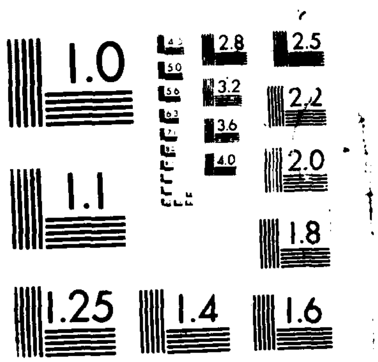
AD-A186 606 ARCHAEOLOGICAL STUDY OF CA-VEN-110 VENTURA CALIFORNIA: 1/1
FISH REMAINS SUPPLEMENT(U) GREENWOOD AND ASSOCIATES
PACIFIC PALISADES CA M A ROEDER AUG 87

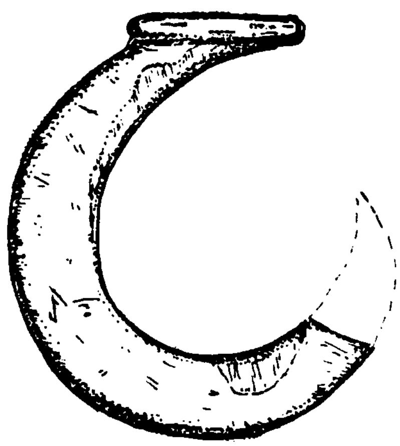
UNCLASSIFIED F/G 5/6 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

7

ARCHAEOLOGICAL STUDY OF CA-VEN-110, VENTURA, CALIFORNIA: FISH REMAINS



MARK A. ROEDER

10

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER	2. GOVT ACCESSION NO. A186 606
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle) Archaeological Study of CA-VEN-110, Ventura, California: Fish Remains	5. TYPE OF REPORT & PERIOD COVERED Supplemental
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Roeder, Mark A.	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Greenwood and Associates, 725 Jacon Way, Pacific Palisades, California 90272	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Corps of Engineers, 300 North Los Angeles Street, Los Angeles, California 90012	12. REPORT DATE August 1987
	13. NUMBER OF PAGES 26
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report) Unclassified
	15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Available from National Technical Information Services,
5285 Port Royal Road, Springfield, VA 22161

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Archaeology
Faunal Analysis
Fish
Seasonality
Otoliths

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

During the excavation of CA-VEN-110 in 1985 by Greenwood and Associates, a large quantity of fish remains were recovered during the wet screening of all soil through one eighth inch mesh. This report presents the analysis of a sample of these fish remains.

A total of 58 species of marine fish were identified from the units analyzed. Based on environmental data on these species, the inhabitants

DD FORM 1473, 1 JAN 73 EDITION OF 1 NOV 65 IS OBSOLETE

ARCHAEOLOGICAL STUDY OF CA-VEN-110, VENTURA, CALIFORNIA: FISH REMAINS

Prepared for:

Los Angeles District, Corps of Engineers
300 North Los Angeles Street
Los Angeles, California 90053

Funded by:

Federal Emergency Management Agency

Mark A. Roeder

August 1987

GREENWOOD AND ASSOCIATES
725 JACON WAY
PACIFIC PALISADES, CALIFORNIA 90272

CONTENTS

FIGURE

TABLES

FISH REMAINS FROM CA-VEN-110

Introduction

During the excavation of CA-VEN-110 in 1985 by Greenwood and Associates, a large quantity of fish remains (primarily vertebrae) was recovered during the wet screening of all soil through 1/8 inch mesh. The fish otoliths were identified and examined for seasonality by Richard W. Huddleston (1986:178-184), and he also prepared some preliminary comments on the skeletal material. The environmental and cultural background, field methods, artifacts, chronology, and interpretations of the site have been described in a technical report (Greenwood, Foster, and Romani 1986).

This report presents the analysis of a sample of fish remains from the 1985 excavation. The sample size was determined by unit placement, availability of radiocarbon dates, and the number of elements.

The fish remains were identified by the author and Dana Bleitz-Sanburg using comparative materials from the Section of Ichthyology, Natural History Museum of Los Angeles County, and collections housed in the Anthropology Laboratory at California State University at Los Angeles. A catalogue was generated with the following information: unit and provenience, species identification, element, size estimate, and evidence of burning and butchering marks.

A total of 58 species of marine fish was identified from the units analyzed. Based on environmental data on these species, the inhabitants of CA-VEN-110 not only utilized the fishes present in nearby Mugu Lagoon, but also exploited species in other marine habitats. Fishing may have occurred on a seasonal basis with the greatest activity occurring in the late summer months.

Methods and Results

Fifty-eight species of marine fish were identified from Units 2, 4, and 5 of CA-VEN-110. Distribution of species by unit appears in Table 1. Distributions of species by unit and level appear in Tables 2-5. In faunal studies the usual method of determining the number of individuals, or abundance of a species represented by skeletal elements, involves sorting and counting of the paired or sided (left or right) bones and/or single elements (such as the atlas vertebra). A minimum number of individuals (MNI) for a single taxon was determined by counting the highest number of either left or right elements, or diagnostic single elements (White 1953). The total number of identified specimens per species (NISP) is another method of determining indexes of abundance (Payne 1975: Grayson 1979). This method relies on the

Table 1. Fish Species Present at CA-VEN-110 by Unit

Species	Common Name	Units 2	4	5	Other*
Heterodontus francisci	horn shark	X	X	X	X
Isurus oxyrhincus	mako shark			X	
Galeorhinus galeus	soupfin shark			X	
Mustelus californicus	gray smoothhound	X	X	X	
Triakis semifasciata	leopard shark	X	X	X	
Triakidae	leopard shark family	X	X		
Prionace glauca	blue shark		X		X
Squatina californica	angel shark	X	X	X	X
Batoidea	ray		X	X	
Rhinobatos productus	shovelnose guitarfish	X	X	X	X
Platyrhinoides triseriata	thornback	X	X	X	
Torpedo californica	electric ray		X		
Urolophus halleri	round stingray	X		X	
Dasyatis brevis	diamond stingray			X	
Myliobatis californica	bat ray	X	X	X	X
Clupea harengus	Pacific herring	X			
Sardinops sagax	Pacific sardine	X	X	X	
Opisthonema sp.	thread herring			X	
Clupeidae	herrings or sardines		X		
Cypselurus californicus ?	California flyingfish	X			
Atherinops affinus	topsmelt	X		X	
Atherinopsis californiensis	jack smelt		X		
Leuresthes tenius	grunion		X		X
Atherinidae	silversides family			X	
Sebastes sp.	rockfish	X	X	X	X
Sebastes alutus	Pacific ocean perch				X
Sebastes atrovirens	kelp rockfish		X		
Sebastes carnatus	gopher rockfish		X	X	
Sebastes flavidus	yellowtail rockfish			X	
Sebastes goodei	chilipepper			X	X
Sebastes miniatus	vermilion rockfish			X	X
Sebastes paucispinus	bocaccio	X	X	X	X
Sebastes rastrelliger	grass rockfish			X	
Scorpaenichthys marmoratus	cabezon		X		
Paralabrax clathratus	kelp bass			X	
Paralabrax sp.	bass	X	X		
Stereolepis gigas	giant seabass	X			
Trachurus symmetricus	jack mackerel			X	
Seriola lalandi	yellowtail	X	X		
Sciaenidae	croakers	X	X	X	
Atractoscion nobilis	white seabass	X		X	
Genyonemus lineatus	white croaker	X	X	X	
Menticirrhus undulatus	corbina				X
Roncador stearnsi	spotfin croaker				X
Seriphus politus	queenfish		X		

Table 1. Fish Species Present at CA-VEN-110 by Unit (continued)

Umbrina roncador	yellowfin croaker				X
Embiotocidae	surfperch		X		
Amphistichus argentea	barred surfperch		X		
Cymatogaster aggregata	shiner surfperch		X		
Damalichthys vacca	pile surfperch	X		X	X
Embiotoca jacksoni	black surfperch	X			X
Embiotoca lateralis	striped surfperch		X		
Hypsurus caryi	rainbow surfperch	X			
Hyperprosopon argenteum	walleye surfperch		X		
Phanerodon furcatus	white surfperch	X	X	X	
Rhacochilus toxotes	rubberlip surfperch		X		
Sphyraena argentea	barracuda	X		X	X
Semicossyphus pulcher	sheephead		X	X	
Scombridae	tunas and mackerels		X		
Euthynnus pelamis	skipjack		X		
Sarda chiliensis	bonito	X	X	X	X
Scomber japonicus	Pacific mackerel	X	X	X	
Scomberomorus sp.	sierra	X			
Thunnus alalunga	albacore	X	X	X	
Thunnus sp.	tuna	X	X	X	
Paralichthys californicus	California halibut	X	X	X	X
Pleuronichthys ritteri	spotted turbot		X		
Hypsopsetta guttulata	diamond turbot	X	X	X	
TOTAL SPECIES		27	30	31	17

*from Huddleston 1986

number of bones and bone fragments assigned to a species. These methods (MNI and NISP) are very different in their operational methodology and results. Tables 2-4 provide a comparison of the results of both methods in determining relative abundance of species within individual levels, units, and the site as a whole.

Each method of determining abundance has its advantages and disadvantages. With fish, the MNI procedure does not work very well because most of the elements recovered in archaeological investigations are vertebrae. In a large sample size, vertebrae are usually separated by most faunal analysts into abdominal and caudal vertebrae. With a sample size as large as that analyzed in this study, the amount of time required to make an exact determination of location along the vertebral column for each vertebra would be inordinate. And many times, the exact position is impossible to assign, thus impeding determination of the MNI index.

NISP, on the other hand, is a different method of determining the abundance of a species by simply counting all identifiable bones for a species. MNI determines the minimum number of individuals in a sample, while NISP is a measure of the numerical abundance

Table 2. NISP and MNI by Level for Unit 2

Species	0-10 NISP	0-10 MNI	10-50	50-60 NISP	50-60 MNI	60-70 NISP	60-70 MNI	70-80 NISP	70-80 MNI	Tot. NISP	% NISP	Tot. MNI	% MNI
			0										
Horn shark						1	1	1	1	2	0.7	2	3.0
Gray smoothhound				2	1	1	1			3	1.0	2	3.0
Leopard shark				3	1	5	1	2	1	10	3.6	3	4.5
Leopard shark family				2	1	2	1	5	1	9	3.2	3	4.5
Angel shark				4	1	2	1	14	1	20	7.2	3	4.5
Shovelnose guitarfish				4	1	4	1	9	1	22	8.0	3	4.5
Thornback				1	1			1	1	2	0.7	2	3.0
Round stingray				2	1					2	0.7	1	1.5
Bat ray				1	1	3	1	4	1	8	2.9	3	4.5
Pacific herring								6	1	6	2.2	1	1.5
Pacific sardine				3	1	5	1	12	1	20	7.2	3	4.5
California flyingfish				1	1					1	0.4	1	1.5
Topsmelt				1	1					1	0.4	1	1.5
Grunion								3	1	3	1.0	1	1.5
Rockfish				1	1	4	1	4	1	9	3.2	3	4.5
Bocaccio						10	1	4	1	14	5.0	2	3.0
Bass	1	1								1	0.4	1	1.5
Kelp bass								1	1	1	0.4	1	1.5
Jack mackerel								1	1	1	0.4	1	1.5
Yellowtail				4	1			3	1	7	2.5	2	3.0
White seabass				1	1			2	1	3	1.0	2	3.0
White croaker								1	1	1	0.4	1	1.5
Croaker								3	1	3	1.0	1	1.5
Pile surfperch				3	1			4	1	4	1.4	2	3.0
Black surfperch						1	1			1	0.4	1	1.5
Rainbow surfperch						1	1	1	1	2	0.7	2	3.0
White surfperch				1	1					1	0.4	1	1.5
Barracuda								2	1	2	0.7	1	1.5
Bonito								16	3	16	5.8	3	4.5
Pacific mackerel				2	1	1	1			3	1.0	2	3.0
Albacore				4	1	11	1	5	1	20	7.2	3	4.5
Sierra				2	1					2	0.7	1	1.5
Tuna								2	1	2	0.7	1	1.5
Tuna family								3	1	3	1.0	1	1.5
Halibut	4	1		9	1	23	1	26	1	62	22.5	4	6.0
Diamond turbot				3	1					10	3.6	2	3.0
TOTAL	5	2		52	21	79	15	152	29	277		67	

Table 3. NISP and MNI by Level for Unit 4

Species	0-10 NISP	0-10 MNI	10-20 NISP	10-20 MNI	20-30 NISP	20-30 MNI	30-40 NISP	30-40 MNI	40-50-60	60-70 NISP	60-70 MNI	70-80 NISP	70-80 MNI	80-90 NISP	80-90 MNI	90-100 NISP	90-100 MNI	Tot. NISP	% NISP	Tot. MNI	% MNI
									0												
Hornshark	1	1																1	0.2	1	0.9
Gray smoothhound														5	1			5	0.9	1	0.9
Leopard shark							5	1		1	1	3	1	5	1	32	1	45	7.6	5	4.3
Leopard shark family							1	1		19	1	9	1	14	1	6	1	49	8.3	5	4.3
Blue shark												2	1	3	1			5	0.9	2	1.7
Angel shark							5	1		2	1	3	1	8	1	5	1	23	3.9	5	4.3
Ray										1	1	3	1					4	0.7	5	4.3
Shovelnose guitarfish	1	1					6	1		1	1	6	1	9	1	4	1	27	4.6	6	5.1
Thornback			1	1										1	1	2	1	4	0.7	3	2.6
Electric ray										1	1			1	1			2	0.3	2	1.7
Bat ray							4	1		1	1			1	1	3	1	9	1.5	4	3.4
Pacific sardine							2	1		20	2	18	2	5	1	16	1	61	10.4	7	6.0
Sardine family										2	2	1	1					3	0.5	3	2.6
Jacksmelt												1	1					1	0.2	1	0.9
Rockfish							1	1		3	1	4	1			5	2	13	2.2	5	4.3
Gopher rockfish										1	1					2	1	3	0.5	2	1.7
Bocaccio												2	1			1	1	3	0.5	2	1.7
Cabezon												2	1					2	0.3	1	0.9
Kelp bass																1	1	1	0.2	1	0.9
Yellowtail										1	1	3	1	15	1	5	1	25	4.2	4	3.4
Croaker										1	1							1	0.2	1	0.9
White croaker												1	1	1	1			2	0.3	2	1.7
Queenfish												2	1					2	0.3	1	0.9
Surfperch										2	1					1	1	3	0.5	2	1.7
Barred surfperch												1	1			1	1	2	0.3	2	1.7
Shiner surfperch														4	1			4	0.7	1	0.9
Striped surfperch							1	1										1	0.2	1	0.9
Walleye surfperch										1	1							1	0.2	1	0.9
Pile surfperch														1	1			1	0.2	1	0.9
White surfperch			1	1			1	1		1	1							3	0.5	3	2.6
Rubberlip surfperch										4	1	3	1	4	1	1	1	12	2.0	4	3.4
Sheephead										9	1	5	1			4	1	18	3.0	3	2.6
Skipjack												1	1					1	0.2	1	0.9
Bonito														4	1	1	1	5	0.9	2	1.7
Pacific mackerel												8	2	7	1	2	1	17	2.9	4	3.4
Albacore							27	3		19	1	3	1	2	1			51	8.7	6	5.1
Tuna	1	1								3	1	1	1	1	1			6	1.0	4	3.4
Halibut	2	1	3	1			10	1		21	1	35	3	40	1	52	1	163	27.7	9	7.7
Spotted turbot							1	1										1	0.2	1	0.9
Diamond turbot			1	1						2	1	1	1	1	1	1	1	8	1.4	5	4.3
Bass												1	1					1	0.2	1	0.9
TOTAL	5	4	6	4			64	14		116	24	119	29	131	20	149	22	589		117	

Table 4. NISP Compared to MNI - Unit 5

	Depth in cm									
	10-20		20-30		30-40		Total	% of	Total	% of
	NISP	MNI	NISP	MNI	NISP	MNI	NISP	Total	MNI	Total
Horn shark			1	1			1	0.2	1	1.5
Mako shark			1	1			1	0.2	1	1.5
Soupfin shark			4	1			4	0.8	1	1.5
Gray smoothhound			2	1			2	0.4	1	1.5
Leopard shark	3	1	16	1			19	3.7	2	3.1
Leopard shark fam.			8	1			8	1.6	1	1.5
Angel shark			21	1			21	4.1	1	1.5
Shovelnose guitarfish	5	1	12	1			17	3.3	2	3.1
Thornback			3	1			3	0.6	1	1.5
Ray			2	1			2	0.4	1	1.5
Round stingray			2	1			2	0.4	1	1.5
Bat ray			15	1			15	3.0	1	1.5
Diamond ray			1	1			1	0.2	1	1.5
Pacific sardine			161	13	4	2	165	32.2	15	23.1
Thread herring			17	1			17	3.3	1	1.5
Topsmelt			1	1			1	0.2	1	1.5
Silversides family			4	1			4	0.8	1	1.5
Grunion			29	1			29	5.7	1	1.5
Rockfish	1	1	26	1	6	1	33	6.5	3	4.7
Gopher rockfish			1	1			1	0.2	1	1.5
Yellowtail rockfish			1	1			1	0.2	1	1.5
Chilipepper			3	2			3	0.6	2	3.1
Vermilion rockfish			7	3			7	1.4	3	4.7
Bocaccio			3	1	1	1	4	0.8	2	3.1
Grass rockfish			6	3			6	1.2	3	4.7
Kelpbass			4	1			4	0.8	1	1.5
Croakers			13	1			13	2.5	1	1.5
White seabass			1	1			1	0.2	1	1.5
White croaker			1	1			1	0.2	1	1.5
Surfperches			2	1			2	0.4	1	1.5
Pile surfperch			7	1			7	1.4	1	1.5
White surfperch			5	1			5	1.0	1	1.5
Sheephead			1	1			1	0.2	1	1.5
Barracuda			3	1			3	0.6	1	1.5
Bonito			1	1			1	0.2	1	1.5
Pacific mackerel			10	1			10	2.0	1	1.5
Albacore			3	1			3	0.6	1	1.5
Tuna			6	1			6	1.2	1	1.5
California halibut			50	1	16	1	65	12.7	2	3.1
Diamond turbot			23	1			23	5.0	1	1.5
Flounders			1	1			1	0.2	1	1.5
TOTAL	9	3	478	58	27	5	513		66	

of elements of a species which, for several reasons such as breakage and higher numbers of identifiable bones in a taxon, may be artificially higher than MNI. To compare the two methods, the number of elements within each taxon was divided by the total of all identified bones to obtain the percentages in Tables 2-4. These percentages will be utilized in the discussion of habitats exploited by the inhabitants of CA-VEN-110.

Previous Work on Fish Remains from Mugu Lagoon

The earliest research on fish remains in the study area was conducted by Follett (n.d.) on material recovered during the Woodward-VanBergen excavations (1929-1932) of nearby CA-VEN-11, the village of Muwu. Follett identified 10 species of fish (Table 5).

Table 5. Fish Species Recovered from CA-VEN-11

Species	Common Name	Follett (n.d.)	Love (1980) Unit S3-W0
Carcharodon carcharias	great white shark	X	
Isurus oxyrhinchus	mako shark	X	X
Galeocerdo cuvier	tiger shark		X
Squatina californica	angel shark		X
Rhinobatos productus	shovelnose guitarfish		X
Urolophus halleri	round stingray		X
Mylobatis californica	bat ray	X	X
Tetrapturus andax	striped marlin		X
Xiphias gladius	broadbill marlin	X	X
Sphyraena argentea	barracuda	X	X
Sebastes atrovirens	kelp rockfish		X
Sebastes serranoides	olive rockfish		X
Sebastes ssp.	rockfish		X
Scorpaena guttata	sculpin		X
Atractoscion nobilis	white seabass		X
Embiotocidae	surfperches		X
Damalichthys vacca	pile surfperch		X
Rhacochilus toxotes	rubberlip surfperch		X
Semicossyphus pulcher	sheephead	X	X
Oxyjulis californica	senorita		X
Anisotremus davidsoni	sargo		X
Scomber japonicus	Pacific mackerel		X
Sarda chiliensis	bonito	X	X
Paralichthys californicus	California halibut	X	X
Seriola lalandi	yellowtail	X	
Sebastes paucispinis	bocaccio	X	

In 1976-1978, test excavations were conducted at CA-VEN-11 under the co-direction of D. Holly Love (UCLA) and Rheta Resnick (CSN) under the supervision of Dr. Clement Meighan (UCLA) and Dr. Charles Rozaire (LACM). As part of her master's thesis, Love analyzed the fish remains from two excavation units (S3-W0 and S4-W10) and two column samples (Love 1979, 1980). From her work, Love identified 23 species of fish from Unit S3-W0 (Table 5). In referring to species identified from CA-VEN-11, Love stated: when examining the species of fish bone found in the midden, the presence of lagoon dwellers could mean that the lagoon was of prime importance in providing the subsistence base in winter, when it was difficult to use canoes for fishing in the open ocean (1980:44).

A large collection of fish was recovered during the 1985 excavation of CA-VEN-110 (Greenwood, Foster, and Romani 1986). Richard W. Huddleston identified and conducted seasonality studies on the fish otoliths recovered and identified some of the fish skeletal materials. From his data, he concluded that the inhabitants of CA-VEN-110 fished "inshore surfzone regions as well as kelp bed and offshore areas" (1986:182), probably utilizing such fishing equipment as spears, nets, harpoons, and hook and line. Based on his seasonality study of otoliths from the site, Huddleston concluded that the inhabitants of CA-VEN-110 fished year-round with maximum activity in the late summer months. Radiocarbon dates derived from the 1985 field work indicated that CA-VEN-110 was occupied from A.D. 660-1050, somewhat earlier than occupation of the nearby village of Muwu, which has been dated at A.D. 900-1720 (Greenwood, Foster, and Romani 1986:82-83).

Fish Habitats Exploited by the Inhabitants of CA-VEN-110

One of the most important concepts on fish habitats was proposed by Allen in 1985. Using 38 faunal studies from a wide range of habitats along the southern California coast, Allen was able to delineate nine distinct habitat groups. These are the bay/estuary (BE), open coast sandy beach (OC), harbor/nearshore soft bottom (H/NSB), nearshore midwater (MU), offshore soft bottom (SB), rocky intertidal (IT), shallow rock reef (SRRF), deep rock reef (RRF), and kelp bed (KB). Clustering of 105 fish species produced 19 groups of both widespread and habitat-specific species.

In comparing the five major habitats with soft substrates (H/NSB, OC, BE, MW, SB), Allen (1985) found that H/NSB and OC were the most closely related, followed by BE, MW, and then SB. Among the rocky substrate habitats (KB, SRRF, RRF, IT), KB and SRRF were most similar, followed by RRF and then IT.

The rocky substrate habitats were divided according to depth and distance offshore (Allen 1985:138). IT (rocky intertidal) was restricted to only rocky intertidal and shallow subtidal areas, while SRRF (shallow rocky reef) areas were close to shore at depths between 2-12 m. KB (kelp bed) habitats were at depths of 8-18 m and more offshore, while RRF (deep rocky reefs) were in waters greater than 20 m (more than 60 feet).

Allen's 1985 study provides to researchers a more precise method to organize possible fish groups and habitats exploited by the peoples of CA-VEN-110. This approach is more accurate than standard species accounts generated from fish identification books such as Miller and Lea (1972) or Eschmeyer et al. (1983). The species group and habitat analysis developed by Allen indicates that certain species of fish are restricted to specific environments, while others are habitat "generalists," that is, they are distributed over a wide array of environments.

Below are the 19 species groups defined by Allen (1985:139-140) and illustrated in Figure 1. Each species group is associated with its habitat, often using Allen's descriptions. Species occurring at CA-VEN-110 have been underlined.

Species Group I contains four small species that are only found in the IT habitat: none of these was present at CA-VEN-110.

Species Group II consists of three species found in all rocky habitats, but which were abundant as juveniles in IT and SFFR: cabezon, opal eye, spotted kelpfish.

Species Groups III, IV, and V includes fishes almost exclusively associated with SRRF, KB, and, to a lesser extent, RRF: grass rockfish, gopher rockfish, brown rockfish, garibaldi, kelp rockfish, painted greenling, salema, black croaker, rock wrasse, sheephead, half moon, rainbow surfperch, rubberlip surfperch, olive rockfish, blue rockfish, blacksmith, senorita, kelp surfperch, kelp bass.

Species Group VI contains four species of ubiquitous fishes that occur in most major habitats: pile surfperch, black surfperch, barred sand bass, white surfperch.

Species Group VII includes two species of midwater (nearshore pelagic) fishes which are loosely associated with RRF and KB habitats at certain times of the year: jack mackerel, bonito.

Species Group VIII members are found in low abundance in a wide range of nearshore habitats: giant kelpfish, barracuda, dwarf surfperch, jacksmelt.

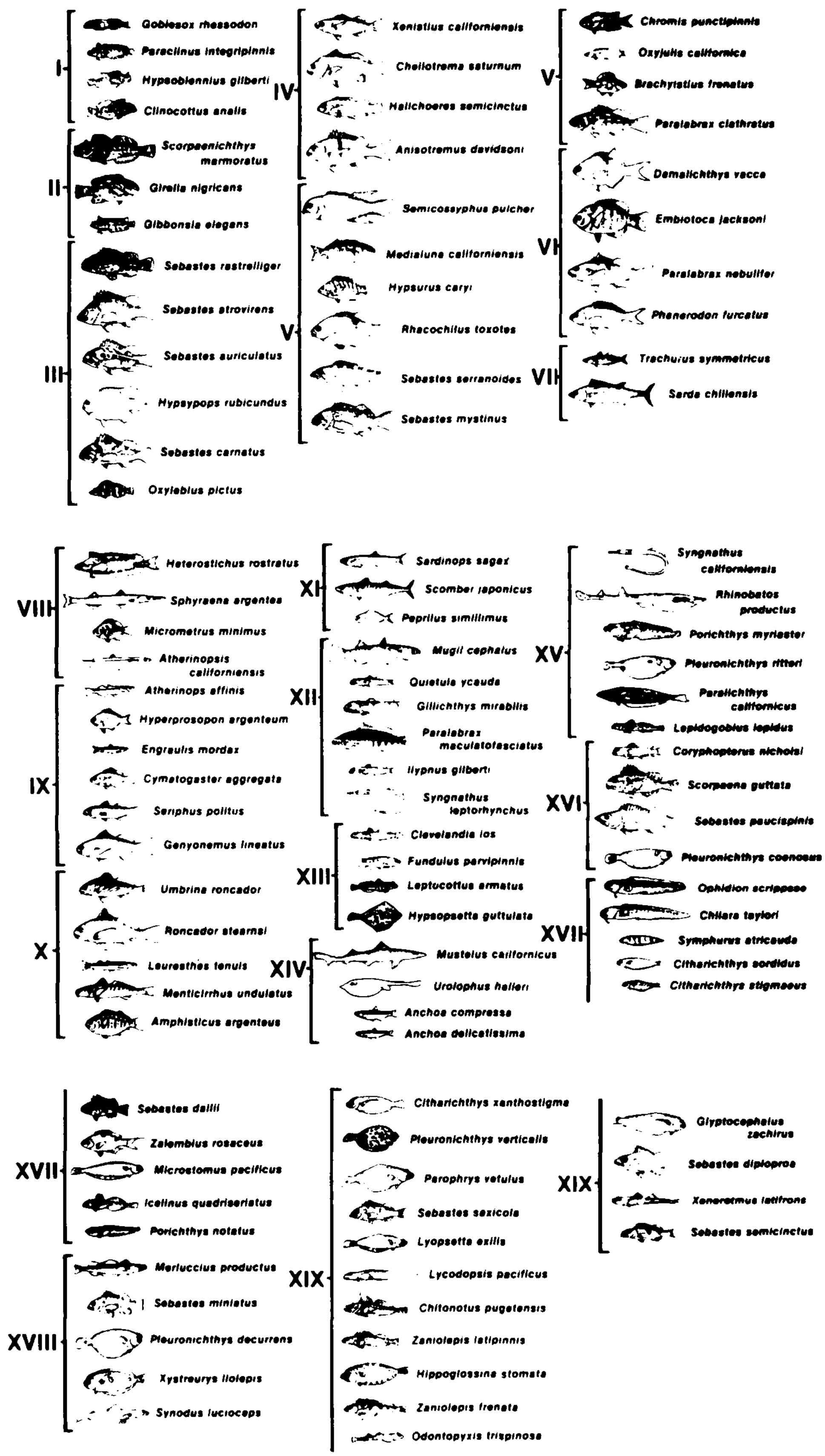


Figure 1. Species Groups by Habitat (Allen 1985)

Species Group IX is composed of six species of abundant habitat generalists which are numerically dominant over virtually all soft substrate habitats and are conspicuously less abundant in KB and RRF habitats: topsmelt, walleye surfperch, northern anchovy, shiner surfperch, queenfish, white croaker.

Species Group X consists of five species, including three croakers, restricted largely to the OC habitat with sporadic/seasonal occurrence in BE (such as Mugu Lagoon) and MW habitats: yellowfin croaker, spotfin croaker, grunion, corbina, barred surfperch.

Species Group XI represents a grouping of three nearshore pelagic species encountered only in the MW habitat samples: Pacific sardine, Pacific mackerel, Pacific butterfish.

Species Group XII contains six species which are indigenous to the BE habitat: striped mullet, shadow goby, bay pipefish (small fish), mudsucker, cheekspot goby (very small fish), spotted sandbass. None of these fish was recovered from CA-VEN-110.

Species Group XIII includes four common BE species which also occur in harbor habitats in low abundance: arrow goby (very small fish), California killifish, staghorn sculpin, diamond turbot.

Species Group XIV is composed of four species which occur in relatively low abundance in shallow, nearshore habitats such as BE, OC, and H/NSB: gray smoothhound, round stingray, deepbody anchovy, slough anchovy.

Species Group XV is made up of six species of benthic fishes more abundant in the H/NSB habitat and, to a much lesser extent, in the BE habitat: kelp pipefish, shovelnose guitarfish, specklefin midshipman, spotted turbot, California halibut, bay goby (very small fish).

Species Group XVI includes four species which may be described as sand-rock (ecotonal) fishes. They have been reported from RRF and KB habitats and were also regularly recorded in otter trawl (on the bottom) samples from SB environments: black eye goby (very small fish), bocaccio (rock fish), C-O turbot, sculpin.

Species Groups XVII, XVIII, and XIX are made up of species associated almost exclusively with the SB habitat: spotted cusk-eel, basketweave cusk-eel, California tonguefish, Pacific sanddab, speckled sanddab, calico rockfish, rosy surfperch, Dover sole, yellowchin sculpin, plainfin midshipman, vermilion rockfish, curlfin turbot, fantail sole, lizardfish, longfin sanddab, horny head turbot, striped tail rockfish, slender sole, blackbelly eelpout.

In his study of fish habitats, Allen (1985) found that the offshore soft bottom (SB), kelp bed (KB), and deep rock reef (RRF) zones show the highest fish diversity in number of species, and that the nearshore midwater (MW), bay/estuary (BE), and rocky intertidal (IT) the lowest. In fact, studies have shown that BE environments tend to have five or six species comprising more than 90% of the population (Allen 1982; Allen and Horn 1975; Onuf and Quammen 1981, 1983). For example, Table 6 lists the species taken in the eastern arm of Mugu Lagoon during seining operations in 1977-1978. This study revealed that six species comprised 92.01% of the catch. Of the 36 species recorded, only 16 were found at CA-VEN-110. Of these 16 species, 11 presently are rare in Mugu Lagoon. It is quite possible that present conditions in the lagoon are very different than they were during the prehistoric occupation of the site.

Love mentioned that the Mugu Lagoon "inlet is maintained by tidal currents and closed by longshore sand drift" (1979:46). She also stated that, "at present the lagoon mouth is sealed off about every six months to a year and is immediately dredged open by the Navy, usually at the head of Mugu submarine canyon" (1979:46). In effect, without the assistance of the Navy, Mugu Lagoon would be closed off part of the year. No doubt, the present fish fauna would suffer without the daily exchange of marine waters through the inlet. It is quite possible that the lagoon in the past, because of the closure of the tidal inlet, may have had a less diverse fish fauna. The lagoon might have been more brackish or hypersaline without the constant tidal flow. Based on this information, it is quite possible that most of the fish taken by the inhabitants of CA-VEN-110 were not captured in the lagoon, but in the open coast sandy beach (OC), harbor/nearshore soft bottom (H/NSB), and/or kelp bed (KB) environments.

Fourteen of the 58 species recovered from CA-VEN-110 are pelagic (Group XI and pelagic species), and are found in open ocean waters (Tables 6, 7). These fishes, which include the tunas and yellowtail, have been taken at the head of Mugu submarine canyon, which is 120 feet deep within only 700 feet of the beach at Mugu Pier. "This means that the Indians could fish for deep-water pelagic fish close to shore" (Love 1980:10). Thirteen kilometers north of Point Mugu, Hueneme submarine canyon is more than 300 feet deep less than one mile from the shore (Warme 1971:6). This further implies that the people of CA-VEN-110 used some kind of seagoing craft.

At least 13 species of fish (Groups III-V and kelp bed/rocky species) were probably taken in shallow rocky reef (SRRF) and KB habitats (Tables 7-9). These species are dominated by various kinds of rockfish and surfperch. Of the RRF habitat, only two rockfish, Sebastes alutus (Pacific ocean perch) and

Table 6. Fish Present in Eastern Arm of Mugu Lagoon, 1977-1978

Species	Common Name	No.	%
*Atherinops affinus	topsmelt	3,567	42.11
*Cymatogaster aggregata	shiner surfperch	2,905	34.30
Leptocottus armatus	staghorn sculpin	610	7.21
*Paralichthys californicus	California halibut	274	3.23
Fundulus parvipinnus	California killifish	235	2.74
*Hypsopsetta guttulata	diamond turbot	205	2.42
TOTAL			92.01%
*Genyonemus lineatus	white croaker	193	2.28
Syngnathus leptorhynchus	bay pipefish	138	1.63
Gillichthys mirabilis	longjaw mudsucker	89	1.05
Symphurus atricauda	California tonguefish	39	0.46
Paralabrax nebulifer	barred sandbass	38	0.45
Hypsoblennius jenkensi	mussel blenny	20	0.24
*Seriphus politus	queenfish	19	0.22
Heterostichus rostratus	giant kelpfish	19	0.22
*Sebastes rastrelliger	grass rockfish	15	0.18
Paralabrax clathratus	kelp bass	14	0.17
Citharichthys stigmaeus	speckled sanddab	13	0.15
Sebastes auriculatus	brown rockfish	10	0.12
Engraulis mordax	northern anchovy	9	0.11
*Mustelus californicus	gray smoothhound	8	0.09
Quietula ycauda	shadow goby	8	0.09
*Rhinobatos productus	shovelnose guitarfish	7	0.08
Girella nigricans	opaleye	7	0.08
*Embiotoca jacksoni	black surfperch	6	0.07
Albula vulpes	bonefish	5	0.06
Sebastes elongatus	green striped rockfish	4	0.05
*Clupea harengus	Pacific herring	3	0.04
*Amphisticus argenteus	barred surfperch	3	0.04
*Urolophus halleri	round stingray	3	0.04
Gibbonsia sp.	kelp fish	2	0.02
*Triakis semifasciata	leopard shark	1	0.01
Sebastes sp.	rockfish	1	0.01
*Platichthys stellatus	starry flounder	1	0.01
*Pleuronichthys ritteri	spotted turbot	1	0.01
Sebastes serranoides	olive rock	1	0.01

* present at CA-VEN-110

(Samples taken with beach seines (4 hauls per month), February 1977 - January 1978, by M. Quammen)

Table 7. Species Recovered by Habitat Groups

Species, by %	Unit 2 NISP	Unit 2 MNI	Unit 4 NISP	Unit 4 MNI	Unit 5 NISP	Unit 5 MNI	Total NISP	Total MNI
Group I (IT)								
GROUP II (all rocky habitats)								
Cabezon			0.3	0.9			0.3	0.9
GROUPS III-V (SRRF, KB, and to lesser extent, RRF)								
Grass rockfish					1.2	4.7	1.2	4.7
Gopher rockfish			0.5	1.7	0.2	1.5	0.3	0.2
Kelp rockfish			0.3	0.8			0.3	0.8
Sheephead			3.0	2.6	0.2	1.5	1.4	1.6
Rainbow surfperch	0.7	3.0					0.1	0.8
Rubberlip surfperch	2.0	3.4					0.9	1.6
Kelp bass	0.8	1.5					0.3	0.4
Total	3.5	7.9	3.8	5.1	1.6	7.7	4.5	10.1
GROUP VI (most habitats)								
Pile perch	2.5	3.0			1.4	1.5	1.0	1.2
Black surfperch	0.4	1.5					0.1	0.4
White surfperch	0.4	1.5	0.5	2.6	1.0	1.5	0.6	2.0
Total	3.3	6.0	0.5	2.6	2.4	3.0	1.7	3.6
GROUP VII (midwater species near RRF and KB)								
Bonito	5.8	4.5	0.9	1.7	0.2	1.5	1.6	2.4
Jack mackerel	0.4	1.5					0.1	0.4
Total	6.2	6.0	0.9	1.7	0.2	1.5	1.7	2.8
GROUP VII (nearshore habitats in low abundance)								
Barracuda	0.7	1.5			0.6	1.5	0.4	0.8
Jacksmelt			0.2	0.9			0.1	0.4
Total	0.7	1.5	0.2	0.9	0.6	1.5	0.5	1.2
GROUP IX (habitat generalists abundant over surf bottoms)								
Topsmelt	0.4	1.5			0.2	1.5	0.1	0.8
Walleye surfperch			0.2	0.9			0.1	0.4
Shiner surfperch			0.7	0.9			0.3	0.4
Queenfish			0.3	0.9			0.1	0.4
White croaker	0.4	1.5	0.3	1.7	0.2	1.5	0.3	1.6
Total	0.8	3.0	1.5	4.4	0.4	3.0	0.9	3.6

Table 7. Species Recovered by Habitat Groups (continued)

Species, by %	Unit 2 NISP	Unit 2 MNI	Unit 4 NISP	Unit 4 MNI	Unit 5 NISP	Unit 5 MNI	Total NISP	Total MNI
GROUP X (restricted to OC; sporadic/ seasonal in Mugu Lagoon and MW)								
Yellowfin croaker			Present; Huddleston 1986					
Spotfin croaker			Present; Huddleston 1986					
Grunion	1.0	1.5			5.7	1.5	2.3	1.6
Corbina			Present; Huddleston 1986					
Barred surfperch			0.3	1.7			0.1	0.8
Total	1.0	1.5	0.3	1.7	5.7	1.5	2.4	2.4
GROUP XI (nearshore pelagic, only encountered in MW)								
Pacific sardine	7.2	4.5	0.5	2.6	32.2	23.1	13.6	8.4
Pacific mackerel	1.0	3.0	2.9	3.4	2.0	1.5	2.2	2.8
Total	8.2	7.5	3.4	6.0	34.2	24.6	15.8	11.2
GROUP XII (indigenous to BE)							-	-
GROUP XIII (common in BE, but rare in harbors)								
Diamond turbot	3.6	3.0	1.4	4.3	5.0	1.5	3.0	4.8
GROUP XIV (nearshore habitats such as BE, OC, and H/NSB)								
Gray smoothhound	1.0	3.0	0.9	0.9	0.4	1.5	0.7	1.6
Round stingray	0.7	1.5			0.4	1.5	0.3	0.8
Total	1.7	4.5	0.9	0.9	0.8	3.0	1.0	2.4
GROUP XV (benthic, abundant H/NSB and to lesser extent, BE)								
Shovelnose guitarfish	8.0	4.5	4.6	5.1	3.3	3.1	4.8	4.4
Spotted turbot			0.2	0.9			0.1	0.4
California halibut	22.5	6.0	27.7	7.7	12.7	3.1	21.0	6.0
Total	30.5	10.5	32.5	13.7	16.0	6.2	25.9	10.8
GROUP XVI (RRF, KB, SB)								
Bocaccio	5.0	3.0	0.5	1.7	0.8	3.1	1.5	2.4
GROUP XVII-XIX (SB)								
Vermilion rockfish					1.4	4.7	0.5	1.2

(Group/Habitat from Allen 1985)

Table 8. Species Recovered at CA-VEN-110, Not Included in Allen's Group-Habitat Analysis

PELAGIC SPECIES

Blue shark			0.9	1.7			0.4	0.8
Mako shark					0.2	1.5	0.1	0.4
Yellowtail	2.5	3.0	4.2	3.4			2.3	2.4
Skipjack			0.2	0.9			0.1	0.4
Sierra	0.7	1.5					0.1	0.4
Albacore	7.2	4.5	8.7	5.1	0.6	1.5	6.1	4.0
Tuna	0.7	1.5	1.0	3.4	1.2	1.5	1.0	2.4
Soupfin					0.8	1.5	0.3	0.4
Pacific herring					2.2	1.5	0.4	0.4
Thread herring					3.3	1.5	1.2	0.4
California flyingfish	0.4	1.5					0.1	0.4
Yellowtail rockfish					0.2	1.5	0.1	0.4
TOTAL	11.5	12.0	15.0	14.5	8.5	10.5	12.2	12.8

KELP BED/ROCKY AREA SPECIES

Pacific electric ray					0.3	1.7	0.1	0.8
Giant seabass				Huddleston	1986			
White seabass				Huddleston	1986			
Striped surfperch			0.2	0.9			0.1	0.4
TOTAL			0.2	0.9	0.3	1.7	0.2	1.2

DEEP ROCKY REEF

Pacific ocean perch				Huddleston	1986			
Chilipepper					0.6	3.1	0.2	0.8

BAY-ESTUARY/OPEN COAST SANDY BEACH

Bat ray	2.9	4.5	1.5	3.4	3.0	1.5	2.2	3.2
Diamond ray					0.2	1.5	0.1	0.4
Leopard shark	3.6	4.5	7.6	4.3	3.7	3.1	5.4	4.0
Thornback	0.7	3.0	0.7	2.6	0.6	1.5	0.6	2.4
TOTAL	7.2	12.0	9.8	10.3	7.5	7.6	8.3	10.0

Table 9. NISP and MNI by Species Groups and Habitats

Group	Habitat	% NISP	% MNI
GROUP I	IT only		
GROUP II	All rocky habitats	0.3	0.9
GROUP III-V	SRRF, KB, lesser extent RRF	5.4	10.1
GROUP VI	Most habitats	1.7	3.6
GROUP VII	Midwater near RRF and KB	1.7	2.8
GROUP VIII	Nearshore habitats, low abundance	0.5	1.2
GROUP IX	Habitat generalists abundant over soft bottom, less in KB and RRF	0.9	3.6
GROUP X	OC, but sporadic/seasonal in BE and MW	2.4	2.4
GROUP XI	Nearshore pelagic only in MW	15.8	11.2
GROUP XII	Indigenous to BE	-	-
GROUP XIII	Common in BE, rare in harbors	3.0	4.8
GROUP XIV	Nearshore habitats BE, OC, H/NSV	1.0	2.4
GROUP XV	Benthic species abundant H/NSB, lesser BE	4.8	4.4
GROUP XVI	Found RRF and KB, also SB	1.5	2.4
GROUP XVII-XIX	SB only	0.5	1.2
	Total	39.5	51.0

Species groups and habitats not assigned to Allen (1985) classification:

PELAGIC SPECIES	12.2	12.8
KELP BED/ROCKY AREAS	0.2	1.2
DEEP ROCKY REEF	0.2	0.8
BAY/ESTUARY/OPEN COAST SANDY BEACH	8.3	10.0

Sebastes goodei (chilipepper), really represent those habitats. Chilipepper adults are usually found below 200 feet, while Pacific ocean perch is seldom seen above 400 feet. The presence of both these species indicates that they may have been taken in nearby submarine canyons with long-lines.

Distribution of Fish Bone at CA-VEN-110

During the initial laboratory analysis of materials from CA-VEN-110, all fish bones were separated into teleost (bony fish) and elasmobranch (shark) classes, and the groups weighed. Table 10 summarizes the distribution of the total recovery. For comparison, the total weight of fish bone per cubic meter from a single unit (S3-W0) at CA-VEN-11 was computed; the weight and density of fish bone from both sites are roughly comparable.

Table 10. Distribution of Fish Bone, CA-VEN-110

Unit	Teleost	Elasmobranch	Total	Weight per M3
1	635.6 g	107.5 g	743.1 g	530.8 g
*2	121.0	25.6	146.6	148.1
3	896.8	95.0	953.7	953.7
3E	140.5	26.8	167.3	743.6
*4	380.0	36.5	416.5	680.6
*5	83.4	25.5	108.9	360.6
6	56.5	7.1	63.7	249.8
TOTAL	2,313.8	324.0	2,637.9	
Site average				546.2
(Greenwood, Foster and Romani 1986:76)				
CA-VEN-11 (S3-W0)				710.0

*Units analyzed in this report

Seasonality

Otoliths are small, hard secretions of calcium carbonate (aragonite) that are found within the neurocranium of bony fish. Otoliths, or earbones, are located in the semicircular canals of the inner ear and appear to be part of the system that controls equilibrium, hearing, and possibly depth perception and/or frequency analysis of sound (Casteel 1976). In teleosts (bony fish), there are three pairs of otoliths: sagitta, lapillus, and asteriscus. In most marine fishes, the sagitta is the largest pair, while the other two pairs are usually microscopic in size. Some families like the sciaenids (croakers), scorpaenids (rockfish), and embiotocids (surfperch) possess sagittal otoliths large enough to be retained by the 1/8 inch mesh screens customarily used by archaeologists to process excavated earth from coastal Indian middens.

Fish otoliths can provide a wealth of information to the archaeologist. With a good comparative collection of local species, otoliths provide unequivocal species identification. Often, otoliths can be identified more rapidly and accurately than other fish bones such as vertebrae, fin spines, skull bones, and others requiring more cumbersome methods of speciation. Because otoliths are sided, that is, left and right sided, they therefore can be effectively utilized to determine minimum numbers of individuals (MNI). There is also a strong relationship between fish size and otolith size; therefore, otoliths can be used in estimating fish length and weight at the time of capture. Finally, otoliths can be used for age-growth and seasonality studies.

In southern California, most growth in coastal fishes occurs during the period between mid-May and early October (Fitch 1980). During this period, a cloudy calcium carbonate ring (much like a tree ring) is deposited on the surface of the otolith. This cloudy, or opaque, ring is called the summer ring. From early October to mid-May, a period of slow or non-growth, a clear or translucent, winter ring is deposited. These two distinct rings combined represent one year of fish life. By estimating the thickness of the seasonal rings from the edge of the otolith to the end of the other seasonal ring, a researcher can estimate roughly the month the fish died or was captured. This method of reading the thickness of the seasonal ring usually involves grinding and/or burning the otolith to read the thickness of the seasonal ring. Thin otoliths can be immersed in water or thin oil and be read directly with the aid of a binocular microscope. Thus, otoliths can provide information on species identification, size and weight estimates, growth rates, season of death or capture, and other information (Casteel 1986; Fitch 1957,1958). Richard W. Huddleston provided the seasonality determinations on the otoliths recovered from the 1985 project (Huddleston 1986).

Table 11. Seasonality of Otoliths

No. of otoliths	Reading	Period of Capture
4	early summer	mid-May to July
4	mid-summer	July to mid-August
9	late summer	mid-August to early October
4	late summer/early winter	September to December
1	early winter	early October to December
1	early to mid-winter	early October to February
1	mid-winter	December to March
4	late winter	March to mid-May
4	late winter/early summer	April to June
32	TOTAL	

Although this method of estimating the season of fish capture has been available to archaeologists for at least 30 years, very few of these studies have been conducted on archaeological fish otoliths. The 33 otoliths recovered from CA-VEN-110 provide some insight into the seasonal fishing at this site. Huddleston (1986:180-181) was able to ascertain seasonality determinations on 32 of the 33 otoliths from CA-VEN-110 (Table 11).

The "summer" growing season for marine fish off southern California is mid-May to early October. Twenty-one of the 32 otoliths from CA-VEN-110 fall into the April-early October period (about six months), seven otoliths fall into the period September-March, and four otoliths fall into the March to mid-May period. Based on the otolith seasonality determinations, Huddleston concluded that fishing was conducted year round with the highest activity in the late summer (mid-August to early October).

Simpson (1962) observed that "during the winter, the Indians of New California suffered from hunger when the cold rain, and roughness of the sea prevented them from fishing." He was probably referring to the months of January, February, and March, when California receives most of its rain from cold Northern Pacific storms. Craig stated, "it is evident that a viable winter fishery existed" (n.d.:23), and he quoted Menzies from the Vancouver Expedition of 1790-1794, who reported these activities during the month of November (Love 1980:4):

> They were always seen out by the dawn of day either examining their fish pots in the bay or fishing in the middle of the Channel where they never fail to catch a plentiful supply of fish of different kinds, especially bonito and a kind of herring with a yellow tail.

The observation by Menzies was during the early part of the winter season for fish and in the fall. Often even species abundant in the late summer are still present in the fall, especially during "El Nino" years.

Love reported that "the lagoon [Mugu] held a year-round supply of bottom dwelling fish such as haibut, flounder, sharks, and rays"(1980:5). In reference to CA-VEN-11, "thus, using environmental studies, we determined that people living at Muwu, in this extraordinarily rich milieu, were not subjected to the same seasonal stress during the winter as other coastal groups observed by the Spanish" (Love 1980:5). She concluded that "contrary to popular belief, the coastal Indians relied upon the annual appearance of tunas for their sustenance, the largest proportion of the fish found in the analysis consisted of non-seasonal non-migratory species" (Love 1980:xi). To the contrary, however, fishery biologists have noted that there is a disparity in the kinds and numbers of fishes present in bays, lagoons, and estuaries (Allen and Horn 1975; Allen 1982; Onuf and Quammen 1983) between summer and winter months. These studies indicate that seasonal changes in temperature, salinity, and to a lesser extent, dissolved oxygen, are factors in determining fish abundance. In Allen and Horn's study of Colorado Lagoon (1975), the number of species and individuals was the highest during the period May-September.

In commenting on upper Newport Bay, Allen stated:

> Fish abundance and diversity fluctuated markedly during the 13 months of the study....Both the number of individuals and biomass began to increase dramatically during May 1978 with peaks of 21,907 individuals and 21.7 kg in June. Both numbers and biomass decreased in August, with numbers of individuals increasing again in September. Biomass declined once again in September during a period of rainfall and then increased in October. In the months from October 1978 to January 1979 a rapid decline in both numbers and biomass was evident (1982:777).

Lagoons like Mugu Lagoon are not static, but dynamic, and because of their closed nature are even more sensitive than the open ocean to changes in salilnity, temperature, turbidity, dissolved oxygen, and other factors. Often these changes are more dramatic than in the ocean and affect fish faunas much more drastically. Fishes in lagoons, bays, and estuaries are seasonal and migratory. Although these bodies of water are 20 times more productive in terms of biomass than the ocean, these areas are seasonal in their abundance of life. In commenting on the decline of fishes in Upper Newport Bay, Allen stated that "by October the extensive algal beds had disappeared" (1982:779). Regarding monthly catches of fish in Mugu Lagoon, Onuf and Quammen reported "monthly catches for the whole lagoon show a peak in abundance in May or June, and a second peak in September or October in all four years of the study. The number of species caught was lowest in the months December-April" (1981:102).

In commenting on the shovelnose guitarfish migration in Mugu Lagoon, Dubois has reported,"Every spring, hundreds of guitarfish enter the eastern arm of Mugu Lagoon, only to leave again in the autumn" (1981:40). Other fish like corbina, grunion, spotfin croaker, yellowfin croaker, and barred surfperch usually are restricted to the OC (open coast sandy beach) habitat, making seasonal and/or sporadic trips into bay/estuarine environments (BE) like Mugu Lagoon.

Gray and Steffen, in their study of Revolon Basin of Mugu Lagoon (1982), found that California halibut and diamond turbots may enter the lagoon as fingerlings and return the the ocean when they are about six inches long. Most of the halibut from CA-VEN-110 were larger, possibly indicating that these fish may have come from coastal, not lagoonal, waters.

To summarize, fish in Mugu and other lagoons are both seasonal and migratory. Mugu Lagoon has its highest quantity and diversity of fish during the months of May through October. Based on Huddleston's analysis of the otoliths from the site and the environmental information presented above, it appears that very little, if any, aboriginal fishing took place in the lagoon from December until the late spring-April.

Discussion

The total analysis of fish remains from three units at CA-VEN-110 yielded more than 58 species, indicating that the inhabitants exploited a wide variety of marine environments. Based upon Allen's 1985 classification of fish habitats, not only was the bay/estuary environment of Mugu Lagoon exploited, but also the open coast sandy beach, shallow rocky reef, kelp beds, nearshore midwater, harbor/near shore soft bottom, and open ocean-pelagic zones. The rocky intertidal, soft bottom-offshore, and the deep rocky reef were the least utilized habitats, based on fish species recovered.

In comparing fish remains per excavated cubic meter (M^3), CA-VEN-110 is comparable to nearby CA-VEN-11, the village of Muwu. Love (1980) partially identified a fish bone sample from two excavation units from CA-VEN-11 and named 23 species. The present study identified all fish remains (mostly vertebrae) from three units and counted 58 species from CA-VEN-110. Love commented that identifying vertebrae in a midden was costly (1979:49), but use of this method at CA-VEN-11 would probably have yielded numbers more comparable to the CA-VEN-110 inventory. Also, the use of fine screening techniques on large samples from CA-VEN-110 may have added an additional 10 to 15 species of fish.

Although CA-VEN-110 is apparently older than site CA-VEN-11, it is possible that the Chumash inhabitants possessed much of the same fishing gear used by later Chumash groups as described at the time of European contact.

A small collection of shell and bone books was recovered from CA-VEN-110 (Table 12).

Table 12. Fish Hooks from CA-VEN-110

Cat. No.	Item	Location	Level	Material
564	fragment	Unit 1	80-90 cm	*Mytilus*
565	fragment	Unit 2	90-100 cm	shell, eroded
566	fish hook	Unit 2	90-100 cm	*Mytilus*
567	fragment	Unit 4	10	*Mytilus*
568	fish hook	Unit 5	3	bone
569	fragment	Unit 3	4	*Argopecten*

According to Fitch, in reference to his analysis of the fish remains from CA-VEN-3, shell and bone fish hooks:

> would have been the most productive and less cumbersome gear for catching moderate and deep living forms (e.g., soupfin shark, spiny dogfish, California halibut, rockfish, Pacific hake, etc.). For the same reason, hook and line would have been the most suitable gear for several schooling species that prefer offshore surface areas (i.e., bonito, barracuda, Pacific mackerel, etc.) [1969:68].

Most of these species were also recovered from CA-VEN-110. No doubt the inhabitants of CA-VEN-110 probably used some kind of sea-going craft to fish the deeper waters of Mugu and Hueneme submarine canyons and the open ocean beyond, as evidenced by the presence of the 12 pelagic species recovered from the site. To capture surf dwelling species such as surfperch and atherinids (topsmelt, grunion, shovelnose guitarfish), Fitch (1969) speculated that the Chumash at CA-VEN-3 used a beach seine. A seine could have been used along with fence and converging weir to capture fish in Mugu Lagoon during tidal exchange.

Harpoons or spears could have been used to capture bottom dwelling fish such as halibut, sharks, and rays in the quiet shallows of Mugu Lagoon. These same instruments could also have been used to spear surface dwelling swordfish, tuna, and sharks in the open ocean waters. Small rays and grunion could have been taken by hand. Several species of fish, such as sheephead and rockfish, are known to enter into traps.

Based upon Huddleston's 1986 otolith study and environmental data, the inhabitants of CA-VEN-110 probably fished year-round with by far the greatest activity in the late summer. Although they may have fished other areas year-round, their use of Mugu Lagoon as a fishing ground may have been only during the summer fish-growth season of May through October. According to Onuf and Quammen (1983), the presence of fishes in Mugu Lagoon is sparsest during the months December through April, as evidenced by their year-long study.

References Cited

Allen, L. G.
1982 Seasonal Abundance, Composition, and Productivity of the Littoral Fish Assemblage in Upper Newport Bay, California. Fishery Bulletin 80 [4]:769-789.

1985 A Habitat Analysis of the Nearshore Marine Fishes from Southern California. Bulletin of the Southern California Academy of Sciences 84[3]:133-155.

Allen, L. G., and M. H. Horn
1975 Abundance, Diversity, and Seasonality of Fishes in Colorado Lagoon, Alamitos Bay, California. Estuarine and Coastal Marine Science 3:371-380.

Casteel, R. W.
1976 Fish Remains in Archaeology and Paleo-Environmental Studies. Academic Press, New York.

Craig, S.
n.d. Marine Fishing. In Ethnozoological Analysis of Faunal Remains from Four Santa Barbara Channel Island Archaeological Sites, by Philip L. Walker. On file, Department of Anthropology, University of California, Santa Barbara.

DuBois, A. F.
1981 Shovelnose Guitarfish-Reproductive Biology and Impact on Mugu Lagoon. In Biennial Mugu Lagoon/San Nicolas Island Ecological Research Symposium, edited by R. J. Dow. Pacific Missile Test Center, October 28-29.

Eschmeyer, W. N., E. S. Herald, and H. Hammann
1983 A Field Guide to the Pacific Coast Fishes. Peterson Field Guide Series, Houghton Mifflin, Boston.

Fitch, J. E.
1969 Fish Remains, Primarily Otoliths, from a Ventura, California, Chumash Village (Ven-3). In A Coastal Chumash Village: Excavation of Shisholop, Ventura County, California, by R. S. Greenwood and R. O. Browne, pp. 56-71. Memoirs of the Southern California Academy of Sciences, Vol. 8: Appendix A.

1957 Earbones aid Science, Link Past with Present. Outdoor California 18[6]:10-11.

1958 Otoliths-Their Importance and Uses. American Malacological Union Annual Report 41.

1980 Personal communication to R. W. Huddleston.

Follett, W. I.
n.d. Incomplete List of Fishes from Point Mugu Shellmound. Unpublished ms. on file, Los Angeles County Museum of Natural History.

Gray, R. L., and L. Steffan
1982 Environmental Assessment: Revolon Slough Outlet. Ms. on file, U. S. Department of Agriculture, Soil Conservation Service, Davis.

Grayson, D. K.
1979 On the Quantification of Vertebrate Archaeofaunas. Advances in Archaeological Method and Theory, Vol. 2:199-237. Academic Press, New York.

Greenwood, R. S., and R. O. Browne
1969 A Coastal Chumash Village: Excavation of Shisholop, Ventura County, California. Memoirs of the Southern California Academy of Sciences, Vol. 8.

Greenwood, R. S., J. M. Foster, and G. R. Romani
1986 Archaeological Study of CA-VEN-110, Ventura, California. Greenwood and Associates. Submitted to the U. S. Army Corps of Engineers, Los Angeles District.

Heizer, R. F., and W. C. Massey
1953 Aboriginal Navigation off the Coasts of Upper and Baja California. Bureau of American Ethnology Bulletin 151:282-311.

Huddleston, R. W.
1986 Preliminary Overview and Seasonality Analysis of the Fish Remains from CA-VEN-110. In Archaeological Study of CA-VEN-110, Ventura, California, by R. S. Greenwood, J. M. Foster, and G. R. Romani, pp. 178-184. Greenwood and Associates. Submitted to the U. S. Army Corps of Engineers, Los Angeles District.

Love, D. H.
1979 Marine Subsistence at Muwu. Journal of New World Archaeology 3[2]:44-57.

1980 Marine Subsistence at Mugu-Ven-11. Unpublished M. A. thesis, Department of Anthropology, University of California, Los Angeles.

Miller, D. J., and R. N. Lea
1972 Guide to the Coastal Marine Fishes of California. California Department of Fish and Game, Fish Bulletin 157:1-235. The Resources Agency, Sacramento.

Onuf, C. P., and M. L. Quammen
1981 Responses of the Mugu Lagoon Community to Episodes of Major Sedimentation. In Biennial Mugu Lagoon/San Nicolas Island Ecological Research Symposium, edited by R. J. Dow. Pacific Missile Test Center, Oct. 28-29.

1983 Fishes in a California Coastal Lagoon: Effects of Major Storms on the Distribution and Abundance. Marine Ecology-Progress Series 12:1-14.

Payne, S.
1975 Partial Recovery and Sample Bias. In Archaeozoological Studies, edited by A. T. Clason, pp. 7-17. American Elsevier, New York.

Simpson, L. B. (editor)
1962 The Letters of Jose Senan, O. F. M., San Buenaventura, 1796-1823. Jown Howell, San Francisco.

Warme, J. E.
1971 Paleoecological Aspects of a Modern Coastal Lagoon. University of California, Berkeley.

White, T. E.
1953 A Method of Calculating the Dietary Percentage of Various Food Animals Utilized by Aboriginal Peoples. American Antiquity

END
DATE
FILMED
JAN
1988