerel	1	.07	0	0
Paralabrax spp.	bass	2	.18	0	0
Sebastes spp.	rockfish	1	.07	6	.50
Semicossyphus pulcher	California sheephead	13	1.05	0	0
Osteichthyes	undif. bony fish	129	5.31	501	21.92

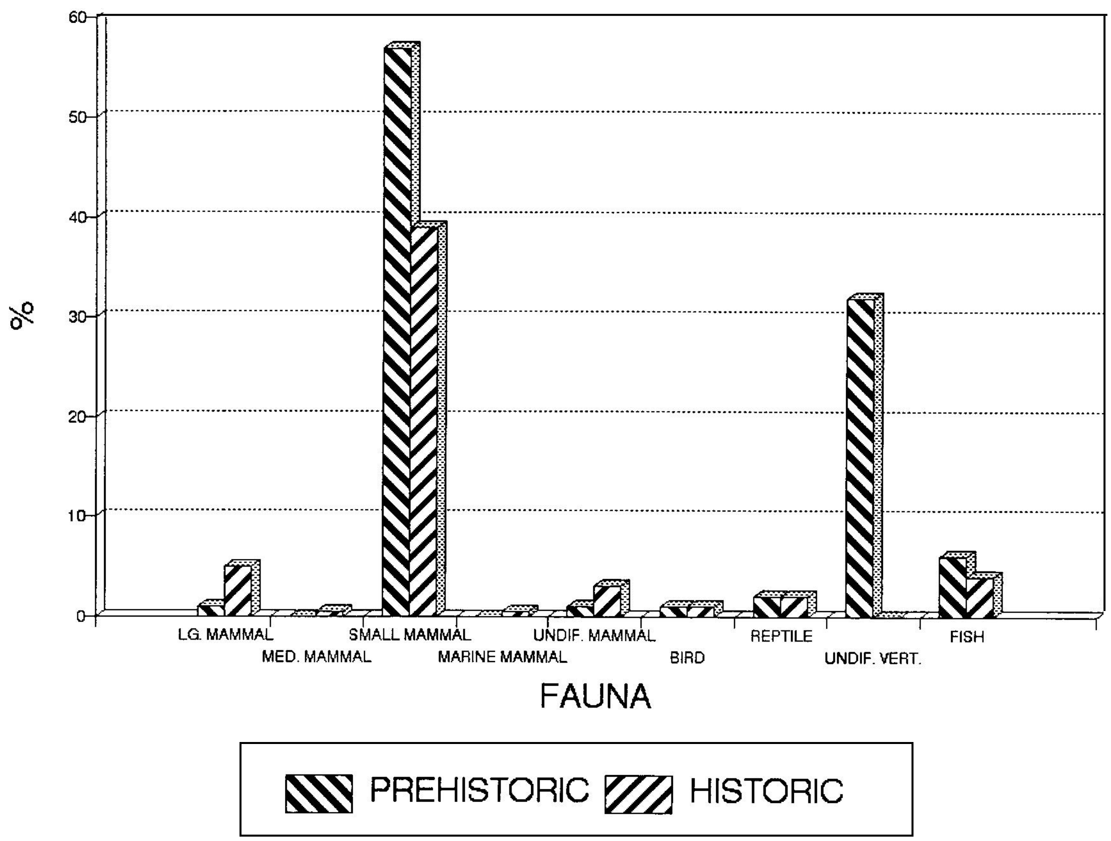

Figure 2. Proportion of NISPs by faunal group in prehistoric versus historic contexts.

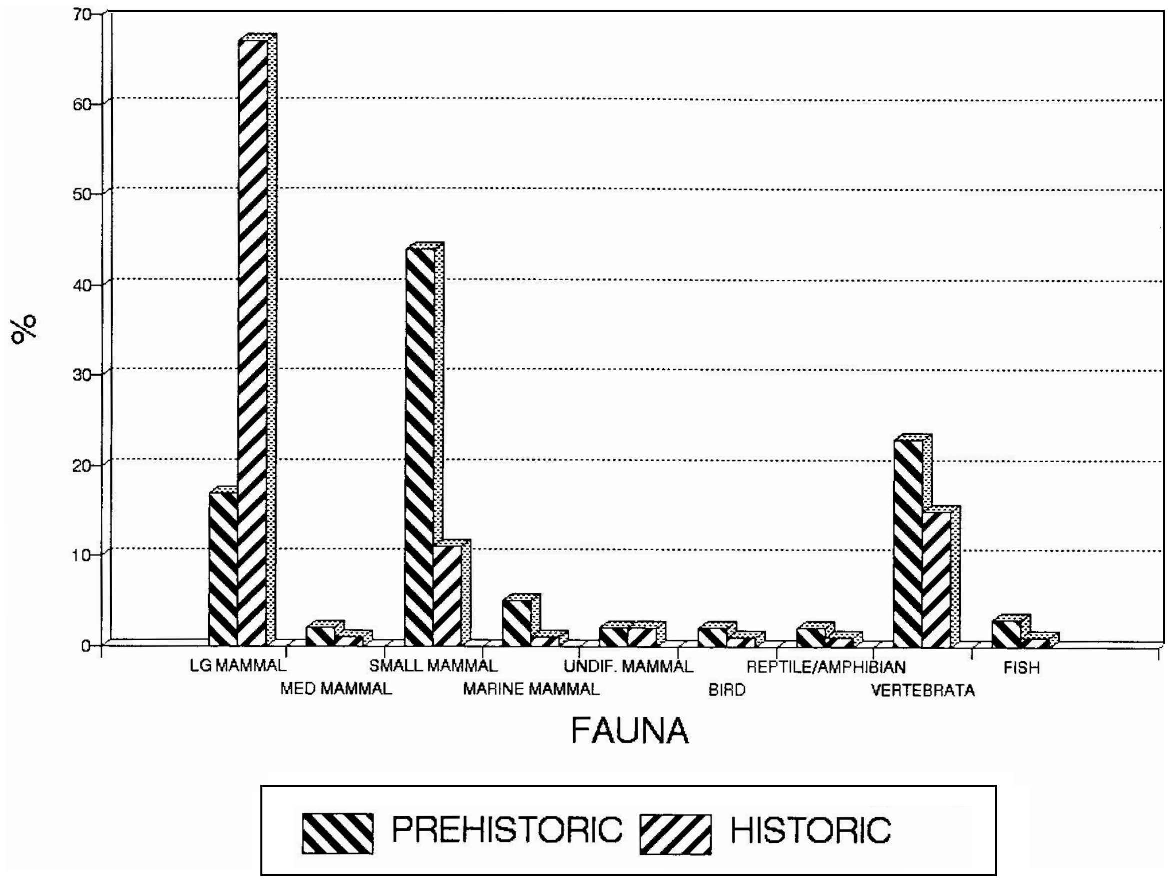

Figure 3. Proportion of bone weight by faunal category in prehistoric versus historic contexts.

and 0.21 for the historic context. These higher values reflect the large mammal bone.

Nineteen specimens of large mammal bone had cut marks (less than 1 percent), and approximately 32 percent (671 specimens) of the large mammal bone was burned. Although more small mammal bone was burned (2,211 specimens), this is only12 percent. This may be the result of differences in food preferences, preparation techniques, or the fact that large, flesh-covered bones are partially protected from direct fire whereas small animal bones are less protected and can be directly charred (Shaffer 1992). There is no evidence of butchering on the small mammal bones, although there is ethnographic evidence of small animals being "pounded" rather than cut (Yohe et al. 1991:659–666; Shaffer 1992:687–688).

Terrestrial Mammals

Large Mammals

Both native and domestic large mammals are found in the collection. Identified domestic animals dominate in both fragment count and bone weight. However, most large mammal bone is highly fragmented and unidentified to genus or species. The single identified native species is the black-tailed, or mule deer (*Odocoileus hemionus*). About 671 large mammal specimens (32 percent) were burned, and several specimens of large mammal bone were worked. No large mammal bone showed evidence of having been gnawed. Some domestic animal bone had been machine cut or sawed, indicating deposition after the Mexican period (Frierman 1992).

Medium Mammals

Medium-size terrestrial mammals include coyote and/or dog (*Canis* spp.), gray fox (*Urocyon cinereoargenteus)*, striped skunk (*Mephitis mephitis*), and raccoon (*Procyon lotor*). While these may not have been primary food animals, their skins would have been valuable. Medium mammal remains occur throughout the site but are most frequent in levels above 40 cm. About 17 percent of the medium mammal specimens were burned. One medium mammal specimen had cut marks, and another had evidence of possible gnawing.

Small Mammals

The small mammal group consists of a variety of rabbits and/or hares, squirrels, rodents, shrews, and weasels. Muskrat (*Ondatra zibethica*) was also identified (1 specimen). This animal is not native to California (Burt and Grossenheider 1964; Jameson and Peeters 1988), but the marshy habitat around LAN-2630 would have been suitable for this animal. The presence of this specimen may reflect a small population living near LAN-2630 after the animal had been imported into the state.

Small mammals appear in all units and in all levels. They increase in density where overall bone density increases, and they are more frequent than other animals at deeper levels. Below 70 cm, they are the most common animal group. This is especially true of the rodents, due in part to their burrowing activities. However, it is also possible that subsistence strategies and dietary preferences of the prehistoric people contributed to the frequency of small mammals and rodents in the deeper levels. Among the terrestrial fauna, small mammals, including the rodents, have the most burned bone.

Gopher (*Thomomys bottae*) is by far the most common animal (3,775 specimens), representing about 20 percent of the small mammal bone by NISP and 37 percent by weight. This is 8.5 percent of the total bone collection by count and 4.9 percent of total bone weight. A large proportion of the unidentified rodent bone is probably gopher. Gophers and the California ground squirrel (*Spermophilus beecheyi*) (312 specimens), as well as other rodents, are responsible for extensive bioturbation (Erlandson 1984; Johnson 1989). Some finds of livestock bone in deeper strata could also be due to subsurface foraging species churning site stratigraphy and cultural materials (Erlandson 1984; Johnson 1989). This suggests that many rodent bones may be intrusive into both the prehistoric and historic contexts and are not necessarily evidence of cultural deposition. However, since 91 specimens (2.4 percent) of the gopher remains are burned, it appears that some gophers might have been cooked (Shaffer 1992).

Marine Mammals

Fifty-four marine mammal specimens were recovered. Of these, 42 were sea otter (*Enhydra lutris*). One specimen was dolphin/porpoise, and 11 specimens were pinniped, eight of which were California sea lion (*Zalophus californianus*). The marine mammals occurred in levels down to 100 cm, but they were most common between 20 and 50 cm. Of identified large terrestrial and marine mammals, the frequency of otter (42 specimens) is second only to domestic cattle (65 specimens). Evidence of human modification of marine mammal bones is meager (2 specimens burned and 1 specimen cut). The bones of large animals such as marine mammals usually exhibit more cut marks than do smaller taxa since more laborious butchering is required to separate portions of the large bodies (Gifford-Gonzalez 1989; Lyman 1992).

It is not known if marine mammals were actively hunted or simply scavenged at the shore. Sick, injured, and dead pinnipeds frequently wash up on beaches. Pinnipeds spend considerable time basking in rookeries or haulouts where they can be killed with clubs or large rocks. Capturing them at sea requires special equipment such as watercraft and harpoons (Jobson and Hildebrandt 1980; Hildebrandt and Jones 1992; Jones and Hildebrandt 1995; Lyman 1995).

Otters would have been highly prized for their pelts as well as for food. Pelts would have been a particularly valuable trade item. Neither offshore hunting nor scavenging fully explains the large number of recovered otter bones. Yet, there is clear evidence that otters were sometimes actively hunted. An otter femur with an embedded stone projectile point was recovered during excavation of nearby, culturally related CA-LAN-2616 (Langenwalter et al. 2001). Otters spend most of their lives foraging for invertebrates in offshore kelp forests, entwining themselves and their young in kelp fronds when resting or sleeping. They spend little time on land. If they were targeted at sea, the hunters would have had to locate and exploit a suitable kelp forest using some type of watercraft and weaponry or snares and traps. There are accounts of adult otters (females) being captured in the kelp beds after their pups had first been caught, tethered, and used as lures (Landberg 1965; Harris 1968).

Another explanation for the quantity of otter bones at LAN-2630 may be considered. Otters are known to forage for invertebrates in estuaries (Harris 1968). The estuary bordering LAN-2630 would have been a natural foraging habitat for the otters where they might have been trapped more easily than in the ocean. Snares and small weapons would be fairly effective for otter capture in an estuary.

Birds

Bird remains included several species of ducks and geese (Anatidae), marine birds such as albatross (*Diomedea* spp., now identified as *Phoebastria* spp.), cormorant (*Phalacrocorax* spp.), nonmarine birds such as turkey vulture (*Cathartes aura*), and small perching birds (passeriformes). Bird bones were recovered throughout the site and in all but the deepest levels. Birds were particularly concentrated above 50 cm. Only 20 specimens (4.6 percent) of the bird bones were burned; 2 specimens had cut marks (less than 1 percent), and one was gnawed. The lack of cut marks or burning on bird bones is not an indication that they were not used for food. Birds can be cooked whole and the flesh removed easily after cooking without the bones being marked or burned.

Reptiles/Amphibians

Several identified reptiles and amphibians might have been used as food. These included turtles, lizards, frogs or toads, and snakes. They were recovered from all units and in all but the earliest levels of the site. About 75 percent of all the reptiles/amphibians were recovered from the upper 50 cm of the site. About 5.7 percent (52 specimens) of the reptile/amphibian collection was burned. No cut, gnawed, or worked reptile/amphibian bone was found.

The reptile/amphibian collection reflects the broad foraging habitat range available at LAN-2630. Several of these animals require slow-moving or nearly still fresh water, while others are adapted to drier conditions. Frogs or toads and the pond turtle are indicative of a moist, watered environment. Many of the lizards and snakes identified at the site, such as the western whiptail lizard (*Cnemidophorus tigris*), rosy boa (*Lichanura trivirgata*), southern alligator lizard (*Gerrhonotus multicarinatus*), coast horned lizard (*Phrynosoma coronatum*), and western fence lizard (*Sceloporus occidentalis*), are best suited to an arid environment.

Other animals such as rattlesnakes (*Crotalus* spp.) and king snakes (*Lampropeltis* spp.) or other nonvenomous snakes survive in nearly any type of environment except high elevations (Stebbins 1985).

Fish

Some 1,556 piscine specimens weighing 70.5 g were recovered; 47 of these were otoliths. Table 4 presents the proportions of fish families represented in the LAN-2630 collection. This table excludes unidentified elasmobranchii (73) and osteichthyes (630). The predominant fish are the Embiotocidae (surf perch), pleuronectiformes (flatfish), and small sharks and rays (e.g., guitarfish, thornback, and bat rays). The abundance of these fish suggests that fishing activity was concentrated in sandy-bottomed habitats close to shore, rocky-bottom nearshore areas, and the estuary. There may also have been some open surface water fishing since a number of pelagic species such as jack mackerel (*Trachurus symmetricus*) and Pacific mackerel (*Scomber japonicus*) were found. However, all the fish species could have been captured nearshore by standing on the shore or wading in shallow water, although a small boat probably was necessary to capture schooling fishes in open surface waters. Some of the fish could have been caught using hook and line or nets, although other methods of capture such as spearing, trapping, or hand capture may be represented. In general, the greatest density of fishbone occurred between 20 and 50 cm, and most specimens (81 percent) were collected above 60 cm.

Table 4. CA-LAN-2630 Proportions of Fish Families.

Family	NISP	%
Embiotocidae	398	46.7
Pleuronectidae	122	14.3
Rhinobatidae	77	9.03
Sciaenidae	73	8.56
Batrachoididae	49	5.74
Atherinidae	37	4.33
Myliobatidae	24	2.81
Scombridae	23	2.70
Labridae	13	1.52
Triakididae	11	1.29
Bethidae	8	>1.0
Scorpaenida	7	>1.0
Clupeidae	5	>1.0
Pomacantridae	2	>1.0
Serranidae	2	>1.0
Carangidae	1	>1.0
Engraulidae	1	>1.0

Although all the fish may be found year-round in the project area, jack mackerel and Pacific mackerel are most abundant in the summer and fall. The moderate presence of these fish suggests occupation during these seasons.

The vast majority of fish bone consists of vertebrae; very few cranial, tail, or appendage elements were recovered. This suggests that these less fleshy parts were removed and discarded before being carried to the site, supporting the argument that this site was a residential/food-consumption locus. However, recovery of 47 otoliths indicates that these special items were deliberately collected even though other cranial bones were discarded.

Of the 47 otoliths, 46 (98 percent) are from the Sciaenidae family: yellowfin croaker (*Umbrina roncador*), spotfin croaker (*Roncador stearnsi*), shortfin corvina (*Cynoscion parvipinnis*), and California corvina (*Menticirrhus undulatus*). A single otolith was of Scorpaenidae (rockfish). Sciaenid species tend to be restricted to open coast sandy beach habitats, although they may occur sporadically or seasonally in bay/estuary or nearshore midwater areas (Allen 1985:139–140; Salls 1988:573). These habitats are entirely consistent with the coastal and estuarine environment near LAN-2630.

On the other hand, sciaenid species do not dominate the overall piscine collection, which includes specimens from 17 families. The 73 Sciaenidae specimens represent only 4.8 percent of the total piscine fish collection and 9.1 percent of the piscine collection identifiable to the family level. Thus, the otolith collection differs markedly from the total piscene collection. There is ethnographic and archaeological evidence that suggests Native Californians used otoliths as jewelry or decorations, particularly large otoliths from croakers (Fitch and Lavenberg 1971:120; Huddleston and Barker 1978). Similar use of otoliths as ornaments is reported from the Midwest (Niehoff 1952). The practice of collecting large otoliths for use as beads, ornaments, or curiosities would explain the almost exclusive appearance of croaker otoliths at LAN-2630.

Dietary Reconstruction

Quantification of the dietary contribution of an archaeofauna is often a contentious issue in archaeology. Discussions of why and how to meaningfully analyze an archaeofauna in terms of quantity of flesh and economic reward began well over six decades ago and persist into the present as zooarchaeological theorists interpret recovered archaeofaunas. Quantification of faunal remains is a complex, sometimes rather subjective, task. It is accomplished by a variety of techniques, the advantages and disadvantages of which are the subject of ongoing concern (e.g., White 1953; Binford and Bertram 1977; Casteel 1978; Grayson 1984; Broughton 1999; Lyman 2008; Reitz and Wing 2008; Joslin 2012).

Some analysts prefer the quantitative method, relying on measures such as the NISP. Others feel that such simple quantifications provide primary, not analytical, data. Certain derived indices such as Minimum Number of Individuals (MNI), Minimum Number of Elements (MNE), or abundance indices (ratios) are frequently used, but these are susceptible to personal and procedural biases (Grayson 1984; Klein and Cruz-Uribe 1984; Reitz and Wing 2008).

Grayson (1984:xix) prefaces his important *Quantitative Zooarchaeology* with a warning that quantification methods are full of "quirks" and "oddities" that are "far from benign and far from being fully understood."

Bone weight is frequently used when it is believed that this method will yield a more realistic estimate of actual meat productivity than bone frequency counts. This is because most animals, especially mammals, have approximately the same number of skeletal elements regardless of their size, and flesh weight and bone weight share a crude though reasonable relationship. Bone weight is also less likely to be biased by fragmentation than is any other form of quantification. Simple bone weight measures have also been criticized because they rely on hypothetical reference specimens that are highly variable in terms of size, sex, age, weight, seasonality, etc. In addition, the relationship between an animal's skeleton and body mass is generally disproportionate (Reitz and Wing 2008:234).

Still other techniques for dietary estimation include application of variously established catalogs of "meat weight multipliers" for various taxa (e.g., Glassow and Wilcoxon 1988; Erlandson 1994; Rick 2007; Jazwa et al. 2012; Perry and Hoppa 2012). However, each of the above methods is problematic in one way or another, and all are generally unsatisfactory in terms of estimating the biomass produced by the skeletal remains. To date, there is general agreement that current techniques produce only reasonable estimates or usable ordinal data rather than precise values. The issue is further contorted by the point of view that dietary estimation of edible meat yield may be an unnecessary aspect of faunal analysis (Gifford-Gonzalez and Hildebrandt 2012).

Nevertheless, having already presented a quantitative view of the LAN-2630 vertebrate archaeofauna based on NISP and bone weight, I now present an alternative, albeit less common, technique for estimating the dietary contribution represented by the archaeofauna. This technique is termed allometry, and it yields the "sample biomass" of animal portions known to have been used based on weight of the archaeologically recovered bone fragments rather than on any quantification, hypothetical whole body estimations, meat weight multipliers, or derived indices.

As described by Reitz and Wing (2008:236), allometry is based on the concept that a fragmentary element or even an entire element of an animal does not represent the biomass of a whole animal. It estimates only the flesh potentially associated with the weight of that fragment or element. The potential biomass is based on an allometric regression formula using constants relating bone weight and flesh derived from large samples of various taxa (Reitz and Wing 2008:68).

> Because allometric predictions of sample biomass are based on a biological relationship, estimates of dietary contributions using allometric formulae have a lower inherent error than other approaches (Casteel 1978; Wing and Brown 1979:131). Such estimates can provide information about the quantity of sample biomass from the material recovered and are not based on assumptions about which tissues are edible or how many individuals are present in the sample [Reitz and Wing 2008:239].

Certainly a number of uncertainties associated with allometry have been cataloged at length (Jackson 1989:601–610; Needs-Howarth 1995:95; Lyman 2008:102–108; Reitz and Wing 2008:237–239), but all other biomass estimation techniques are similarly problematic. In the absence of any generally approved or standardized technique for biomass estimation, I apply allometry to present potential nutritional reward of the LAN-2630 archaeofauna. Specifically, the allometric method for sample biomass is structured on the following formula:

$$Y = aX^b$$

where Y is the estimated sample biomass (i.e., meat yield) contributed by the archaeological specimens for a taxon or a category of taxa, X is the weight of the archaeological specimens for a taxon or a category of taxa, *a* is the Y-intercept of the linear regression line, and *b* is the slope of the regression line as demonstrated in Reitz and Wing (2008:236, Method 3).

To further refine the biomass estimates, a meat weight percentage of total body weight is then applied for some vertebrates as suggested by White (1953:397). Meat weight for most mammals and birds is calculated at 70 percent of total body weight and 50 percent for artiodactyla and leporidae. Fish flesh is estimated at 84 percent total body weight (Wing and Brown 1979:132). However, the meat weight percentage for most mammals is probably inappropriate for pinnipeds because of their sizeable layers of blubber. The 70 percent factor applies to otters since they carry no blubber.

Setting the stage for the allometric estimation of biomass, Figure 4 shows bone weights of the six major vertebrate categories (large, medium, and small nonmarine mammals; marine mammals; birds; and fish) in kg for LAN-2630. These data are presented two ways: first by the initially established prehistoric/historic division based on excavation strata and/or dates and secondly as separated by the 60-cm prehistoric/historic division based on domestic bone. A log scale is used so that small quantities can be seen. Small rodents, reptiles and amphibians, and undifferentiated mammal and vertebrata bones are excluded from this figure.

Figure 5 presents the allometrically derived biomass estimates for the vertebrate categories and prehistoric/

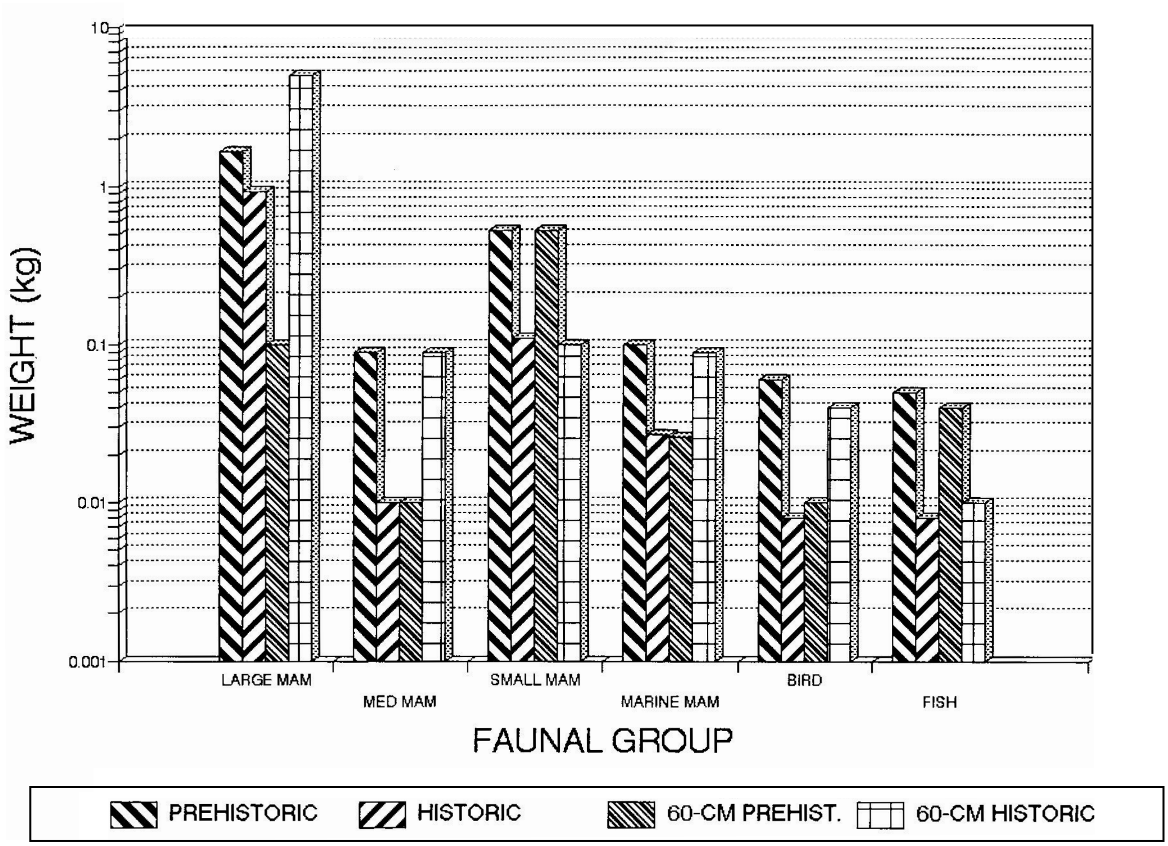

Figure 4. Weight of CA-LAN-2630 faunal category bone by occupational separation (prehistoric versus historic).

historic occupational periods presented in Figure 4. Total vertebrate biomass is 75.1 kg. Clearly, in nearly all cases there is an expected direct relationship between the bone weights and the resultant biomass. The unreasonably inflated quantity of large mammal bone in the prehistoric period (Figure 4) produces an overly large quantity of large mammal biomass (Figure 5). As noted above, this is likely a result of the mixing of historic bone into the prehistoric context by a combination of bioturbation, water movement, and agricultural activities. This anomaly is less apparent in the 60-cm separation data where large mammal weight and biomass are somewhat more realistic.

In addition to the vertebrate biomass estimated, the 1.25 metric tons of shellfish would have contributed an allometrically derived biomass of 133 kg of flesh to the LAN-2630 diet. Thus, total site biomass (vertebrate and invertebrate) is about 208 kg, 64 percent of which is invertebrate.

To summarize the allometric dietary reconstruction, the LAN-2630 prehistoric diet was made up primarily of small mammals. Most of the large mammal constituent was mixed into the prehistoric context. Only about 11 per cent of shellfish remains were recovered from the prehistoric levels below 60 cm (Boxt and Hale 2016:5, Figure 4). Medium-size mammals and birds were less important, and fish were a relatively small dietary constituent. Marine mammals played a greater role in the diet than medium terrestrial mammals. The historic occupation is characterized by the enormous quantity of domestic large mammal bone and shellfish along with substantial use of both

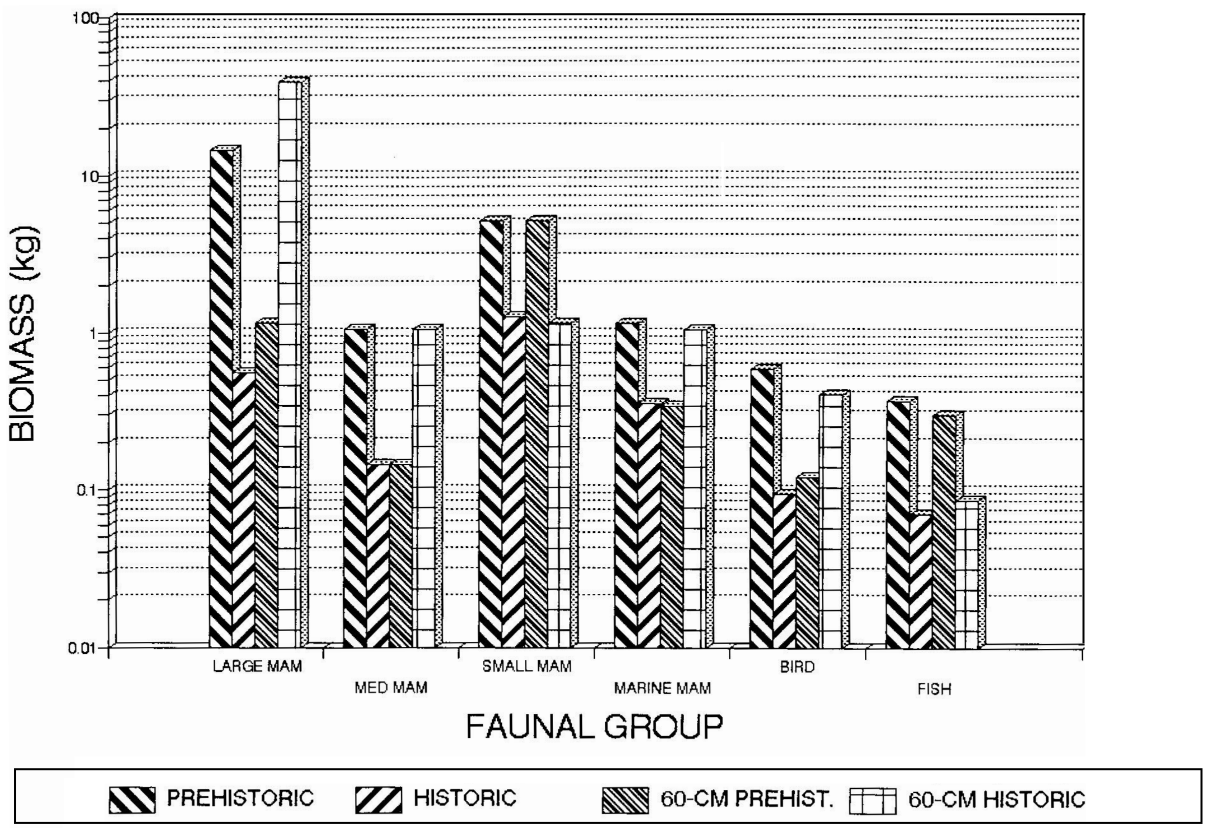

Figure 5. Allometrically derived biomass of CA-LAN-2630 archaeofauna bone by occupational separation (prehistoric versus historic).

medium and small mammals. Greater use is made of marine mammals and birds, with lesser use of fish.

What does the LAN-2630 Faunal Collection Signify?

What can the LAN-2630 vertebrate faunal remains tell us about the lives of regional Native communities? This question can be addressed by examining the number of taxa represented at the site (i.e., dietary breadth or richness), the degree to which these taxa are restricted to the immediate vicinity, evidence of on-site consumption, and evidence of other types of activities and functions at the site.

In terms of dietary breadth, this analysis identified some 113 different vertebrate animals (identified to family/genus/species) (Table 1). The Margalef species richness data confirm a diverse archaeofauna. This would not be present if this had been a food procurement or processing location where specific taxa were concentrated and targeted. If the site were a procurement or food processing locale where terrestrial and estuarine taxa were collected and prepared for consumption elsewhere, the taxa represented should be limited to those native to the immediate environment and should be represented in approximately the relative abundances natural to the site. There would be little evidence of on-site consumption of animals not inhabiting the immediate vicinity. If the site were primarily a residential base, the range of animals represented would be broader, including some taxa obtained from distant locations. There would also be considerable evidence of food consumption at the site, and there would be additional evidence of other, nonsubsistence activities.

Furthermore, the fish collection, which consists primarily of vertebrae, suggests that the fish were initially processed elsewhere (heads, tails, appendages removed) before the fish were brought to the site. The large marine mammals (e.g., pinnipeds, dolphins) may well have been scavenged at the coast and carried back to the site, whole or butchered. Sea otter bones are so abundant that both offshore hunting and estuarine capture may be indicated.

In addition to the dietary breadth shown for LAN-2630, there is some indication of food processing even though some evidence of butchering and cooking may have been obscured by the dark staining of much of the bone. In general, however, the frequency of butchering evidence is low. In addition, some burning may have resulted from natural causes such as wildfires. Some 6,307 specimens (weighing 1,696 g) were burned. This is 14 percent of the archaeofauna. Much of the burned bone was identifiable only to class due to fragmentation. To avoid biasing the quantity of burned bone, nonpiscene specimens were identified as burned only when black charring or white calcination was observed. Other indicators of human activity, such as cut marks or evidence of tool use, occurred on less than 1 percent of the specimens. Gnawing, which indicates disturbance in the site by rodents and other animals, is found on less than 1 percent of the specimens and may have occurred on fresh or long-buried bone. In sum, there is limited but unequivocal evidence of butchering, and there is strong evidence of cooking.

The recovery of awl-like implements suggests that domestic activities such as sewing of hides, basketmaking, or tool-sharpening were performed locally. These activities are typical of residential settings, not of single-activity sites. Recovery of apparently selected sciaenid otoliths for possible use as decorative items suggests that manufacture of ornaments and adornment of costume took place at this location, or they may have been retained by site occupants as charms or simple curiosities.

Bone awls, commonly found in prehistoric California sites, were used in all periods of California prehistory (Moratto 1984). They were generally made from large mammal limb bones, although bird bones were sometimes used. The cervid metapodial was frequently used for this purpose since its proximal end provides a flat surface that makes the tool comfortable in the hand during use. Table 5 and Figure 6 provide descriptive detail on some of the LAN-2630 specimens of worked bone. All eight tapered, pointed fragments appear to be pieces of awl-like artifacts. Even the polished splinter FN 2178 (item e in Figure 6) could be part of a broken awl shaft. Specimen FN 2626 (item a in Figure 6) represents a complete example of a Type A1bII artifact (Gifford 1940:168, 200). If these artifacts are awls or similar implements, they might have been used to make holes in hides, although the use most commonly ascribed to these tools is basketmaking.[1] The fact that nine of the 12 bone artifacts appear to be awl-like tools suggests a fairly concentrated and consistent use of this site for domestic activities such as weaving baskets or nets or producing objects from animal hide.

Summary

The diverse faunal assemblage at LAN-2630 suggests that prehistoric peoples exploited a wide range of local habitats to obtain vertebrate taxa but relied nearly equally on dietary shellfish. The prehistoric component shows a mixed subsistence strategy in which a small quantity of large mammals and a great quantity of small mammals were important and where local freshwater and estuarine habitants provided waterfowl, fish, reptiles, amphibians, and especially invertebrates. The major prehistoric vertebrate dietary constituents were small mammals and fish. Reliance on marine resources is indicated by coastal fish species (e.g., Embiotocidae

Table 5. CA-LAN-2630 Worked Bone.

Unit/FN	Depth	Item	L	W	T	Wt (g)
A10/1394	30–40	Large mammal limb shaft worked to point (4 fagments)	117	13	5	7.6
A13/643	20–30	Tip of pointed artifact	14.7	3.5	2.2	.07
T01/663	20–30	Large mammal limb shaft, tapered	116.5	13.5	7.5	6.86
TT5-5/3232	30–40	Tip of pointed artifact	14	3.5	3.8	.14
V04/2012	50–60	Tapered pointed end of awl-like tool	53.5	10	5.5	1.5
V04/2178	30–40	Polished bone fragment	36.5	9.5	4.5	1.26
V06/2626	50–60	Complete awl-like artifact made from large mammal metapodial	118	17.5	10	14.92
X09/3509	30–40	Bead	3 mm diam.			.02
Y12/3639	20–30	Large mammal limb shaft, tapered and polished	54.5	11.7	7.5	2.71
Y04/214	0–23	Large mammal cortical bone, flat with blade-like edge	22.5	13.7	3.2	.7
Z07/2038	10–20	Tapered, pointed end of awl-like tool	25	6.5	5.2	.55
Locus 4/ Unit 4/97	0–10	Tapered end of spatulate	14.2	8.3	2.14	.4

Note: Dimensions in mm.

or surf perch) and sea mammal, especially sea otter. The historic component is characterized by large quantities of both large and small mammals, especially cattle, goat, horse/burro, and sheep. However, the predominance of shellfish is amplified in the LAN-2630 historic assemblage. This finding is problematic since it presents the enigmatic image of ranch and/or agricultural personnel using far more shellfish than did the earlier Native population. Bioturbation, water movement, flood, and other processes were salient factors in postdepositional disturbance.

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Endnote

1. Based on microwear analysis, Dr. Gary S. Hurd (personal communication, 1995) concluded that specimens FN 663 (item e in Figure 8) and FN 2626 (item a in Figure 8) were used as flaking tools (cf. Gifford 1940:170–171, 207–209). They have broad cross

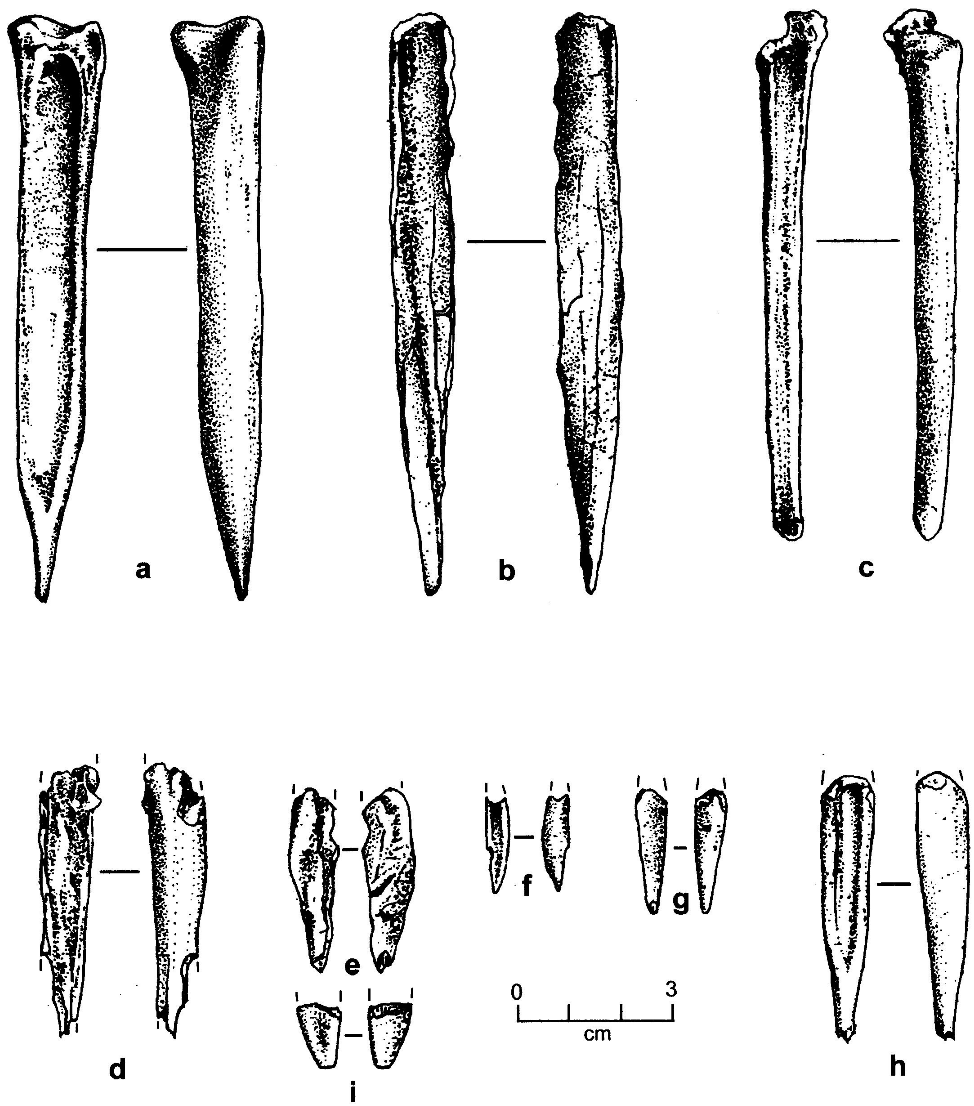

Figure 6. Worked bone recovered from CA-LAN-2630.

sections and relatively blunt tips, which are appropriate for net-making tools such as spacers.

References Cited

Allen, Larry G.
1985 A Habitat Analysis of the Nearshore Marine Fishes from Southern California. *Bulletin, Southern California Academy of Sciences* 84(3):133–155.

Binford, Lewis R., and J. B. Bertram
1977 Bone Frequencies and Attritional Processes. In *For Theory Building in Archaeology*, edited by L. R. Binford, pp. 77–153. Academic Press, New York.

Boxt, Matthew A., and Brian Dervin Dillon
2013 Prehistoric Pottery of Coastal Los Angeles County. *Pacific Coast Archaeological Society Quarterly* 47(3 and 4):45–87.

Boxt, Matthew A., and Alice Hale
2016 Archaeological Shell from CA-LAN-2630. *Pacific Coast Archaeological Society Quarterly* 52(1):1–25.

Broughton Jack M.
1999 *Resource Depression and Intensification During the Late Holocene, San Francisco Bay: Evidence from the Emeryville Shellmound Vertebrate Fauna*. Anthropological Records Vol. 32. University of California Press, Berkeley and Los Angeles.

Burt, William H., and Richard P. Grossenheider
1964 *A Field Guide to the Mammals*. Houghton Mifflin, Boston.

Casteel, R. W.
1978 Faunal Assemblages and the "Wiegemethode" or Weight Method. *Journal of Field Archaeology* 5(1):71–77.

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*. Plenum Press, New York.

Fitch, John E., and Robert J. Lavenberg
1971 *California Marine Food and Game Fishes*. University of California Press, Berkeley.

Frierman, J. D.
1992 The Pastoral Period in Los Angeles: Life on the Ranchos and in the Pueblo, 1800–1850. In *Historical Archaeology of Nineteenth-Century California*, edited by J. D. Frierman and Roberta S. Greenwood, pp. 1–52. William Andrews Clark Memorial Library, University of California, Los Angeles.

Gifford, Edward W.
1940 *Californian Bone Artifacts*. Anthropological Records 3(2). University of California Press, Berkeley and Los Angeles.

Gifford-Gonzalez, Diane
1989 Ethnographic Analogues for Interpreting Modified Bones: Some Cases from East Africa. In *Bone Modification*, edited by R. Bonnichsen and M. Sorg, pp. 179–246. Center for the Study of the First Americans, University of Maine, Orono.

Gifford-Gonzalez, Diane, and William R. Hildebrandt
2012 If Mussels Weighed a Ton: Problems with Quantifying Santa Barbara Channel Archaeofaunas. In *Exploring Methods of Faunal Analysis: Insights from California Archaeology,* edited by M.A. Glassow and T. L. Joslin, pp. 97–107. Perspectives in California Archaeology, Vol. 9, J.E. Arnold, series editor, Cotsen Institute of Archaeology, University of California, Los Angeles.

Glassow, Michael A., and L. R. Wilcoxon
1988 Coastal Adaptations near Point Conception, California, with Particular Regard to Shellfish Exploitation. *American Antiquity* 53(1):36–51.

Grayson, Donald K.
1984 *Quantitative Zooarchaeology.* Academic Press, New York.

Harris, C. J.
1968 *Otters: A Study of the Recent Lutrinae*. Weidenfeld and Nicolson, London.

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 11:360-401.

Huddleston, Richard W., and Lloyd W. Barker
1978 Otoliths and Other Fish Remains from the Chumash Midden at Rincon Point (SBa-1), Santa Barbara-Ventura Counties, California. *Los Angeles County Museum Contributions in Science* No. 289. Los Angeles County Museum, Los Angeles.

Jackson, H. Edwin
1989 The Trouble with Transformations: Effects of Sample Size and Sample Composition on Meat Weight Estimates Based on Skeletal Mass Allometry. *Journal of Archaeological Science* 16(6):601–610.

Jameson, E. W., Jr., and Hans J. Peeters
1988 *California Mammals*. University of California Press, Berkeley.

Jazwa, Christopher S, Douglas J. Kennett, and Danielle Hanson
2012 Late Holocene Subsistence Change and Marine Productivity on Western Santa Rosa Island, Alta California. *California Archaeology* 4(1):69–97.

Jobson, R. 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., and William R. Hildebrandt
1995 Reasserting a Prehistoric Tragedy of the Commons: Reply to Lyman. *Journal of Anthropological Archaeology* 14:78–98.

Joslin, Terry L.
2012 Analytical Sampling Strategies for Marine Fish Remains: Measuring Taxonomic Diversity and Abundance in Central California Middens. In *Exploring Methods of Faunal Analysis: Insights from California Archaeology,* edited by M.A. Glassow and T. L. Joslin, pp.135–147, Perspectives in California Archaeology, Vol. 9, J.E. Arnold, series editor, Cotsen Institute of Archaeology, University of California, Los Angeles.

Klein, Richard G., and Kathryn Cruz-Uribe
1984 *The Analysis of Animal Bones From Archeological Sites*. Chicago and London: University of Chicago Press, Chicago and London.

Landberg, L. C. W.
1965 *The Chumash Indians of Southern California*. Southwest Museum Papers 19. Southwest Museum, Los Angeles.

Langenwalter, Paul E. II, Matthew A. Boxt, Lawrence M. Boxt, and Theodore T. Miller
2001 A Sea Otter (*Enhydra Lutris*) Femur with Embedded Projectile Point Fragment from a Late Prehistoric Camp Site in Long Beach, California. *Pacific Coast Archaeological Society Quarterly* Vol. 37(1):51–60.

Lyman, R. Lee
1992 Prehistoric Seal and Sea-Lion Butchering on the Southern Northwest Coast. *American Antiquity* 57(2):246–261.

1995 On the Evolution of Marine Mammal Hunting on the West Coast of North America. *Journal of Anthropological Archaeology* 14:45–77.

2008 *Quantitative Paleozoology*, Cambridge Manuals in Archaeology, Cambridge University Press, New York.

Magurran, Anne E.

2004 *Measuring Biological Diversity.* Blackwell Publishing, Oxford.

Miller, Alan C., and Matthew A. Boxt

2009 Ecological Considerations of Archaeological Shell Materials from CA-LAN-2630. *Pacific Coast Archaeological Society Quarterly* 45 (1 and 2):79–99.

2010 A Nutritional Study of Seven Molluscan Species Recovered from CA-LAN-2630, Long Beach, California. *Pacific Coast Archaeological Society Quarterly* 46(4):19–31.

Moratto, Michael J.

1984 *California Archaeology*. Academic Press, Orlando.

Needs-Howarth, Suzanne

1995 Quantifying Animal Food Diet: A Comparison of Four Approaches Using Bones from a Prehistoric Iroquoian Village. *Ontario Archaeology* 60:92–101.

Niehoff, Arthur

1952 Otoliths as Ornaments. *Wisconsin Archaeologist* 33:223–234.

Perry, Jennifer E., and Kristin M. Hoppa

2012 Subtidal Shellfish Exploitation on the California Channel Islands Wavy Top (*Lithopoma undosum*) in the Middle Holocene. In *Exploring Methods of Faunal Analysis: Insights from California Archaeology*, edited by M. A. Glassow and T.L. Joslin, pp. 65–86. Perspectives in California Archaeology, Vol. 9, J.E. Arnold, series editor, Cotsen Institute of Archaeology, University of California, Los Angeles.

Rick, Torben C.

2007 *The Archaeology and Historical Ecology of Late Holocene San Miguel Island.* Perspectives in California Archaeology Vol. 8. Cotsen Institute of Archaeology, University of California, Los Angeles.

Reitz, Elizabeth J., and Elizabeth S. Wing

2008 *Zooarchaeology.* (2nd ed.). Cambridge University Press, Cambridge.

Salls, Roy A.

1988 *Prehistoric Fisheries of the California Bight*. Ph.D. dissertation, University of California, Los Angeles.

Shaffer, Bradley S.

1992 Interpretation of Gopher Remains from Southwestern Archaeological Assemblages. *American Antiquity* 57(4):683–692.

Stebbins, Robert C.

1985 *A Field Guide to Western Reptiles and Amphibians*. Houghton Mifflin, Boston.

White, Theodore H.

1953 A Method of Calculating the Dietary Percentages of Various Food Animals Utilized by Aboriginal Peoples. *American Antiquity* 13(4):396–398.

Wing, Elizabeth S., and A. B. Brown

1979 *Paleonutrition: Method and Theory in Prehistoric Foodways.* Academic Press, New York.

Yohe, Robert M. II, M. E. Newman, and Joan S. Schneider
1991 Immunological Identification of Small-Mammal Proteins on Aboriginal Milling Equipment. *American Antiquity* 56(4):659–666.