A Review of the Analysis of Fish Remains in Chumash Sites

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Abstract

The paper begins with a review of techniques that can be used to analyze fish remains in archaeological sites. The remains can be used to identify the fish species and to estimate such details as fish size and weight, minimum number of individuals represented, and season of capture, and to make judgments about fishing techniques and subsistence patterns. The review of analysis techniques is followed by a discussion of the analysis that has been reported for fish remains from Chumash sites. The paper concludes with comments on the analysis of fish remains from Chumash sites.

The inspiration of this paper came from a Christmas present. The present was the book *Early Hunter-Gatherers of the California Coast*, by Jon M. Erlandson (1994). I was impressed by the level of analysis of fish remains and faunal remains in general. I had previously read earlier reports where the level of analysis was more basic. The topic for this paper then evolved as an attempt to review the change in analysis of fish remains over the years and to look at where further analysis of earlier data might be promising.

The Analysis of Fish Remains

The basis of all analysis of fish remains is species identification. Once the species have been identified other areas of analysis such as quantification, estimates of size, seasonality considerations, exploitation, and subsistence evaluation can be investigated.

Identification

Identification is the primary step in fish remains analysis. Identification of the species allows other analyses to proceed such as quantification, size estimation, seasonality, and exploitation.

Various fish parts can be used to identify fish remains to species level. These parts include scales, otoliths, vertebrae, dentaries, and pharyngeals to name a few. Casteel (1976) feels that otoliths are the best identifiers. Otoliths are of two types: statoconia and statoliths. Statoliths are the more important for identification and are of three types: sagitta, lapilus, and asteriscus. Otoliths generally have two faces. The outer face may show concentric rings, and the inner face has a high degree of sculpturing. These structural details allow identification usually to the species level (Casteel 1976:18-21). Casteel (1976:38) lists four types of scales: placoid (Chondrichthyes), ganoid (gars, sturgeons, and paddlefishes), cycloid (freshwater fishes), and ctenoid (sunfishes, perches, and marine fishes). "Both cycloid and ctenoid scales show variations which are sufficiently consistent to allow the use of scales for identification purposes" (Casteel 1976:43). Olivier (1993) has shown that the preopercula can be reliably used to identify rockfish (*Sebastes*) to a species level.

Quantification

Information on the number of fish represented by the remains is important in other analyses such as subsistence evaluations. Both number of identified specimens (NISP) and minimum number of individuals (MNI) are used to quantify remains. Crabtree (1990:156) feels both measures have problems, and the best solution is to present both NISP and MNI.

Wheeler and Jones (1989:149) lists the prevomer and basioccipital as single bones of the neurocranium that are readily identifiable and stout enough to survive. Bones occurring in pairs—premaxil-laries, maxillaries, dentaries, and sagittal otoliths—are easily identifiable and all but the otoliths survive well[1] (Wheeler and Jones 1989:149). As paired elements, they are readily separated into left or right elements which doubles the chance of survival, recovery, and recognition (Wheeler and Jones 1989:149).

> A crude estimation of minimum numbers of individuals represented by the identified material can therefore be made by counting the number of single bones (e.g. prevomer), or by sorting the paired bones in a sequence of left and right and later by visual estimate or measurement for size. Left and right examples of the same bone which are identical in size have to be assumed to be a pair from the same fish specimen, but unmatched bones can all be counted as representing single individuals. The maximum number of matched and unmatched elements present represents the minimum number of individuals in the material (Wheeler and Jones 1989:150).

In discussing the use of otoliths to determine MNI, Casteel (1976:31) said:

> Because of the positive relationship between fish size and otolith length it would be most helpful to use the otolith lengths and, preferably, estimated fish weights, to identify individuals or individuals of the same size within a species from a particular assemblage. This approach, combined with a comparison of left and right elements, appears to provide the best means for estimating the minimum number of individuals based upon otoliths.

To estimate MNI from scales Casteel (1976:62) described the following procedure: count circuli; graph the data as a histogram; look for clustering of counts; then calculate live weights

1. Based on the reports surveyed in this paper, it appears that in the Chumash area otoliths survive quite well.

using a formula relating circuli count to weight; plot these data as bar graphs; identify clusters of weights to indicate separate individuals[2].

To estimate MNI from vertebrae Casteel (1976:87) prefers a method attributed to White (1953). In this method the vertebrae are first separated as to type (preatlas, atlas, thoracic, precaudal, caudal, penultimate, and ultimate). The observed frequency by type is divided by the expected frequency. This ratio gives the MNI represented by each vertebral type separately. Also, the MNI for the entire assemblage can be determined by summing all the individual ratios and dividing by the number of types.

Size Estimation

Estimates of the size and weight of the fish represented by the remains are the basis for determining meat yields which are used in the analysis of subsistence patterns. According to Wheeler and Jones (1989), the most useful elements for size estimation are premaxilla, dentary, articular, quadrate, basiocciptial, parasphenoid, and abdominal vertebrae. Bone size is more correlated to fish length than to weight because fish of the same length are not all the same weight due to differences in condition (Wheeler and Jones 1989:139). Casteel (1976) lists otoliths as the preferred element for estimating size. Wheeler and Jones (1989:141) said that the quickest way to estimate fish size is to compare the specimen with the equivalent element of a fish of known size as would be found in a comparative collection-the larger the collection the closer the size estimate. John Johnson (personal communication 1996) described a method for estimating length and body weight from the width of suprapharyngeal bones of California sheephead (*Semicossyphus pulcher*). He said that the method was reported in an unpublished paper by Jo Boyer-Sebern of UCLA, a copy of which is in his possession.

Wheeler and Jones (1989:144) presented data showing a strong correlation between otolith length and fork length for cod (*Gadus morhua*). Wheeler and Jones (1989:145) feels that otolith weights might be a better indicator of fish length than size. The accuracy would depend on the taphonomy of the otolith. The preservation conditions could greatly affect the weight.

Scales can also be used in size estimation. Wheeler and Jones (1989:146) said that the length of large scales (less than 50 scales along the length of the fish) should have a linear relationship to the length of the fish. Once the length is known the weight can be found from a relationship like:

$$\text{Weight} = \text{constant} \times (\text{length})^n$$

2. I would question this procedure based on the example Casteel presented of a controlled test sample. The example did not compare well with other methods for MNI .

where n varies from 2.4 to 4 and is usually 3 for round fish (Wheeler and Jones 1989:148). The number of circuli also correlates linearly to the fork length of a fish (Casteel 1976:53).

Casteel (1976:49) says that fish scale can be used to estimate fish weight. Two criteria are to be applied. The first is that size is in terms of live weight, and the second is that size is determined from the number of circuli (rings) in its anterior field from the focus to the anterior margin. Wheeler and Jones (1976:146) feels that the use of scales for archaeological analysis is limited since they rarely survive intact. However, scales have a good survival rate in the middens of the Santa Barbara Channel Islands (John Johnson, personal communication 1996).

Seasonality

Analysis of season of capture provides evidence concerning habitation and subsistence patterns of the fishermen. Various fish elements can be used to determine the season of death or capture. These elements can also be used to determine the age of the fish. Casteel (1976) touts scales as the primary element for seasonal dating. “The scales of fishes show annual marks or annuli represented either by a number of rows of closely packed circuli separating areas of more widely spaced circuli or by circuli which intersect or ‘cut across’ other circuli” (Casteel 1976:65). The close circuli represent slower growth during cool months and “cutting across,” a complete stopping of growth. The wider spaced circuli form during rapid growth in warmer months. The configuration of the annuli and circuli can be used to estimate the season of death. “When the scale grows, sclerites are deposited on its outer layer. In the summer when scales grow rapidly, the sclerites are wider and the distance between them is wider than when growth of the scale is slow (at the end of summer and in the autumn)” (Casteel 1976:66). Casteel (1976:69) also states that “Fish scales allow accurate ageing during the earlier years of a fish’s life but begin to increasingly underestimate ages in progressively older individuals.” Wheeler and Jones (1989) emphasize otoliths for dating and also mentions vertebral centra which Casteel (1976:78) gives as his second choice. These elements, as well as others such as opercula, can also be used to determine the age of the fish due to the presence of annular growth rings. Seasonal dating based on vertebra centra rely on annular rings on the anterior and posterior faces of the centrum. These can be used for determining both age and season of death. Winter growth stoppage is indicated by dark bands, and rapid summer growth is represented by white bands (Casteel 1976:82).

Exploitation

Analysis of the remains can allow for inferences to be made regarding the probable fishing technology required and used by the Chumash and the fish habitats that were being exploited. Presence of remains of deep water fish would indicate the use of watercraft. Remains of uniform size might indicate use of nets or traps. Landberg (1975) describes the Chumash fishing technology recorded by participants of the Anza expedition (1774-1776) and the Vancouver expedition (1790-1794) in the later eighteenth century. Both expeditions described the use of large and small nets to take fish. They also described hook and line fishing with gorges, composite fishhooks, and curved, single fishhooks. Landberg (1975:149-150) also relates the types of fish being taken during the late eighteenth and early nineteenth centuries. Landberg (1975:146-152) discusses the fishing zones exploited by aboriginal Chumash based on reconstruction from accounts of the early historic observers. Landberg (1975:162) feels that plank canoes were only used seasonally for fishing due to heavy seas during winter months. Landberg (1975:162) thinks they were mostly used to fish the kelp beds close to shore. King (1990:48-49) also references early historic accounts that describe Chumash fishing. Fages (in Priestley 1937) described the use of tridents and shell fishhooks, and the use of baskets for taking sardines. Fonts (in Bolton 1930) described the use of harpoons and traps. King (1990:50) says that these ethnohistoric accounts all substantiate the reconstruction given by Fitch (1969:68), part of which is quoted later in this paper.

Subsistence Evaluation

Study of the subsistence patterns of the native peoples can give clues to diet, population density, and environmental conditions.

Three areas of investigation that relate to subsistence are meat content of the represented fish, stratigraphic distribution of the remains, and inferences about diet that can be drawn from the data. Determining the amount of meat represented for the fish remains usually starts with determining the MNI for a species in the assemblage. The weight of each individual is derived from the length and a relationship between length and live weight for the species. Then one needs to know the ratio of edible meat to total weight. According to Casteel (1976:83), studies have shown a positive relationship between vertebral width and the total length of a fish, and other studies have shown a relationship between the length of vertebrae and the length of the fish. Casteel (1976:84) showed that the width of the posterior face of the vertebral centrum is related to total live weight of the fish.

The stratigraphic distribution of remains can be used to draw inferences about the changes in fish exploitation over time. One can examine the ratios of the weights of different species as they relate to the total weight represented by the assemblage.

Inferences about diet can also be drawn from the remains. These can be in terms of percentages of various fish in the diet or in relations of fish to other meat in the diet.

Other Analysis

Other areas of fish remains analysis include the evidence of butchery practices and intersite comparisons. Salls (1988:223-230) discussed marks that might be evident on fish bones from different dismembering procedures. Wheeler and Jones (1989:136) points out that the elements which are present for each species may give information about butchery or preservation techniques.

This survey indicates that generally fish remains were found where they should be expected. However, VEN-100 is a mystery. According to Simons (1979), no fish remains were found. Screen sizes of 3 mm and 6 mm were used for the most part, but smaller screens were used in some pits where small beads were found. Since VEN-100 is only about one mile from Mugu Lagoon (as the crow flies but over a trail through a 900-foot-high pass), it seems strange that no fish remains were found. It seems logical to assume that the residents of VEN-100 were eating fish. One possible explanation might be that the fish were being filleted before being carried over the hill to the village. In that case one might expect to find evidence of filleting in the remains found in the lagoon area, such as at VEN-11.

Intersite comparisons can give information on possible trade networks between villages. Of particular worth might be comparing the remains at inland versus coastal sites. Van Horn (1987) discusses these issues and possible connections between Conejo Valley sites and coastal sites based on fish and other marine remains. He feels that rather then showing evidence of trade the archaeological record agrees more closely with a scenario of people living seasonally at inland and coastal sites depending on the resources being exploited.

Table 1. Chronology of Survey Data.

Year of Report	Sites
1963	LAN-52, LAN-227
1965	VEN-69, LAN-264
1969	VEN-3, LAN-229
1972	SLO-2
1975	VEN-87
1976	VEN-7, VEN-87, LAN-264, LAN-311, LAN-1298
1978	SBA-1, VEN-125, VEN-294
1979	VEN-11, VEN-261, VEN-294
1980	SBA-1, SBA-71, SBA-72, SBA-73, SBA-1674
1982	LAN-229
1983	SBA-1731 (two reports)
1984	SBA-1, SBA-1203
1986	VEN-110
1987	VEN-110
1988	SBA-142
1990	SBA-46, LAN-229
1991	SBA-142
1992	SCRI-191, SCRI-192, SCRI-330, SCRI-474
1993	SBA-48, SBA-224, SBA-225, SBA-1731, SCRI-191,SCRI-192, SCRI-240, SCRI-330, SCRI-474, SMI-504, SMI-525
1995	SCRI-191, SCRI-192, SCRI-330, SCRI-474
1996	SBA-97, SBA-1491

Table 2. Sources of Site Data.

References	Sites
Bowser 1984	SBA-1203
Bowser 1993a	SMI-504, 525
Bowser 1993b	SBA-1731
Colten 1991	SBA-142
Colten 1992	SCRI-191, 192, 330, 474
Colten 1995	SBA-1731; SCRI-191, 192, 330, 474
Erlandson 1994	SBA-1807, 2057, 2061
Fitch 1969	VEN-3
Fitch 1972	SLO-2
Fitch 1975	SLO-2; SBA-1; VEN-3, 11, 69, 87, 168; LAN-52, 227, 229
Follett 1963a	LAN-227
Follett 1963b	LAN-52
Follett 1965	VEN-69
Follett 1969	LAN-229
Glassow 1965	LAN-264
Glenn 1990	SBA-46
Glenn 1996	SBA-46, 97, 1491, 1731
Gobalet 1990	LAN-229
Gobalet 1992	VEN-69; LAN-227, 229
Huddleston 1986	VEN-110
Huddleston and Barker 1978	SBA-1; VEN-3
Johnson, J. 1980a	SBA-71, 72, 73, 1674
Johnson, J. 1980b	SBA-1
Johnson, J. 1982	VEN-7, 69, 261; LAN-227, 229, 264
Johnson, J. 1983	SBA-1731
Johnson, J. 1993	SCRI-191, 192, 240, 330, 474
Johnson, M. 1980	VEN-271
Landberg 1975	VEN-3, 11, 69; LAN-52, 227, 229
Langenwalter 1978	VEN-125, 294
Love 1979	VEN-11
Moss 1983	SBA-1731
Peterson 1984	SBA-1
Pritchett and McIntyre 1979	VEN-65
Roeder 1976	SLO-2; SBA-1; VEN-3, 7, 11, 69, 87, 168; LAN-52, 227, 229, 264
Roeder 1978	VEN-294
Roeder 1979	VEN-3, 7, 11, 69, 87, 100, 122, 125, 168, 261, 294; LAN-52, 227, 229, 264
Roeder 1987	VEN-11, 110
Rosen 1979	VEN-294
Salls 1988	LAN-52, 264, 311, 1298
Salls 1993a	SBA-48
Salls 1993b	SBA-224
Salls 1993c	SBA-225
Tartaglia 1976	SLO-2; SBA-1; VEN-3, 7, 63, 69, 87, 168, 261; LAN-52, 227, 229, 264

Table 3. Fish Remains Analysis: Identification.

References	Identification			
	Scales	Otoliths	Vertebrae	Other
Bowser 1984		X	X	X
Bowser 1993a		X	X	X
Bowser 1993b		X	X	X
Colten 1991				
Colten 1992				
Colten 1995		X		
Erlandson 1994		X	X	X
Fitch 1969		X	X	X
Fitch 1972	X	X	X	X
Fitch 1975	X	X	X	X
Follett 1963a			X	X
Follett 1963b			X	X
Follett 1965		X	X	X
Follett 1969			X	X
Glassow 1965				
Glenn 1990		X	X	
Glenn 1996				
Gobalet 1990		X	X	X
Gobalet 1992				
Huddleston 1986		X		
Huddleston & Barker 1978	X	X	X	X
Johnson, J. 1980a	X	X	X	X
Johnson, J. 1980b		X	X	X
Johnson, J. 1982		X	X	X
Johnson, J. 1983		X		
Johnson, J. 1993			X	X
Johnson, M. 1980				X
Landberg 1975				
Langenwalter 1978			X	X
Love 1979				
Moss 1983			X	X
Peterson 1984				
Pritchett & McIntyre 1979				X
Roeder 1976		X	X	X
Roeder 1978			X	X
Roeder 1979		X	X	X
Roeder 1987				
Rosen 1979				
Salls 1988				
Salls 1993a			X	X
Salls 1993b				
Salls 1993c				
Tartaglia 1976				

Analysis of Fish Remains from Chumash Sites

The data surveyed in this paper come from reports published from 1963 to 1996. Table 1 lists the chronology of the data sources used in the paper. Table 2 lists the 43 sources of site data and the sites covered by each site report. Tables 3 through 6 summarize the analysis methods reported by the different sources. The site abbreviations used are as follows: SLO = San Luis Obispo County, SBA = Santa Barbara County, VEN = Ventura County, LAN = Los Angeles County, SCRI = Santa Cruz Island, and SMI = San Miguel Island.

Identification

Appendix C summarizes the identification data from the site references. Most of the species identifications were based on otoliths and vertebrae. Various other elements such as teeth, pharyngeals, and dentaries were also used. Scales were seldom found, or, if found, were seldom used for identification. In one case, X-rays of shark centra were used for identification (Roeder 1978).

While compiling Appendix C, several changes of generic and species names over the years were observed. For example, before about 1970 the rockfish genus was given as *Sebastodes*, but after that time, *Sebastes* was used. There is also some variation of species names given in the reports. Two different species names are used for the California sheephead, and three names were used for the Pacific mackerel.

All rockfish are listed as *Sebastes* in Appendix C, and the species naming has been

Table 4. Fish Remains Analysis: Quantification and Size Estimation.

References	Quantification		Size Estimation	
	NISP	MNI	Length	Weight
Bowser 1984	X			
Bowser 1993a	X			
Bowser 1993b	X	X		X
Colten 1991				
Colten 1992				
Colten 1995	X			
Erlandson 1994	X			X
Fitch 1969	X	X	X	X
Fitch 1972	X			
Fitch 1975	X		X	X
Follett 1963a	X			
Follett 1963b	X		X	X
Follett 1965	X		X	
Follett 1969	X		X	X
Glassow 1965				
Glenn 1990	X			X
Glenn 1996				
Gobalet 1990	X		X	
Gobalet 1992	X			
Huddleston 1986				
Huddleston & Barker 1978	X	X		
Johnson, J. 1980a				
Johnson, J. 1980b	X	X		
Johnson, J. 1982		X		X
Johnson, J. 1983	X			
Johnson, J. 1993	X			
Johnson, M. 1980	X			
Landberg 1975				
Langenwalter 1978	X	X		
Love 1979				
Moss 1983	X	X		X
Peterson 1984				
Pritchett & McIntyre 1979	X			
Roeder 1976	X		X	X
Roeder 1978	X		X	
Roeder 1979	X		X	
Roeder 1987	X	X		
Rosen 1979	X			
Salls 1988	X	X		
Salls 1993a	X	X		
Salls 1993b	X	X		
Salls 1993c	X	X		
Tartaglia 1976				

standardized to those in Robins, et al. (1991). Appendix D is a list of the changes of species names from those used in the reports. In some cases the variant names were given in Robins as being formerly used names. In order to have uniformity of identification, I decided to use the Robins species names when more than one species name was given in the reports for the same common named fish. Spellings of several species and genus names were also changed to conform to the spellings in Robins.

One entry, Batoidea, given by Roeder (1987) and identified only as "ray," was left as is. That term was not in Robins, and I could not find it in any other reference consulted. Roeder may have meant the same as the *Raja* sp. entries also listed under Elasmobranchs in Appendix C.

Quantification

NISP was the most common unit of quantification. MNI was used in less than 30 percent of the reports. Glenn (1996) used a modified MNI that standardizes the vertebrae count by dividing the total number of vertebra specimens of a species represented in a sample by the estimate relative abundances.

Generally little was said about the details of how MNI was determined. Bowser (1993b:143-144), however, went into detail on how she determined MNI. Glenn (1990) describes a method using vertebra count and weight to derive an estimated species count.

Size Estimation

Size estimation also appeared in less than 30 percent of the reports. For the most part

Table 5. Fish Remains Analysis: Seasonality and Exploitation.

References	Seasonality		Exploitation	
	Season of Capture	Age	Fishing Technology	Habitat
Bowser 1984				
Bowser 1993a			X	X
Bowser 1993b	X		X	X
Colten 1991				X
Colten 1992				
Colten 1995				X
Erlandson 1994	X	X	X	X
Fitch 1969			X	
Fitch 1972			X	
Fitch 1975		X	X	
Follett 1963a			X	
Follett 1963b			X	
Follett 1965			X	
Follett 1969			X	
Glassow 1965				
Glenn 1990				X
Glenn 1996				X
Gobalet 1990				
Gobalet 1992				
Huddleston 1986	X			
Huddleston & Barker 1978			X	
Johnson, J. 1980a			X	
Johnson, J. 1980b			X	X
Johnson, J. 1982			X	X
Johnson, J. 1983				
Johnson, J. 1993	x		X	
Johnson, M. 1980				
Landberg 1975				
Langenwalter 1978			X	
Love 1979				
Moss 1983			X	
Peterson 1984				
Pritchett & McIntyre 1979				
Roeder 1976			X	
Roeder 1978				
Roeder 1979				
Roeder 1987	X		X	X
Rosen 1979			X	
Salls 1988			X	X
Salls 1993a			X	
Salls 1993b			X	X
Salls 1993c			X	X
Tartaglia 1976				

nothing was said about the method used to determine either length or weight. In one case it was indicated that the length of the otoliths was used. In other cases one could infer that comparisons of elements with standard collections were being used to estimate length.

Seasonality

Five reports discussed season of capture, and two gave estimates of the age of fish represented by the remains. Season of capture was discussed in Bowser (1993b), Erlandson (1994), Huddleston (1986), Johnson (1983), and Roeder (1987). In other reports seasonality was addressed in terms of the seasonal availability of certain species and their presence in the assemblage indicating possible seasonal occupation of the site. This was argued based upon the presence of species as opposed to evidence from the remains themselves, such as the examination of growth rings on scales, otoliths, or vertebrae.

Exploitation

Most of the reports addressed the fishing technology required to catch the fish represented by the remains. The most complete analysis of fishing technology was given by Fitch (1969) in his analysis of the fish remains from VEN-3. The quote from Fitch (1969:68) used by King (1990:47-48)[3] summarizes Fitch's discussion very well:

> Based upon a knowledge of the gear needed to capture

3. Corrected for transcription errors in King.

> various species in present-day fisheries, as well as fish habits, habitats, and associations, it appears that the Chumash used several kinds of fishing gear and techniques. …(Hooks and line) would have been the most productive and least cumbersome gear for catching moderate and deep-living forms (e.g., soupfin shark, spiny dogfish, California halibut, rockfish, Pacific hake, etc.). For the same reasons, 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.).
>
> The only gear that will catch one size of fish to the exclusion of others is a gill net, and such a net having 1 1/2- to 2-inch stretch mesh would have been ideal for taking the 7- to 10-inch white croakers that contributed their otoliths to the midden. Since otoliths of several other species (queenfish, yellowfin croaker, jacksmelt, embiotoid perch, etc.) were from fishes that were the right sizes to have been captured in the same sized mesh, and since most of these are found in the identical habitat and at the same time, they undoubtedly were taken with gill nets also.
>
> Several of the surf-dwelling species (surf perches, atherinids, shovelnose guitarfish, etc.) would not have been caught in any quantity without a beach seine, although anchovies … would have been more vulnerable to a cast net… None of the other surf zone inhabitants utilized by the Chumash would have been able to escape a beach seine constructed of the same mesh (or larger) as a gill net.
>
> Application of similar logic points rather strongly toward the use of harpoons or spears (especially for swordfish), traps (sheephead and some rockfish), and bare hands (grunion). Thus, from available evidence, it would seem that the Ven-3 Chumash utilized hooks, gill nets, cast nets, beach seines, traps, harpoons or spears, and their hands in their fishing activities [Fitch 1969:48].

Davenport, et al. (1993) argued that capture of swordfish required the barbed harpoon and the plank canoe and that the appearance of swordfish remains in the archaeological record about 2,000 B.P. is correlated with these advances in fishing technology.

The more recent reports also generally discussed the fish habitats being exploited by the fishermen. Most reports reference Allen (1985) for the definition of the various habitats and the fish that would be obtained in each. Bowser (1993a) performed a statistical analysis of the change in habitat exploitation over time for sites on San Miguel Island. Glenn (1990) also has an extensive analysis of habitat exploitation. Roeder (1987) discussed the fish habitats exploited at VEN-110.

Table 6. Fish Remains Analysis: Subsistence Evaluation and Other.

References	Subsistence Evaluation			Other	
	Meat Content	Stratigraphic Distribution	Diet	Butchering	Intersite Comparison
Bowser 1984		X			
Bowser 1993a		X			
Bowser 1993b		X	X		
Colten 1991			X		
Colten 1992			X		
Colten 1995	X	X	X		X
Erlandson 1994		X	X		X
Fitch 1969	X		X		
Fitch 1972		X			
Fitch 1975		X			X
Follett 1963a		X			
Follett 1963b		X			
Follett 1965		X			
Follett 1969		X			X
Glassow 1965		X	X		
Glenn 1990					X
Glenn 1996					X
Gobalet 1990		X			
Gobalet 1992					X
Huddleston 1986					
Huddleston & Barker 1978					
Johnson, J. 1980a		X			
Johnson, J. 1980b		X			
Johnson, J. 1982		X	X		X
Johnson, J. 1983					
Johnson, J. 1993		X			X
Johnson, M. 1980					
Landberg 1975					X
Langenwalter 1978		X			
Love 1979	X	X			
Moss 1983	X	X	X		
Peterson 1984	X		X		
Pritchett & McIntyre 1979					
Roeder 1976		X			
Roeder 1978		X			
Roeder 1979		X			
Roeder 1987		X			X
Rosen 1979					
Salls 1988					
Salls 1993a					
Salls 1993b				X	
Salls 1993c				X	
Tartaglia 1976	X	X			

Subsistence Evaluation

Most of the reports include the stratigraphic distribution of the remains, but not all of these discuss the import of the information in terms of the change of subsistence patterns over time. Information concerning Chumash diet is discussed primarily in the later reports such as those of Bowser (1993b), Colten (1991,1992, 1995), and Erlandson (1994). Only four of the earlier reports address the data as they relate to diet (Fitch 1969, Glassow 1965, Moss 1983, and Peterson 1984).

Meat content of the fish represented is discussed in only six of the reports. Glenn (1996) determined the relative importance of different species in the diet by multiplying his modified MNI by the live weight for each species to arrive at a calculated live weight. Johnson (1982) used MNI and meat content to create an index of relative importance based on an average between the percentage of a species in terms of MNI and the percentage of a species in terms of biomass represented.

It would appear that the results in many of the reports understate the importance of fish in the Chumash diet. In most of the early excavations, the excavated material was screened through 1/8 inch (3.2 mm) mesh and some only through 1/4 inch (6.4 mm) mesh. Several investigators report a large increase in recovered fish remains by going just one step finer to 1/16 inch (1.6 mm) mesh. Johnson (1991:139) points out that "…the configuration of fish remains is badly skewed by omitting small vertebrae, teeth, and otoliths retained in 1/16-in. screens." He states that some vertebrae are 10 to 50 times more prevalent in 1/16 inch (1.6 mm) samples than in 1/8 inch (3.2 mm) samples. "The weight of fish remains retained in 1/16 [inch] mesh screen is almost equal to the weight of fish remains in the 1/8 [inch] mesh screen" (Johnson 1980b).

In analyzing the results from VEN-3, Fitch (1969) identified 10 species of fish based on 7,357 otoliths recovered from 1/8 inch (3.2 mm) screens. He then dug two other pits and wet screened the samples through 1/8 inch (3.2 mm) mesh, followed by successive screening through 2 mm, 1 mm, and 0.5 mm meshes. The 1 mm mesh yielded an additional 12 species that had not been detected previously. After analyzing the 0.5 mm mesh material, the species total rose to 45.

Crabtree (1990:186) said that "Singer has shown experimentally that at least 75 percent of all herring-sized fish bones are lost when quarter-inch-mesh screens are used. In general, the use of 1-mm mesh is recommended for the recovery of fish and other small vertebrate remains, although deposits rich in fish should be sieved to 500 microns in order to determine the quantity of minute fish bones."

Not using finer than 1/8 inch (3.2 mm) mesh can skew the results. Several early reports (Fitch 1969 and others) stated that the occurrence of sardine and anchovy remains in middens resulted from the stomach contents of marine predators that subsequently were eaten by the

Chumash. However, based on the results from the finer screening, Johnson (1980b, 1982) concluded that sardines and anchovies were a substantial part of the Chumash diet.

Other Analysis

Only two of the reports (Salls 1993b, 1993c) addressed butchery issues and that was only to say that no butchery marks were found. Intersite comparisons were made in 11 of the reports. The comparisons were generally in terms of differences in habitat exploitation. Glenn (1990) provides a good example of such intersite comparisons. In other reports the comparison was made in terms of contribution to the diet, types of fish included in the diet and fish versus non-fish. Johnson (1982) and Roeder (1987) are good examples of the latter.

Concluding Remarks

Nothing too definitive can be said about current analysis trends. The analysis methods used vary widely depending on the researcher. For identification, otoliths and vertebrae (plus various other skeletal parts) continue to be used. Use of scales for identification has not been reported since 1980. NISP continues to be the most used quantification measure. Size estimation and seasonality are not often reported in the 1990s. Discussion of fishing technology and habitat is prominent. Subsistence is discussed but maybe with a bit less frequency.

The Chumash were very good fishermen. The available evidence indicates that they used hook and lines, gill nets, cast nets, beach seines, traps, harpoons, spears, and bare hands in their fishing. They fished from the surf as well as from boats. Based on the quantities of sardine and anchovy remains found, they apparently made some nets with a very fine mesh.

One goal of the paper was to look at how the analysis of fish remains has changed and to see if further analysis of the material would be promising. In general, the reports did not indicate where the material from the sites is being curated or even if it is being curated. In only two reports were specifics of curation given (Follett 1963a and 1969). Much of the material from Santa Barbara County sites is curated at the University of California, Santa Barbara (John Johnson, personal communication 1996). Several collections are also at the Santa Barbara Museum of Natural History. The California Academy of Sciences transferred their Follett collections to the Santa Barbara Museum in 1988. Some of these, such as the Century Ranch and Conejo Rock Shelter fish remains, will be sent to UCLA to be rejoined with the rest of the artifact collections from those sites. The potential for further analysis would depend on the availability of the material.

Whether any further research could be conducted with the earlier collections depends upon the excavation methods used and the research design. Since most researchers used 1/8 inch (3.2 mm) mesh screens rather than 1/16 inch (1.6 mm) mesh screens, much of the potential data on fish remains from a site may not be available in the curated material. Both Fitch

(1972) and Johnson (1991) pointed out the large gains in fish remains data available using smaller mesh sizes. To properly answer questions on subsistence patterns and diet which have been popular in more recent studies, further excavation would be necessary, at least collection of column samples. The only reason not to do finer screening is the greatly increased time involved to analyze the small fish parts thereby retained. Fitch (1972) spent 900 hours examining the residue from a 0.5 mm screen on SLO-2. If fish remains are not part of the research design, such efforts are not going to be made.

The depth of analysis in the more recent reports has definitely improved. Screening to at least 1/16 inch (1.6 mm) mesh has become the standard, and most researchers seem to be primarily concerned with questions such as subsistence patterns, diet, and habitat exploitation.

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Appendix A. Elasmobranch Common Names

Alopiidae	Thresher sharks
Alopias superciliosus	Bigeye thresher shark
Alopias vulpinus	Common thresher shark
Carcharhinidae	Requiem sharks
Carcharhinus brachyurus	Narrowtooth shark
Carcharodon carcharias	White shark
Cephaloscyllium ventriosum	Swell shark
Cetorhinus maximus	Basking shark
Dasyatidae	Stingrays
Dasyatis dipterura	Diamond stingray
Echinorhinus cookei	Prickly shark
Galeocerdo cuvier	Tiger shark
Galeorhinus zyopterus	Soupfin shark
Heterodontus francisi	Horn shark
Isurus oxyrinchus	Shortfin mako
Lamnidae	Mackerel sharks
Lamna ditropis	Salmon shark
Mustelus sp.	Smoothhound sharks
Mustelus californicus	Gray smoothhound shark
Mustelus henlei	Brown smoothhound shark
Myliobatoidae	Eagle rays
Myliobatis californica	Bat ray
Notorynchus cepedianus	Sevengill shark
Platyrhinoidis triseriata	Thornback ray
Prionace glauca	Blue shark
Raja sp.	Hardnosed skates
Rhinobatos productus	Shovelnose guitarfish
Squalus acanthias	Spiny dogfish
Squatina californica	Angel shark
Torpedo californica	Pacific electric ray
Triakis semifasciata	Leopard shark
Urolophus halleri	Round stingray

Appendix B. Teleost Common Names

Amphistichus argenteus	Barred surfperch
Amphistichus koelzi	Calico surfperch
Anarrhichthys ocellatus	Wolf-eel
Anisotremus davidsonii	Sargo
Anoploma fimbria	Sablefish
Artedius notospilotus	Bonehead sculpin
Atheresthes stomias	Arrowtooth flounder
Atherinidae	Silversides
Atherinops affinis	Topsmelt
Atherinopsis californiensis	Jacksmelt
Atractoscion nobilis	White seabass
Bothidae	Lefteyed flounders
Brachyistius frenatus	Kelp perch
Caranx caninus	Pacific crevalle jack
Caulotatilus princeps	Ocean whitfish
Cebidichthys violaceus	Monkeyface prickleback
Ceratoscopelus townsendi	Dogtooth lampfish
Cheilotrema saturnum	Black croaker
Chilara taylori	Spotted cusk-eel
Chromis punctipinnis	Blacksmith
Citharichthys sordidus	Pacific sanddab
Citharichthys stigmaeus	Speckled sanddab
Clupeidae	Herrings
Clupeiformes	Herrings, anchovies, etc.
Clupea pallasi	Pacific herring
Cottidae	Sculpins
Cymatogaster aggregata	Shiner perch
Cypselurus californicus	California flyingfish
Embiotcidae	Surfperches
Embiotoca jacksoni	Black perch
Embiotoca lateralis	Striped seaperch
Engraulidae	Anchovies
Engraulis mordax	Northern anchovy
Eopsetta jordani	Petrale sole
Genyonemus lineatus	White croaker
Gila orcutti	Arroyo chub
Girella nigricans	Opaleye
Gobiesox maeandricus	Northern clingfish

Gymnothorax mordax	California moray
Halichoeres semicinctus	Rock wrasse
Hemilepidotus spinosus	Brown Irish lord
Hermosilla azurea	Zebra perch
Heterostrichus rostratus	Giant kelpfish
Hexagrammos decagrammus	Kelp greenling
Hippoglossus stenolepis	Pacific halibut
Hyperprosopon anale	Spotfin surfperch
Hyperprosopon argenteum	Walleye surfperch
Hyperprosopon ellipticum	Silver surfperch
Hypsopsetta guttulata	Diamond turbot
Hypsurus caryi	Rainbow seaperch
Katsuwonus pelamis	Skipjack tuna
Leprocottus armatus	Pacific staghorn sculpin
Leuresthes tenuis	California grunion
Medialuna californiensis	Halfmoon
Menticirrhus undulatus	California corbina
Meluccius productus	Pacific hake
Micrometrus aurora	Reef perch
Micrometrus minimus	Dwarf perch
Mola mola	Ocean sunfish
Neoclinus uninotatus	Onespot fringehead
Oncorhynchus sp.	Salmon or trout
Oncorhynchus mykiss	Rainbow trout or steelhead
Oncoryhchus tshawytscha	Chinook salmon
Ophiodon elongatus	Lingcod
Opisthonema sp.	Thread herring
Oxyjulis californica	Senorita
Paralabrax sp.	Sand bass
Paralabrax clathratus	Kelp bass
Paralabrax maculatofasciatus	Spotted sand bass
Paralabrax nebulifer	Barred sand bass
Paralichthys californicus	California halibut
Phanerodon atripes	Sharpnose seaperch
Phanerodon furcatus	White seaperch
Plagiogrammus hopkinsii	Crisscross prickleback
Platichthys stellatus	Starry flounder
Pleuronectes vetulus	English sole
Pleuronectiformes	Flatfishes
Pleuronichthys coenosus	C-O sole
Pleuronichthys ritteri	Spotted turbot
Porichthys sp.	Midshipman

Porichthys myriaster	Specklefin midshipman
Porichthys notatus	Plianfin midshipman
Rhacochilus toxotes	Rubberlip seaperch
Rhacochilus vacca	Pile perch
Roncador stearnsi	Spotfin croaker
Sarda chiliensis	Pacific bonito
Sardinops sp.	Sardine
Sardinops sagax	Pacific sardine
Sciaenidae	Croakers
Scomberomorus sp.	Mackerel
Scomber japonicus	Chub mackerel
Scomberomorus concolor	Gulf sierra
Scombridae	Mackerels
Scorpaena guttata	California scorpionfish
Scorpaenichthys marmoratus	Cabezon
Sebastes sp.	Rockfish
Sebastes alutus	Pacific ocean perch
Sebastes atrovirens	Kelp rockfish
Sebastes auriculatus	Brown rockfish
Sebastes babcocki	Redbanded rockfish
Sebastes carnatus	Gopher rockfish
Sebastes caurinus	Copper rockfish
Sebastes chlorostictus	Greenspotted rockfish
Sebastes chrysomelas	Black-and-yellow rockfish
Sebastes constellatus	Starry rockfish
Sebastes crameri	Darkblotched rockfish
Sebastes dalli	Calico rockfish
Sebastes diploproa	Splinose rockfish
Sebastes elongatus	Greenstriped rockfish
Sebastes entomelas	Widow rockfish
Sebastes eos	Pink rockfish
Sebastes flavidus	Yellowtail rockfish
Sebastes gilli	Bronzespotted rockfish
Sebastes goodei	Chilipepper
Sebastes helvomaculatus	Rosethorn rockfish
Sebastes hopkinsi	Squarespot rockfish
Sebastes jordani	Shortbelly rockfish
Sebastes levis	Cowcod
Sebastes macdonaldi	Mexican rockfish
Sebastes maliger	Quillback rockfish
Sebastes melanops	Black rockfish
Sebastes melanostomus	Blackgill rockfish

Sebastes miniatus	Vemilion rockfish
Sebastes mystinus	Blue rockfish
Sebastes ovalis	Speckled rockfish
Sebastes paucispinis	Bocaccio
Sebastes phillipsi	Chameleon rockfish
Sebastes pinniger	Canary rockfish
Sebastes polyspinis	Northern rockfish
Sebastes rastrelliger	Grass rockfish
Sebastes rosaceus	Rosy rockfish
Sebastes rosenblatti	Greenblotched rockfish
Sebastes ruberrimus	Yelloweye rockfish
Sebastes rubrivinctus	Flag rockfish
Sebastes rufus	Bank rockfish
Sebastes saxicola	Stripetail rockfish
Sebastes semicinctus	Halfbanded rockfish
Sebastes serranoides	Olive rockfish
Sebastes serriceps	Treefish
Sebastes simulator	Pinkrose rockfish
Sebastes umbrosus	Honeycomb rockfish
Sebastes zacentrus	Sharpchin rockfish
Sebastolobus alascanus	Shortspine thornyhead
Semicossyphus pulcher	California sheephead
Seriola lalandi	Yellowtail
Seriphus politus	Queenfish
Serranidae	Sea basses and groupers
Sphyraena argentea	Pacific barracuda
Spirinchus starksi	Night smelt
Stereolepis gigas	Giant sea bass
Tetrapturus andex	Striped marlin
Thunnus sp.	Tunas
Thunnus alalunga	Albacore
Thunnus albacares	Yellowfin tuna
Thunnus thynnus	Bluefin tuna
Trachurus symmetricus	Jack mackerel
Trichiurus nitens	Pacific cutlassfish
Umbrina roncador	Yellowfin croaker
Xiphias galdius	Swordfish
Xiphiidae	Swordfishes
Xiphister mucosus	Rock prickleback
Zaniolepis frenata	Shortspine combfish

Appendix C. Fish Species Identified in Chumash Sites

Fish Species	Sites
Elasmobranchs	
Alopiidae	SBA-1, 1731
Alopias superciliosus	LAN-229
Al*opias vulpinus*	SBA-1
Batoidea	VEN-110
Carcharhinidae	SBA-1, 46, 1203; VEN-168; SCRI-191, 474
Carcharhinus brachyurus	LAN-229
Carcharodon carcharias	SBA-1, 1731; VEN-11, 63, 69, 168, 261, 294
Cephaloscyllium ventriosum	SBA-1, 72, 73; VEN-3; LAN-229; SCRI-330
Cetorhinus maximus	SBA-73; VEN-168
Dasyatididae	SBA-1731
Dasyatis dipterura	SBA-1; VEN-110, 168
Echinorhinus cookei	VEN-3
Galeocerdo cuvier	VEN-11
Galeorhinus zyopterus	SBA-1, 48, 72, 73, 142, 1203, 1731; VEN-3, 69, 87, 100, 110, 122, 125, 168, 261; LAN-227, LAN-229, 264; SCRI-240
Heterodontus francisi	SBA-1, 48, 1731; VEN-3, 110; LAN-229
Isurus oxyrinchus	SBA-1, 72, 1731; VEN-3, 7, 11, 63, 69, 87, 110, 122, 125, 261, 271, 294; LAN-52, 227, 229, LAN-264, 311
Lamnidae	VEN-261
Lamna ditropis	VEN-125, 168, LAN-52; SCRI-*
Mustelus sp.	SBA-48, 224, 1203, 1731; VEN-110, 261, 294; LAN-229; SCRI-*
Mustelus californicus	SLO-2; SBA-1, 48; VEN-3, 110; LAN-311
Mustelus henlei	VEN-87
Myliobatoidae	SBA-1
Myliobatis californica	SLO-2, SBA-1, 46, 48, 72, 73, 142, 1203, 1731, 1807, 2057; VEN-3, 7, 11, 69, 87, 100, 110, 122, VEN-125, 168, 261, 294; LAN-52, 227, 229, 311, SCRI-*
Notorynchus cepedianus	SBA-1, 1203, 1731; VEN-3, 87, 168, 294; LAN-229

Platyrhinoidis triseriata	SBA-46, 48, 142, 1203, 1731, 1807, 2057; VEN-3, 110; LAN-229; SCRI-240
Prionace glauca	SLO-2; SBA-1, 72, 1731; VEN-110, 168; LAN-227, 229; SCRI-192
Raja sp.	SLO-2; SBA-1; VEN-3, 87; LAN-229
Rhinobatos productus	SBA-1, 46, 48, 142, 225, 1203, 1731, 1807; VEN-3, 7, 11, 65, 69, 87, 100, 110, 122, 125, 261, 294; LAN-52, 227, 229, 311, 1298
Shark sp.	SBA-2061
Squalus acanthias	SLO-2; SBA-1; VEN-3, 87; LAN-229
Squatina californica	SLO-2; SBA-1, 48, 142, 1731; VEN-3, 7, 11, 63, 87, 100, 110, 122, 125, 168, 261, 294; LAN-52, LAN-227, 229, 264; SCRI-191
Torpedo californica	VEN-110; SCRI-*
Triakis semifasciata	SLO-2; SBA-1, 48, 224, 1203, 1731; VEN-3, 7, 69, 87, 100, 110, 122, 168, 261; LAN-52, 227, 229, LAN-264, 311; SCRI-*
Urolophus halleri	SBA-48, 142, 1203, 1807; VEN-11, 110

Teleosts

Amphistichus argenteus	SBA-1, 46, 48, 224, 225, 1731, 2061; VEN-3, 87, 110, 168; SCRI-*
Amphistichus koelzi	SCRI-*
Anarrhichthys ocellatus	SLO-2
Anisotremus davidsoni	SBA-48; VEN-11
Anoploma fimbria	SMI-525
Artedius notospilotus	SBA-46
Atheresthes stomias	SLO-2
Atherinidae.	SBA-1; VEN-122; SCRI-330
Atherinops affinis	SBA-1, 46, 48, 224, 1203, 1731; VEN-3, 110; SCRI-*; SMI-*
Atherinopsis californiensis	SBA-1, 46, 48, 142, 1203, 1731, 2061; VEN-3, 110; LAN-229; SMI-504, 525; SCRI-*
Atractoscion nobilis	SBA-1, 46, 48, 1203, 1731,1807, 2057, 2061; VEN-3, 11, 87, 110, 168; LAN-227, 229, 311; SCRI-*
Bothidae	SBA-46
Brachyistius frenatus	SLO-2; SBA-1731; SCRI-*
Caranx caninus	SBA-2057
Caulotatilus princeps	SCRI-*
Cebidichthys violaceus	SLO-2; SMI-525; SCRI-*
Ceratoscopelus townsendi	VEN-3

Cheilotrema saturnum	SBA-48, 224, 1731; VEN-168
Chilara taylori	SLO-2; SBA-46; SCRI-*
Chromis punctipinnis	SBA-48; VEN-3; LAN-52; SCRI-*
Citharichthys sordidus	SCRI-*
Citharichthys stigmaeus	VEN-3
Clupeidae	SBA-1, 71, 72, 73, 1203, 1674, 2057; VEN-110; LAN-229
Clupeiformes	SBA-46
Clupea pallasi	VEN-110; LAN-229
Cottidae	SBA-1807; LAN-229; SCRI-*
Cymatogaster aggregata	SBA-1, 46, 48, 71, 225, 1203, 1807; VEN-3, 122; LAN-264; SMI-*
Cypselurus californicus	VEN-110
Embiotocidae.	SBA-1, 46, 48, 71, 72, 73, 142, 224, 1203, 1674, 1731, 1807, 2057; VEN-11, 110; LAN-311; SCRI-*
Embiotoca jacksoni	SBA-46, 48, 224, 225, 1731, 1807; VEN-3, 87, 110; LAN-311; SMI-504, 525; SCRI-*
Embiotoca lateralis	SLO-2; SBA-1731; VEN-110; SMI-504; SCRI-*
Engraulidae	SBA-1731, 1807; SCRI-192, 240, 330
Engraulis mordax	SLO-2; SBA-1, 46, 48, 224, 225, 1203, 1731; VEN-3, 87; LAN-229
Eopsetta jordani	SCRI-*
Genyonemus lineatus	SLO-2; SBA-1, 46, 48, 72, 73, 1203, 1731, 1807, 2057; VEN-3, 69, 87, 110, 168; LAN-229; SCRI-*
Gila orcutti	LAN-229
Girella nigricans	VEN-69; SCRI-*
Gobiesox maeandricus	SLO-2
Gymnothorax mordax	SCRI-*
Halichoeres semicinctus	SBA-48; SCRI-191
Hemilepidotus spinosus	SLO-2
Hermosilla azurea	SCRI-*
Heterostrichus rostratus	SBA-46, 48, 142, 1731; LAN-52; SCRI-191, 192
Hexagrammos decagrammus	SBA-48, 224
Hippoglossus stenolepis	SCRI-192, 240
Hyperprosopon anale	SBA-1731, 2061; SCRI-*
Hyperprosopon argenteum	SLO-2; SBA-1, 46, 1731; VEN-3, 110; SMI-504; SCRI-*
Hyperprosopon ellipticum	SBA-1731; SCRI-*
Hypsopsetta guttulata	VEN-110; SCRI-*
Hypsurus caryi	SBA-46, 225, 1731, 2061; VEN-110; SCRI-*
Katsuwonus pelamis	SBA-46; VEN-110, 261; LAN-227, 229, 264
Leprocottus armatus	SLO-2; SBA-46, 48; VEN-3; SCRI-*

Leuresthes tenuis	SLO-2; SBA-46, 48, 73, 1203, 1731; VEN-3, 110; SCRI-*; SMI-*
Medialuna californiensis	SBA-1731; SCRI-192
Menticirrhus undulatus	SBA-46, 48; VEN-110; LAN-229, 311
Merluccius productus	SBA-1, 46, 48, 1807; VEN-7; SCRI-240
Micrometrus aurora	SLO-2; SBA-1731
Micrometrus minimus	SBA-1807; SCRI-*
Mola mola	SCRI-192
Neoclinus uninotatus	SBA-1
Oncorhynchus sp.	SBA-1731
Oncorhynchus mykiss	SBA-1807; LAN-229, 311
Oncorhynchus tshawytscha	SBA-1731
Ophiodon elongatus	SLO-2; SBA-48, 142, 224, 1731; LAN-229; SCRI-192, 330; SMI-504, 525
Opisthonema sp.	VEN-110
Oxyjulis californica	SLO-2; SBA-1, 46, 72, 73, 1731; VEN-11; LAN-229; SCRI-191, 192, 240, 330, 474; SMI-504, 525
Paralabrax sp.	SBA-72, 1674; VEN-110
Paralabrax clathratus	SBA-46, 48, 224, 1203, 1731; VEN-110; LAN-52, 227; SCRI-192, 240; SMI-504
Paralichthys californicus	SBA-1, 46, 48, 224, 225, 1731, 2057; VEN-3, 11, 63, 110, 168, 261, 294; LAN-227, 229; SCRI-*
Paralabrax maculatofasciatus	SCRI-*
Paralabrax nebulifer	SBA-48; SCRI-*
Phanerodon atripes	SBA-1731; SCRI-*
Phanerodon furcatus	SBA-1, 46, 48, 224, 1731; VEN-3, 110; SCRI-*
Plagiogrammus hopkinsii	SLO-2
Platichthys stellatus	SLO-2; SBA-1731
Pleuronectes vetulus	SCRI-*
Pleuronectiformes	LAN-227; SMI-525
Pleuronichthys coenosus	SBA-224
Pleuronichthys ritteri	VEN-110; SCRI-*
Porichthys sp.	SBA-2057
Porichthys myriaster	SBA-46, 48, 1731, 2061; LAN-52
Porichthys notatus	SBA-1, 46, 71, 1807; VEN-7; LAN-1298; SMI-*
Rhacochilus toxotes	SBA-48, 72, 224, 225, 1731; VEN-11, 69, 110; LAN-311; SCRI-*
Rhacochilus vacca	SLO-2; SBA-1, 46, 48, 1203, 1731, 1807, 2057; VEN-3, 11, 110; LAN-229; SCRI-191, 192, 240, SCRI-330, 474
Roncador stearnsi	SBA-46, 1731, 2057; VEN-87, 110

Sarda chiliensis	SBA-1, 46, 48, 73, 1674, 1731; VEN-3, 11, 110, 261; LAN-52, 227, 229, 311, SCRI-*
Sardinops sp.	SBA-1807, 2057; SCRI-191, 192, 240, 330, 474; SMI-525
Sardinops sagax	SLO-2; SBA-1, 46, 48, 142, 224, 225, 1731; VEN-69, 87, 110, 168; LAN-227, 229; SMI-525; SCRI-*
Sciaenidae	SBA-46, 48; VEN-110; LAN-229; SCRI-*
Scomber japonicus	SLO-2; SBA-1, 46, 72, 73, 97, 225, 1674, 1731; VEN-7, 65, 87, 100; LAN-52, 227, 229, 1298; SCRI-191, 240, 330
Scomberomorus sp.	VEN-110
Scomberomorus concolor	VEN-3
Scombridae	VEN-110; LAN-229
Scorpaena guttata	SBA-48; VEN-63; LAN-311; SCRI-*
Scorpaenichthys marmoratus	SLO-2; SBA-46, 224, 225, 1731; VEN-110; SCRI-191, 192, 330; SMI-504, 525
Sebastes sp.	SLO-2; SBA-1, 46, 48, 71, 72, 73, 224, 225, 1203, 1674, 1731, 1807; VEN-3, 11, 63, 69, 87, 110, VEN-168; LAN-52, 227, 229, 311; SCRI-191, 192, 240, 330, 474; SMI-504, 525
Sebastes alutus	VEN-110; SCRI-*
Sebastes atrovirens	SLO-2; SBA-1, 1731; VEN-11, 110; LAN-229; SCRI-*
Sebastes auriculatus	SBA-46, 48, 224, 225; SCRI-*
Sebastes babcocki	SBA-46, 1731; SCRI-*
Sebastes carnatus	SLO-2; SBA-48, 224, 225, 1731; VEN-110; SCRI-*
Sebastes caurinus	SMI-525, SCRI-*
Sebastes chlorostictus	SBA-46; SCRI-*
Sebastes chrysomelas	SBA-1; SMI-*
Sebastes constellatus	VEN-69, 261; SCRI-*
Sebastes crameri	SBA-46; VEN-3; SCRI-*
Sebastes dalli	SBA-46; SCRI-*
Sebastes diploproa	SBA-1, 1731; SCRI-*
Sebastes elongatus	SBA-1731; SCRI-*
Sebastes entomelas	SBA-46, 1731; SCRI-*
Sebastes eos	SBA-46, 1731; SCRI-*
Sebastes flavidus	SLO-2; VEN-110; SCRI-*
Sebastes gilli	SCRI-*
Sebastes goodei	SBA-1, 46, 1731; VEN-110; LAN-52; SMI-525; SCRI-*
Sebastes helvomaculatus	SCRI-*
Sebastes hopkinsi	SBA-46, 1731; SCRI-*

Sebastes jordani	SCRI-*
Sebastes levis	SCRI-*
Sebastes macdonaldi	SBA-46; SCRI-*
Sebastes maliger	SCRI-*
Sebastes melanops	LAN-229; SCRI-*
Sebastes melanostomus	SCRI-*
Sebastes miniatus	SBA-1, 46, 1731; VEN-110; SCRI-*
Sebastes mystinus	SLO-2; SBA-46; LAN-229; SCRI-330
Sebastes ovalis	SCRI-*
Sebastes paucispinis	VEN-11; LAN-52, 229, 311
Sebastes phillipsi	SBA-1731; SCRI-*
Sebastes pinniger	SBA-46, 1731; SCRI-*
Sebastes polyspinis	SBA-1731
Sebastes rastrelliger	SBA-48, 224, 225; VEN-110; LAN-311; SCRI-*
Sebastes rosaceus	SCRI-*
Sebastes rosenblatti	SCRI-*
Sebastes ruberrimus	SCRI-*
Sebastes rubrivinctus	SCRI-*
Sebastes rufus	SCRI-*
Sebastes saxicola	SCRI-*
Sebastes semicinctus	SCRI-*
Sebastes serranoides	SBA-46; VEN-11; SMI-525; SCRI-*
Sebastes serriceps	SBA-224, 225; SCRI-*
Sebastes simulator	SCRI-*
Sebastes umbrosus	SCRI-*
Sebastes zacentrus	SCRI-*
Sebastolobus alascanus	SMI-*
Semicossyphus pulcher	SBA-1, 46, 48, 142, 224, 1203, 1731; VEN-3, 11, 63, 69, 110, 168, 294; LAN-52, 227, 229, 311; SCRI-191, 192, 240, 330, 474; SMI-504, 525
Seriola lalandi	SBA-1, 46, 73, 1731, 1807; VEN-11, 63, 110; LAN-52, 227, 229; SCRI-*
Seriphus politus	SLO-2; SBA-1, 46, 48, 1731, 1807, 2061; VEN-3, 87, 110, 168; SCRI-*
Serranidae	LAN-229; SCRI-*
Sphyraena argentea	SBA-1, 46, 48, 72, 1203, 1731, 1807; VEN-3, 11, 69, 87, 110, 168; LAN-52, 227, 229; SCRI-191, SCRI-474; SMI-*
Spirinchus starksi	SLO-2
Stereolepis gigas	SLO-2; SBA-1; VEN-3, 110
Tetrapturus andex	VEN-63
Thunnus sp.	VEN-110, 294; SCRI-*

Thunnus alalunga	SBA-46, 1731; VEN-110; LAN-52, 227, 229, 311; SCRI-*
Thunnus albacares	SBA-1731
Thunnus thynnus	LAN-52
Trachurus symmetricus	SLO-2; SBA-1, 46, 48, 72, 73, 224, 1674, 1731; VEN-3, 110; LAN-229; SCRI-192
Trichiurus nitens	VEN-87
Umbrina roncador	SBA-46, 48; VEN-3, 87, 110, 168
Xiphias gladius	SBA-1; VEN-3, 11, 63
Xiphiidae	SCRI-*
Xiphister mucosus	SBA-1
Zaniolepis frenata	SCRI-*

Note: SCRI-* denotes data from sites SCRI-191, SCRI-192, SCRI-330, and SCRI-474 that is not differentiated by site. SMI-* similarly denotes data from SMI-504 and SMI-525 not differentiated by site.

Appendix D: Species Name Changes

Species Name in Report	Name Used in Appendix C
Holorhinus californicus	*Myliobatis californica*
Isurus glaucus	*Isurus oxyrinchus*
Notorynchus maculatus	*Notorynchus cepedianus*
Pheumatophorus japonicus	*Scomber japonicus*
Pimelometopon pulchrum	*Semicossyphus pulcher*
Sardinops caeruleus	*Sardinops sagax*
Scomber diego	*Scomber japonicus*
Seriola dorsalis	*Seriola lalandi*