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Fish Remains as Indicators of Changes in Environment, Technology, and Sociopolitical Organization on Santa Cruz Island

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Subsistence strategies of the hunter-gatherer-fishers who inhabited the Northern Channel Islands have included fishing since at least 9,000 B.P. While there has been a steady increase of fish meat to the diet over this extended time period, there was a pronounced increase identified during the Middle and Late periods (2,600–200 B.P.). This increase occurred during a time of significant technological innovation, marked population growth, and expansive environmental stress. Recent data collected from numerous sites across the Northern Channel Islands have been critical in understanding the behavioral response to the significant environmental stress and cultural changes characteristic of the transition from the Middle Period to the Late Period on the Islands. We contribute to this growing body of data with an analysis of fish remains from CA-SCRI-195, a well-preserved site deposit on Santa Cruz Island that spans a 1,500-year time period inclusive of the Middle and Late periods. The data from CA-SCRI-195 suggest that evidence of environmental variation, technological development, and changes in sociopolitical organization can all be identified in the data and all uniquely contributed to subsistence changes identified at the site. The patterns of distribution and the trends apparent in the identified fish remains from this study are an important contribution to the larger goal of understanding developments in economic and sociopolitical organization on the Northern Channel Islands.

Many archaeologists working in California's Santa Barbara Channel region have investigated the evolution of fishing through space and time (e.g., Braje 2010; Colten 2001; Davenport et al. 1993; Erlandson et al. 2009; Glassow 1993; Lambert 1993; Pletka 1996, 2001; Rick 2004; Rick and Erlandson 2000; Rick and Glassow 1999; Rick et al. 2001, 2002, 2005; Walker and Erlandson 1986). These investigations have demonstrated that ancient hunter-gatherers who inhabited this region intensively fished near-shore waters since at least 9,000 B.P. Fish protein also steadily increased in dietary importance from the Early through the Late Holocene (Braje 2010; Erlandson et al. 2007, 2009; Glassow 1993; Kennett 1998, 2005; Kennett and Conlee 2002; Rick 2007, 2011; Vellanoweth et al. 2000). The underlying reasons for the sustained increase in fish protein to the diet through time have been debated and include changes in settlement, technological development, rising sociopolitical complexity, and environmental stresses (Arnold 2001; Braje 2010; Davenport et al. 1993; Erlandson et al. 2009; Gamble 2002; Kennett and Kennett 2000; Pletka 2001; Rick 2004, 2007, 2011). While changes and variations through time are certainly expected over a 9,000-year period, a sharp increase in fishing—coupled with significant technological innovations, marked population growth, and expansive environmental stress—has been identified during the Middle and Late periods (2,600–200 B.P.) within the Santa Barbara Channel region. The introduction of the plank canoe (Arnold 1992, 2007; Fagan 2004; Gamble 2002; King 1990), changes in

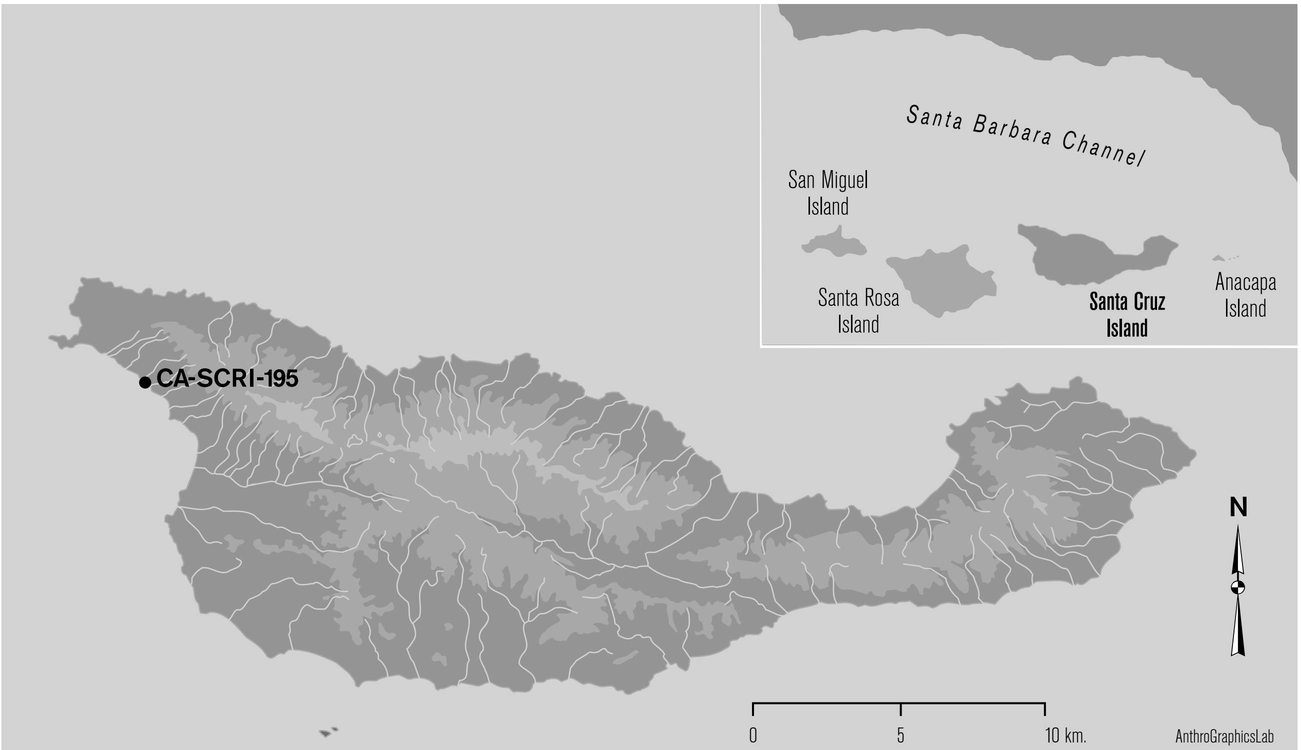

Figure 1. Location of SCRI-195 on Santa Cruz Island, California (courtesy of Michael Glassow).

the design of shell and bone fishhooks (Kennett 2005; King 1990; Tartaglia 1976), changes in marine biodiversity (Kennett 2005; Kennett and Kennett 2000), and the development of large, permanent settlements (Arnold 1992, 2001; Braje 2010; Colten 2001; Kennett 2005; Rick 2007) have all been documented for this time period and may be implicated in the expansion of fishing. Data to evaluate the significant changes that occurred during this time period have been accumulating in recent years (Braje 2010; Erlandson et al. 2009; Rick 2004, 2007, 2011) and are critical to understanding the behavioral response to the significant environmental stress and cultural changes characteristic of the transition from the Middle Period to the Late Period on the Northern Channel Islands. Data from many site deposits dating within this time frame show an increase in the abundance and diversity of fish species present in site assemblages (Braje 2010; Colten 2001; Glassow 1993; Kennett 2005; Kennett and Conlee 2002; Pletka 1996, 2001; Rick 2004, 2007, 2011; Walker and Snethkamp 1984) and have helped define the pronounced ecological changes that occurred.

CA-SCRI-195 is a site located on the western section of Santa Cruz Island with well-preserved deposits that span a 1,500-year time period inclusive of both the Middle Period (2,600–700 B.P.) and the Late Period (700–200 B.P.) (Fig. 1). The fish assemblage excavated from the site has the potential to contribute to the growing body of knowledge not only on the evolution of fishing within the Santa Barbara Channel, but also on the marked increase in fishing that has been noted from the end of the Middle Period into the Late Period. The Northern Channel Islands are ideal for undertaking this type of fine-grained analysis as the relative absence of burrowing animals and historical developments have fostered remarkable preservation in many areas of the islands. Numerous island sites have distinct undisturbed strata and deposits with lower levels of fragmentation than are seen within mainland sites (Rick et al. 2006). Investigations at SCRI-195 recovered over 4,700 relatively well-preserved individual fish elements that were identifiable to at least the family level. The high density of fish remains recovered from the site samples suggests the increased importance of fish meat to the diet that co-occurred with advances in technology, environmental variation, and settlement shifts. The subsistence data recovered from the site can contribute

Figure 2. Photograph of SCRI-195 (Photo by Anabel Ford).

to understanding broader questions focused on the effects of environmental, technological, and sociopolitical changes during the Middle and Late periods on the Northern Channel Islands.

ENVIRONMENTAL CONTEXT

SCRI-195 is located along a south-facing shore of Santa Cruz Island near its west end. This shell-mound site rises at least five meters above a relatively flat coastal plain (Fig. 2), with rocky intertidal and kelp habitats located adjacent to the site and sandy beach habitats located slightly north of the site (Kennett 1998:Fig. 3.13). Prehistorically, as well as today, the waters surrounding the site and the Channel Islands in general are very productive for both fish and shellfish due to pronounced upwelling in the region (Erlandson et al. 2005:173; Kinlan et al. 2005:125). This productive environment is reflected in the numerous sites on the west end of Santa Cruz Island, many of which have deposits in excess of two meters in depth containing abundant shellfish, fish, and sea mammal remains. The waters adjacent to SCRI-195 have a high marine biodiversity due to two converging currents: the cold, southward flowing California Current and the warmer, northward flowing California Countercurrent (Browne 1994). The California Countercurrent flows along the mainland coast and along the southern margins of Santa Cruz Island, transporting warm water from equatorial regions (Winant and Harms 2002), while the California Current branches off and affects waters off the northern and western shores of Santa Cruz (Browne 1994). Santa Cruz's location at the convergence of these two currents results in a diversity of fish species from both northern and southern regions. Warm-water fish are more common around the southern and eastern shores, and cold-water fish are more prevalent along the northern and western shores (Engle 1993; Love 1996).

Although marine productivity is considered high in the Santa Barbara Channel region, millennial-scale oscillations in regional sea surface temperatures (SSTs) throughout the Holocene affected marine productivity levels (Kennett and Kennett 2000; Kennett 2005:66, Fig. 11A). These climatic shifts have led numerous researchers to consider the effect of environmental variation on mobility, subsistence strategies, technological advances, and sociopolitical complexity of the region's prehistoric and historic societies (Arnold 1987, 1992, 1995; Braje 2010; Colten 1994; Erlandson 2001; Gamble 2005; Glassow 2002, 2006; Glassow et al. 1988; Johnson 2000; Jones et al. 1999; Kennett 2005; Kennett and Kennett 2000; Perry 2003; Rabb and Larson 1997; Raab et al. 1995; Rick 2004, 2007, 2011). The time span of SCRI-195 occupation included warm- and cold-water intervals as well as increased and lowered levels of marine productivity. The first approximately 400 years (1,900–1,500 B.P.) of occupation at SCRI-195 was characterized by a warm-water interval with relatively low marine productivity and less upwelling. The next 1,000-year period of site occupation (1,500 to 500 B.P.) was characterized by a cold-water interval. Beginning about 1,000 B.P. within that cold-water cycle, there was an increase in marine productivity that lasted until the end of site occupation around 350 B.P. (Glassow et al. 2008:37; Kennett 2005:66, Fig. 11B).

TECHNOLOGICAL CONTEXT

During the same 2,000-year time span, a time in which the region was experiencing a fluctuation in marine climate and productivity, there were various advancements in technologies used to procure the abundant marine animals found in the waters around the Santa Barbara Channel region. Changes in the design of fishhooks, the development of the harpoon, and a wider use of the plank canoe all fostered the exploitation of a greater variety of marine habitats and species. Many researchers have argued that these technological changes played a vital role in the onset of social inequality and the development of cultural complexity within the region (Arnold 1987, 1995; Fagan 2004; Gamble 2002; Pletka 1996, 2001).

There has been a great deal of discourse about the time frame within which the plank canoe, or Chumash *tomol*, became an important economic tool for groups living on the Northern Channel Islands (Arnold 1995, 2001, 2007; Davenport et al. 1993; Fagan 2004; Gamble 2002; King 1990). The earliest recorded date for a piece of wood with asphaltum that may have been part of a plank canoe is about 2,300 B.P. (see Gamble 2002:308). If the wood plank were part of a *tomol*, it would suggest that the plank canoe was used over 2,000 years ago (Gamble 2002:312). This date, however, involves the discovery of one small piece of material involved in building a plank canoe and does not necessarily indicate that a fully developed *tomol* was a typical part of the maritime hunter-gatherer tool kit at this early time period. The regular appearance of large-bodied pelagic fish in sites has been suggested as indirect evidence for increasing *tomol* use. Bernard (2004) amassed data from over 70 collections and found that around A.D. 500–600 pelagic fish are consistently found in site assemblages, suggesting a more sustained use of the *tomol*. Arnold (2007:200) offers direct evidence for the sustained manufacture of plank canoes involving material recovered from the A.D. 1300–1400 stratum at SCRI-192. She suggests that the numerous pieces of redwood in association with large quantities of asphaltum and more than 1,200 small pieces and plugs of asphaltum recovered from the site (Arnold and Bernard 2005) is a reasonable standard of evidence for sustained and focused *tomol* manufacture. While solid evidence for use of the *tomol* for hunting large pelagic fish and for trading with the mainland Chumash is still in question, it is clear that pronounced *tomol* use and manufacture had occurred by at least A.D. 1300 and corresponds with major changes in sociopolitical organization in the region (Arnold 1995; Davenport et al. 1993; Gamble 2002)

Other fishing-related technologies integral to the economy of prehistoric groups on Santa Cruz Island became widespread during the Late Holocene. The single-piece shell fishhook appeared throughout southern California by around 2,500 years ago (Rick et al. 2002). The size and form of this hook developed over time, with the greatest variety appearing in assemblages dating between 1,500 to 1,100 B.P. (Kennett 2005:Fig. 28). The harpoon was also developed during this time period, making larger pelagic fish more easily attainable (King 1990). Researchers have noted that contemporaneous with these technological developments, various site assemblages around the Santa Barbara region show a rapid increase in the ratio of fish to shellfish by meat weight and an increase in the number of such pelagic fish as tuna and swordfish (Arnold and Bernard 2005;

Figure 3. Sea cliff where samples were collected (soils samples collected from back of unit).

Bernard 2004; Braje 2010; Colten 2001; Davenport et al. 1993; Glassow 1993; Kennett 2005; King 1990; Rick 2004, 2007, 2011).

SAMPLE CONTEXT AND CHRONOLOGY

The fish remains analyzed in this study came from two 25 cm. × 25 cm. column samples, CS-1 and CS-2, collected in the mid 1970s from an exposure along a sea cliff at SCRI-195 (Fig. 3). CS-1 was collected from a deposit over four meters deep located towards the center of a house depression. CS-2 was collected from a shallower deposit on a downward slope of the house depression, approximately nine meters east of CS-1. The columns were divided into discernible strata except when a stratum was more than 25 cm. thick. In this case, the stratum was divided arbitrarily into two or more strata (Table 1).

Chronological control of the samples was established through both radiocarbon dating and the use of temporally diagnostic artifacts. Three radiocarbon dates were obtained in 1974 from three separate strata of CS-1; however, these dates may be spurious as the lowermost stratum dated 800 years later than the stratum 25 cm. above it. Additionally, there are inconsistencies between the radiocarbon dates and the diagnostic shell beads and microblades within the uppermost stratum of CS-1. As a result, the upper 168 cm. of CS-1 have been dated using the shell beads and microliths present in the deposits exclusively. Recently, five additional radiocarbon dates were obtained for CS-1 and six additional dates were obtained for CS-2. Combining both the diagnostic artifact dates and the radiocarbon dates, CS-1 has an occupation range from 1,810 cal B.P. to 700 B.P. (bead date), while the radiocarbon dates from CS-2 indicate a similar time frame extending from 1,920 cal B.P. to 470 cal B.P. (Table 2). All of the radiocarbon dates were calibrated with CALIB 4.3 using a marine reservoir correction of 225 ± 35, and the $^{13}C/^{12}C$ corrections were

Table 1

LEVELS AND CORRESPONDING VOLUME MEASUREMENTS

Sample No.	Level Depth (cm.)	Volume (liters)	Sample No.	Level Depth (cm.)	Volume (liters)
CS 1	0–20	12.500	CS 2	0–11	6.875
CS 1	20–40	12.500	CS 2	11–20	5.625
CS 1	40–53	8.125	CS 2	20–33	8.125
CS 1	53–80	16.875	CS 2	33–58	15.625
CS 1	80–100	12.500	CS 2	58–72	8.750
CS 1	100–120	12.500	CS 2	72–93	13.125
CS 1	120–134	8.750	CS 2	93–107	8.750
CS 1	134–145	6.875	CS 2	107–115	5.000
CS 1	145–168	14.375	CS 2	115–126	6.875
CS 1	168–185	10.625	CS 2	126–134	5.000
CS 1	185–199	8.750	CS 2	134–148	8.750
CS 1	199–227	17.500	CS 2	148–158	6.250
CS 1	227–247	12.500	CS 2	158–180	13.750
CS 1	247–251	2.500	CS 2	180–189	5.625
CS 1	251–269	11.250	CS 2	189–191	1.250
CS 1	269–280	6.875	CS 2	191–200	5.625
CS 1	280–290	6.250	CS 2	200–228	17.500
CS 1	290–299	5.625	CS 2	228–236	5.000
CS 1	305–308	1.875	CS 2	236-245	5.625
CS 1	308–313	3.125	CS 2	245-260	9.375
CS 1	313–323	6.250	CS 2	260-273	8.125
CS 1	323–335	7.500	CS 2	273–285	7.500
CS 1	335–349	8.750	CS 2	285–301	10.000
CS 1	349–372	14.375	CS 2	301–308	4.375
CS 1	372–376	2.500	CS 2	308–323	9.375
CS 1	376–387	6.875	CS 2	323–330	4.375
CS 1	387–406	11.875			
CS 1	406–410	2.500			

Table 2

SCRI-195 DATES USED IN TEXT

Sample	Depth (cm.)	Lab No.	Conventional Age (B.P.)	Calendar Year (cal B.P.)	Artifact Date	Material
CS1[a]	0–20				700 B.P.	Historic Bead
CS1[a]	20–80				850–700 B.P.	Triangular prepared microdrill
CS1[a]	80–100				1,000–850 B.P.	Trapezoidal microdrill & Split-punched bead
CS1[a]	100–120				1,100 B.P.	Wall bead
CS1	168–185	Beta-240436	1,930 ± 70	1,400 (1,270) 1,110		*Mytilus californianus*
CS1	251–269	Beta-240437	2,150 ± 50	1,600 (1,490) 1,340		*Mytilus californianus*
CS1	308–313	Beta-240438	2,420 ± 70	1,980 (1,810) 1,600		*Mytilus californianus*
CS1	387–406	Beta-240439	2,430 ± 50	1,940 (1,810) 1,680		*Mytilus californianus*
CS1[b]	387–406	Beta-260101	2,570 ± 40	2,120 (1, 970) 1,840		*Mytilus californianus*
CS2	11–20	Beta-240440	1,050 ± 70	560 (470) 300		*Mytilus californianus*
CS2	58–72	Beta-260102	1,950 ± 40	1,360 (1,280) 1,210		*Mytilus californianus*
CS2	115–126	Beta-261910	2,130 ± 60	1,610 (1,470) 1,300		*Mytilus californianus*
CS2	126–134	Beta-260103	1,950 ± 60	1,360 (1,280) 1,210		*Mytilus californianus*
CS2	206–228	Beta-260104	2,190 ± 40	1,650 (1,520) 1,400		*Mytilus californianus*
CS2	308–323	Beta-240441	2,530 ± 50	2,080 (1,920) 1,800		*Mytilus californianus*

SCRI-195 DATES OBTAINED IN THE 1970'S[c]

Sample	Depth (cm.)	Uncorrected Date	Calibrated Date B.P.	Calibrated Date B.C./A.D.	Lab No.	Material
CS1	100-109	280±150	501(303) 0	A.D. 1449 (1647) 1954	UCR-206	Charcoal
CS1	380-388	2,310±150	2,332 (2,144) 1,961	382 (195) 11 B.C.	UCR-207	*Mytilus californianus*
CS1	406-410	1,605±100	1,451 (1,326) 1,256	A.D. 499 (624) 694	UCR386	*Mytilus californianus*

[a]Dates determined by Glassow and Paige (n.d.)

[b]Retested level 387–406 due to possible error. Level 75 cm. above had exact same date.

[c]Dates obtained from Breschini.

determined by the radiocarbon lab. All dates presented in the analysis are given in calendar calibrated years (cal B.P.).

METHODS

Both samples were screened through 1/4- and 1/8-inch mesh. Although 1/16-inch mesh is preferable in order to obtain a fuller representation of the small fish found in assemblages (Bowser 1993; Erlandson 1994; Glassow 1993; Pletka 1996), this collection was acquired 40 years ago, when such fine-grained screening was not stressed. As a result, small fish species may be underrepresented within the data presented.

The initial phase of sorting began shortly after the samples were collected in 1974. At that time, a small portion of CS-1 was sorted and analyzed (Glassow 1993). In the 1990s, one of the coauthors, Peter Paige, sorted the remainder of both column samples with the help of undergraduate assistants, and assigned all fish remains in the upper 168 cm. of CS-1 to a taxon (Glassow and Paige 2006). During the fall of 2007, Gusick identified the fish remains from the remaining 233 cm. of CS-1 and all of CS-2. During this last phase, only identifiable vertebrae, jaw elements, teeth, and otoliths were classified to the most specific taxon possible. Although the fish remains from SCRI-195 are well preserved, many of the bones are fragmented, leaving mostly vertebrae in an identifiable state. All identifications were performed using comparative collections housed at the University of California, Santa Barbara, and the Santa Barbara Museum of Natural History.

Taxonomic assignments were conservative and were done in consultation with both Dr. John Johnson

(Curator of Anthropology at the Santa Barbara Museum of Natural History) and Dustin Mckenzie (Instructor at Cabrillo College). An attempt was made to identify elements to at least the family level. If identification to this level could not be made, the element was identified only to Teleostei or Elasmobranchii. Additionally, all surfperch vertebrae and jaw elements were identified as Embiotocidae and all rockfish elements were identified as *Sebastes* sp. The family Clupeidae includes herring, sardine, and anchovy, the family Triakidae includes leopard shark, brown and grey smoothhound, and soupfin shark, and the family Squalidae is most likely all spiny dogfish (*Squalus acanthias*). More precise identification was not made within each of the above taxa due to the similarity of the elements between the various species in each taxon.

All fish species present in the samples were classified according to the habitat in which they are commonly found, their SST preference, and the technologies most likely used in their capture (Table 3). Categorizing the fish taxa in this manner allowed for an assessment of temporal variations in fish taxa that focused on the specific environmental and technological variables unique to each taxon. To determine temporal variations within the samples, NISP, density, and bone weights were calculated and used in a variety of analyses. Each unit of analysis (e.g., NISP, MNI, bone weight) presents a number of issues regarding comparability (Casteel 1978; Lyman 1979; Reitz and Wing 1999). For this study, NISP was used as the fundamental unit of analysis as it is an actual count and not an estimate such as MNI (Pletka 1996). All of the fragmentary elements identified were over 50% complete, thus avoiding duplicate counts (Reitz and Wing 1999). As the overall goal was to compare temporal variations in fish taxa and not the dietary contributions of differing faunal classes, measures such as meat or protein weight were not considered.

Data sets from both samples were kept separate for analysis as the radiocarbon dates between the two samples did not correspond in a straightforward manner. Deposits at CS-2 are not as thick as at CS-1, yet the dates for the CS-2 deposit span a greater time interval than that represented by the CS-1 dates. Combining the data would have required making assumptions as to which strata between the two samples corresponded. While both samples were used for identifying generalized trends apparent over the entire occupation span, results from CS-1 were used in most of the more date-specific analyses pertaining to the Middle and terminal Middle periods, and CS-2 was used for aspects of the analysis pertaining to the Late Period because of the presence of more Late Period-dated strata in the CS-2 sample.

The fish data were considered within the cultural chronology developed for the Santa Barbara region that splits time into the Middle Period (2,500–850 B.P.), the Middle-Late Transitional Period (850–700 B.P.), and the Late Period (700–200 B.P.) (Arnold 1992). Variations in subsistence across these temporal cultural markers may be indicative of a change due to cultural factors such as technological developments, shifts in settlement patterns, or increases in population. Within these same cultural time periods, identified fluctuations in SST and marine productivity were also considered. Such fluctuations have been identified in research focused on variations in SST temperature and on marine productivity through time within the Santa Barbara Basin (Kennett 2005, Fig.11; Kennett and Kennett 2000). For the purposes of the current study, three environmental periods were identified: the Warm Period (2,000–1,500 B.P.), the Cool Period (1,500–1,000 B.P.), and the Productive Period (1,000–350 B.P.). Each of these periods is defined on the basis of a dominant characteristic. The Warm Period is characterized by warmer SSTs. Directly following is the Cool Period, characterized by cooler SSTs. The last period, the Productive Period, is the first time since identified occupation of SCRI-195 that marine productivity underwent a significant increase. Interestingly, the SSTs during this Productive Period varied between warm and cool periods, but the marine productivity stayed relatively high despite the temperature variation (Fig. 4).

To determine significantly high densities of a particular taxon across all strata, standardized NISP counts were used in a variety of analyses. For identification of any obvious trends, these data were graphically displayed in a histogram. Data were also analyzed using principal components analysis (PCA) to discern similarities and patterns. This analysis is helpful in identifying complex patterns of variation and can aid in recognizing major summary trends in the data that may not be immediately apparent (Shennan 2009). The characteristics of any covariation among particular taxa indicated by the PCA were compared to environmental

Table 3

IDENTIFIED FISH AT SCRI-195 AND THEIR HABITAT, RANGE AND LIKELY METHOD OF CAPTURE[a]

Taxa	Common Name	Habitat	Range	Method of Capture
Teleostei	**Ray-finned fish**			
Atherinidae	Silversides	N/A	Wide-ranging	N/A
Atherinops affinis	Topsmelt	Sandy near-shore	Wide-ranging	Nets/Hook
Atherinopsis californiensis	Jack silverside	Near-shore	Wide-ranging	Nets/Hook
Chromis punctipinnis	Blacksmith	Rocky near-shore	Southern	Hook/Spear
Clinidae	Clinids and kelpfishes	Rocky near-shore/Kelp	Wide-ranging	Hook/Spear
Clupeidae	Herrings, shads, sardines	Midwater/inshore	N/A	Boats/Nets/Hook
Cottidae	Sculpins	Near-shore	N/A	Nets/Hook/Spear
Damalichthys vacca	Pile surfperch	Near-shore	Wide-ranging	Nets/Hook
Embiotocidae	Surfperches	Near-shore	N/A	Nets/Hook
Engraulididae	Anchovies	Midwater	Warm-water	Boats/Nets
Gymnothorax mordax	Moray Eel	Rocky near-shore	Southern	Hook
Halichoeres semicinctus	Rockwrasse	Near-shore	Southern	Nets/Hook/Spear
Heterostichus rostratus	Giant kelpfish	Rocky near-shore/Kelp	Wide-ranging	Hook/Spear
Hexagrammidae	Greelings	Near-shore	Northern	Hook
Leptocottus armatus	Pacific staghorn sculpin	Sandy near-shore	Wide-ranging	Nets/Hook
Medialuna californiensis	Halfmoon	Rocky near-shore	Southern	Hook/Spear
Mola mola	Ocean sunfish	Offshore	Wide-ranging	Boats/Hook/Harpoon
Ophiodon elongates	Lingcod	Rocky near-shore	Northern	Boats/Hook
Oxyjulis californica	Señorita	Rocky near-shore	Wide-ranging	Boats/Nets
Paralabrax sp.	Basses	Near-shore	Wide-ranging	Hook
Sarda chilensis	Pacific bonito	Midwater	Warm-water	Boats/Hook
Sardinops sagax	Pacific sardine	Midwater	Warm-water	Boats/Nets
Sciaenidae	Croakers and drums	Sandy near-shore	N/A	N/A
Scomber japonicus	Pacific mackerel	Midwater	Warm-water	Boats/Hook
Scombridae sp.	Mackerels	Midwater	N/A	N/A
Scorpaenichthys marmoratus	Cabezon	Rocky near-shore	Wide-ranging	Hook/Spear
Sebastes sp.	Rockfishes	Rocky near-shore	N/A	Boats/Hook
Semicossyphus pulcher	Sheephead	Rocky near-shore	Southern	Nets/Hook/Spear
Sphyraena argentea	Pacific barracuda	Midwater	Southern	Boats/Nets/Hook/Harpoon
Stereolepis gigas	Giant Sea Bass	Rocky near-shore/Kelp	Southern	Boats/Hooks/Harpoon
Stichaeidae	Pricklebacks	Near-shore	Wide-ranging	Boats/Nets/Hooks
Trachurus symmetricus	Jackmackerel	Midwater	Warm-water	Boats/Hook
Elasmobranchii	**Sharks, rays**			
Galeorhinus galeus	Soupfin shark	Near-shore	Wide-ranging	Boats/Nets/Hook/Harpoon
Myliobatis californica	Batray	Sandy near-shore	Wide-ranging	Nets/Hook/Spear
Platyrhinoidis triseriata	Thornback Ray	Sandy near-shore	Wide-ranging	Hook/Spear
Rhinobatidae	Shovelnose Guitarfish	Sandy near-shore	Wide-ranging	N/A
Squalus acanthias	Spiny dogfish	Near-shore	Wide-ranging	Boats/Hook
Squalidae	Dogfish sharks	Near-shore	Wide-ranging	Boats/Hook
Squatina californica	Pacific angel shark	Sandy near-shore	Wide-ranging	Hook/Spear
Torpedo californica	Pacific electric ray	Near-shore	Wide-ranging	Nets/Hook
Triakidae	Hound sharks	Near-shore	Wide-ranging	Nets/Hook/Spear
Urolophus halleri	Round stingray	Sandy near-shore	Wide-ranging	Hook/Spear

[a]Sources consulted: Bowser (1993), Eschmeyer et al. (1983), Love (1996), and Pletka (2001).

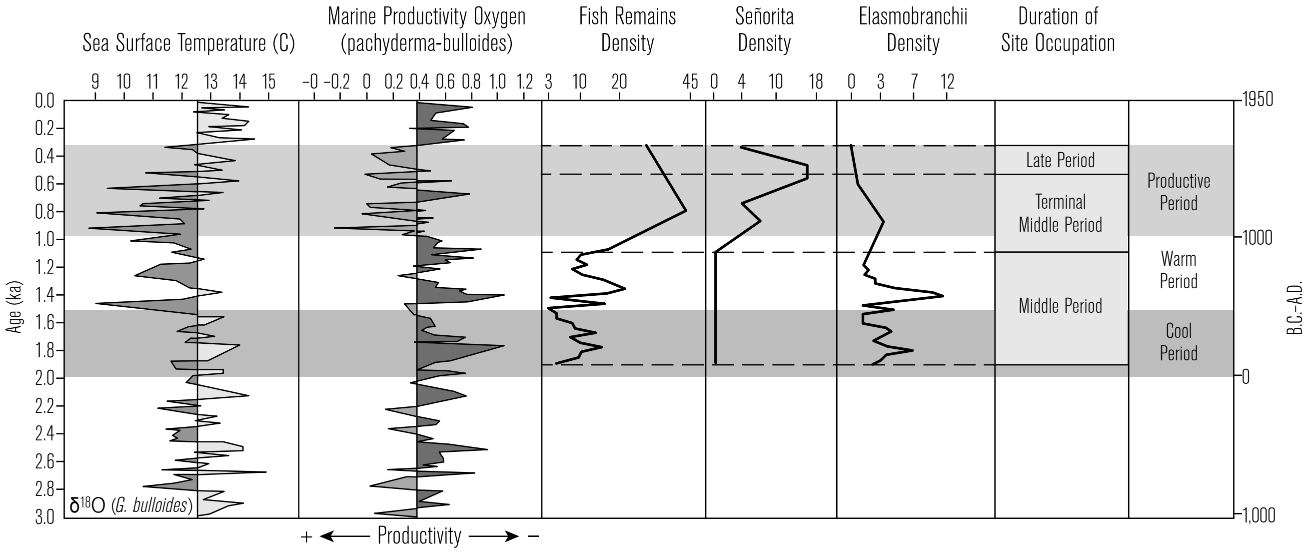

Figure 4. Adapted from Kennett (2005:Figure 11). Image shows the cultural time periods and the environmental time periods used for analysis in comparison with the SST and marine productivity variations shown in the two left columns. Density measurements for total fish remains, senorita, and Elasmobranchii are shown.

and technological changes pertaining to each time period in order to identify any correlation.

The Shannon-Weaver index was used to determine the evenness and diversity of fish taxa and their abundances within the sample. Values were calculated for "H" and "V" measures, corresponding to diversity and evenness, respectively. Changes in the diversity of a sample may indicate a shift in subsistence strategies to achieve a broader diet breadth. The evenness measure was used to determine those species that were dominant in the subsistence pattern during each time period.

Although all fish species found in the assemblage were used in determining the diversity calculations, only taxa that accounted for over 3% of the total standardized NISP in each sample were considered in most other analyses. In both column samples these taxa were Clupeidae, surfperch (Embiotocidae), señorita (*Oxyjulius californica*), rockfish (*Sebastes* sp.), Triakidae, Squalidae, giant kelpfish (*Heterostichus rostratus*), and cabezon (*Scorpaenichthys marmoratus*).

FISH REMAINS

Only fish remains identified to at least a family level were used in the analyses. These included 4,774 complete or fragmentary elements: 3,023 vertebrae, 918 teeth, 765 jaw elements, and 68 otoliths. During the identification process, it became apparent that 90% of the identified teeth and over 50% of the identified jaw elements were from two species, pile surfperch (*Damalichthys vacca*) and California sheephead (*Semicossyphus pulcher*). As these particular elements from these species seemed to preserve inordinately well, all teeth and jaw elements were excluded from the analysis to avoid bias in the data. The remaining vertebrae and otolith data consisted of 65% (3,091 NISP) of the total identified elements and all analyses were inclusive of only these two elements (Tables 4 and 5).

Thirty-nine categories of Teleostei and 12 categories of Elasmobranchii were identified in the assemblage. Of the Elasmobranchs identified to at least a family level, Triakidae (mostly smoothound) accounted for 49% and 40% of the NISP from CS-1 and CS-2, respectively. Squalidae accounted for 34% and 56% of the NISP from CS-1 and CS-2, respectively. All other Elasmobranch fish each accounted for less than 5% of the identified Elasmobranchii and include Mylobatidae, Rhinobatidae, Torpinidae, Squatinidae, Thornback Guitarfish (*Platyrhinoidis triseriata*) and Round Stingray (*Urolophus halleri*).

Turning to Teleostei, the two samples have the same six species that were most dominant; however, the ratio

Table 4

COUNT AND WEIGHT OF FISH REMAINS BY COLUMN SAMPLES AND CULTURAL TIME PERIOD

	Column Sample 1						Column Sample 2			
	Late		Terminal Middle		Middle		Late		Middle	
Taxa	Count	Weight	Count	Weight	Count	Weight	Count	Weight	Count	Weight
Elasmobranchii										
Elasmobranchii	3	0.19	42	1.28	410	15.28	3	0.17	142	6.75
Galeorhinus galeus	–	–	1	0.90	–	–	–	–	–	–
Myliobatidae	–	–	–	–	1	0.15	–	–	1	0.08
Myliobatis californica	–	–	–	–	2	0.17	–	–	–	–
Platyrhinoidis triseriata	–	–	–	–	1	0.02	–	–	–	–
Rhinobatidae	–	–	–	–	4	0.37	–	–	2	0.06
Squalidae	–	–	2	0.04	76	2.75	–	–	67	1.45
Squatina californica	–	–	5	2.06	–	–	–	–	–	–
Torpedo californica	–	–	–	–	1	0.01	–	–	–	–
Torpedinidae	–	–	–	–	–	–	–	–	1	0.01
Triakidae	–	–	12	6.97	82	36.39	–	–	48	20.08
Urolophus halleri	–	–	1	0.01	–	–	–	–	–	–
Elasmobranchii Total	**3**	**0.19**	**63**	**11.26**	**577**	**55.14**	**3**	**0.17**	**261**	**28.43**
Teleostei										
Atherinidae	–	–	–	–	2	0.03	–	–	–	–
Atherinops affinis	–	–	–	–	1	0.01	–	–	–	–
Atherinopsis californiensis	–	–	–	–	3	0.08	–	–	6	0.10
Cebidichthys violaceus	–	–	–	–	–	–	1	0.35	–	–
Chromis punctipinnis	3	0.10	17	0.71	–	–	8	0.23	15	0.38
Clinidae	–	–	20	0.25	–	–	–	–	–	–
Clupeidae	13	0.07	40	0.32	96	0.64	6	0.04	191	1.04
Cottidae	2	0.02	21	0.28	18	0.19	–	–	31	0.28
Damalichthys vacca	–	–	3	4.33	4	1.59	–	–	–	–
Embiotocidae	54	3.69	125	7.97	140	8.30	18	1.25	111	7.57
Engraulidae	–	–	–	–	3	0.05	–	–	–	–
Engraulis mordax	–	–	–	–	–	–	1	0.01	4	0.01
Gymnothorax mordax	2	0.19	1	0.23	11	0.60	–	–	2	0.11
Halichoeres semicinctus	–	–	–	–	3	0.11	–	–	9	0.14
Heterostichus rostratus	5	0.40	72	6.45	22	0.80	8	0.64	20	0.76
Hexagrammidae	–	–	1	0.01	2	0.01	–	–	–	–
Hexagrammos Decagrammus	–	–	–	–	–	–	3	0.02	6	0.23
Labridae (not sheepshead)	–	–	–	–	–	–	–	–	14	0.13
Leptocottus armatus	–	–	–	–	1	0.01	–	–	–	–
Medialuna californiensis	–	–	–	–	2	0.11	–	–	–	–
Micropogonias undulatus	–	–	–	–	1	0.04	–	–	–	–
Mola mola	–	–	–	–	1	5.36	–	–	–	–
Ophiodon elongatus	3	0.28	4	0.30	11	1.03	1	0.04	15	1.67
Oxyjulis californica	19	0.28	541	5.07	28	0.30	8	0.07	159	1.25
Paralabrax clathratus	–	–	–	–	1	0.04	–	–	2	0.79
Paralabrax sp.	–	–	–	–	4	0.25	–	–	–	–
Porichthys notatus	–	–	–	–	–	–	–	–	2	0.02
Sardinops sagax	–	–	–	–	1	0.01	–	–	–	–
Sciaenidae	–	–	1	0.06	–	–	–	–	3	0.12
Scomber japonicus	3	0.12	11	0.49	16	0.65	1	0.03	11	0.49
Scombridae sp.	–	–	–	–	2	0.02	–	–	9	0.20
Scorpaenichthys marmoratus	20	7.48	22	2.43	40	12.16	4	0.38	28	4.29
Sebastes sp.	56	5.79	125	12.93	181	15.23	26	1.51	177	16.27
Semicossyphus pulcher	1	0.12	10	5.03	24	13.01	1	0.02	21	6.08
Sphyraena argentea	27	8.07	1	0.08	3	0.27	–	–	–	–
Stereolepis gigas	–	–	–	–	1	1.80	–	–	–	–
Stichaeidae	–	–	3	0.06	1	0.01	–	–	–	–
Teleostei	133	6.19	955	26.05	987	43.50	80	2.26	869	42.91
Trachurus symmetricus	1	0.08	5	0.21	3	0.18	–	–	4	0.12
Teleostei Total	**342**	**32.88**	**1,978**	**73.26**	**1,613**	**106.39**	**166**	**6.85**	**1,709**	**84.96**
Grand Total	**345**	**33.07**	**2,041**	**84.52**	**2,190**	**161.53**	**169**	**7.02**	**1,970**	**113.39**

Table 5

COUNT AND WEIGHT OF FISH REMAINS BY COLUMN SAMPLES AND ENVIRONMENTAL TIME PERIOD

	Column Sample 1						Column Sample 2					
	Productive		Cool		Warm		Productive		Cool		Warm	
Taxa	Count	Weight	Count	Weight	Count	Weight	Count	Weight	Count	Weight	Count	Weight
Elasmobranchii												
Elasmobranchii	45	1.47	291	9.14	119	6.14	3	0.17	120	5.13	22	1.62
Galeorhinus galeus	1	0.90	–	–	–	–	–	–	–	–	–	–
Myliobatidae	–	–	–	–	1	0.15	–	–	1	0.08	–	–
Myliobatis californica	–	–	2	0.17	–	–	–	–	–	–	–	–
Platyrhinoidis triseriata	–	–	1	0.02	–	–	–	–	–	–	–	–
Rhinobatidae	–	–	2	0.24	2	0.13	–	–	2	0.06	–	–
Squalidae	2	0.04	43	1.44	33	1.31	–	–	66	1.44	1	0.01
Squatina californica	5	2.06	–	–	–	–	–	–	–	–	–	–
Torpedo californica	–	–	1	0.01	–	–	–	–	–	–	–	–
Torpedinidae	–	–	–	–	–	–	–	–	1	0.01	–	–
Triakidae	12	6.97	52	18.93	30	17.46	–	–	40	12.60	8	7.50
Urolophus halleri	1	0.01	–	–	–	–	–	–	–	–	–	–
Elasmobranchii Total	**66**	**11.45**	**392**	**29.95**	**185**	**25.19**	**3**	**0.17**	**230**	**19.30**	**31**	**9.13**
Teleostei												
Atherinidae	–	–	1	0.01	1	0.02	–	–	–	–	–	–
Atherinops affinis	–	–	–	–	1	0.01	–	–	–	–	–	–
Atherinopsis californiensis	–	–	3	0.08	–	–	–	–	3	0.07	3	0.03
Cebidichthys violaceus	–	–	–	–	–	–	1	0.35	–	–	–	–
Chromis punctipinnis	20	0.81	–	–	–	–	8	0.23	15	0.38	–	–
Clinidae	20	0.25	–	–	–	–	–	–	–	–	–	–
Clupeidae	53	0.39	71	0.52	25	0.12	6	0.04	158	0.77	33	0.27
Cottidae	23	0.30	15	0.17	3	0.02	–	–	28	0.27	3	0.01
Damalichthys vacca	3	4.33	3	1.58	1	0.01	–	–	–	–	–	–
Embiotocidae	179	11.66	86	5.82	54	2.48	18	1.25	81	5.30	30	2.27
Engraulidae	–	–	3	0.05	–	–	–	–	–	–	–	–
Engraulis mordax	–	–	–	–	–	–	1	0.01	4	0.01	–	–
Gymnothorax mordax	3	0.42	3	0.09	8	0.51	–	–	2	0.11	–	–
Halichoeres semicinctus	–	–	–	–	3	0.11	–	–	9	0.14	–	–
Heterostichus rostratus	77	6.85	16	0.67	6	0.13	8	0.64	9	0.50	11	0.26
Hexagrammidae	1	0.01	–	–	2	0.01	–	–	–	–	–	–
Hexagrammos Decagrammus	–	–	–	–	–	–	3	0.02	5	0.05	1	0.18
Labridae (not sheepshead)	–	–	–	–	–	–	–	–	14	0.13	–	–
Leptocottus armatus	–	–	1	0.01	–	–	–	–	–	–	–	–
Medialuna californiensis	–	–	2	0.11	–	–	–	–	–	–	–	–
Micropogonias undulatus	–	–	–	–	1	0.04	–	–	–	–	–	–
Mola mola	–	–	1	5.36	–	–	–	–	–	–	–	–
Ophiodon elongatus	7	0.58	7	0.29	4	0.74	1	0.04	13	1.55	2	0.12
Oxyjulis californica	560	5.35	27	0.29	1	0.01	8	0.07	159	1.25	–	–
Paralabrax clathratus	–	–	1	0.04	–	–	–	–	2	0.79	–	–
Paralabrax sp.	–	–	4	0.25	–	–	–	–	–	–	–	–
Porichthys notatus	–	–	–	–	–	–	–	–	2	0.02	–	–
Sardinops sagax	–	–	1	0.01	–	–	–	–	–	–	–	–
Sciaenidae	1	0.06	–	–	–	–	–	–	3	0.12	–	–
Scomber japonicus	14	0.61	4	0.18	12	0.47	1	0.03	11	0.49	–	–
Scombridae sp.	–	–	2	0.02	–	–	–	–	4	0.07	5	0.13
Scorpaenichthys marmoratus	42	9.91	31	10.59	9	1.57	4	0.38	28	4.29	–	–
Sebastes sp.	181	18.72	107	8.29	74	6.94	26	1.51	147	14.2	30	2.12
Semicossyphus pulcher	11	5.15	7	1.14	17	11.87	1	0.02	13	3.68	8	2.40
Sphyraena argentea	28	8.15	1	0.09	2	0.18	–	–	–	–	–	–
Stereolepis gigas	–	–	–	–	1	1.8	–	–	–	–	–	–
Stichaeidae	3	0.06	1	0.01	–	–	–	–	–	–	–	–
Teleostei	1,088	32.24	787	25.43	200	18.07	80	2.26	657	35.30	212	7.57
Trachurus symmetricus	6	0.29	1	0.03	2	0.15	–	–	4	0.12	–	–
Teleostei Total	**2,320**	**106.14**	**1,186**	**61.13**	**427**	**45.26**	**166**	**6.85**	**1,371**	**69.6**	**338**	**15.36**
Grand Total	**2,386**	**117.59**	**1,578**	**91.08**	**612**	**70.45**	**169**	**7.02**	**1,601**	**88.9**	**369**	**24.49**

between taxa varied between each sample. In CS-1, señorita was overwhelmingly abundant, accounting for 32% of the total NISP. Rockfish and surfperch were relatively even, accounting for 20% and 17%, respectively, while Cluepidae accounted for 8%, giant kelpfish (*Heterostichus rostratus*) accounted for 5%, and cabezon (*Scorpaenichthys marmoratus*) accounted for 4%. These taxa were a bit more evenly distributed in CS-2, with rockfish and Cluepidae accounting for 22% and 21%, respectively, and señorita and Embiotocidae accounting for 18% and 14%, respectively; Cabezon accounted for 4% and giant kelpfish accounted for 3%. All other Teleostei accounted for less than 3% of the identified Teleostei within each sample.

Although smaller species of fish are overall the most abundant in each column sample, they are most prevalent in strata dating between 1,000–500 cal B.P., representing the Productive Period. PCA analysis shows that most small fish, including señorita, correlate most strongly with the Productive Period (Fig. 5). The Shannon-Weaver index also shows that señorita is statistically significant during the Productive Period, with an overall "V" value of 0.64 for the entire sample and a 43% relative proportion. Conversely, señorita is virtually absent from the strata dating to the Cool and Warm periods, which correspond to the entire Middle Period occupation of SCRI-195. The only exception to this appears to be a few strata dating to between 1,500–1,400 cal B.P., where señorita accounts for a small percentage of the overall strata constituents. These strata are dominated by elasmobranch fish, which may indicate that the señorita were introduced into these strata through the digestive tracts of captured sharks. While señorita dominate the assemblage during the majority of the Productive Period, their presence decreases towards the end of site occupation around 700 cal B.P., the beginning of the Late Period (see Fig. 4).

The presence of another taxon of smaller fish, Cluepidae, is slightly more consistent throughout the deposit, but varies between the samples. Before 1,800 cal B.P. in CS-1, the Warm Period, this species occurs almost solely in strata in which barracuda (*Sphyraena argentea*) is present. This co-occurrence again suggests that within these lower strata this smaller fish may have been introduced into the assemblage through the digestive tracts of larger species. Though not as dominant as señorita in the Productive Period strata, deposits

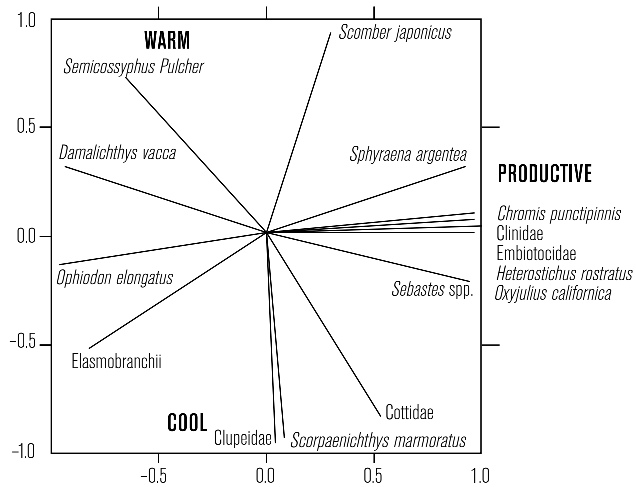

Figure 5. PCA analysis graph showing most species of small fish correlating with the Productive Period.

dating to this period have the most consistent density of Cluepidae of the strata within CS-1. Although density decreases, the family is still present in strata dating to the Late Period. Conversely, in CS-2, Cluepidae has a relatively high density in some of the lower strata dating to the Cool Period. This discrepancy between the samples could be due to the location of CS-2 outside of the main activity area of the site.

The largest identified fish taxa present in the assemblage, Triakidae and Squalidae, show a trend that is decidedly different from the smaller fish mentioned above. Both elasmobranch families were present throughout both samples, but with a higher density in the mid to lower strata of CS-1, which date to before 1,200 cal B.P. This time period is inclusive of both the Warm and Cool Periods. Before 1,400 cal B.P., elasmobranch fish accounted for up to 45% of the total density in certain strata. This trend changes in the Productive Period strata, where the density of elasmobranch fish decreases significantly (see Fig. 4). The Shannon-Weaver index shows a relative proportion for Elasmobranchii of 45% for the Warm Period and 50% for the Cool Period in CS-1, while the PCA analysis shows Elasmobranchii almost evenly correlated between the Warm and Cool periods (see Fig. 5). The only similarity in the trends between the smallest and largest fishes is that both are not present in the assemblage past 500 cal B.P.

The other dominant taxa in the assemblage, rockfish, cabezon, and Embiotocidae, show a more general trend of increasing density through time from the Warm to the

Productive periods (Middle to Late Period) within both samples. This trend is consistent with the general increase in density and diversity of fish species during the same interval. Rockfish, cabezon, and Embiotocidae are the only three taxa present in strata dating later than 500 cal B.P. in CS-2. These strata show a significant decrease in the density of fish remains and in the diversity of fish taxa compared to the strata corresponding to the terminal Middle Period (see Fig. 4).

Many of the fish taxa identified at SCRI-195 are wide-ranging, meaning that they are typically distributed from north of Point Conception to south of northern Baja California (Pletka 2001). Most taxa identified within the assemblage can be found in nearshore habitats, including rocky intertidal, sandy beach, and kelp bed habitats (Love 1996; Pletka 2001:225–227). SCRI-195 is in close proximity to both rocky intertidal and sandy beach habitats, and the fish taxa present in the assemblage indicate the importance of both of these habitats in the fishing strategies of the site inhabitants. Two of the most abundant taxa present, rockfish and señorita, are found within the rocky intertidal habitat adjacent to the site. The presence of giant kelpfish in the assemblage indicates fishing within the kelp beds that are nearby. Embiotocidae could have been taken from a variety of nearshore habitats, whereas Triakidae and Squalidae tend to reside in sandy bottom habitats. Pacific mackerel (*Scomber japonicus*), a less abundant species in the assemblage, is present relatively consistently in Late Period strata. As this is a pelagic species (Love 1996; Pletka 2001), its presence may indicate a more intensified use of the deeper water habitat past the kelp beds, suggesting a use of boats as part of the fishing strategy during the Late Period. Pacific mackerel are, however, occasionally found in nearshore waters, particularly from July to November (Love 1996:312), and their presence could also indicate a seasonal use of the site during the Late Period and not necessarily a more intensive use of watercraft for capturing pelagic fish.

DISCUSSION

In many ways, analyses of the fish remains from SCRI-195 support previous conclusions drawn from studies of other Middle and Late Period sites on the Northern Channel Islands (Arnold 1992, 2001; Braje 2010; Colten 1994, 2001; Glassow 1993; Kennett 2005; Pletka, 1996, 2001; Rick 2004, 2007, 2011). A definitive change in fishing strategy from the earlier Middle Period to the Late Period is apparent in the SCRI-195 data. Within the Middle Period, there is a low diversity of species during the Warm Period (2,000–1,500 B.P.) and a reliance on hook and line or spear fishing is apparent. The Cool Period (1,500–1,000 B.P.) presents an increase in species diversity. This coincides with technological advancements in the design of fishhooks that may have facilitated the capture of a wider array of targeted species. During the Terminal Middle Period (1,100–700 cal B.P.), which is inclusive of the Productive Period (1,000–350 cal B.P.), there is an increase in the diversity of species and a significant increase in the number of small fish species in the assemblage. This greater taxonomic richness and expanding diet breadth suggests nets, and possibly boats, were used with increasing frequency to procure fish during the terminal Middle Period. During the Late Period, pelagic fish are found in the assemblage with more consistency, but there is a decrease in the diversity of fish species acquired. As will be discussed below, this trend may be indicative of a seasonal use of the site or the consolidation of this settlement with a nearby village.

Middle Period (1,800–1,100 cal B.P.)

SSTs likely influenced trends in taxa diversity and abundance throughout the Middle Period. The density of fish remains at SCRI-195 is particularly low between 1,800 and 1,500 cal B.P., suggesting that fishing occurred in conjunction with other subsistence pursuits. This finding is consistent with subsistence reconstructions from various sites on the Northern Channel Islands that show a diet focused on shellfish and locally available finfish during the Early Period and the early part of the Middle Period (Glassow 1993; Kennett 2005; Rick et al. 2001). This time frame encompasses the Warm Period, when the SST was higher, resulting in lowered marine productivity (Glassow et al. 2008:37; Kennett 2005:66, fig. 11B). Site inhabitants may have exploited the reliably productive rocky nearshore habitat to collect shellfish and catch fish using spear or hook and line. Surfperch and rockfish were particularly dominant in the SCRI-195 assemblage during this time period, while the sandy-bottom dwelling Triakidae and Squalidae were present in lower densities.

After 1,500 cal B.P., SSTs lowered and marine productivity increased (Glassow et al. 2008:37; Kennett 2005:66, fig. 11B). The inhabitants of SCRI-195 continued their reliance on the rocky shore and kelp bed habitats, but also began increasing their use of sandy bottom habitats. Species common to sandy bottom habitats are consistently present in the strata dating between 1,500 and 1,000 cal B.P. The overall density of fish remains also increases over this time period as islanders began to exploit fish resources more intensively. Surfperch, rockfish, Triakidae, Squalidae, and to a lesser extent sheephead, cabezon, and Clupeidae were dominant throughout this time period. This trend towards increased diet breadth and a reliance on fish meat in the diet during the Middle Period is apparent at sites across the Northern Channel Islands, and it coincides with the significant environmental change and cultural stress apparent on these islands during the late Middle Period (*inter alia* Braje 2010; Colten 2001; Colten and Arnold 1998; Erlandson et al. 2007, 2009; Glassow 1993; Kennett 1998, 2005; Kennett and Conlee 2002; Pletka 2001; Rick 2004, 2007, 2011; Rick et al. 2005).

Evidence for technological change during this time period may be inferred from the greater taxonomic diversity identified in the assemblage. The smaller Cluepidae fish that appear with increasing frequency may indicate net fishing; however, the predominant technologies appear to still be hook and line or spear. Although surfperch and rockfish can be caught with nets (Fitch 1972:115), sheephead and cabezon tend to occur in the rocky nearshore habitat, where net use is difficult (Bowser 1993:112). Site occupants most likely practiced opportunistic fishing from shore and possibly from boats, though evidence for boat use remains weak at this point.

Terminal Middle Period (1,100–700 cal B.P.)

While the terminal Middle Period encompasses the Middle-Late Transitional Period recognized in other research (Arnold 1992; Colten 2001; Munns and Arnold 2002; Pletka 1996, 2001), the data from SCRI-195 presents no good evidence for this transition. The one stratum that may relate to the Middle-Late Transitional Period, 20–40 cm., is too narrow a stratum to confidently be assigned to this period. The fish remains in this stratum relate well to those immediately below it, which further justifies considering this stratum part of the terminal Middle Period.

The increasing density of fish remains and the frequency with which small fish appear in the assemblage indicate a shift in fishing practices beginning at ~1,100 cal B.P. The diversity of fish taxa present in the SCRI-195 assemblage increased from an average of five different taxa per stratum during the Middle Period to an average of 12 different taxa per stratum. This increase may be related to a change in predation technology to one more suitable for large captures of fish and/or to a more intensive exploitation of the marine environment. Señorita appears as the most dominant fish in all strata dating to the terminal Middle Period. Due to the small size of this fish and the significant increase in the diversity and density of fish remains, nets seem to emerge as an important technological item used for the procurement of fish resources during the terminal Middle Period. The possible focus on net use during this time has been identified at sites across the Northern Channel Islands. The assemblage at SMI-232 on San Miguel Island shows a possible reliance on net use, as señorita is also the dominant taxon in the assemblage during this time period (Braje 2010:122). Rick (2011:138–139) has noted that Labrids and other small fish are fairly abundant in other late Middle Period samples on San Miguel Island, suggesting an increased use of nets. Other sites near SCRI-195 have also shown a slight increase in net use during this time period, particularly for midwater fish (Pletka 1996:77), though the trend is more pronounced at SCRI-195.

The fish present in the strata at SCRI-195 dated to the terminal Middle Period are from a variety of habitats, but the dominance of señorita, coupled with the presences of the pelagic pacific mackerel and pacific bonito (*Sarda chiliensis*), suggests that boats may have been an increasingly important part of the exploitive technology. Señorita are common in rocky inshore habitats, but they also tend to school in larger numbers in outer kelp beds and around rocks in open water (Bowser 1993:112; Eschmeyer et al. 1983:237). As previously mentioned, net fishing in rocky nearshore waters can be difficult due to the surf and surge (Bowser 1996), but net fishing from a boat past the inshore surf would be ideal for catching groups of schooling fish. The use of boats as part of the subsistence strategy would also provide a means of transporting large quantities of fish back to the shore, possibly explaining the increase in fish density seen in the terminal Middle Period strata. While boats may have facilitated the transport of large fish captures in an economy more reliant on fish meat, the increase in fish density identified in the assemblage may also be due to a population increase at the site or shifting site use.

It is important to consider the fact that there is not a *marked* increase or diversification in the pelagic fish species present in the terminal Middle Period strata. Although a few pelagic fish taxa are more consistently present, they do not represent a significant percentage of the density of fish remains and do not appear to be integral to the economy at this time. The lack of indirect evidence, such as a marked increase in pelagic fish species, suggests that frequent use of the plank canoe for subsistence pursuits is not immediately apparent at SCRI-195 by the end of the Middle Period. Consistent use of the plank canoe has been identified in some locales as early as 1,300 B.P. (Gamble 2002; King 1990), but data from SCRI-195 suggest that watercraft were likely not intensively used until later in time at the site.

Considering the effect of environmental changes on the taxonomic diversity identified at the site, there were almost three times as many fish species that can be classified as either warm-water species or southern species during the Late Period than were identified during the terminal Middle Period at SCRI-195. The lower incidence of warm-water species is likely due to a drop in SSTs occurring from 1,500 to 500 B.P. (Kennett 2005:Fig. 11). The SST was at its coldest point in over 10,000 years during this interval, making the habitats around portions of the Northern Channel Islands unsuitable for some species of warm-water fish. Pletka's (2001:237) research concerning contemporaneous west end sites also noted a "relatively low proportion of warm-water and southern species" during the terminal Middle Period; however, he attributed his findings to "suppressed upwelling and low overall marine productivity." He argued that this would have brought "fewer than expected migratory, warm-water species into the region." This conclusion conflicts with Kennett's (2005) finding that marine productivity was at a high point from 1,000 to 500 B.P., a time period inclusive of both the terminal Middle and Middle-Late Transitional periods. This increase in marine productivity likely provided a favorable environment for increased fish captures, which is reflected in the higher density of fish remains at SCRI-195 and at other sites across the Northern Channel Islands.

Late Period (700–400 cal B.P.)

Although the terminal Middle Period was characterized by an increase in fishing and contribution of fish meat to the diet, the Late Period at SCRI-195 was characterized by a significant and steady decrease in fishing until the abandonment of the site around 400 cal B.P. The density of fish remains as well as the overall diversity of taxa decreases. Most notably, there is a complete absence of señorita in the top two Late Period strata of CS-2. This is a significant change from the terminal Middle Period, in which señorita dominates all strata. The taxa that are present indicate that fishing strategies did not include a heavy reliance on nets, but instead returned to the use of hook and line or casual net use. This finding is consistent with other sites around the Northern Channel Islands (such as SMI-468 [Rick 2007]), which show a dominance of rockfish and surf perch during the Late Period (Braje 2010; Colten 2001).

There is evidence that the decrease in fish density at SCRI-195 was due to a more seasonal use of the site. California barracuda (*Sphyraena argentea*) is at its highest density in the Late Period stratum of CS-1. This fish is common from Point Conception to northern Baja California, but it occupies the northern part of its range during the summer and then moves south in autumn (Eschmeyer et al. 1983:235). The relatively high density of this fish in a Late Period stratum at SCRI-195 suggests that the site was utilized primarily in the summer months. Further evidence to support a seasonal use of the site is the increase in warm-water species present in Late Period strata. Over one-third of the fish identified in these strata are considered either warm-water or southern species, again suggesting use during summer months when the SST was slightly elevated. It should be noted that an elevated SST interval began around 500 cal B.P. (Kennett 2005: Fig. 11); however the presence of the warm-water fish at SCRI-195 began about 200 years prior to this date.

The site was abandoned during the period of high and consistent marine productivity identified as the Productive Period. The timing of this abandonment suggests that shifts in environmental factors were likely not a driving force in the disuse of the site. The seasonal use of SCRI-195 and the eventual abandonment of the site around 400 cal B.P. may have been a result of changes in the sociopolitical organization of the island groups during the Late Period. There was a sustained increase in human population during this period, which had the potential to impact island resources and ecosystems (Rick 2004, 2011). Arnold (1992, 2001) and Arnold et al. (1997) have suggested that a reorganization of Chumash society occurred during this time, with ascribed leadership, craft specialization, and more extensive trade networks. The consolidation of settlements that has been noted for this period may have been a result of this reorganization (Arnold 1992, 2001; Arnold and Graesch 2001; Arnold and Munns 1994; Arnold et al. 2001; Kennett 1998, 2005; Munns and Arnold 2002). The population at SCRI-195 may have been combined with that at the nearby complex at Forney's Cove (SCRI-328, -329, -330), which had an occupation throughout the Late Period and into the Historic Period (Arnold 2001). SCRI-195 may have been used as a satellite site for seasonal use and the procurement of targeted resources. This type of site consolidation was common on the Northern Channel Islands, starting during the Middle-Late Transitional Period and continuing into the Late Period (Munns and Arnold 2002). While the marine habitat around SCRI-195 was productive, accessing the open ocean habitat would have been more difficult than at Forney's Cove, where there was easy access to rocky shore, kelp bed, sandy beach, and open ocean habitats. Access to a wider variety of habitats, including those with larger pelagic fish such as swordfish and tuna, may have become more important to the islanders during the Late Period (Davenport et al. 1993; Pletka 2001). After 400 cal B.P., seasonal use of SCRI-195 may have ceased in order to focus exploitation on the open-ocean habitat from Forney's Cove.

CONCLUSION

SCRI-195 is a multi-component site that spans much of the Middle Period and includes the earlier part of the Late Period. This study considered the well-preserved fish remains from two column samples collected at the site. The fish taxa in the assemblage varied through time, with the most notable change occurring in strata dated to the terminal Middle Period. This change suggests a heavier reliance on net fishing accompanying a general increase in emphasis on fishing from the Middle Period through the terminal Middle Period. This corresponds to a productive period within the marine habitat. The evidence for an increase in fishing during this time period is consistent with numerous other studies of sites from around the Northern Channel Islands. During the Late Period, SCRI-195 appears to have been used seasonally, possibly as a special-use site associated with the nearby village at Forney's Cove. The site was eventually abandoned around 400 cal B.P.

The data from SCRI-195 show that environmental variation, technological developments, and changes in sociopolitical organization all uniquely contributed to various changes identified at the site. The increase in the diversity of fish within the assemblage from the Middle to the Terminal Middle Period corresponds to an identified increase in the productivity of the marine environment. Likewise, the increase in smaller species, particularly señorita during this same time period, is indicative of more intensive net fishing starting around 1,000 cal B.P. Conversely, the change in intensity of site use that occurred at the start of the Late Period may be related to both a more intensive use of the plank canoe and to economic shifts in fishing. The less frequent use of the site and its eventual abandonment occurred during a period of stable and high marine productivity, indicating that sociopolitical factors may have been a larger contributor to site use decisions.

The patterns of distribution and the trends apparent in the identified fish remains from this study are an important contribution to the larger goal of understanding developments in economic and sociopolitical organization on the Northern Channel Islands. The conclusions derived from the data emphasize the importance of identifying multiple possibilities for behavioral change, particularly when considering temporal changes over a broad time span. While this research focused solely on the analysis of fish remains, future research will incorporate additional faunal and artifactual data into analyses in order to further clarify economic and sociopolitical changes on Santa Cruz Island.

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