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Prehistoric Native American Fisheries of the Central California Coast

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Abstract.—Over 77,000 fish remains from 51 archaeological sites on the central California coast between San Mateo and San Luis Obispo counties, deposited between 6200 B.C. and A.D. 1830, were studied to assess prehistoric species distribution, diversity, and Native American fisheries. Remains were obtained from exposed rocky coastal sites, lagoon–estuaries at Elkhorn Slough and Morro Bay, and the freshwater drainages of the Pajaro and Salinas rivers. On the rocky coast, 58.4% of the remains represented large inshore species, 26.9% were small schooling species, and 11.8% were surfperches (family Embiotocidae). Large inshore species included rockfishes *Sebastes* spp., lingcod *Ophiodon elongatus*, kelp greenling *Hexagrammos decagrammus*, cabezon *Scorpaenichthys marmoratus*, and monkeyface prickleback *Cebidichthys violaceus*. At Elkhorn Slough and Morro Bay, about half of the remains of marine species represented moderately small schooling species, including Pacific herring *Clupea pallasi*, Pacific sardine *Sardinops sagax*, northern anchovy *Engraulis mordax*, topsmelt *Atherinops affinis*, jacksmelt *Atherinopsis californiensis*, and California grunion *Leuresthes tenuis*. Surfperches also were common, and specialized local fisheries for flounders or sharks and rays were suggested. Aquatic conditions at Elkhorn Slough were dramatically different from those that exist today. Sites on Elkhorn Slough had both marine and freshwater fishes and showed site occupation when the Salinas River entered the slough and did not follow its present course into Monterey Bay. Sacramento perch *Archoplites interruptus* was the most abundant species found at freshwater sites, and remains of extinct thicktail chub *Gila crassicauda* confirm its presence in the Pajaro and Salinas rivers. Surprisingly rare are the remains of steelhead (the anadromous form of rainbow trout) *Oncorhynchus mykiss*. As is the case today, Pacific salmon were apparently absent from central coast streams south of the San Lorenzo River. Presumably the remains reflect local species availability.

The archaeological record provides an important baseline for the study of prehistoric North American fisheries and empirical evidence for species distribution and diversity before contact with European culture. Archaeological investigations completed along the central coast of California over the last three decades and summarized here provide abundant evidence for fisheries between 6200 B.C. and A.D. 1830. Many of the archaeological findings have been reported only in obscure, poorly circulated literature.[1] The value of these data increases when they are regionally considered. Our paper summarizes and interprets findings from 51 archaeological sites from the central California coast between San Mateo and San Luis Obispo counties (Figure 1).

Most of the sites are exclusively prehistoric, but several were also occupied after Spanish contact (about A.D. 1769). Most are shell middens, which are primarily deposits of concentrated mollusk and other animal remains associated with villages, camps, and processing sites. The sites are adjacent to three aquatic habitats: exposed rocky coasts, lagoon-estuaries, and freshwater drainages. How-

[1] This "gray literature" is not available in most libraries but is filed as governmental agency or cultural management reports prepared to satisfy legal requirements. The information is rarely subject to anonymous authoritative review and by the standards of most scientific journals, is not considered published. However, these standards differ from those in archaeology in which review is rare and reports are available from regional archaeological clearinghouses. For San Mateo (SMA), Santa Cruz (SCR), Santa Clara (SCL), San Benito (SBN), and Monterey (MNT) counties, site reports are a matter of public record and are available from the Northwestern Information Center, California Archaeological Survey, Sonoma State University, Rohnert Park. Site information for San Luis Obispo County (SLO) is available from the Central Coast Information Center, Department of Anthropology, University of California, Santa Barbara.

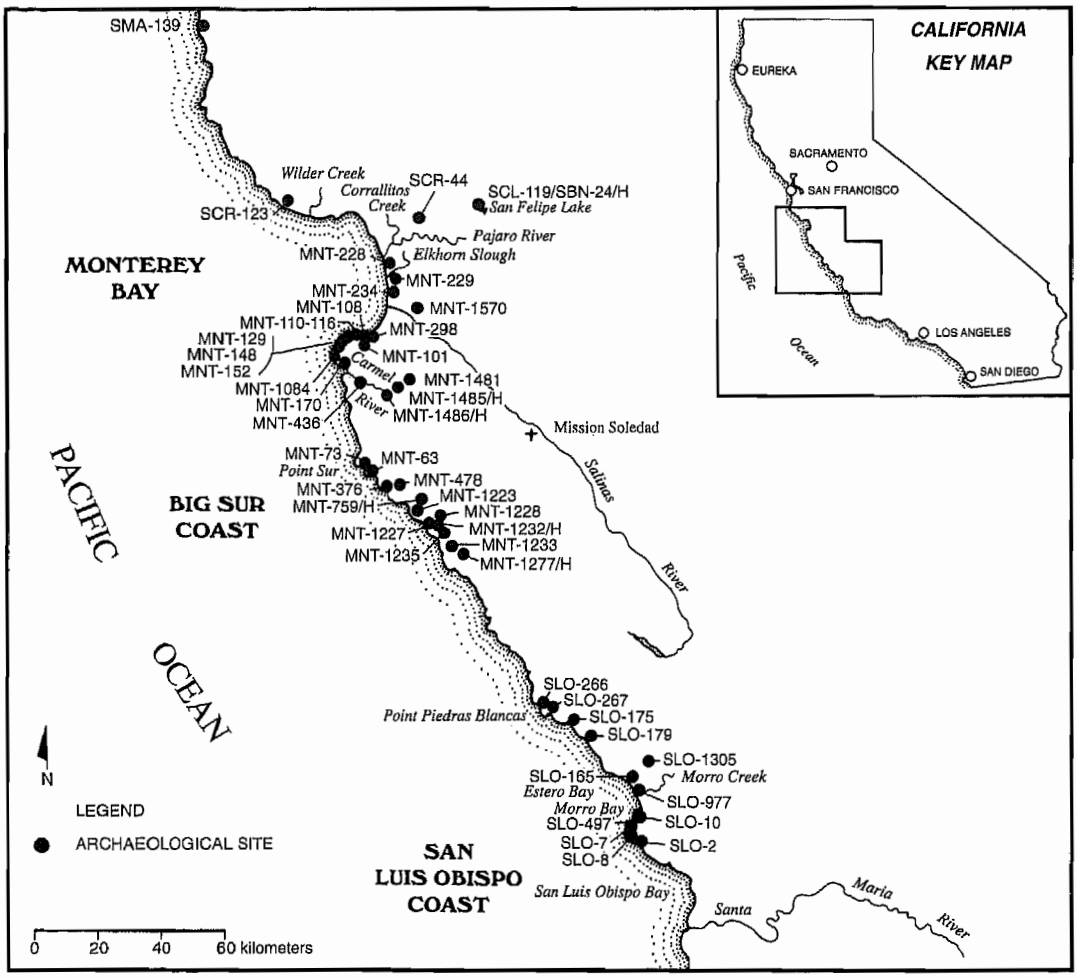

FIGURE 1.—Location of archaeological sites on the central California coast.

over, as shown by excavated remains, Native Americans obviously often exploited multiple habitats from the same residential site.

Fitch (1972) was the first to seriously study fish remains of the central California coast, and Follett (1972a, 1972b) published short reports. Fitch's painstaking analysis of midden samples obtained from CA-SLO-2[2] on the open coast of San Luis Obispo County demonstrated a previously unsuspected abundance of fish remains. More recently, Salls (1989) summarized the fishery associated with the early Spanish Mission Nuestra Señora de la Soledad in the Salinas Valley (Figure 1), and Gobalet (1990a, 1993) addressed zoogeographical questions using fish remains from three sites at Elkhorn Slough and the inland use of marine fishes in central California (Gobalet 1992).

Native Fishing Equipment and Techniques

Methods of fishing in aboriginal California have been described by Kroeber and Barrett (1960), Fitch (1972), Hoover (1973), Tartaglia (1976), Strudwick (1986), and Salls (1988, 1989). The oldest marine fishing technique was probably hand collection in the intertidal zone with occasional use of traps. Subsequently, weirs or seines were used in tidal flats, probably in conjunction with dip nets or baskets. All but the smallest fishes could be taken with bone gorges or shell hooks. Watercraft, used as long as aboriginals have oc-

[2] Archaeological sites are designated by trinomials consisting of abbreviations for the state- and county (see footnote 1)- and the site number.

cupied North America (Engelbrecht and Seyfert 1994), were limited to dugout canoes and tule balsas on the central California coast (Greenwood 1978). Seines, drift nets, and trident spears could have been used from such watercraft. Fishing technology clearly became quite sophisticated.

Field Recovery Techniques

Until the 1970s, 6-mm-mesh sieves were commonly used to extract fish remains and other artifacts from midden soils, but Fitch (1969, 1972), among others, demonstrated enhanced recovery with smaller-aperture screens. Most of the data reported here were obtained with 3-mm-mesh screens which increased representation, particularly of the more diminutive individuals and taxa. Smaller mesh (1.5 and 0.6 mm) or direct microscopic examination of soil has also been used at several locations: CA-MNT-228, CA-MNT-229, CA-MNT-73, CA-MNT-376, CA-MNT-759/H, CA-MNT-1223, CA-MNT-1227, CA-MNT-1228, CA-MNT-1232/H, CA-MNT-1233, CA-MNT-1235, CA-SLO-175, CA-SLO-165, and CA-SLO-2 (Jones 1995; Jones and Waugh 1995). Washing sediments through sieves further increases recovery, as remains become more visible. The two sites producing the greatest number of fish bones and extensive species lists, CA-MNT-234 and CA-SLO-165, were water-processed.

Methods of Identification

Common and scientific names follow Robins et al. (1991) and are given in Table 1. Our identifications were made by comparison with skeletal materials at the Department of Biology, California State University, Bakersfield; Department of Anthropology, University of California, Davis; California Academy of Sciences, San Francisco; American Museum of Natural History, New York; and Natural History Museum of Los Angeles County. The lowest possible taxon was determined except where discrimination was not useful. For example, distinguishing among the 59 ecologically and morphologically similar species of rockfishes (Lea 1992) is looked upon with suspicion, particularly when identification is based on vertebrae and fragmentary skeletal materials. Thus, specific identifications within the genus *Sebastes* are combined as rockfishes. Within the genera *Acipenser, Xiphister, Paralabrax, Amphistichus, Phanerodon,* and *Embiotoca,* either the limited availability of comparative materials or inability to discriminate prohibited further identification. The kelp greenling and plainfin midshipman were chosen over the rock greenling and specklefin midshipman on geographic grounds. Certain elements are diagnostic for Pacific sardine and Pacific herring (family Clupeidae); topsmelt, jacksmelt, and California grunion (family Atherinidae); surfperches (family Embiotocidae); numerous members of the order Pleuronectiformes; and five reported species of requiem sharks (family Carcharhinidae). However, we have usually reported the broader group because discriminating between species based on the most commonly recovered elements—vertebrae—is time-consuming, if possible at all. We have condensed some unsupported or questionable identifications by other investigators within higher taxonomic categories. Fishes represented by fewer than 10 elements or found only at a single site are listed only in table footnotes. Some of the remains undoubtedly reached the midden in the stomachs of harvested predators and reflect indirect Native American exploitation. For example, threespine sticklebacks are armored, spiny, and of questionable palatability to humans.

Certain species undoubtedly are underrepresented in the archaeological and subfossil record because of fragility (Hopkirk 1988; Butler and Chatters 1994) or chance, whereas others are disproportionately represented because they possess durable elements, such as the dental plates of bat rays or the pharyngeal teeth of pile perch. Small individuals are also more likely to completely decompose.

Results

Over 77,000 fish bones, teeth, scales, and otoliths from 51 archaeological sites have been identified. The remains represent over 80 species of marine (Tables 2, 3) and freshwater fishes (Table 4).

Exposed Rocky Coastal Sites

Rockfishes are the most abundant group represented at the 42 exposed coastal sites (Table 2). When rockfishes are combined with lingcod, cabezon, kelp greenling, and monkeyface prickleback, this group of moderately large inshore species represents 55.5% of the remains (Table 5). Small schooling species account for 24.8% of the remains, surfperches compose 11.3%, and fewer than 0.5% come from sharks, skates, rays, or members of the flounder families.

Lagoon and Estuary Sites

At Elkhorn Slough, 83.5% of the remains were from marine species and included virtually no

TABLE 1.—List of scientific and common names of fishes used in this paper. Names and order follow Robins et al. (1991).

Scientific name	Common name
Elasmobranchiomorphi	
Heterodontus francisci	Horn shark
Carcharhinidae	Requiem sharks
Galeorhinus zyopterus	Soupfin shark
Mustelus californicus	Gray smoothhound
M. henlei	Brown smoothhound
Prionace glauca	Blue shark
Triakis semifasciata	Leopard shark
Squalus acanthias	Spiny dogfish
Squatina californica	Angel shark
Platyrhinoidis triseriata	Thornback
Rhinobatos productus	Shovelnose guitarfish
Rajidae	Skates
Dasyatidae	Stingrays
Myliobatis californica	Bat ray
Osteichthyes	
Acipenser medirostris	Green sturgeon
A. transmontanus	White sturgeon
Clupeidae	Herrings
Clupea pallasi	Pacific herring
Sardinops sagax	Pacific sardine
Engraulis mordax	Northern anchovy
Cyprinidae	Carps and minnows
Gila crassicauda	Thicktail chub
Lavinia exilicauda	Hitch
Mylopharodon conocephalus	Hardhead
Orthodon microlepidotus	Sacramento blackfish
Pogonichthys macrolepidotus	Splittail
Ptychocheilus grandis	Sacramento squawfish
Catostomus occidentalis	Sacramento sucker
Osmeridae	Smelts
Spirinchus starksi	Night smelt
Salmonidae	Trouts
Oncorhynchus mykiss	Steelhead (anadromous rainbow trout)
O. tshawytscha	Chinook salmon
Merluccius productus	Pacific hake
Microgadus proximus	Pacific tomcod
Chilara taylori	Spotted cusk-eek
Porichthys myriaster	Specklefin midshipman
P. notatus	Plainfin midshipman
Gobiesox maeandricus	Northern clingfish
Atherinidae	Silversides
Atherinops affinis	Topsmelt
Atherinopsis californiensis	Jacksmelt
Leuresthes tenuis	California grunion
Gasterosteus aculeatus	Threespine stickleback
Sebastes spp.	Rockfishes
Anoplopoma fimbria	Sablefish
Hexagrammos decagrammus	Kelp greenling
H. lagocephalus	Rock greenling
Ophiodon elongatus	Lingcod
Cottidae	Sculpins
Hemilepidotus spinosus	Brown Irish lord
Leptocottus armatus	Pacific staghorn sculpin
Scorpaenichthys marmoratus	Cabezon
Morone saxatilis	Striped bass
Paralabrax clathratus	Kelp bass
P. maculatofasciatus	Spotted sand bass
P. nebulifer	Barred sand bass
Archoplites interruptus	Sacramento perch
Seriola lalandi	Yellowtail
Trachurus symmetricus	Jack mackerel
Anisotremus davidsoni	Sargo
Xenistius californiensis	Salema
Sciaenidae	Drums
Atractoscion nobilis	White seabass
Genyonemus lineatus	White croaker
Seriphus politus	Queenfish
Girella nigricans	Opaleye
Embiotocidae	Surfperches
Amphistichus argenteus	Barred surfperch
A. koelzi	Calico surfperch
A. rhodoterus	Redtail surfperch
Brachyistius frenatus	Kelp perch
Cymatogaster aggregata	Shiner perch
Embiotoca jacksoni	Black perch
E. lateralis	Striped seaperch
Hyperprosopon anale	Spotfin surfperch
H. argenteum	Walleye surfperch
Hypsurus caryi	Rainbow seaperch
Hysterocarpus traski	Tule perch
Micrometrus aurora	Reef perch
Phanerodon atripes	Sharpnose seaperch
P. furcatus	White seaperch
Rhacochilus toxotes	Rubberlip seaperch
R. vacca	Pile perch
Chromis punctipinnis	Blacksmith
Sphyraena argentea	Pacific barracuda
Oxyjulis californica	Señorita
Semicossyphus pulcher	California sheephead
Stichaeidae	Pricklebacks
Cebidichthys violaceus	Monkeyface prickleback
Plagiogrammus hopkinsi	Crisscross prickleback
Xiphister atropurpureus	Black prickleback
X. mucosus	Rock prickleback
Anarrhichthys ocellatus	Wolf-eel
Clinidae	Clinids
Gibbonsia metzi	Striped kelpfish
Heterostichus rostratus	Giant kelpfish
Gobiidae	Gobies
Scombridae	Mackerels
Scomber japonicus	Chub mackerel
Bothidae	Lefteye flounders
Citharichthys sordidus	Pacific sanddab
C. stigmaeus	Speckled sanddab
Paralichthys californicus	California halibut
Pleuronectidae	Righteye flounders
Atheresthes stomias	Arrowtooth flounder
Eopsetta jordani	Petrale sole
Hypsopsetta guttulata	Diamond turbot
Microstomus pacificus	Dover sole
Platichthys stellatus	Starry flounder
Pleuronectes vetulus	English sole
Pleuronichthys coenosus	C-O sole
P. ritteri	Spotted turbot
Psettichthys melanostictus	Sand sole
Mola mola	Ocean sunfish

moderately large inshore species (Table 3). One-half of the marine remains represented small schooling species (Pacific herring, Pacific sardine, northern anchovy, topsmelt, jacksmelt, and California grunion; Table 5), whereas 33% were from members of the flounder families (mostly starry flounder), and 12.2% were from surfperches

TABLE 2.—Number of elements of fish remains from 42 exposed rocky coastal archaeological sites on the central California coast from San Mateo County to San Luis Obispo County. Listing is north to south. Fishes represented by fewer than 10 elements or found only at a single site are listed only in the footnotes.

Taxon	SMA-139	SCR-123	Monterey Peninsula[a]	Carmel Valley[b]	Big Sur Coast[c]	Piedras Blancas[d]	South San Luis Obispo County[e]	Total
Skates or stingrays					1	2	8	11
Bat ray		1	4				6	11
Requiem sharks			8		4	4	1	24
Herrings	1	319	2,254	21,106	59	349	176	24,264
Northern anchovy		1	13	7	125	135	198	479
Pacific hake		1	10		48	7	8	74
Plainfin midshipman		4	112			1	33	150
Northern clingfish					2	6	3	11
Silversides		68	375	207	2	14	25	691
Rockfishes		11	1,258	64	3,277	664	1,019	6,293
Kelp greenling	3		16		237	70	5	331
Lingcod		1	103	6	184	17	24	335
Sculpins		1	5		2	1		9
Cabezon	1	3	341	30	1,180	193	69	1,817
Jack mackerel			197	10		3	1	211
White croaker			7			3	1	11
Surfperches	12	123	305	67	295	160	561	1,523
Amphistichus spp.	1		7		2	5		15
Embiotoca spp.	8		31		14	16	9	78
Phanerodon spp.			17			1		18
Walleye surfperch			4				6	10
Rainbow seaperch			13					13
Rubberlip seaperch	1		9			4		14
Pile perch	4		43	1	1	65	67	181
Pacific barracuda	1		42	3				46
Señorita			53	3			61	117
Pricklebacks			114		24	7		145
Monkeyface prickleback			65	2	165	92	192	516
Xiphister spp.	1		18		118	50	11	198
Striped kelpfish					1	13		14
Giant kelpfish			15			1	1	17
Chub mackerel			26	33	1		2	62
Lefteye and righteye flounders		2	10		5			17
Starry flounder		9	2			1	1	13
Total[f]	33	544	5,505	21,554	5,780	1,933	2,763	38,112

[a] Sites included are MNT-108 (Langenwalter et al. 1989); MNT-298 (M. Roeder, Costa Mesa, California, personal communication), also found 2 mackerel, 1 steelhead, and 3 white seabass; MNT-101; MNT-110–MNT-116; also found 3 yellowtail, 9 California halibut, 3 petrale soles, and 1 sablefish; MNT-129 (Langelwalter and Huddleston 1991) also found 2 *Paralabrax* sp., 1 queenfish, 1 sheephead, and 2 clinids; MNT-148, MNT-152 (Langenwalter, in press a); MNT-1084 (Langenwalter and Bowser 1991); MNT-170 includes data of Langenwalter (in press b); MNT-436 (Follett 1972a).

[b] MNT-1481, MNT-1485/H and MNT-1486/H (Langenwalter and Bowser 1992) also found 1 trout family, 2 sheepheads, and 2 blacksmiths.

[c] MNT-73; MNT-63 also found 18 steelhead, 7 threespine sticklebacks, and 1 goby; MNT-478; MNT-376; MNT-759/H; MNT-1227; MNT-1232/H; MNT-1228; MNT-1233; MNT-1277/H; MNT-1223; and MNT-1235.

[d] SLO-266; SLO-267 also found 1 drum and 29 gobies; SLO-175 also found 18 smelt; SLO-179 also found 1 clinid.

[e] SLO-10, SLO-497 also found 5 shovelnose guitarfishes; SLO-7, SLO-8 (Langenwalter et al. 1988) also found 4 drums and 7 blacksmiths; SLO-2 (Fitch 1972) also found 1 queenfish, 116 wolf-eels, 1 arrowtooth flounder, 1 brown Irish lord, 1 Pacific staghorn sculpin, 12 shiner perch, 1 kelp perch, 1 reef perch, 1 spotted cusk-eel, 3 crisscross pricklebacks, 3 leopard sharks, 1 blue shark, 3 gray smoothhounds, 3 angel sharks, 15 spiny dogfish, and 95 night smelt.

[f] Includes totals from footnotes.

(mostly shiner perch). Only 0.6% of the remains were from sharks, skates, or rays. Freshwater and euryhaline species (sturgeon, steelhead or rainbow trout, and threespine stickleback) made up 16.5% of the remains (Table 4).

Small schooling taxa also predominated at Morro Bay (52.3%), and surfperches represented over 20% of the remains. Although flatfishes were uncommon (0.6%), sharks, skates, and rays were more common (15.0%) than at Elkhorn Slough. Large inshore species (2.3%) were poorly represented.

TABLE 3.—Number of elements of marine fishes identified from seven lagoon and estuarine archaeological sites on the central California coast from Elkhorn Slough, Monterey County, and Morro Bay, San Luis Obispo County. Listing is north to south. Freshwater fishes from the Elkhorn Slough sites are listed in Table 4. Fishes represented by fewer than 10 elements or found only at a single site are listed in the footnotes.

	Elkhorn Slough					Morro Bay			
Taxon	MNT-228[a]	MNT-229[b]	MNT-234[c]	MNT-1570[a]	Subtotal	SLO-165[d]	SLO-1305	SLO-977[e]	Subtotal
Skates or stingrays					0	9	1	5	15
Bat ray	45	44	36	1	126	187	4	11	202
Requiem sharks	7	43	11		61	158	2	18	178
Thornback					0	28		9	37
Shovelnose guitarfish			2		2	33		27	60
Herrings	644	123	>5,137	20	>5,924	829	4	4	837
Northern anchovy	260		109	5	374	209			209
Steelhead (rainbow trout)	17	32	154	1	204	7	1		8
Pacific hake		16	322		338	14		15	29
Pacific tomcod			32		32	2			2
Plainfin midshipman	62	5	139	1	207	13	1	1	15
Silversides	1,459	28	>7,057	8	>8,552	1,045	1	61	1,107
Rockfishes	2		10		12	49	3	1	53
Threespine stickleback	466		119	1	586	4			4
Kelp greenling			1		1	6			6
Lingcod			4		4	18			18
Sculpins	6				6	18	2		20
Pacific staghorn sculpin	131		389		520	207		55	262
Cabezon			5		5	10		1	11
Jack mackerel		4	2	1	7				0
White croaker		1	3		4	4			4
Surfperches	525	182	1,546	16	2,269	538	11	4	553
Amphistichus spp.	21	34	348	5	408	2			2
Shiner perch	180		467		647	47			47
Embiotoca spp.	1	7	10		18	7			7
Walleye surfperch	1		3		4	15			15
Rainbow seaperch		1			1	90			90
Phanerodon spp.		1	3		4	11			11
Rubberlip seaperch	2	1	1		4	7			7
Pile perch	22	11	227		260	123	1	2	126
Monkeyface prickleback			3		3	5			5
Xiphister spp.					0	5	1		6
Chub mackerel		1	48		49	1			1
Lefteye and righteye flounders	32	25	>8,806	6	>8,869	5			5
California halibut	1	24			25	3			3
Starry flounder	8	23	911	1	943	4			4
Total[f]	3,907	611	25,913	66	30,497	3,869	32	218	4,119

[a] Gobalet (1993) also found 4 clinids, 6 gobies, 1 white seabass, and 4 English soles.
[b] Gobalet (1990a) also found 4 yellowtail and 1 English sole.
[c] Also found were 2 kelp perch, 1 queenfish, 1 mackerel, 1 ocean sunfish, 2 English soles, and 1 Pacific barracuda.
[d] Totals include data from R. A. Salls (deceased, personal communication). Also found were 113 Elasmobranchiomorphi, 4 horn sharks, 3 angel sharks, 1 yellowtail, 1 kelp perch, 1 Pacific barracuda, 1 spotfin surfperch, 9 night smelt, 4 smelt, 1 sargo, 1 salema, 1 *Paralabrax* sp., 1 drum, 1 giant kelpfish, 2 opaleyes, 2 *Citharichthys* spp., 7 diamond turbot, 1 C-O sole, 1 Dover sole, and 1 spotted turbot.
[e] Also found 4 angel sharks.
[f] Includes totals from footnotes.

Pajaro–Salinas Basin Freshwater Sites Including Prehistoric Elkhorn Slough

Ten freshwater or euryhaline species were represented by remains from two sites in the Pajaro River drainage and four sites associated with the former estuary of the Salinas River (Table 4). The Sacramento perch was the most abundant freshwater species.

Discussion

Although over 80 species were represented, comparatively few dominated the fisheries, and the

TABLE 4.—Number of elements of freshwater fishes, and those likely captured from freshwater, recovered from six Native American archaeological sites in the Pajaro–Salinas Basin of central California. Site listing is approximately north to south. The marine species from the Elkhorn Slough sites are found in Table 3.

Taxon	SCR-44[a]	SCL-119/ SBN-24/H[b]	MNT-228[c]	MNT-229[d]	MNT-234	MNT-1570[c]	Total
Sturgeons			8		3		11
Carps and minnows	70	2	86		1,188	60	1,406
Thicktail chub		64	23	10	177	2	276
Hitch	14	36	7	64	32	1	154
Sacramento blackfish		45	3	36	49	7	139
Sacramento squawfish			2	5		2	9
Sacramento sucker	12	15	10	2	512	25	576
Minnows or Sacramento sucker				1,132			1,132
Steelhead (rainbow trout)			17	32	154	1	204
Threespine stickleback			466		119	1	586
Sacramento perch	31	344	127	273	653	57	1,485
Tule perch	3	7	1	5	3	5	24

[a] P. E. Langenwalter II (La Mirada, California, personal communication) includes new data and 102 night smelt.
[b] P. D. Schulz (California State Department of Parks and Recreation, personal communication), Pacific herring or Pacific sardine and possibly marine surfperch material also present.
[c] Gobalet (1993) and new data.
[d] Gobalet (1990a).

fishes exploited were predominantly from habitats near the archaeological sites.

Exposed Rocky Coast

Well over half of the remains represented rockfishes, lingcod, kelp greenling, cabezon, and monkeyface prickleback which generally inhabit rocky reefs and kelp forests and would have been taken most easily from shore on the rough coast. These species were poorly represented at Elkhorn Slough and Morro Bay, where sandy bottoms and shallow water were the norm. In contrast, only a quarter of the exposed coast remains represented small schooling species which were so abundant in the lagoon and estuary sites. Trapping masses of the small schooling fishes from small watercraft would have been risky on the exposed coast. On a biomass basis, the importance of large inshore species was even more dramatic because of the size difference between the typical large inshore species and the smaller schooling fishes. The scarcity of flounder habitat was reflected by the negligible number of their remains on the open coast. Surfperches, however, occupy a wide range of marine habitats (Eschmeyer et al. 1983), and were strongly represented, as they were at the protected sites.

TABLE 5.—Summary of findings of marine fish remains from archaeological sites from San Mateo County to San Luis Obispo County on the central California coast.

Taxa	Elkhorn Slough	Morro Bay	Exposed coast[a]
Total number of elements			
All	29,707[b]	4,119	16,558
Relative abundance (percent of remains)			
Sharks, skates, rays	0.6%	15.0%	0.5%
Surfperches	12.2	20.9	11.3
Lefteye and righteye flounders	33.1	0.6	0.2
Small schooling species[c]	50.0	52.3	24.8
Large inshore species[d]	<0.1	2.3	55.5
Total	95.9	91.1	92.3

[a] Excludes three inland Carmel Valley sites not associated with any marine habitat (Table 2); MNT-1481, MNT-1485/H, and MNT-1486/H (Breschini and Haversat 1992).
[b] Total excludes sturgeons, steelhead, and threespine sticklebacks which are included in Table 4.
[c] Pacific herring, Pacific sardine, northern anchovy, topsmelt, jacksmelt, and grunion.
[d] Rockfishes, lingcod, cabezon, kelp greenling, and monkeyface prickleback.

Elkhorn Slough

Today, Elkhorn Slough is a saltwater embayment dominated by marine species (Kukowski 1972; Yoklavich et al. 1991, 1992). The prehistoric setting of this site was different, however, in that before 1908, the Salinas River (and possibly the Pajaro River) entered Elkhorn Slough, forming an estuary (Gordon 1985). The fish assemblages from CA-MNT-229 (73% freshwater taxa) and CA-MNT-1570 (72% freshwater taxa) reflected the previous route of the Salinas River. Site inhabitants apparently concentrated their fishing activities on the river and occasionally meandered downstream to fish the mouth of the river or Mon-

terey Bay. Conversely, closer to the ocean, only 18% of the remains from CA-MNT-228 and 10% at CA-MNT-234 represented freshwater species. Based on the abundance of Pacific herring, Pacific sardine, silverside, and flatfish remains, the inhabitants of CA-MNT-234 apparently exploited the slough extensively and fished at the beach and river less frequently.

The marine component of the Elkhorn Slough sites was dominated by small schooling species and flounders, which together accounted for 83.1% of the remains (Table 5). These species apparently were vulnerable to seines, dip nets, baskets, and weirs in the comparatively quiet, shallow backwaters and tidal channels. Pacific sardine, Pacific herring, topsmelt, and jacksmelt may also have been caught on small hooks, and flounders may have been speared.

Although we confidently identified only three species of flounders from the Elkhorn Slough sites, most diagnostic elements (pterotics, jaw parts, posttemporals, and otoliths) represented starry flounder, suggesting that the other 8,869 remains (mostly vertebrae) were from this species. On this basis, nearly 33% of the remains represented starry flounder, which constituted a unique concentration of a single species. Although starry flounder reach a larger size (Miller and Lea 1972), most of these remains were from individuals under 300 mm in total length, the average size of spawning males (Haugen 1992). Starry flounder are the only Pacific flounder to regularly occur in brackish water (Moyle 1976). The prehistoric estuary of the Salinas River was probably a spawning and developmental area for this extensively exploited species. In the contemporary marine Elkhorn Slough, starry flounder ranked eighth in relative abundance, along with Pacific herring (Yoklavich et al. 1991). The prehistoric starry flounder fishery must have been extensive but localized at CA-MNT-234.

The top 10 species ranked by Yoklavich et al. (1991)—shiner perch (most abundant); Pacific staghorn sculpin, white seaperch, black perch, northern anchovy, speckled sanddab, English sole, Pacific herring, and starry flounder (tied); and sand sole—accounted for 90% of the relative abundance. The abundance of surfperch, Pacific herring, and starry flounder in the archaeological record is consistent with the current local abundance. Although ranked lower by Yoklavich et al. (1991), topsmelt and jacksmelt are common, so their frequency in the midden was not surprising. A testament to the dramatic environmental change resulting from the shift of the Salinas River was the absence of native freshwater species in the contemporary census data (Yoklavich et al. 1991) and the modest archaeological representation of lingcod, cabezon, and rockfishes which are now common in Elkhorn Slough. These findings suggest a habitat far more suitable for freshwater and euryhaline species in the past (Gobalet 1990a, 1993). The freshwater species of Elkhorn Slough are discussed later.

The finding of the premaxillary tip from a 400-mm-long ocean sunfish is the first record of this species from an archaeological site. The size is typical for this species which occurs in relatively large numbers in the late summer and early fall when die-offs occur in Monterey Bay (Gotshall 1977).

Morro Bay

As at Elkhorn Slough, the abundance of small schooling species in the protected waters of Morro Bay was not surprising. Similarly, Morro Bay also showed a scarcity of large inshore species because of the lack of appropriate rocky reef and kelp forest habitat.

Surfperches, represented by 10 species, were approximately twice as abundant at Morro Bay as at Elkhorn Slough or the exposed coast. Based on contemporary samples (Fierstine et al. 1973), the abundance of shiner perch in these middens must reflect fishing in the shallow and quiet backwaters, probably with seines, weirs, and dip nets.

Sharks, skates, and rays exhibited their highest frequency at Morro Bay where all nine species found by Fierstine et al. (1973) in the contemporary environment have been identified in the archaeological record. The relative abundance of cartilaginous fishes at Morro Bay probably reflects a specialized local fishery. North of Morro Bay, remains of cartilaginous fishes have been abundant only in middens near San Pablo Bay, where seven species have been identified (Gobalet 1990b).

Shark, skate, and ray material is more common from southern California archaeological sites. Salls (1988) reported 18 species of cartilaginous fishes from 23 sites south of Point Conception. Sixteen cartilaginous fishes were identified at Malibu Creek alone (Follett 1969; Gobalet 1992). Together these findings suggest that, in the diet of coastal prehistoric inhabitants, sharks, skates, and rays generally decreased in importance from south to north.

Pajaro–Salinas Basin Freshwater Sites Including Prehistoric Elkhorn Slough

The strong representation of Sacramento perch, three minnows (thicktail chub, hitch, and Sacramento blackfish), and the Sacramento sucker met expectations based on other studies (Schulz and Simons 1973; Gobalet 1990c; Gobalet and Fenenga 1993). Doubts concerning the prehistoric status of the extinct thicktail chub in the Pajaro–Salinas drainages (Gobalet 1990a) can be dismissed based on the recovery of 276 diagnostic pharyngeals and basioccipitals in both the Pajaro and Salinas river drainages. The controversial specimens of thicktail chub reported by Miller (1963) from Soap Lake on the Pajaro River were probably accurately identified. That these remains arrived in these deposits via human exchange is highly unlikely because the value of fishes as items of trade lay in their exchange to populations with limited access to fishes (Heizer 1978). Our excavations and surveys of these drainages by Snyder (1912), Hubbs (1947), and Smith (1982) failed to locate splittail or hardhead, two minnows of the central valley which would be expected in this assemblage of native species (Gobalet 1993). We conclude that they have not been in the basin for at least the 8,200 years of human habitation.

Considering the putative importance of steelhead to central coast and central valley tribes (Baumhoff 1963; McEwan 1992), the rarity of their remains at our freshwater sites is intriguing.

Although all five species of Pacific salmon have been recorded from the Pacific Ocean off southern California, records of their presence in freshwater south of the San Lorenzo River in Monterey Bay are controversial (Swift et al. 1993). The report of chinook salmon from the Pajaro River by Snyder (1912) is also questionable because he did not collect the specimens himself and Smith (1982) failed to record them. The lack of salmon at any of our sites is consistent with their absence from Central Coast drainages and contrasts markedly with the reported importance of salmon to Native Americans on the northern California coast (Boydstun et al. 1992).

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