REVIEW OF HABITAT INFORMATION ON WHITE CROAKER (*GENYONEMUS LINEATUS*) AND NEARSHORE SOFT-AND HARD-BOTTOM FISH ASSEMBLAGES OF SOUTHERN CALIFORNIA

M. James Allen
Southern California Coastal Water Research Project
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INTRODUCTION

White croaker (*Genyonemus lineatus*) is an important sport fish that is frequently caught and consumed by pier and private boat anglers in southern California (Puffer *et al*. 1981, 1982; M. J. Allen *et al*. 1996). Although it is frequently caught and consumed, white croaker has high levels of contaminants (e.g., DDT and PCBs) in the vicinity of the Palos Verdes Shelf and Los Angeles Harbor (Pollock *et al*. 1991, SCCWRP *et al*. 1992, M. J. Allen and Cross 1994). As a result, health risk advisories are posted on piers in this area (Pollock *et al*. 1991, M. J. Allen *et al*. 1996). Most piers in southern California are surrounded by soft (sediment) bottoms, which are the primary habitat of white croaker (M. J. Allen 1982, L. G. Allen 1985). Hard-bottom species (e.g., surfperches, Embiotocidae; basses , Serranidae) caught by anglers in the area tend to have lower contaminant levels (Pollock *et al*. 1991, SCCWRP *et al*. 1992, M. J. Allen and Cross 1994). If soft bottoms surrounding piers were covered by rock, anglers may encounter less contaminated fishes, thus reducing their health risks from fish consumption.

This study provides background information for addressing the following question: Would placing new hard-bottom habitat (including artificial reefs) over existing soft bottom around piers and other fishing areas reduce the catch of white croaker while increasing or not affecting the catches of pelagic fish and hard-bottom fish. It attempts to provide an evaluation of the habitat preferences of white croaker and a description of species with which it is associated. The study also provides information on habitat and community studies where white croaker was not found. This information will aid in determining what species would be lost and gained by changing soft-bottom habitat to hard bottom, and thus how anglers' catch would change.

The following is a brief summary of literature on white croaker habitat and its associated species, as well as on fish species composition of pier fisheries and shallow hard-bottom assemblages. Appendix I is an annotated bibliography with information obtained from the literature cited. At present, about 70 journal publications, books, dissertations or theses, gray literature reports, and monitoring reports have been examined in detail. Most were obvious sources of information on white croaker, and of soft- and hard-bottom surveys and assemblages. Many of the white croaker studies were focused on aspects of its biology that did not involve habitat or provided only general information. Most monitoring

reports involve trawl monitoring, and do not yield a lot of new information regarding white croaker on hard-bottom habitat.

WHITE CROAKER HABITAT OBSERVATIONS

WHITE CROAKER OVER SOFT BOTTOM

Multimethod Studies.

L. G. Allen (1985) described assemblages of fishes in southern California from different habitat studies. Of 105 species in 38 ichthyofauna studies conducted by different methods over a variety of habitats in southern California, white croaker was in Species Group IX [soft substrate habitat] -- white croaker, queenfish (*Seriphus politus*), shiner perch (*Cymatogaster aggregata*), northern anchovy (*Engraulis mordax*), walleye surfperch (*Hyperprosopon argenteum*), topsmelt (*Atherinops affinis*). Most of these species are neritic water-column species, with white croaker being more demersally oriented than other members of group. The species in this group were numerically dominant in all soft substrate habitats and were conspicuously less abundant in kelp bed and deep rock reef habitats. The group was found in offshore soft-bottom, nearshore midwater, harbor/nearshore soft bottom, open coast sandy beach, bay/estuary, and shallow rock reef habitats. [Note that while the species groups are predominantly associated with specific habitats, this does not mean that all members of a species group will occur on all habitats. The author does not indicate the number of species in a group that was found on a habitat before considering the group as being present. Typically one or more species are used, rather than all the species. Hence it is not known if white croaker itself was found on hard substrate habitats -- MJA].

In a study investigating diel differences in catches in Los Angeles Harbor (L. G. Allen *et al*. 1983), white croaker was collected during day and night by bag seine, otter trawl, and gill net at Cabrillo Beach at depths of 0-6 m (sand surrounded by jetties and other structures) in 1979-1980. It was 12th in abundance in seine catches and first in abundance in otter trawl and gill net catches. White croaker was more abundant at night.

M. D. Moore and Mearns (1980) captured white croaker by hook-and-line (at 60 m) and observed it in photographs (mentioned in table) in Santa Monica Bay in 1978-1979.

S. L. Moore (1998) summarized information from a variety of sources to characterize the overall habitat of the species. White croaker lives on soft-bottom habitat ranging from the surfzone to 183 m, but are most abundant in semiprotected nearshore areas of soft, sandy-mud substrata at depths of 3-30 m, with anomalous deepwater concentrations to 100 m.

Beach Seine Studies.

In 451 beach seines collected between El Capitan (near Santa Barbara) and San Diego from 1953 to 1956, white croaker was the 8th most abundant species (following northern anchovy; queenfish; barred surfperch, *Amphistichus argenteus*; walleye surfperch; shiner perch; topsmelt; and Pacific staghorn sculpin, *Leptocottus armatus*) (Carlisle *et al*. 1960)

Lampara Net Studies.

White croaker was collected during day and night by lampara net over sand or sand/cobble bottom at depths of 5-27 m off San Onofre in 1979-1981. Of 62 taxa (mostly fishes), white croaker was third in abundance behind northern anchovy and queenfish (L. G. Allen and DeMartini 1983). In a cluster analysis of species of 21 species with a minimum occurrence of 20, white croaker occurred in Species Group I, which consisted of the five most abundant species (northern anchovy; queenfish; white croaker; Pacific pompano, *Peprilus simillimus*; and silversides, Atherinidae spp.). White croaker was most closely associated with queenfish. This group schooled in shallow water (5-11 m) during the day and dispersed offshore at night to feed on nocturnally active prey. Catches of white croaker were higher at night and at shallow depths..

Otter Trawl Studies.

Based on 342 otter trawl samples at 10-200 m off central southern California and Santa Catalina Island in 1972-1973, white croaker occurred in 21% of samples (ranking 22.5) and ranked 12th in abundance (M. J. Allen 1982). It formed a recurrent group (nearshore schoolers) with shiner perch, which was found predominantly on the Palos Verdes Shelf, San Pedro Bay, and Newport-Dana Point Shelf but did not occur in Santa Monica Bay or at Santa Catalina Island. It was found from 10 to 130 m but not at 90 m. The shelf break, which often has low-relief rocky bottom, was at 90 m in this study. White croaker is described as a temperate species that lives on soft bottoms on the inner shelf (10-30 m). It lives in schools on soft bottoms, forming inactive schools during the day and foraging at night. It feeds largely on benthic prey consisting of tube-dwelling polychaetes, gammaridean amphipods, and crabs. It has been observed in videotapes at depth, cruising slightly above the bottom with the chin and mouth close to the bottom, probably foraging. Whitish coloration typical of the species is typical of species that occur in midwater over sandy bottoms.

Based on 303 otter trawl samples from 1969 to 1972 in southern California, white croaker occurred in a recurrent group with queenfish and white seaperch (*Phanerodon furcatus*) (SCCWRP 1973). In a larger data set of 448 samples, it occurred with queenfish (Mearns et al. 1973, Mearns 1974).

In 1994, white croaker occurred in only 4.3% of the area sampled in a trawl survey of the mainland shelf of southern California at depths of 10 to 200 m (M. J. Allen et al. 1998). However, it ranked 11th in abundance, comprising 2.7% of the fish captured. It did not occur in a recurrent group (M. J. Allen and S. L. Moore 1997, M. J. Allen et al. 1998). It occurred in two site clusters -- inner shelf (9-24 m) and muddy inner/middle shelf (13-86

m) but did not occur in the sandy middle shelf (18-97 m) site cluster; it was most abundant in the muddy inner/middle shelf site cluster (M. J. Allen et al. 1998, 1999). It was a member of a White Croaker-California Scorpionfish (*Scorpaena guttata*) species cluster, and formed an apparently artificial subcluster with gulf sanddab (*Citharichthys fragilis*; typically a deeper species), calico rockfish (*Sebastes dallii*), and specklefin midshipman (*Porichthys myriaster*).

Hook-and-line Studies.

In 1975, a hook-and-line survey (using set-line and rod-and-reel) of soft-bottom fishes at trawl stations in Santa Monica Bay collected 24 species of fish at depths of 18 to 182 m (M. J. Allen *et al*. 1975). White croaker were the third most abundant fish (following spiny dogfish, *Squalus acanthias*, and sablefish, *Anoplopoma fimbria*) caught by set-line and second most abundant fish caught by rod-and-reel (following bocaccio, *Sebastes paucispinis*). Only wide-ranging benthic feeders were caught by set lines (which were laid across the bottom); rockfishes were conspicuously absent. White croaker formed a recurrent group with spiny dogfish. This group occurred widely on the inner and middle shelf zones. White croaker occurred at 18 to 91 m but was most abundant at 18 m.

WHITE CROAKER ABSENT OVER ROCKY BOTTOM

Multimethod Studies.

In a review of literature of fishes found around oil platforms, artificial reefs, oil islands, and wastewater discharge pipes in southern California and artificial reefs at Monterey, CA (MBC 1987a), white croaker was mentioned as occurring near oil platforms, southern California artificial reefs, and oil islands but not wastewater discharge pipes and Monterey artificial reefs. It was not among the fishes occurring in 80% or more of the dive surveys of oil platforms, artificial reefs, and oil islands off California (from Carlisle *et al*. 1964) nor among fishes occurring in 50% or more of the dive surveys at Platforms *Hilda* and *Hazel*. It was considered to be one of the major species on soft bottoms at depths less than 40 m. In a study of the fish fauna on the soft-bottom, artificial reefs, and armored shore of Island Chaffee in Long Beach Harbor, white croaker was abundant in gill nets set on soft-bottom between reefs at night, but were never seen by divers on the reefs during the day (MBC 1987b).

Wall-net Study

In 1958, a wall net was set up around (1.3 acre) a kelp bed at a depth of 11 m at Del Mar and fish were collected within the area by dynamite and fish poison (Quast 1968b). About 0.35 lb/acre of white croaker (regarded as a sandy demersal species) was taken (ranking 16th among 24 species). It was otherwise not among the fishes captured at kelp beds sampled off San Diego.

Diver Observation Studies

White croaker were not observed in a study of marine organisms around the Hyperion outfall pipes in Santa Monica Bay (10-61 m) based on photographs taken by divers using SCUBA or in a submersible in 1974. Divers observed 31 species of fish along the pipes, ballast, and adjacent soft bottom in this study (M. J. Allen *et al*. 1976). However, white croaker do occur in the waste fields of some wastewater discharge pipes (SCCWRP 1973, Ware 1979, M. J. Allen 1982, Stull and Tang 1996).

Of 22 species observed in a SCUBA study of cryptic fishes on cobble and bedrock at Big Fisherman's Cove, Santa Catalina Island, in 1984-1985, none were white croaker (or any other croaker), although nektonic labrids, pomacentrids, kyphosids, and embiotocids were observed (L. G. Allen *et al*. 1992). [White croaker may not occur naturally at Santa Catalina Island -- MJA].

White croaker was not among the 54 species of fish considered typical, occasional, or rare in California kelp beds, based on 10 years of diving observations by the late C. Limbaugh and additional years by the late C. Turner (both of whom were regarded as the foremost diving biologists on the west coast during their careers; the former was the first to use SCUBA on the west coast) (Feder et al. 1974). White croaker was not among the 125 species of fishes observed near kelp beds from 1948 to 1954 by Limbaugh (1955).

R. R. Ware (Coastal Resources Management, pers. com., Aug 11, 1999), who conducted a feeding study of white croaker in Los Angeles Harbor (Ware 1979), has never observed white croaker over rocky bottoms while diving but has seen them occasionally over soft-bottom (but never near the bottom).

White croaker were not among at least 41 species of fish (there were possibly more than one species of atherinid, and possibly more than one species of *Gibbonsia* and *Rathbunella*) from 10 artificial reefs and 16 natural reefs at depths <25 m censused by water-column and benthic dive transects from Ventura to San Diego, CA in fall of 1986 (Ambrose and Swarbrick 1989).

WHITE CROAKER NEAR A HARD STRUCTURE OR HARD BOTTOM

Diver Observation Studies.

In 1965 *Sealab II* was placed at a depth of 61 m on featureless silty-sand bottom at the edge of Scripps Submarine Canyon at La Jolla for divers to observe marine life at that depth (Clarke et al. 1967). Divers observed that white croaker were attracted to lights near the viewing port on day 1 and were attracted there every night until day 24, when California sea lions (*Zalophus californianus*) began feeding there. It is a schooling species commonly found over sand bottoms in shallow water. Few were seen during the day, but at night, individuals milled around the lights and at times pressed so thickly against the viewing ports that they blocked the view completely. They fed nonselectively on zooplankton attracted to the lights, inhaling them. Vermilion rockfish (*Sebastes miniatus*) and California scorpionfish preyed on them and some had wounds or scars. However, the

white croaker were not perturbed by them. They were alarmed by a sudden appearance of a school of jack mackerel (*Trachurus symmetricus*) but would join them and move off only for a short distance. After sea lions appeared on day 24, the croakers were seen only in tight columnar schools. After four nights of attacks on them by sea lions, croaker abundance was 1% of that before. Sea lions ate them, but probably not so many to cause the reduction; white croaker probably moved away.

White croaker was one of 51 species of fish observed near oil platforms *Hilda* and *Hazel* during April to September 1975 by divers using SCUBA (Mearns and M. D. Moore 1976). White croaker were observed at depths of 12-24 m (mentioned Fig. 9 in Mearns and M. D. Moore 1976 but not in the text).

Of 78 fish species observed at three artificial reefs in Santa Monica Bay from August 1960 to January 1965, white croaker was the only species not observed 480 man-hours of diving in 200 dives (Turner *et al*. 1969). Although not observed in the water by divers, fishermen were catching them at WBC reef #2 (streetcar reef) in Santa Monica Bay during the dive surveys. The authors thought that they were apparently quite wary, remaining just outside the divers' range of vision while diving.

White croaker were observed in one of 132 dives at two artificial reefs, three oil platforms, and one oil island off southern California (Santa Barbara Channel to Seal Beach) from May 1958 to 1960 (Carlisle *et al*. 1964). It was only observed near the Monterey Oil Platform at Seal Beach, CA.

Love *et al*. (1984) mentions anecdotally that white croaker is found in large numbers in kelp beds attached to soft-bottoms.

WHITE CROAKER PRESENT OVER ROCKY BOTTOM

Some local marine scientists have provided anecdotal information on the occurrence of white croaker over hard bottom. Mike Curtis (MBC Applied Environmental Sciences; pers. comm., 31 Aug 1999) and Dan Pondella (Occidental College, Van Tuna Research Group; pers. comm. 30 Aug. 199) have seen white croaker over rocky reef jetties and breakwater of 45^{o} angle but not over low slope reefs. Mike Curtis had only seen them at night and did not see them feeding over the rocks. Dan Pondella thought that the ones he had seen looked damaged, as if they had been discarded from a bait tank. The Occidental dive surveys (conducted during the day) reported fish if they were within 1.5 m of diver and the night surveys of MBC probably gave the divers a short field of vision. It is possible that if a diver came near them that they may move up over the jetty rock.

WHITE CROAKER CATCHES IN DIFFERENT RECREATIONAL FISHERIES

The Marine Recreational Fishery Statistics Survey of the National Marine Fisheries Service regularly surveys the recreational fish catch along the coast of the United States.

Pacific Coast surveys are divided into four regions: Washington, Oregon, Northern California, and Southern California (e.g., NMFS 1984, 1985, 1987). In southern California during 1981 to 1984, chub mackerel (*Scomber japonicus*) was the dominant species caught, followed by white croaker, Pacific bonito (*Sarda chiliensis*), and kelp bass (*Paralabrax clathratus*) (NMFS 1984, 1985). However, in 1986, white croaker was fifth following chub mackerel, kelp bass, Pacific bonito, and barred sand bass (*Paralabrax nebulifer*) (NMFS 1987). Relative to catches for different fishing modes in southern California, white croaker was second to chub mackerel for man-made structures (e.g., piers, jetties) and private boats in 1981 to 1984 and second to barred surfperch for beaches in 1981-1982 (NMFS 1984, 1985). However for party boats, white croaker followed several other species (e.g., kelp bass; bocaccio; Pacific bonito; other rockfishes (*Sebastes* spp.); California scorpionfish) besides chub mackerel. In 1986, beach and man-made structures were combined into a shore category (NMFS 1987). Barred surfperch and California corbina (*Menticirrhus undulatus*) dominated this category (species more commonly caught on beaches than at piers) followed by chub mackerel and white croaker (both pier species). More recent MRFSS survey reports (not reviewed here) provide more current information.

A study of seafood consumption among Santa Monica Bay anglers in 1991-1992 described catch and consumption rates of white croaker and other species (M. J. Allen *et al*. 1996). In this study, 1,244 anglers were interviewed in monthly survey trips (a total of 113 trips) to the different fishing mode sites from Point Dume to Cabrillo Pier. White croaker was the fourth most abundant species caught by anglers over all modes; chub mackerel, barred sand bass, and kelp bass were the most abundant species. White croaker was second in abundance behind chub mackerel on piers and jetties (comprising 18.2% of the catch), and from private boats (comprising 16.6% of the catch). However, it only comprised 0.2% of the party boat catch.

NEARSHORE HARD-BOTTOM AND PELAGIC FISH ASSEMBLAGES

L. G. Allen (1985) provides information on hard-bottom and pelagic fish assemblages found in the nearshore environment of southern California. These can be used to estimate what species would likely to be found near piers at hard-bottom sites. Of 19 assemblages described in that study, seven are comprised of species that would likely be found in such sites. These are the following:

Assemblage II [rocky habitat] -- cabezon (*Scorpaenichthys marmoratus*), opaleye (*Girella nigricans*), and spotted kelpfish (*Gibbonsia evides* (=*elegans*)). These occur in all rocky habitats but are abundant as juveniles in intertidal and shallow rock reef habitats. Intertidal, deep rock reef, shallow rock reef, kelp bed. [Cabezon and opaleye are sport fishes -- MJA].

Assemblage III [northern kelp bed/shallow rock reef] -- grass rockfish (*Sebastes rastrelliger*), kelp rockfish (*Sebastes atrovirens*), brown rockfish (*Sebastes auriculatus*), garibaldi (*Hypsypops rubicundus*), gopher rockfish (*Sebastes carnatus*), black-and-yellow

rockfish (*Sebastes chrysomelas*), and painted greenling (*Oxylebius pictus*). This is found in the north on shallow rock reefs and in kelp beds but in the south on deep rocky reefs. [Grass rockfish, kelp rockfish, brown rockfish, and gopher rockfish are sportfishes -- MJA].

Assemblage IV [southern rock reef/kelp bed] -- salema (*Xenistius californiensis*), black croaker (*Cheilotrema saturnum*), rock wrasse (*Halichoeres semicinctus*), and sargo (*Anisotremus davidsonii*). This assemblage is found at shallow rock reefs, kelp beds, and in the nearshore midwater. [Salema, black croaker, and sargo are sportfishes -- MJA].

Assemblage V [shallow rock reef /deep rock reef/kelp bed] -- California sheephead (*Semicossyphus pulcher*), halfmoon (*Medialuna californiensis*), rainbow seaperch (*Hypsurus caryi*), rubberlip seaperch (*Rhacochilus toxotes*), olive rockfish (*Sebastes serranoides*), blue rockfish (*Sebastes mystinus*), blacksmith (*Chromis punctipinnis*), senorita (*Oxyjulis californica*), kelp perch (*Brachyistius frenata*), and kelp bass. All of these except kelp perch are widespread at shallow rock reefs, deep rock reefs, and kelp bed habitats. [California sheephead, halfmoon, rainbow seaperch, rubberlip seaperch, olive rockfish, blue rockfish, and kelp bass are sportfishes; olive and blue rockfishes have not been abundant since the early 1980s -- MJA].

Assemblage VI [soft and hard substrate habitats] -- pile perch (*Rhacochilus vacca*), black perch (*Embiotoca jacksoni*), barred sand bass, white seaperch. Fishes in this assemblage are ubiquitous, particularly where there is a combination of soft and hard substrates. They are found in shallow rock bottom, nearshore midwater, harbor/nearshore soft bottom, open coast sandy bottom, bays/estuaries, deep rock bottom, shallow rock reef, kelp bed. [Pile perch, black perch, barred sand bass, and white seaperch are sportfishes -- MJA].

Assemblage VII [nearshore midwater] -- jack mackerel (*Trachurus symmetricus*) and Pacific bonito (*Sarda chiliensis*). This assemblage consists of midwater (nearshore pelagic) species reported to be loosely associated with deep rock reefs and kelp beds at particular times of year. [Jack mackerel and Pacific bonito are sport fishes -- MJA].

XI [nearshore pelagic] -- Pacific sardine (*Sardinops sagax*), chub mackerel (*Scomber japonicus*), and Pacific pompano (*Peprilus simillimus*). These nearshore pelagic fishes found only found in nearshore midwater. [Chub mackerel is a sportfish -- MJA].

Based on these assemblages, a hard-bottom habitat near a pier would likely have some or all of the following sport fish species:

1) Rocky bottom species -- kelp rockfish, brown rockfish, gopher rockfish, blue rockfish, grass rockfish, olive rockfish, cabezon, kelp bass, barred sand bass, salema, sargo, black croaker, opaleye, halfmoon, black perch, rainbow seaperch, white seaperch, rubberlip seaperch, pile perch, and California sheephead. Other species (e.g., white seabass, *Atractoscion nobilis*; lingcod, *Ophiodon elongatus*) may also occur in that habitat.

2) Pelagic species -- jack mackerel, Pacific bonito, chub mackerel. Pacific barracuda (*Sphyraena argentea*), poorly classified in this cluster analysis, would also likely to be among the pelagic species.

Three of the assemblages of L. G. Allen (1985) are characteristics of nearshore soft-bottom areas where piers are currently found:

Assemblage IX [soft substrate habitat] -- white croaker (*Genyonemus lineatus*), queenfish (*Seriphus politus*), shiner perch (*Cymatogaster aggregata*), northern anchovy (*Engraulis mordax*), walleye surfperch (*Hyperprosopon argenteum*), and topsmelt (*Atherinops affinis*). This group consists of abundant habitat generalists. The species were numerically dominant in all soft substrate habitats and were conspicuously less abundant in kelp bed and deep rock reef habitats. Found in offshore soft-bottom, nearshore midwater, harbor/nearshore soft bottom; open coast sandy beach; bay/estuary; shallow rock reef. White croaker more demersally oriented than other members of group. [White croaker, queenfish, shiner perch, and walleye surfperch are sportfishes -- MJA].

Assemblage IX [open coast sandy beaches] -- yellowfin croaker (*Umbrina roncador*), spotfin croaker (*Roncador stearnsii*), California grunion (*Leuresthes tenuis*), California corbina (*Menticirrhus undulatus*), and barred surfperch (*Amphistichus argenteus*). This assemblage is restricted largely to open coast sandy beaches, and has a sporadic or seasonal occurrence in bays/estuaries or nearshore midwater habitats. [Yellowfin croaker, spotfin croaker, California grunion, California corbina, and barred surfperch are sportfishes. However, California grunion is caught by hand or net when spawning on beach and not by hook-and-line -- MJA].

XV [harbor/nearshore soft bottom] -- kelp pipefish (*Syngnathus californiensis*), shovelnose guitarfish (*Rhinobatos productus*), specklefin midshipman (*Porichthys myriaster*), spotted turbot (*Pleuronichthys ritteri*), California halibut (*Paralichthys californicus*), and bay goby (*Lepidogobius lepidus*). This benthic assemblage is most abundant in harbor/nearshore soft bottom, less so in bays/estuaries, and also in offshore soft bottom. [Shovelnose guitarfish, California halibut are sport fishes -- MJA].

Species currently caught near soft-bottom piers that would likely be absent at hard-bottom piers are the following: shovelnose guitarfish, white croaker, California corbina, spotfin croaker, queenfish, yellowfin croaker, barred surfperch, shiner perch, walleye surfperch, and California halibut.

DISCUSSION

SUMMARY

White croaker is typically caught by otter trawl, gill nets, lampara nets, hook-and-line, and set-line. It is taken in almost all trawl surveys except those at depths greater than 100 m or in back bays (further in than near the mouth of the bay). White croaker is seldom seen by divers using SCUBA while conducting visual or video transects or assessments, and seldom seen by submersibles or remote photography. However, it was observed by divers living in Sealab II placed in La Jolla Canyon (Clarke et al. 1967).

White croaker is found on soft bottoms, particularly near shore but also at depths of 60 m. Based on the information reviewed here, there are no records of it being caught or found on hard bottoms but they can be found near vertical hard substrates (e.g., piers, Sealab II). It is absent in all rocky reef and kelp bed studies examined so far, although one (Love *et al*. 1984) mentions anecdotally that they are found in large numbers in kelp beds attached to soft-bottoms. Clarke *et al*. (1967) surmise that white croaker occurrence at Sealab II was probably due to the zooplankton attracted to the artificial lights on the platform as those observed ate large quantities of these with their mouths pressed against the glass of the port hole. Based on anecdotal information, white croaker may stray over steeply sloping hard bottom habitats.

White croaker has appeared in many studies using cluster analysis or recurrent groups, generally forming cluster or group with other neritic or pelagic species. It is never clustered with hard-bottom species. In one study, L. G. Allen (1985), white croaker was associated with other schooling, soft-bottom species found on nearshore and offshore soft-bottoms. This study provides species clusters for the various coastal habitats, and thus provides a basis for predicting what fish species would be attracted to rocky bottoms placed near piers and which species would be lost.

DATA QUALITY

The information in the studies needs vary with regard to quality. In some published studies and gray literature, complete species lists are not provided (and particularly by habitat). Habitats are characterized by the most abundant species or most common species. Hence, low abundance or occurrences of white croaker may not be mentioned. Few of the studies examined comparing soft and hard habitat. When the two were compared (e.g., MBC 1987b), different sampling methods and sampling times are typically used.

One study (L. G. Allen 1985) noted that the clusters containing white croaker sometimes occurs on shallow rocky bottom. However, the study does indicate how many species in the cluster were necessary to conclude that the species cluster was found there. In many cases, several but not all species in the cluster may be used to indicate that a species is found there. The only information of any occurrence of white croaker straying over hard bottom is based on anecdotal information from local marine scientists.

HARD-BOTTOM PIER CONSIDERATIONS

Based on the information presented above, replacing soft-bottom beneath piers with hard bottom might create an environment unsuitable for white croaker. This change may also affect the occurrence of other soft-bottom species caught from piers (e.g., California halibut, yellowfin croaker, queenfish, shiner perch). However, hard-bottom would increase the diversity of species that might be caught under a pier, with many desirable bass, surfperch, and rockfish species.

However, while putting a low-relief rocky reef around a pier may ultimately keep white croaker away, such a change in habitat may cause a new suite of problems. A cobble or boulder bottom may result in a large increase in lost gear by anglers as they hook the bottom. Rocky bottom species typically utilize the reef for refuge, and hence may be more resident than soft-bottom species which may move from place to place along the soft bottom. Although many rocky bottom fishes are desirable to anglers, those living near a pier may be fished out to lower population levels and may not live long. These problems may result in decreased fishing for any fish at a pier.

CONCLUSIONS

1. White croaker lives on soft-bottom habitat ranging from the surfzone to 183 m, but are most abundant in semiprotected nearshore areas of soft, sandy-mud substrata at depths of 3-30 m, with anomalous deepwater concentrations at a depth of 60 m on the Palos Verdes Shelf

2. White croaker may occur near hard-bottom habitats but are unlikely to occur over hard-bottom habitats, unless by accident or above steeply sloping armored shorelines.

3. Nearshore soft-bottom assemblages include the following sportfishes: shovelnose guitarfish, white croaker, California corbina, spotfin croaker, queenfish, yellowfin croaker, barred surfperch, shiner perch, walleye surfperch, and California halibut.

4. Nearshore hard-bottom assemblages include the following sportfishes: kelp rockfish, brown rockfish, gopher rockfish, blue rockfish, grass rockfish, olive rockfish, cabezon, kelp bass, barred sand bass, salema, sargo, black croaker, opaleye, halfmoon, black perch, rainbow seaperch, white seaperch, rubberlip seaperch, pile perch, and California sheephead.

5. Nearshore pelagic assemblages include the following sportfishes: jack mackerel, Pacific bonito, chub mackerel

6. Pier fish assemblages are likely to vary in species composition relative to the bottom near the pier, with the nearshore soft-bottom assemblages predominating on soft bottom and the hard-bottom assemblage on hard bottoms. The pelagic assemblage near piers is less likely to be altered by bottom habitat.

7. Species lost by adding hard-bottom around piers would be the soft-bottom species and the species gained by adding hard-bottom would be the hard-bottom species.

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APPENDIX II
Annotated Bibliography

This appendix includes annotations on some but not all papers cited in text. It also has annotations on some papers not cited in the text. Most but not all of the papers given here without annotations have not been reviewed but some were used in the text without annotating them here. This information is provided as is until a final report is submitted.

Allen, L. G. 1985. A habitat analysis of the nearshore marine fishes from southern California. Bull. So. Calif. Acad. Sci. 84(3):133-155.

Quantitative cluster analysis conducted on results of 38 ichthyofaunal studies from range of habitats in Southern California Bight (mainland shelf, Santa Barbara to San Diego; Santa Cruz and Santa Catalina Islands). Seven collecting methods were used: 1) beach seine; 2) diver census; 3) diver transect; 4) gill net; 5) lampara net; 6) otter trawl; and 7) poison (rotenone or quinaldene). Nine habitat clusters were defined: 1) bay/estuary; 2) open coast sandy beach; 3) harbor/nearshore soft bottom; 4) nearshore midwater; 5) offshore soft bottom; 6) rocky intertidal; 7) shallow rock reef; 8) deep rock reef; and 9) kelp bed. Data included 105 species. Only species occurring in at least 3 samples and a minimum summed percentage $\geq$ 5% were included. All northern anchovy (*Engraulis mordax*) were excluded because of their overwhelming abundance.

Species groups

I [rocky intertidal] -- California clingfish (*Gobiesox rhessodon*), reef finspot (*Paraclinus integripinnis*), rockpool blenny (*Hypsoblennius gilberti*), woolly sculpin (*Clinocottus analis*) -- restricted to intertidal habitat and subtidal areas. [none is a sportfish -- MJA].

II [rocky habitat] -- cabezon (*Scorpaenichthys marmoratus*), opaleye (*Girella nigricans*), spotted kelpfish (*Gibbonsia evides* (=*elegans*)) -- occurred in all rocky habitats but abundant as juveniles in intertidal and shallow rock reef habitats. Intertidal, deep rock reef, shallow rock reef, kelp bed [cabezon and opaleye are sport fishes -- MJA].

III [northern kelp bed/shallow rock reef] -- grass rockfish (*Sebastes rastrelliger*), kelp rockfish (*Sebastes atrovirens*), brown rockfish (*Sebastes auriculatus*), garibaldi (*Hypsypops rubicundus*), gopher rockfish (*Sebastes carnatus*), black-and-yellow rockfish (*Sebastes chrysomelas*), painted greenling (*Oxylebius pictus*). In north in shallow rock reef and kelp bed, in south in deep rock reef; garibaldi at Santa Cruz Island only [in this study]. [grass rockfish, kelp rockfish, brown rockfish, and gopher rockfish are sportfishes -- MJA].

IV [southern rock reef/kelp bed] -- salema (*Xenistius californiensis*), black croaker (*Cheilotrema saturnum*), rock wrasse (*Halichoeres semicinctus*), sargo (*Anisotremus davidsonii*) -- shallow rock reef, kelp bed, and nearshore midwater. [salema, black croaker, and sargo are sportfishes -- MJA].

V [shallow rock reef /deep rock reef/kelp bed] -- California sheephead (*Semicossyphus pulcher*), halfmoon (*Medialuna californiensis*), rainbow seaperch (*Hypsurus caryi*), rubberlip seaperch (*Rhacochilus toxotes*), olive rockfish (*Sebastes serranoides*), blue rockfish (*Sebastes mystinus*), blacksmith (*Chromis punctipinnis*), senorita (*Oxyjulis californica*), kelp perch (*Brachyistius frenata*), kelp bass (*Paralabrax clathratus*) -- all except kelp perch widespread in shallow rock reef, deep rock reef, and kelp bed habitat. [California sheephead, halfmoon, rainbow seaperch, rubberlip seaperch, olive rockfish, blue rockfish, and kelp bass are sportfishes; olive and blue rockfishes have not been abundant since the early 1980s -- MJA].

VI [soft and hard substrate habitats] -- pile perch (*Rhacochilus vacca*), black perch (*Embiotoca jacksoni*), barred sand bass (*Paralabrax nebulifer*), white seaperch (*Phanerodon furcatus*) -- ubiquitous, particularly where there is a combination of soft and hard substrates. Found in shallow rock bottom, nearshore midwater, harbor/nearshore soft bottom, open coast sandy bottom, bays/estuaries, deep rock bottom, shallow rock reef, kelp bed. [pile perch, black perch, barred sand bass, and white seaperch are sportfishes].

VII [nearshore midwater] -- jack mackerel (*Trachurus symmetricus*), Pacific bonito (*Sarda chiliensis*) -- midwater (nearshore pelagic), reported to be loosely associated with deep rock reef and kelp beds at particular times of year. [jack mackerel and Pacific bonito are sport fishes -- MJA].

VIII [algae/open-water] -- giant kelpfish (*Heterostichus rostratus*), dwarf perch (*Micrometrus minimus*), Pacific barracuda (*Sphyraena argentea*), jacksmelt (*Atherinopsis californiensis*) -- artificial group, first to associated with algal substrate, second with open water within habitats. Found in nearshore midwater, harbor/nearshore soft bottom, open coast sandy bottom, rocky intertidal, shallow rocky reef, and kelp bed [Pacific barracuda and jacksmelt are sportfishes -- MJA].

IX [soft substrate habitat] -- white croaker (*Genyonemus lineatus*), queenfish (*Seriphus politus*), shiner perch (*Cymatogaster aggregata*), northern anchovy (*Engraulis mordax*), walleye surfperch (*Hyperprosopon argenteum*), topsmelt (*Atherinops affinis*). Group consists of abundant habitat generalists. The species were numerically dominant in all soft substrate habitats and were conspicuously less abundant in kelp bed and deep rock reef habitats. Found in offshore soft-bottom, nearshore midwater, harbor/nearshore soft bottom; open coast sandy beach; bay/estuary; shallow rock reef. White croaker more demersally oriented than other members of group. [white croaker, queenfish, shiner perch, and walleye surfperch are sportfishes -- MJA]. [Note that while the species groups are predominantly associated with specific habitats, this does not mean that all members of a species group will occur on all habitats. The author does not indicate the number of species in a group that was found on a habitat before considering the group as being present. Typically one or more species are used, rather than all the species. Hence it is not known if white croaker itself was found on hard substrate habitats -- MJA].

X [open coast sandy beaches] -- yellowfin croaker (*Umbrina roncador*), spotfin croaker (*Roncador stearnsii*), California grunion (*Leuresthes tenuis*), California corbina (*Menticirrhus undulatus*), barred surfperch (*Amphistichus argenteus*) -- restricted largely to open coast sandy beaches, sporadic or seasonal occurrence in bays/estuaries or nearshore midwater habitats. [yellowfin croaker, spotfin croaker, California grunion, California corbina, and barred surfperch are sportfishes; however, California grunion is caught by hand or net when spawning on beach and not by hook-and-line -- MJA].

XI [nearshore pelagic] -- Pacific sardine (*Sardinops sagax*), chub mackerel (*Scomber japonicus*), Pacific pompano (*Peprilus simillimus*) -- nearshore pelagic fishes found only found in nearshore midwater. [chub mackerel is a sportfish -- MJA].

XII [bay/estuaries] -- striped mullet (*Mugil cephalus*), shadow goby (*Quietula y-cauda*), longjaw mudsucker (*Gillichthys mirabilis*), spotted sand bass (*Paralabrax maculatofasciatus*), cheekspot goby (*Ilypnus gilberti*), bay pipefish (*Syngnathus leptorhynchus*) -- indigenous to bays and estuaries. [striped mullet and spotted sand bass are sportfishes -- MJA].

XIII [bay/estuaries and harbor/nearshore soft-bottom] -- arrow goby (*Clevelandia ios*), California killifish (*Fundulus parvipinnis*), Pacific staghorn sculpin (*Leptocottus armatus*), diamond turbot (*Pleuronichthys guttulatus* (=*Hypsopsetta guttulata*)) -- bays/estuaries, sometimes in harbors. [None are sportfishes -- MJA].

XIV [bays/estuaries, open coast sandy beach, and harbor/nearshore soft bottom] -- gray smoothhound (*Mustelus californicus*), round stingray (*Urolophus halleri*), deepbody anchovy (*Anchoa compressa*), slough anchovy (*Anchoa delicatissima*) -- low abundance in shallow nearshore habitats, such as bays/estuaries, open coast sandy beach, and harbor/nearshore soft bottom. [none are sportfishes although gray smoothhound and round stingray may occasionally be caught -- MJA].

XV [harbor/nearshore soft bottom] -- kelp pipefish (*Syngnathus californiensis*), shovelnose guitarfish (*Rhinobatos productus*), specklefin midshipman (*Porichthys myriaster*), spotted turbot (*Pleuronichthys ritteri*), California halibut (*Paralichthys californicus*), bay goby (*Lepidogobius lepidus*) -- benthic, most abundant in harbor/nearshore soft bottom, less in bays/estuaries, also offshore soft bottom. [shovelnose guitarfish, California halibut are sport fishes -- MJA].

XVI [sand/rock] -- blackeye goby (*Coryphopterus nicholsii*), California scorpionfish (*Scorpaena guttata*), bocaccio (*Sebastes paucispinis*), C-O sole (*Pleuronichthys coenosus*) -- sand-rock interface, deep rock reef, kelp beds, offshore soft bottom, harbors/nearshore soft bottom. [California scorpionfish and bocaccio are sportfishes -- MJA].

XVII [abundant offshore soft-bottom/harbor and nearshore soft bottom] -- basketweave cusk-eel (*Ophidion scrippsae*), spotted cusk-eel (*Chilara taylori*), California tonguefish

(*Symphurus atricauda*), Pacific sanddab (*Citharichthys sordidus*), speckled sanddab (*Citharichthys stigmaeus*), calico rockfish (*Sebastes dallii*), pink seaperch (*Zalembius rosaceus*), Dover sole (*Microstomus pacificus*), yellowchin sculpin (*Icelinus quadriseriatus*), plainfin midshipman (*Porichthys notatus*) -- numerically dominant soft-bottom fishes in harbors and nearshore soft bottoms and offshore soft bottoms (cusk-eels abundant only at night). [none are sportfishes -- MJA].

XVIII [uncommon offshore soft-bottom/harbor and nearshore soft bottom] -- Pacific hake (*Merluccius productus*), vermilion rockfish (*Sebastes miniatus*), curlfin sole (*Pleuronichthys decurrens*), fantail sole (*Xystreurys liolepis*), California lizardfish (*Synodus lucioceps*) -- uncommon to rare offshore soft-bottom and harbor/nearshore soft-bottom fishes. [vermilion rockfish and California lizardfish are sportfishes; California lizardfish are abundant now -- MJA].

XIX [offshore soft-bottom] -- longfin sanddab (*Citharichthys xanthostigma*), hornyhead turbot (*Pleuronichthys verticalis*), English sole (*Pleuronectes vetulus*), stripetail rockfish (*Sebastes saxicola*), slender sole (*Eopsetta exilis*), blackbelly eelpout (*Lycodopsis pacifica*), roughback sculpin (*Chitonotus pugetensis*), longspine combfish (*Zaniolepis latipinnis*), bigmouth sole (*Hippoglossina stomata*), shortspine combfish (*Zaniolepis frenata*), pygmy poacher (*Odontopyxis trispinosa*), rex sole (*Errex zachirus*), splitnose rockfish (*Sebastes diploproa*), blacktip poacher (*Xeneretmus latifrons*), halfbanded rockfish (*Sebastes semicinctus*) -- offshore soft bottom. [none are sportfishes -- MJA].

Note that while the species groups are predominantly associated with specific habitats, this does not mean that all members of a species group will occur on all habitats. The author does not indicate the number of species in a group that was found on a habitat before considering the group as being present. Typically one or more species are used, rather than all the species -- MJA]

[This study provides species clusters for the various coastal habitats, and thus provides a basis for predicting what fish species would be attracted to rocky bottoms placed near piers -- MJA].

Allen, L. G., L. S. Bouvier, and R. E. Jensen. 1992. Abundance, diversity, and seasonality of cryptic fishes and their contribution to a temperate reef fish assemblage off Santa Catalina Island, California. Bull. So. Calif. Acad. Sci. 91(2):55-69.

Of 22 species observed in a SCUBA study of cryptic fishes on cobble and bedrock at Big Fisherman's Cove, Santa Catalina Island, in 1984-1985, none were white croaker (or any other croaker), although nektonic labrids, pomacentrids, kyphosids, and embiotocids were observed. [I do not know of any record of white croaker from Santa Catalina Island -- MJA].

Allen, L. G., and E. E. DeMartini. 1983. Temporal and spatial patterns of nearshore distribution and abundance of the pelagic fishes off San Onofre-Oceanside, California. Fish. Bull. 81(3):569-586.

White croaker were collected during day and night by lampara net over sand or sand/cobble bottom at depths of 5-27 m off San Onofre in 1979-1981. Of 62 taxa (mostly species) of fish, white croaker was third in abundance behind northern anchovy and queenfish. In a cluster analysis of species with a minimum occurrence of 20 (20 species and one family [Atherinidae]), white croaker occurred in Species Group I, which consisted of the five most abundant species (northern anchovy, queenfish, white croaker, Pacific pompano, and silversides (Atherinidae spp.). White croaker was most closely associated with queenfish. This group schooled in shallow water (5-11 m) during the day and dispersed offshore at night to feed on nocturnally active prey. Catches of white croaker were higher at night and at shallow depths.

Allen, L. G., M. H. Horn, F. A. Edmands II, and C. A. Usui. 1983. Structure and seasonal dynamics of the fish assemblage in the Cabrillo Beach area of Los Angeles Harbor, California. Bull. So. Calif. Acad. Sci. 82(2):47-70.

White croaker were collected during day and night by bag seine, otter trawl, and gill net at Cabrillo Beach at depths of 0-6 m (sand surrounded by jetties and other structures) in 1979-1980. White croaker was 12th in abundance in seine catches and first in abundance in otter trawls and gill nets. White croaker was more abundant at night.

Allen, M. J. 1982. Functional structure of soft-bottom fish communities of the southern California shelf. Ph.D. dissertation, Univ. Calif. San Diego, La Jolla, CA. 577 p.

Based on 342 otter trawl samples at 10-200 m in central southern California and Santa Catalina Island in 1972-1973, white croaker occurred in 21% of samples (ranking 22.5) and ranked 12th in abundance (Allen 1982). It formed a recurrent group (nearshore schoolers) with shiner perch, which was found predominantly on the Palos Verdes Shelf, San Pedro Bay, and Newport-Dana Point Shelf but did not occur in Santa Monica Bay or at Santa Catalina Island. It was found from 10 to 130 m but not at 90 m. [90 m was the depth of the shelf break in this study, which often has low-relief rocky bottom-- MJA]. It is a temperate species that lives on soft bottoms on the inner shelf (10-30 m). It lives in schools soft bottoms, forming inactive schools during the day and foraging at night. It feeds largely on benthic prey consisting of tube-dwelling polychaetes, gammaridean amphipods, and crabs. M. J. Allen has observed them in videotapes at depth, cruising slightly above the bottom with the chin and mouth close to the bottom, probably foraging. Whitish coloration typical of species that occur in midwater over sandy bottoms.

Allen, M. J., and J. N. Cross. 1994. Contamination of recreational seafood organisms off Southern California. Pages 100-110 i*n* J. N. Cross (ed.) Southern

California Coastal Water Research Project Annual Report 1992-1993. So. Calif. Coastal Water Res. Proj., Westminister, CA.

Allen, M. J., D. Diener, J. Mubarak, S. B. Weisberg, and S. L. Moore. 1999. Demersal fish assemblages of the mainland shelf of southern California in 1994. Pages 101-112 *in* S. B. Weisberg and D. Hallock (eds.), Southern California Coastal Water Research Project, Annual Report 1996. So. Calif. Coastal Water Res. Proj., Westminster, CA.

In a trawl survey of the mainland shelf of southern California at depths of 10 to 200 m in 1994, white croaker ranked 11th in abundance, comprising 2.7% of the fish captured. It occurred in two site clusters -- inner shelf (9-24 m) and muddy inner/middle shelf (13-86 m) but did not occur in the sandy middle shelf (18-97 m) site cluster; it was most abundant in the muddy inner/middle shelf site cluster. It was a member of a White Croaker-California Scorpionfish species cluster, and formed an apparently artificial subcluster with gulf sanddab (*Citharichthys fragilis*; typically a deeper species), calico rockfish, and specklefin midshipman (see Allen et al. 1998 below).

Allen, M. J., and K. T. Herbinson. 1991. Beam-trawl survey of bay and nearshore fishes of the soft-bottom habitat of southern California in 1989. Calif. Coop. Oceanic Fish. Inves. Rep. 32:112-127.

This study sampled larval and juveniles of most species, and adults of small species, using a 1.0 and 1.6 m wide beam trawl with 2.5 mm mesh. A total of 288 samples were collected from soft-bottom habitat at Hermosa Beach to Carlsbad, CA, including Long Beach Harbor, Anaheim Bay, and Agua Hedionda Lagoon at depths of 0.0-3.5 m in bays and 6-11 m on the coast during April to September 1989. White croaker was the fourth most abundant species overall, following topsmelt (*Atherinops affinis*), queenfish (*Seriphus politus*), and cheekspot goby (*Ilypnus gilberti*); it was ninth in frequency of occurrence, occurring in 25% of the samples. White croaker had the highest density of any species in the semiprotected coastal habitat (Hermosa Beach, Long Beach), was fourth in density on the exposed coast (San Onofre, Carlsbad), and was not in the top 10 in bays. It occurred in only 4% of the bay samples but 36% of the coast samples. White croaker accounted for 2% of the fish biomass. It was the seventh smallest species (ranging in size from 3 to 208 mm standard length, mean 14.7 mm), indicating that most individuals were larvae or small juveniles. Larval white croaker and queenfish occur near the bottom but may also occur higher in the water column than sampled by the beam trawl (0.4 m in height). [Although focusing on larvae and juveniles, this study emphasizes that even at this size, the species is common on soft bottoms. It also indicates that bays are marginal habitats, the coast less so, and the semiprotected coast of harbors and open embayments the best habitat].

Allen, M. J., J. B. Isaacs, and R. M. Voglin. 1975. Hook-and-line survey of demersal fishes in Santa Monica Bay. So. Calif. Coastal Water Res. Proj., El Segundo, CA. TM 222.

In a hook-and-line survey (using set-line and rod-and-reel) of soft-bottom fishes at trawl stations ranging in depth from 18 to 182 m in Santa Monica Bay in 1975, 24 species of fish were caught. White croaker were the third most abundant fish caught by set-line (following spiny dogfish, *Squalus acanthias*, and sablefish, *Anoplopoma fimbria*) and second most abundant fish caught by rod-and-reel (following bocaccio). Only wide-ranging benthic feeders were caught by set lines (which were laid across the bottom); rockfishes were conspicuously absent. White croaker formed a recurrent group with spiny dogfish; this group occurred widely on the inner and middle shelf zones and occurred. White croaker occurred at 18 to 91 m but was most abundant at 18 m.

Allen, M. J., and S. L. Moore. 1997. Recurrent groups of demersal fishes on the mainland shelf of southern California in 1994. Pages 122-128 *in* S. B. Weisberg, C. Francisco, and D. Hallock (eds.), Southern California Coastal Water Research Project, Annual Report 1996. So. Calif. Coastal Water Res. Proj., Westminster, CA.

In a trawl survey of the mainland shelf of southern California at depths of 10 to 200 m in 1994, did not occur in a recurrent group (see Allen et al. 1998 below).

Allen, M. J., S. L. Moore, K. C. Schiff, S. B. Weisberg, D. Diener, J. K. Stull, A. Groce, J. Mubarak, C. L. Tang, and R. Gartman. 1998. Southern California Bight Pilot Project: V. Demersal fishes and megabenthic invertebrates. So. Calif. Coastal Water Res. Proj., Westminster, CA. 324 p.

In a trawl survey of the mainland shelf of southern California at depths of 10 to 200 m in 1994, white croaker occurred in only 4.3% of the area sampled. However, it ranked 11th in abundance, comprising 2.7% of the fish captured. It did not occur in a recurrent group (see Allen and Moore 1997 above). It occurred in two site clusters -- inner shelf (9-24 m) and muddy inner/middle shelf (13-86 m) but did not occur in the sandy middle shelf (18-97 m) site cluster; it was most abundant in the muddy inner/middle shelf site cluster. It was a member of a White Croaker-California Scorpionfish species cluster, and formed an apparently artificial subcluster with gulf sanddab (*Citharichthys fragilis*; typically a deeper species), calico rockfish, and specklefin midshipman (see Allen et al. 1999 above).

Allen, M. J., H. Pecorelli, and J. Word. 1976. Marine organisms around outfall pipes in Santa Monica Bay. J. Water Pollut. Control Fed. 48(8):1881-1893.

White croaker were not observed in a study of marine organisms around the Hyperion outfall pipes in Santa Monica Bay (10-61 m) based on photographs taken by divers using SCUBA or in a submersible in 1974. Divers observed 31 species of fish along the pipes, ballast, and adjacent soft bottom in this study (Allen et al. 1976).

Allen, M. J., P. V. Velez, D. W. Diehl, S. E. McFadden, and M. Kelsh. 1996. Demographic variability in seafood consumption rates among recreational anglers of Santa Monica Bay, California in 1991-1992. Fish. Bull. 94:597-610.

This study describes seafood consumption rates of Santa Monica Bay anglers and consists of a census of anglers and their catches at piers, party boats, private boats, and beaches (and intertidal). The study also consisted of interviews of anglers to assess how much of each species they consumed. A total of 1,244 anglers were interviewed in monthly survey trips (a total of 113 trips) to the different fishing mode sites from Point Dume to Cabrillo Pier. White croaker was the fourth most abundant species caught by anglers over all modes; chub mackerel (*Scomber japonicus*), barred sand bass (*Paralabrax nebulifer*), and kelp bass (*Paralabrax clathratus*) were the most abundant species. **It was second in abundance behind chub mackerel on piers and jetties (comprising 18.2% of the catch), and from private boats (comprising 16.6% of the catch). However, it only comprised 0.2% of the party boat catch.** Overall, a median of 11 g/day (90th percentile = 32 g/day) of white croaker were consumed; this median was less than the 16 g/day for chub mackerel, barred sand bass, kelp bass, Pacific barracuda (*Sphyraena argentea*), and California halibut (*Paralichthys californicus*), and about the same as for Pacific bonito (*Sarda chiliensis*), surfperches, and jacksmelt (*Atherinopsis californiensis*). Blacks had the highest median consumption rate (13 g/day) and Asians the least (5 g/day); however, Asians had the highest 90th percentile rate (51 g/day) and whites the least (11 g/day). Characterization of white croaker consumers indicated that the species was eaten primarily by males (92%), hispanics (57%), 21-30 yr olds (26%), and by anglers refusing to give information on incomes. White croaker was caught primarily on piers (82%) (specifically Cabrillo Pier; 68%) during all seasons (51%) by anglers fishing for 0-5 years (61%). It was primarily eaten 1 time per month (4 weeks), 150 g/meal (51%), and primarily fried (79%) whole but gutted (68%).)f the anglers consuming white croaker, 50% were aware of health risk warnings, 63% of these thought the warnings were very important, but 50% of the aware anglers did not alter their consumption patterns. Most (30%) became aware of the warnings from a combination of sources (e.g., signs, TV, print, friends).

Ambrose, R. F., and S. L. Swarbrick. 1989. Comparison of fish assemblages on artificial and natural reefs off the coast of southern California. Bull. Mar. Sci. 44:718-733.

White croaker were not among at least 41 species of fish (there were possibly more than one species of atherinid, *Gibbonsia*, and *Rathbunella*) from 10 artificial reefs and 16 natural reefs at depths <25 m censused by water-column and benthic dive transects from Ventura to San Diego, CA in fall of 1986.

Species occurring in more than 50% of 10 artificial reefs in southern California were 1) kelp bass (*Paralabrax clathratus*), opaleye (*Girella nigricans*), black perch (= surfperch) (*Embiotoca jacksoni*), pile perch (= surfperch) (*Rhacochilus* (= *Damalichthys*) *vacca*), blacksmith (*Chromis punctipinnis*), rock wrasse (*Halichoeres semicinctus*) -- all 100%; halfmoon (*Medialuna californiensis*),

Common Name	Species	Percent of Reefs Artificial	Natural
Rocky Reef Fishes			
black perch	Embiotoca jacksoni	100	100
rock wrasse	Halichoeres semicinctus	100	100
kelp bass	Paralabrax clathratus	100	100
blacksmith	Chromis punctipinnis	100	75
pile perch	Rhacochilus vacca	100	69
opaleye	Girella nigricans	100	56
senorita	Oxyjulis californica	90	88
California sheephead	Semicossyphus pulcher	80	100
barred sand bass	Paralabrax nebulifer	80	88
rainbow seaperch	Hypsurus caryi	80	63
garibaldi	Hypsypops rubicundus	70	69
sargo	Anisotremus davidsonii	70	38
olive rockfish	Sebastes serranoides	70	19
painted greenling	Oxylebius pictus	60	50
rubberlip seaperch	Rhacochilus toxotes	60	25
black croaker	Cheilotrema saturnum	60	6
kelp perch	Brachyistius frenatus	50	63
white seaperch	Phanerodon furcatus	50	13
Pelagic Fishes			
jack mackerel	*Trachurus symmetricus*	20	38
silversides	Atherinidae	30	13
Pacific bonito	*Sarda chiliensis*	0	6

Bond, A. B., J. S. Stephens, Jr., D. J. Pondella II, M. J. Allen, and M. Helvey. 1999. A method for estimating marine habitat values based on fish guilds, with comparisons between sites in the Southern California Bight. Bull. Mar. Sci. 64(2):219-242.

White croaker was classed in a guild of substrate associated, nocturnal generalists. Although based on a number of studies of a variety of habitats (soft bottom, hard bottom, kelp beds, and different depth zones), methods (trawls and diver transects), sampling sites (Port Hueneme to Torrey Pines), and years, 1975 to 1996, it does not give details on what species were found in what habitats.

Carlisle, J. G., Jr. 1969. Results of a six-year trawl study in an area of heavy waste discharge: Santa Monica Bay, California. Calif. Fish Game. 55(1):26-46.

White croaker was ninth in abundance (comprising 1.9% of the catch) in 705 samples collected at depths of 18 to 182 m in Santa Monica Bay from 1958 to 1963 using 7.3-m headrope otter trawls with 1.2 cm cod-end mesh. It occurred at depths of 18 to 130 m and ranged from 28l to 305 mm in length.

Carlisle, J. G., J. W. Schott, and N. J. Abramson. 1960. The barred surfperch (*Amphistichus argenteus* Agassiz) in southern California. Calif. Dep. Fish and Game, Fish Bull. 109. 79 p.

In 451 beach seines collected between El Capitan (near Santa Barbara) and San Diego from 1953 to 1956, white croaker was the 8th most abundant species (following northern anchovy, queenfish, barred surfperch, walleye surfperch, shiner perch, topsmelt, and Pacific staghorn sculpin.

Carlisle, J. G., Jr., C. H. Turner, and E. E. Ebert. 1964. Artificial habitat in the marine environment. Calif. Dep. Fish Game, Fish Bull. 124. 93 p.

White croaker were observed in 1 out of 132 dives at two artificial reefs, three oil platforms, and one oil island off southern California (Santa Barbara Channel to Seal Beach) from May 1958 to 1960. It was only observed near the Monterey Oil Platform at Seal Beach, CA (in 1 of 3 surveys) (see Appendix A of that study).

City of Los Angeles. 1995. Marine monitoring in Santa Monica Bay: Annual assessment report for the period July 1993 through December 1994. City of Los Angeles, Dep. Publ. Works, Bur. Sanit., Environ. Monit. Div., Los Angeles, CA.

White croaker was not listed in trawl catches from 4 stations along the 60-m isobath on soft bottom near the Hyperion Treatment Plant discharge pipes in Santa Monica Bay from July 1993 to December 1994. Dominant species were yellowchin sculpin (*Icelinus quadriseriatus*), Pacific sanddab (*Citharichthys sordidus*), and speckled sanddab (*Citharichthys stigmaeus*).

City of San Diego. 1995. Ocean monitoring program, Receiving waters monitoring report 1995. City of San Diego, Metro. Wastewater Dep., Environ. Monit.& Tech. Serv. Div, San Diego, CA.

White croaker was 19th in abundance in trawl catches from 38 stations on soft bottom near the Point Loma Wastewater Treatment Plant discharge pipes off Point Loma, CA during 1995, comprising <1% of the catches. Pacific sanddab (*Citharichthys sordidus*), yellowchin sculpin (*Icelinus quadriseriatus*), and plainfin midshipman (*Porichthys notatus*) were the dominant species.

City of San Diego. 1996. Ocean monitoring program, Receiving waters monitoring report 1996. City of San Diego, Metro. Wastewater Dep., Environ. Monit.& Tech. Serv. Div, San Diego, CA.

White croaker was 29th in abundance in trawl catches from 38 stations on soft bottom near the Point Loma Wastewater Treatment Plant discharge pipes off Point Loma, CA during 1996, comprising <1% of the catches. Pacific sanddab (*Citharichthys sordidus*), yellowchin sculpin (*Icelinus quadriseriatus*), and Dover sole (*Microstomus pacificus*) were the dominant species.

City of San Diego. 1997. Ocean monitoring program, Receiving waters monitoring report 1997. City of San Diego, Metro. Wastewater Dep., Environ. Monit.& Tech. Serv. Div, San Diego, CA.

White croaker was not collected in trawl catches from 38 stations on soft bottom near the Point Loma Wastewater Treatment Plant discharge pipes of Point Loma, CA during 1997. Pacific sanddab (*Citharichthys sordidus*), yellowchin sculpin (*Icelinus quadriseriatus*), and longfin sanddab (*Citharichthys xanthostigma*) were the dominant species.

Clarke, T. A., A. O. Flechsig, and R. W. Grigg. 1967. Ecological studies during Project Sealab II. Science 157(3795):1381-1389.

In 1965 *Sealab II* was placed at a depth of 61 m on featureless silty-sand bottom at the edge of Scripps Submarine Canyon at La Jolla. Divers observed that white croaker were attracted to lights near the viewing port on day 1 and were attracted there every night until day 24, when sea lions began feeding there. It is a schooling species commonly found over sand bottoms in shallow water. Few were seen during the day, but at night, individuals milled around the lights and at times pressed so thickly against the viewing ports that they blocked the view completely. They fed nonselectively on zooplankton attracted to the lights, inhaling them. Vermilion rockfish and California scorpionfish preyed on them and some had wounds or scars. However, the white croaker were not perturbed by them. They were alarmed by a sudden appearance of a school of jack mackerel but would join them and move off only for a short distance. After sea lions appeared on day 24, the croakers were seen only in tight columnar schools. After four nights of attacks on them by sea lions, croaker abundance was 1% of that before. Sea lions ate them, but probably not so many to cause the reduction; white croaker probably moved away.

County Sanitation Districts of Los Angeles County. 1996. Annual report 1996: Palos Verdes ocean monitoring. County Sanit. Dist. Los Angeles County, Whittier, CA.

White croaker was ninth in abundance, accounting for 3.6% (9,954 individuals) of 274,917 fish collected off Palos Verdes at 12 trawl stations (four at each depth of 23, 61, and 137 m) from 1973 to 1996. It occurred in 16% of 1,020 trawl samples collected during this period. Dover sole (*Microstomus pacificus*), Pacific sanddab (*Citharichthys sordidus*), and slender sole (*Eopsetta exilis*) were the most abundant species Plainfin midshipman (*Porichthys notatus*), Pacific sanddab, and Dover sole were the most common. It was not observed at 4 dive stations (24 m depth) on rocky reefs by divers using SCUBA in Oct 1996; barred sand bass (*Paralabrax nebulifer*) occurred at all dive

stations, with painted greenling (*Oxylebius pictus*), kelp bass (*Paralabrax clathratus*), pile perch (*Rhacochilus vacca*), blacksmith (*Chromis punctipinnis*), senorita (*Oxyjulis californica*), California sheephead (*Semicossyphus pulcher*), and blackeye goby (*Coryphopterus nicholsii*) occurring at 75% of the stations.

County Sanitation Districts of Orange County. 1994. Annual report 1994: Marine monitoring. County Sanit. Dist. Orange County, Fountain Valley, CA.

White croaker was the 7th most abundant fish (3,541 fish) in 288 trawl samples collected 8 stations (2 replicates per station, two surveys per year) from 1985 to 1994 on soft bottom near the Orange County Sanitation District discharge pipes off Huntington Beach, CA. The dominant species were yellowchin sculpin (*Icelinus quadriseriatus*), Pacific sanddab (*Citharichthys sordidus*), and speckled sanddab (*Citharichthys stigmaeus*).

White croaker was the 2nd most abundant fish (1,637) (following chub mackerel, *Scomber japonicus*, 2380) collected in rig-fishing surveys from 1974 to 1994 near the discharge pipes. White croaker abundance was relatively constant during this period but chub mackerel abundance showed a steady increase when they first appeared in the catch in 1978. White croaker and spiny dogfish, *Squalus acanthias* were tied for third most common species, occurring in 85% (17 of 20) of the years; California lizardfish (*Synodus lucioceps*) was most common (95%), followed by California scorpionfish (*Scorpaena guttata*) (90%).

From 1985 to 1994, 1,086 white croaker were taken in rig-fishing surveys versus 702 in otter trawl surveys (excluding stations T0 and T4).

County Sanitation Districts of Orange County. 1995. Annual report 1995, including a ten-year synthesis: 1985-1995 -- Marine monitoring. County Sanit. Dist. Orange County, Fountain Valley, CA.

White croaker was the 2nd most abundant fish (1,807) (following chub mackerel, *Scomber japonicus*, 3278) collected in rig-fishing surveys from 1974 to 1995 near the discharge pipes. White croaker abundance was relatively constant during this period but chub mackerel abundance showed a steady increase when they first appeared in the catch in 1978. White croaker and spiny dogfish, *Squalus acanthias* were tied for third most common species, occurring in 86% (18 of 21); California lizardfish (*Synodus lucioceps*) was most common (95%), followed by California scorpionfish (*Scorpaena guttata*) (90%).

Hook-and-line fishing (with rod and reel) was more effective at getting white croaker than set-line catches [both done during the day -- MJA]. Annual catch per unit effort (CPUE; number of fish per hour) of white croaker caught by hook-and-line in rig-fishing surveys from 1985 to 1995 ranged from none to 1.71 whereas for set-line during the same period, CPUE was none to 0.034. White croaker was the most abundant species (comprising 46.4% of the catch) in the rig-fishing survey of July 1994. However, in January 1995, it was 8th in abundance and only comprised 0.3% of the catch. The summer catch was 167

fish and the winter catch was 3 fish. Chub mackerel was the most abundant species in the winter. Over a 10-year period at 55-m stations, white croaker was 21st in abundance (181 fish) in trawl catches but 2nd in abundance (1256 fish) in rig-fishing.

County Sanitation Districts of Orange County. 1996. Annual report 1996: Marine monitoring. County Sanit. Dist. Orange County, Fountain Valley, CA.

In rig-fishing surveys, white croaker was first in abundance (195 fish, 61.1% of the catch) in July 1995 and 7th in abundance (11, 1.2%) in February 1996. Chub mackerel was most abundant in February.

County Sanitation Districts of Orange County. 1997. Annual report 1997: Marine monitoring. County Sanit. Dist. Orange County, Fountain Valley, CA.

In rig-fishing surveys, white croaker was first in abundance (145 fish, 50.5% of the catch) in July 1996 and 5th in abundance (8, 1.2%) in January 1997. Chub mackerel was most abundant in February.

County Sanitation Districts of Orange County. 1998. Annual report 1998: Marine monitoring. County Sanit. Dist. Orange County, Fountain Valley, CA.

White croaker was the 2nd most abundant fish (1,625) (following chub mackerel, *Scomber japonicus*, 5,563) collected in rig-fishing surveys from 1985 to 1998 (13 years) near the discharge pipes. The trend in white croaker abundance was relatively constant during this period but chub mackerel abundance showed a steady increase. White croaker and chub mackerel were the most common species, both occurring in all years.

Hook-and-line fishing (with rod and reel) was more effective at getting white croaker than set-line catches [both done during the day -- MJA]. Annual catch per unit effort (CPUE; number of fish per hour) of white croaker caught by hook-and-line in rig-fishing surveys from 1985 to 1998 ranged from none to 1.71 whereas for set-line during the same period, CPUE was none to 0.034.

Cross, J. N., and L. G. Allen. 1993. Fishes. Pages 459-540 *in* M. D. Dailey, D. J. Reish, and J. W. Anderson (eds.), Ecology of the Southern California Bight: A synthesis and interpretation. Univ. Calif. Press, Berkeley, CA.

Literature review [including many sources in this study -- MJA]. White croaker occupies the nearshore zone (caught within 3 km of the coast). It is abundant in Los Angeles Harbor-Long Beach Harbor where it was the most abundant species caught by otter trawl and gillnet; it comprised 41% of the otter trawl catch, 25% by gillnet, 4% by purse seine, and <1% by beach seine (part of this data was from Allen et al. 1983). It was considered to be a resident fish which has high recruitment to the harbor habitat. White croaker was considered to be a member of the inner shelf [soft-bottom] community. White croaker was not considered to be a member of the following communities: bays and estuaries, rocky

reef and kelp bed, outer shelf [soft-bottom], epipelagic, mesopelagic, and bathypelagic. It was not among the species collected in Upper Newport Bay by otter trawl, gillnet, bag seine, and small seine in 1978-1979. It was also not among the most common and conspicuous fishes in the canopy and near the bottom in kelp beds. [Without complete species lists, it is not known if they occurred there at all -- MJA].

White croaker larvae were not among the top 10 species most abundant species in ichthyoplankton surveys in the California Current or Southern California Bight (SCB; as a whole). However, it ranked 5th in abundance (2%) in the SCB <100 km from the coast and 9th (3%) in Upper Newport Bay. Their larvae were most abundant within 4 km of the coast) and are most abundant near the bottom. Older larvae are concentrated in the epibenthic layer close to shore and recruitment is greatest in shallow water.

Davis, N., G. R. VanBlaricom, and P. K. Dayton. 1982. Man-made structures on marine sediments: Effects on adjacent benthic communities. Mar. Biol. 70(3):295-303.

Examines effects of artificial reefs on natural sand bottom communities. Studied San Diego-La Jolla Underwater Park Reef (Bureaucrat Reef) (50 m x 13 m x 2.5 m high built of large quarry stones at depth of 13 m) and constructed on 15-17 April, 1995. Two transects sampled regularly from 1 May 1975 to January 1977. Fish were observed in 18 dives and some were collected by spears for stomach content analysis. White croaker was not among the species observed or speared. Barred sand bass (*Paralabrax nebulifer*) was observed in all dives, spotted sand bass (*Paralabrax maculatofasciatus*) in 83%, and blacksmith (*Chromis punctipinnis*) in 78%. Recruitment of fish species to reef was as follows:

1) within 1-mo of construction (by mid-May) -- white seaperch, *Phanerodon furcatus*; black perch, *Embiotoca jacksoni*; kelp bass, *Paralabrax clathratus*; barred sand bass, and blacksmith;

2) by June, add -- rainbow seapech (*Hypsurus caryi*), sargo (*Anisotremus davidsonii*), spotted sand bass, ocean whitefish (*Caulolatilus princeps*), juvenile California sheephead (*Semicossyphus pulcher*), California scorpionfish (*Scorpaena guttata*), juvenile kelp rockfish (*Sebastes atrovirens*), gopher rockfish (*Sebastes carnatus*), and treefish (*Sebastes serriceps*);

3) by July -- juvenile blue rockfish (*Sebastes mystinus*);

4) by Aug -- halfmoon (*Medialuna californiensis*)

5) by Jan -- most species common in kelp beds except opaleye (*Girella nigricans*)

DeMartini, E. E., D. A. Roberts, and T. W. Anderson. 1989. Contrasting patterns of fish density and abundance at an artificial rock reef and a cobble-bottom kelp forest. Bull. Mar. Sci. 44(2):881-892.

Pendelton Artificial Reef (PAR; 8 modules of 14-35 m length, separated by 10-75 m of sand, 13 m depth, off Camp Pendelton, CA). San Onofre Kelp (SOK), cobble bottom kelp bed, 1-km^2, at depths of 8-18 m. Fish counts made in diver transects (3-m wide, 1.5 m high) conducted during the day. Three surveys at each module on 6 and 25 November 1986 and 20 January 1987 at PAR. At SOK, 3-8 surveys at each of 7 stations.

White croaker not mentioned among species observed. Data for the 16 most abundant species were described; complete species lists were not given. By number, blacksmith (*Chromis punctipinnis*) was the most important species at PAR whereas senorita (*Oxyjulis californica*) was most important at SOK. However, California sheephead (*Semicossyphus pulcher*) was most important by biomass at PAR; senorita was most important at SOK.

DeMartini, E. E., and L. G. Allen. 1984. Diel variation in catch parameters for fishes sampled by a 7.6-m otter trawl in southern California coastal waters, California. Calif. Coop. Oceanic Fish. Invest. Rep. 25:119-134.

Thirteen pairs of diel cruises were made over a 13-mo interval, May 1980-May 1981. The two diel cruises were 36-60 hr apart, but one was 10.5 days apart. Day (sunrise-sunset), night (sunset-sunrise). On each cruise, four tows were made at each of two depths (18 and 30 m) at two locations (San Onofre and Stuart Mesa, upcoast from Oceanside). Used 7.6-m head-rope otter trawls with 1.25-cm cod-end mesh liner. White croaker was the dominant species (of 52 species collected) in abundance during day and night at 18 m; it was third most abundant (following pink seaperch, *Zalembius rosaceus*, and Pacific sanddab, *Citharichthys sordidus*) during the day at 30 m but was the most abundant species at night at this depth. During the day, white croaker was second in biomass during the day (following California halibut, *Paralichthys californicus*) at 18 m but was dominant in biomass at 30 m. At night, white croaker was the dominant species in biomass at 18 and 30 m. During the day, white croaker formed a cluster with queenfish (*Seriphus politus*) and at night with basketweave cusk-eel (*Ophidion scrippsae*), speckled sanddab (*Citharichthys stigmaeus*), hornyhead turbot (*Pleuronichthys verticalis*), and fantail sole (*Xystreurys liolepis*). White croaker in 18 m were about the same size (1% difference) during day and night, but length frequencies differed by 10% at 30 m, with more smaller fish <14 cm being present. Adult white croaker migrate offshore from 5-10 m depths at dusk (Allen and DeMartini 1983). Possibly greater night catches are due to more white croaker being near the bottom. Suggests that a diel shift in onshore-offshore distribution of white croaker.

Dixon, R. L., and W. J. Eckmayer. 1975. A checklist of the elasmobranchs and teleosts in the outer harbor of Anaheim Bay. Pages 175-183 *in* E. D. Lane and C. W. Hill (eds.), The marine resources of Anaheim Bay. Calif. Dep. Fish Game, Fish Bull. 165.

Monthly sampling in outer Anaheim Bay from June 1972 to June 1973, 2 day and 2 night seine collections (using each of two seines, 15.2 m bag seine, and 30.4 m bar mesh seine) during a 24-hour period at 6 stations; 4.9-m otter trawls were towed along length of beach, inside and outside eelgrass beds, three times during study period. Maximum water depth was 3.6 m. Of much more than 2,883 fish of 41 species collected, white croaker ranked 14th with 29 individuals; topsmelt (*Atherinops affinis*) was by far the most abundant species (counted only as many, meaning 1000-3000 per month). White croaker was collected in night collections but not during the day; it was most abundant in the fall (October) and was not taken in spring. All were taken by seine, with sizes ranging from 8.0-22.9 cm. Gillnet collections along the south jetty during 1973 captured large numbers.

Ebeling, A. W., and R. N. Bray. 1976. Day versus night activity of reef fishes in a kelp forest off Santa Barbara, California. U.S. Natl. Mar. Fish. Serv. Fish. Bull. 74(4):703-717.

SCUBA diver survey at Naples Reef, 24 km west of Santa Barbara. Reef 275 m x 80 m (2.2 ha) and lies 1.6 km offshore. Substratum consists of sandstone rills and ridges running parallel to coast. Depths across reef average 8-10 m, but some prominences come to 5 m below surface. Bottom around reef consists of sand with rocky outcrops inshore or sand and cobbles offshore. Giant kelp (*Macrocystis*) is always present at reef, but densities fluctuated. Temperatures ranged from 11-19^{o} C.

Two 40-m transect lines along either side, shoreward and seaward, of a high-relief ridge with a crest at 6 m during 42 paired day and night scuba transects made throughout the year. For each day-night surveys of the transects, counts were made within 2 m on either side of the line. Hand lights were used to inspect holes during day and used continuously at night. Vertical distribution and feeding activities of residential kelp-bed fishes were compared between day and night off reef. Abundances and positions of fishes were within four vertically oriented zones: I) shelter -- holes, crevices, or under ledges; II) bottom -- in physical contact with bottom but exposed; III) suprabenthic -- within 1.0 m of bottom; and IV) midwater -- greater than 1.0 m above the bottom, in open water and/or near kelp stipes. Feeding habits were also observed and stomach contents examined from fish speared during all hours of day and night.

Of 25 species of fish observed; in fact, no sciaenid was observed. Blue rockfish (*Sebastes mystinus*) and blacksmith (*Chromis punctipinnis*) were the most abundant species in all seasons. The former was also the most abundant species observed during the day and the latter at night. Black perch (*Embiotoca jacksoni*) was second in abundance during day and night. Anecdotally, black croaker (*Cheilotrema saturnum*) were occasionally seen in relatively inactive schools on the reef during the day but not at night; these were not observed in this study. White croaker was not observed by divers swimming out onto the soft-bottom at night, although white seaperch (*Phanerodon furcatus*), pile perch (*Rhacochilus* (= *Damalichthys*) *vacca*), spotted cusk-eel (*Chilara taylori*), skates, and rays were observed.

Ebeling, A. W., R. J. Larson, W. S. Alevizon, and R. N. Bray. 1980. Annual variability of reef-fish assemblages in kelp forests off Santa Barbara, California. U.S. Natl. Mar. Fish. Serv. Fish. Bull. 78(2):361-377.

Assemblages of kelp-bed fishes were censused by cine transects every September from 1971 to 1974 at two rock reefs: Naples reef (24 km west of Santa Barbara) and Fry's Harbor (on north side of Santa Cruz Island).

Naples Reef was 1.6 km offshore and was 275 m x 80 m (2.2 ha) with depths across reef averaging 8-12 m, but some prominences come to 5 m below surface. Reef was surrounded by flat sand and cobble, with smaller rock outcrops. Kelp canopy proliferated in spring and summer but thinned out in fall and winter.

At Fry's Harbor, substrates were mostly rocky, with boulder areas, ledges, and caves interspersed occasionally with sand or flat-faced rock. Bottom sloped steeply to sand at depths of 15-25 m at a distance of 20-50 m from shore. Most sampling was conducted at depths of 3-15 m. Kelp canopy extended a short distance seaward over greater depths and shoreward to meet steep rock cliffs. It was next to shore whereas Naples Reef was offshore.

Cine transects using 8 mm movie films were taken by scuba divers. Divers swam at constant speeds along transects with camera spanning 10^{o} arcs, pointed forward or slightly toward bottom (in bottom transects); canopy transects were done 2-3 m below surface kelp fronds. A total of 297 and 331 cine transects were made at mainland and island study sites, respectively. Cluster analysis was done comparing proportionate abundances of species between samples.

In these surveys, 46 species were identified; white croaker was not observed in these surveys. In the kelp canopy habitat, blue rockfish (*Sebastes mystinus*) and blacksmith (*Chromis punctipinnis*) were the most abundant species on the mainland whereas kelp perch (*Brachyistius frenatus*) and blacksmith were the most abundant species at the island site. On the reef bottom, black perch (*Embiotoca jacksoni*) and kelp bass (*Paralabrax clathratus*) were the most abundant species on the mainland whereas kelp bass and garibaldi (*Hypsypops rubicunda*) were most abundant on the island. Variation in species composition was less between sites than between years. Densely aggregating midwater planktivores fluctuated most in abundance.

Feder, H. M., C. H. Turner, and C. Limbaugh. 1974. Observations on fishes associated with kelp beds in southern California. Calif. Dep. Fish Game Fish Bull. 160. 138 p.

White croaker was not among the 54 species of fish considered typical, occasional, or rare in California kelp beds, based on 10 years of diving observations by the late C. Limbaugh and additional years by the late C. Turner (both of whom were regarded as the foremost diving biologists on the west coast during their careers; the former was the first to use SCUBA on the west coast).

Frey, H. W., 1971. California's living marine resources and their utilization. Calif. Fish Game, 148 p.

Summary of biology and fishery. In southern California they are taken commercially by small round nets, and incidentally on hook-and-line set for other species. In central California they are taken by round haul, gill, and drag nets, and on hook-and-line. From 1918 to 1971, the catch was usually lower than 454 mt (1 million lb) statewide. However, in 1981, 1952, 1953, 1959, 1960, and 1965 it was over 454 mt (1 million lb), and it was 1,452 mt (3.2 million lb) in 1952.

White croaker usually swims in loose schools at or near the bottom in sandy areas. Sometimes they are abundant in the surf zone, and in shallow bays and lagoons. Most of the time they are found in offshore areas of 3-30 m or more, and are abundant at depths as great as 90 m on rare occasions. .

Gold, M. D., J. Alamillo, S. Fleischli, J. Forrest, R. Gorke, L. Heibshi, and R. Gossett. [1998]. Let the buyer beware: A determination of DDT and PCB concentrations in commercially sold white croaker. Heal the Bay, Santa Monica, CA. 18 p.

Goldberg, S. R. 1976. Seasonal spawning cycles of the sciaenid fishes *Genyonemus lineatus* and *Seriphus politus*. Fish. Bull. 74:983-984.

Gossett, R. W., H. W. Puffer, R. H. Arthur, Jr., and D. R. Young. 1983. DDT, PCB, and benzo(a)pyrene levels in white croaker (*Genyonemus lineatus*) from southern California. Mar. Pollut. Bull. 14:60-65.

Gossett, R., G. Wikholm, J. Ljubenkov, and D. Steinman. 1989. Human serum DDT levels related to consumption of fish from the coastal waters of Los Angeles. Environ. Toxicol. and Chem. 8:951-955.

Gotshall, D. W. 1987. The use of baited stations by divers to obtain fish relative abundance data. Calif. Fish Game. 73:214-229.

Hart, J. L. 1973. Pacific fishes of Canada. Fish. Res. Board Canada, Bull. 180. 740 p.

Helvey, M., and R. W. Smith. 1985. Influence of habitat structure on the fish assemblages associated with two cooling-water intake structures in southern California. Bull. Mar. Sci. 37(1):189-199.

Divers censused fishes at four artificial reefs and two generating station intake structures in Santa Monica Bay from April 1978 to January 1979. A total of 64 random swim censuses were conducted (8-12) at each structure. Time of day was not noted. A total of 36 fish species were observed, 19 benthic species and 17 water-column species. White croaker **was not** among the species observed in this study.

Hose, J. E., and J. N. Cross. 1994. Evaluation of evidence for reproductive impairment in white croaker by DDT and/or PCBs. Prepared for National Oceanic and Atmospheric Administration. Prepared by Occidental College, VANTUNA Research Group, Los Angeles, CA. 54 + pages (1 or more missing)

Hose, J. E., J. N. Cross, S. G. Smith, and D. Diehl. 1989. Reproductive impairment in a fish inhabiting a contaminated coastal environment off southern California. Environ. Poll. 57:139-148.

Jay, C. V. 1996. Distribution of bottom-trawl fish assemblages over the continental shelf and upper slope of the U.S. west coast, 1977-1992. Can. J. Aquat. Sci. 53:1203-1225.

Jessee, W. N., A. L. Carpenter, and J. W. Carter. 1985. Distribution patterns and density estimates of fishes on a southern California artificial reef with comparisons to natural kelp-reef habitats. Bull. Mar. Sci. 37(1):214-226.

Divers conducted visual (strip) censuses at Pendelton Artificial Reef (PAR), Las Pulgas Reef (LPR), and San Onofre Kelp (SOK) off Camp Pendelton and San Onofre, CA during 1981-1982. Censuses were conducted once per month during mid-day; a total of 29 transects were sampled. Eight fish species were monitored; **none were white croaker**.

Johnson, T. D., A. M. Barnett, E. E. DeMartini, L. L. Craft, R. F. Ambrose, and L. J. Purcell. 1994. Fish production and habitat utilization on a southern California artificial reef. Bull. Mar. Sci. 55(2-3):709-723.

Jordan, D. S., and B. W. Evermann. 1896-1900. The fishes of North and Middle America. Bull. U.S. Nat. Mus. 47. 3313 p.

Karpov, K. A., D. P. Alpin, and W. H. Van Buskirk. 1995. The marine recreational fishery in northern and central California: A historical comparison (1958-86), status of stocks (1980-86), and effects of changes in the California Current. Calif. Dep. Fish Game, Fish Bull. 176. 192 p.

The number, weight, and average weight of white croaker caught in the recreational fishery of northern and central California was about the same in 1958-61 and 1981-1986 (e.g., mean weight, kg/fish -- 0.23 in 1958-61, 0.20 in 1981-1986). A mean of 289,000

per yr were taken in 1958-61 and 310,000 per year in 1981-86. The average annual catch (numbers) by fishing mode was 203,000 for private boats; 98,000 for piers and docks; 6,000 for beaches and banks; 2,000 for jetties and breakwaters; 1,000 for CPFVs (commercial passenger fishing vessels = party boats); and none for spearfishing. Annual fishing effort by fishing mode was the following (with 1958-61 first, then 1981-86): pier and dock (531,000; 587,000); jetty and breakwater (ND; 103,000); shore, beach, and bank (603,000; 632,000); skiff and private/rental boats (227,000; 936,000); party boat/CPFV (227,000; 406,000); skin-diving/spear (40,000; 21,000); and total (1,628,000; 2,685,000). Marine Recreational Fisheries Statistics Survey (MRFSS) data were main source of data for 1980-1986. Data for 1958-61 were from Miller and Gotshall (1965).

Klingbeil, R. A., R. D. Sandell, and A. W. Wells. 1975. An annotated checklist of the elasmobranchs and teleosts of Anaheim Bay. Pages 79-90 *in* E. D. Lane and C. W. Hill (eds.), The marine resources of Anaheim Bay. Calif. Dep. Fish Game, Fish Bull. 165.

Lane, E. D. 1975. Early collections of fishes from Anaheim Bay made between 1919 and 1928. Pages 13-15 *in* E. D. Lane and C. W. Hill (eds.), The marine resources of Anaheim Bay. Calif. Dep. Fish Game, Fish Bull. 165.

Limbaugh, C. 1955. Fish life in the kelp beds and the effects of kelp harvesting. Univ. Calif., Inst. Mar. Resources, La Jolla, CA. 156 p.

White croaker was not among the 125 species of fishes observed near kelp beds from 1948 to 1954.

Love, M. 1996. Probably more than you want to know about fishes of the Pacific Coast. Really Big Press, Santa Barbara, CA. 381 p.

Love, M., and S. Hansen. 1999. Recreational vessel fishery for white croaker on the Palos Verdes Shelf. Univ. Calif. Santa Barbara, Institute of Mar. Sci., Santa Barbara, CA. 41 p.

Love, M. S., G. E. McGowen, W. Westphal, R. J. Lavenberg, and L. Martin. 1984. Aspects of the life history and fishery of the white croaker, *Genyonemus lineatus* (Sciaenidae), off California. Fish. Bull. 82(1):179-198.

Mentions anecdotally that that white croaker are found in large numbers in kelp beds attached to soft-bottoms.

Love, M. S., J. S. Stephens, Jr., P. A. Morris, M. S. Singer, M. Sandhu, and T. C. Sciarrotta. 1986. Inshore soft substrata fishes in the Southern California Bight: an overview. Calif. Coop. Oceanic Fish. Inves. Rep. 27:84-106.

MacDonald, C. K. 1975. Notes on the family Gobiidae from Anaheim Bay. Pages 117-121 *in* E. D. Lane and C. W. Hill (eds.), The marine resources of Anaheim Bay. Calif. Dep. Fish Game, Fish Bull. 165.

Matthews, K. R. 1985. Species similarity and movement of fishes on natural and artificial reefs in Monterey Bay, California. Bull. Mar. Sci. 37(1):252-270.

Divers surveyed four natural reefs and one artificial reef (Capitola artificial reef) near Soquel Point in Monterey Bay at depths of 10 to 27 m. Reefs had maximum vertical relief of 1-5 m; some of the natural reefs consisted of flat rocks interspersed with sand.. More than 20 dive transects (at least four transects per reef per quarter) were conducted from fall 1981 to fall 1982, and from summer 1983. A total of 25 species of fish were observed but white croaker **was not** among them.

MBC Applied Environmental Sciences. 1987a. Ecology of oil/gas platforms offshore California. U. S. Dep. Interior, Minerals Mgt. Serv., Pac. OCS Reg., Los Angeles, CA. OCS Study, MMS 86-0094. 71 p.

In this review of literature of fishes found around oil platforms, artificial reefs, oil islands, and wastewater discharge pipes in southern California and artificial reefs at Monterey, CA, white croaker were mentioned as occurring oil platforms, southern California artificial reefs, and oil islands but not wastewater discharge pipes and Monterey artificial reefs. No details were given other than the depth range given in Mearns and Moore (1976, see below). It was not among the fishes occurring in 80% or more of the dive surveys of oil platforms, artificial reefs, and oil islands off California (from Carlisle et al. 1964) nor among fishes occurring in 50% or more of the dive surveys at Platforms *Hilda* and *Hazel*. It was considered to be one of the major species on soft bottoms at depths less than 40 m.

MBC Applied Environmental Sciences. 1987b. THUMS artificial reef monitoring program. Prepared for THUMS Long Beach Company, Long Beach. Prepared by MBC Applied Environmental Sciences, Costa Mesa, CA. 105 p.

In a study of the fish fauna on the soft-bottom, artificial reefs, and armored shore of Island Chaffee in Long Beach Harbor, white croaker was abundant in gill nets set on soft-bottom between reefs at night, but were never seen by divers on the reefs during the day. **White croaker were the most common and most abundant fish species among 52 species caught in the gill net survey (MBC 1987 -- CHECK)** .

Mearns, A. J. 1974. Southern California's inshore demersal fishes: diversity, distribution, and disease as responses to water quality. Calif. Coop. Oceanic Fish. Invest. Rep. 18:141-148.

In 448 samples it occurred with queenfish (see Mearns et al. 1973).

White croaker captured by hook-and-line (at 60 m) and observed in photographs (mentioned in table) in Santa Monica Bay in 1978-1979 (Moore and Mearns 1980).

Mearns, A. J. 1979. Abundance, composition and recruitment of nearshore fish assemblages on the southern California mainland shelf. Calif. Coop. Oceanic Fish. Invest. Rep. 20:111-119.

Mearns, A. J., M. J. Allen, M. J. Sherwood, and R. Gammon. 1973. An otter trawl survey off the Palos Verdes Peninsula and Santa Catalina Island, November-December 1972. So. Calif. Coastal Water Res. Proj., El Segundo, CA. TM 205. 25 p.

In 448 samples it occurred with queenfish (see Mearns 1974).

Mearns, A. J., and M. D. Moore. 1976. Biological study of oil platforms *Hilda* and *Hazel*, Santa Barbara Channel, California. Prepared for Univ. Calif. San Diego, Scripps Institution of Oceanography, Inst. Mar. Resources, La Jolla, CA. Prepared by So. Calif. Coastal Water Res. Proj., El Segundo, CA. 101 p.

White croaker was one of 51 species of fish observed near oil platforms *Hilda* and *Hazel* during April to September 1975 by divers using SCUBA. White croaker were observed at depths of 12-24 m (mentioned Fig. 9 but not in the text).

Mearns, A. J., and M. J. Sherwood. 1977. Distribution of neoplasms and other diseases in marine fishes relative to the discharge of waste water. Pages 210-224 *in* H. F. Kraybill, C. J. Dawe, J. C. Harshbarger, and R. G. Tardiff (eds.), Aquatic pollutants and biologic effects with emphasis on neoplasia, Ann. N.Y. Acad. of Sci., vol. 298.

Miller, D. J., and D. Gotshall. 1965. Ocean sportfish catch and effort from Oregon to Point Arguello, California, July 1, 1957-June 30, 1961. Calif. Dep. Fish Game, Fish Bull. 130. 130 p.

White croaker was listed among the most commonly taken species in the surf, pier, and shallow sand bottom habitats in . It was not listed among the most commonly taken fishes from Oregon to Point Arguello in tide pool, shallow rock, kelp bed, shallow reef, deep reef, deep sand bottom, and pelagic habitats. It was important in pier and skiff fisheries from San Francisco southward. Juveniles frequent inshore areas around piers. Adults from loose-knit schools over sandy bottoms and is easily taken on small baited hooks.

White croaker ranked 2nd in numbers (9.0% of 3,218,146 fish in 1,410,238 angler days) and 10th by weight (3.4% of 1,982.2 mt) and was taken by all fishing methods (surf net; pier, party boat, and skiff anglers) except skin-diving.

1. Fishing effort at 16 major piers amounted to 530,702 angler days during 1958; white croaker was the most abundant species (21.1% of the catch) from Trinidad to Pismo Beach, CA. It was the most abundant species at piers from San Francisco to Point Arguello.

2. White croaker was 2nd in abundance (16.3% of 318,667 fish caught by skiff anglers in 19054 angler days from Crescent City to Avila from March 1959 to February 1960; it comprised 0.6% of fish caught by trolling (33,494) and 18.1% of fish caught from the bottom (285,173). Most were caught from San Pedro Point (Pacifica) to Moss Landing (Monterey Bay).

3. White croaker was 1.5% of 1,024,916 fish caught by shore fishermen (shore and rock combined, 603,097 angler days) from Oregon to Point Arguello in 1960.

4. White croaker accounted for 0.1% of 800,381 fish (and trace of 842,506 kg) of fish caught (115,701 angler days) on party boats from Crescent City to Avila in 1960; it was 0.3% of 84,282 fish caught by trolling and 0.1% of 716,099 caught on the bottom.

5. It did not appear in 21,615 fish taken by SCUBA and free divers from Oregon to Pismo Beach , March 1960 to February 1961 in 3,614 week-end field surveys of divers.

Moore, M. D., and A. J. Mearns. 1980. Photographic survey of benthic fish and invertebrate communities in Santa Monica Bay. Pages 143-148 *in* W. Bascom (ed.), Coastal Water Research Project Biennial Report for the years 1979-1980. So. Calif. Coastal Water Research Project, Long Beach, CA.

White croaker captured by hook-and-line (at 60 m) and observed in photographs (mentioned in table) in Santa Monica Bay in 1978-1979 (Moore and Mearns 1980).

Moore, S. L. 1998. Age and growth of white croaker (*Genyonemus lineatus* (Ayres)) off Palos Verdes and Dana Point, California. M.S. Thesis. Calif. State Univ., Long Beach, Long Beach, CA. 87 p.

Myers, M. S., C. M. Stehr, O. P. Olson, L. L. Johnson, B. B. McCain, S. L. Chan, and U. Varanasi. 1994. Relationships between toxicopathic hepatic lesions and exposure to chemical contaminants in English sole (*Pleuronectes vetulus*), starry flounder (*Platichthys stellatus*), and white croaker (*Genyonemus lineatus*) from selected marine sites on the Pacific Coast, USA. Environmental Health Perspectives 102:200-214.

Oliphant, M. S., P. A. Gregory, B. J. Ingle, and R. Madrid. 1990. California marine fish landings for 1977-1986. Calif. Dep. Fish Game Fish Bull. 173. 52 p.

Gives dollar value of landings by California regions (Eureka, San Francisco, Monterey, Santa Barbara, Los Angeles, and San Diego) from 1977 to 1986. The value of landings was highest in 1984 and 1985 and lowest in 1977, 1978, and 1979. Overall, average value of landings (ranked) were highest in Los Angeles, followed by Monterey, San Francisco, Santa Barbara, San Diego, and Eureka. However, the greatest value shifted from Los Angeles (1977-79; 1984) to Monterey (1980-1982) to San Francisco (1983,85-86).

Patton, M. L., R. S. Grove, and R. F. Harman. 1985. What do natural reefs tell us about designing artificial reefs in southern California. Bull. Mar. Sci. 37(1):279-298.

Divers conducted 270 visual transect surveys at 76 sites (shallow natural reefs) between Point Conception and Mexican border in 1979. Investigated effect of structural characteristics (e.g., height, rock area, percent vertical height, etc.) of natural reef habitats on the abundance of 25 fish species **(none of which were white croaker)**; cryptic, rare, and transient species were not included in the study.

Phillips, L. C., C. Terry, and J. S. Stephens, Jr. 1972. Status of the white croaker (*Genyonemus lineatus*) in the San Pedro Bay region. So. Calif. Coastal Water Res. Proj., El Segundo, CA. Tech. Rep. 109. 49 p.

Pinkas, L., M. S. Oliphant, and C. W. Haugen. 1968. Southern California marine sportfishing survey: private boats, 1964; shoreline, 1965-66. Calif. Dep. Fish Game, Fish Bull. 143. 42 p.

White croaker was the third [fourth if kelp bass/barred sand bass are treated as species] most abundant fish species of more than 68 species (8.8% of 957,119 fish caught) in 2,773,405 man-hours of fishing from private boats fishing off southern California in 1964. It was 20th of at least 30 species (0.7% of 235,693 fish) caught along the open-coast shoreline in 1965-1966 whereas it was the most abundant species of at least 34 species (35.1% of 266,041 fish) taken along inland-bay shorelines. No effort estimate was provided. In 1963-1966, it was among the 15 most abundant fish species and 11th [12th if kelp bass/barred sand bass are treated as species] in abundance (0.6% of 8,997,389 fish) in party boat catches and second in abundance (18.5% of 1,844,970 fish) at piers and jetties in southern California. Of 545,012 white croaker caught by recreational anglers in southern California surveys in 1963-1966, 62.8% of 545,012 were caught at piers and jetties, 15.5% from private boats, 17.4% from shoreline, and 4.3% from party boats. An effort estimate by fishing mode was generally not available and different year combinations were lumped (i.e., 1963-1966 total, 1963 piers, 1964 private boats, 1965-1966 shoreline, and 1963-1966 party boats).

Pollock, G. A., I. J. Uhaa, A. M. Fan, J. A. Wisniewski, and I. Witherell. 1991. A study of chemical contamination of marine fish from southern California: II.

Comprehensive study. Calif. Environ. Prot. Agency, Off. Environ. Health Hazard Assess., Sacramento CA. 393 p.

Pondella, D. J., II, and J. S. Stephens, Jr. 1994. Factors affecting the abundance of juvenile fish species on a temperate artificial reef. Bull. Mar. Sci. 55(2-3):1216-1223.

SCUBA divers censused young-of-year (YOY) fish in King Harbor along two transects (one along inner side of outer breakwater and the other along Portofino Reef on opposite side of channel) from April 1986 to December 1990. Transects lengths were 254 and 208 m, respectively; transect depths were 10 and 5 m, respectively. Sampling frequency was once a month in winter (Dec-Mar), every 2 wk in early spring (Apr-May), once a week during strong recruitment season (Jun-Aug) and every 2 wk in fall (Sep-Nov). Divers swam 1.5 m above bottom and at 1.5 m below surface along each transect. Total counts were from 1.5 m above and below diver to 3 m into water column away from reef. This formed a parallelogram with a slope of the reef.

White croaker were not among the 34 species with YOY observed in survey; no evidence that older white croaker were observed. Blacksmith (*Chromis punctipinnis*) was the most common species.

Puffer, H. W., S. P. Azen, and D. R. Young. 1981. Consumption rates of potentially hazardous marine fish caught in the metropolitan Los Angeles area. U. S. Environ. Prot. Agency, Environ. Res. Lab., Corvallis, OR. EPA Grant 807 120010. 34 p.

Puffer, H. W., M. J. Duda, and S. P. Azen. 1982. Potential health hazards from consumption of fish caught in polluted coastal waters of Los Angeles County. N. Am. J. Fish. Manage. 2:74-79.

Quast, J. C. 1968a. Fish fauna of the rocky inshore zone. In: W. J. North, and C. L. Hubbs, eds. *Utilization of Kelp-Bed Resources in Southern California.* Calif. Dept. Fish Game Fish Bull. No. 139. Pp. 35-55.

Quast, J. C. 1968b. Estimates of the populations and the standing crop of fishes. Pages 57-79 *in* W. J. North and C. L. Hubbs (eds.), Utilization of kelp-bed resources in southern California. Calif. Dep. Fish Game Fish Bull. 139.

In 1958, a wall net was set up around a 0.53 ha (1.3 acre) kelp bed at a depth of 11 m at Del Mar and fish were collected within the area by dynamite and fish poison. About 0.39 kg/ha (0.35 lb/acre) of white croaker (regarded as a sandy demersal species) was taken (ranking 16th among 24 species). It was otherwise not among the fishes captured at kelp beds sampled off San Diego (Quast 1968).

SCCWRP (Southern California Coastal Water Research Project). 1973. The ecology of the Southern California Bight: implications for water quality management. So. Calif. Coastal Water Res. Proj., El Segundo, CA. TR 104. 531 p.

Based on 303 otter trawl samples from 1969 to ____? in southern California, white croaker occurred in a recurrent group with queenfish and white seaperch (SCCWRP 1973).

SCCWRP (Southern California Coastal Water Research Project). 1986. Changes in DDT and PCB concentration in white croaker are related to the reproductive cycle. Pages 43-47 *in* Southern California Coastal Water Research Project, Annual report 1986, Long Beach, CA.

SCCWRP (Southern California Coastal Water Research Project). 1987. Impaired reproduction in white croaker off southern California. Pages 48-49 *in* Southern California Coastal Water Research Project, Annual report 1987, Long Beach, CA.

This paper summarizes work by J. N. Cross and J. E. Hose described above (Hose and Cross 1994, Hose et al. 1989). The study indicates that white croaker inhabiting contaminated areas near Los Angeles have higher chlorinated hydrocarbon body burdens, greater early oocyte destruction and preovulatory degeneration, lower fertilization rates, and decreased egg production than do fish from the reference location. **This study does not give any information on white croaker habitat.**

SCCWRP (Southern California Coastal Water Research Project), MBC Applied Environmental Sciences, and University of California, Santa Cruz, Trace Organics Facility. 1992. Santa Monica Bay seafood contamination study. Prepared for Santa Monica Bay Restoration Project, Monterey Park, CA. So. Calif. Coastal Water Res. Proj., Long Beach, CA. 179 p.

Skogsberg, T. 1939. The fishes of the family Sciaenidae (croakers) of California. Calif. Dep. Fish Game. Fish Bull. 54. 62 p.

Solonsky, A. C. 1985. Fish colonization and the effect of two artificial reefs in Monterey Bay, California. Bull. Mar. Sci. 37(1):336-347.

Divers conducted visual census surveys of two artificial reefs at Soquel Cove, Monterey Bay between October 1981 and 1982. Two 15-m transects were surveyed at each reef per month. Twenty fish species observed in these surveys but white croaker **was not** among them.

Starks, E. C. 1919. The fishes of the croaker family (Sciaenidae) of California. Calif. Fish Game 5(1):13-20.

Paper gives description and range (Santa Barbara to Lower California) of white croaker but no information on habitat.

Stephens, J. S., Jr., P. A. Morris, D. J. Pondella, T. A. Koonce, and G. A. Jordan. 1994. Overview of the dynamics of an urban artificial reef fish assemblage at King Harbor, California, USA, 1974-1991: A recruitment driven system.

Stephens, J. S., Jr., P. A. Morris, K. Zerba, and M. Love. 1984. Factors affecting fish diversity on a temperate reef: The fish assemblage of Palos Verdes Point, 1974-1981. Environ. Biol. Fishes. 11(4):259-275.

Stephens, J. S., Jr., and K. E. Zerba. 1981. Factors affecting fish diversity on a temperate reef. Environ. Biol. Fish 6(1):111-121.

Stull, J. K. 1995. Two decades of marine biological monitoring, Palos Verdes, California, 1972 to 1992. Bull. So. Calif. Acad. of Sci. 94(1):21-45.

Stull, J. K., K. A. Dryden, and P. A. Gregory. 1987. A historical review of fisheries statistics and environmental and societal influences off the Palos Verdes Peninsula, California. Calif. Coop. Oceanic Fish. Invest. Rep. 28:135-154.

Fisheries data were gathered from personal surveys, commercial catch landing receipts, and required partyboat catch logs. Study focused on CDFG Fish Blocks 719 (PV Peninsula west from White Point to Redondo Beach) and 720 (from White Point east to Long Beach, including all of Los Angeles Harbor and parts of Long Beach Harbor west of Island Freeman).

Partyboat catches (numbers) of white croaker in 5-year increments from 1936-40 to 1981-85 ranged from 3,089 (1956-60) to 14,052 (1947-50); no data was collected from 1941-1946 [during WWII -- MJA]. Median catch of 6,232 was in 1981-85. On the average it ranked 8 in partyboat species, ranging from 6-10; prior to 1956-1960, it ranked 6 or 7 but ranked 8-10 after that. Rockfishes were dominant in 1951-55 to 1956-60 and 1971-75 to 1976-1980; Pacific bonito in 1961-65 to 1966-70; basses (kelp and barred sand bass) in 1947-50; chub (= Pacific) mackerel) in 1981-85; and Pacific (= California) barracuda in 1936-40. From 1981-1984, white croaker catches in the Palos Verdes region ranged from 1,399 to 2,212, but dropped to 205 in 1985 (after California Department of Health Services health risk advisories were posted due to high levels of chlorinated hydrocarbon contamination). From 1936 to 1985, white croaker comprised 0.9% of the partyboat catch in block 719, 0.4% in block 720, and 0.5% at Palos Verdes (blocks 719 and 720 combined).

White croaker are common in harbors and open coastal areas, particularly over organically enriched sediments, over a broad depth range. White croaker is not held in high regard by most experienced partyboat anglers but increases in catch may be due to the fish's appeal among Asian Americans, whose numbers were probably increasing on partyboats, and because of its use as bait for California halibut and other predators.

From 1969-83, white croaker comprised 5% of the commercial landings from block 719, 0.3% from block 720, and 1% from Palos Verdes (both blocks combined). It ranked 4th in

these blocks, following northern anchovy, chub mackerel, and Pacific bonito. Eighty percent of the total commercial landings of white croaker were from block 719. The total average take over 15 years was 75,000 lb,, with peaks in 1974 and 1979. The commercial catch pattern paralleled partyboat records. Increased use of monofilament gillnets may have contributed to higher landings. Most were sold fresh but some were used in Asina food products.

Stull, J. K., and C. L. Tang. 1996. Demersal fish trawls off Palos Verdes, Southern California, 1973-1993. Calif. Coop. Oceanic Fish. Invest. Rep. 37:211-240.

Turner, C. H., E. E. Ebert, and R. R. Given. 1969. Man-made reef ecology. Calif. Dep. Fish Game. Fish Bull. 146. 221 p.

Of 78 fish species observed at 3 artificial reefs in Santa Monica Bay from August 1960 to January 1965, white croaker was the only species not observed 480 man-hours of diving in 200 dives. Although not observed in the water by divers, fishermen were catching them at WBC reef #2 (streetcar reef) in Santa Monica Bay during the dive surveys. The authors thought that they were apparently quite wary, remaining just outside their range of vision while diving.

Ware, R. R. 1979. The food habits of the white croaker (*Genyonemus lineatus*) and an infaunal analysis near areas of waste discharge in outer Los Angeles Harbor. M.A. Thesis. Calif. State Univ., Long Beach, Long Beach, CA. 113 p.

Sixty-one otter trawl samples were collected at five trawl stations at depths of 2.5 to 10.0 m in Outer Los Angeles Harbor near the Fish Harbor Cannery from 20 January 1976 to 6 January 1977. Stations were sampled during the day using a 4.5 m otter trawl. A 30.4 m beach seine was used to capture fish along the sand spit next to Fish Harbor jetty. A 30.4 m monofilament gill nets (2.4 m deep, with panels of 3.8, 6.4, and 7.6 cm mesh) were used to sample fish congregated near the effluent discharge pipes. Beach seines and gill nets were sampled on May 28 and November 18, 1976.

Of 25 species collected by otter trawl, white croaker was the most common (28% of samples) and most abundant (58% of samples). Peak abundance was in March, May, and June, the spring recruitment period. Only 12 white croaker were taken in beach and gill nets set in May 1976; none were collected in November. Most white croaker were concentrated at 5.5 m where most fin erosion occurred. The least productive areas had the lowest concentrations of white croaker. Near the outfall, most were concentrated in midwater. Primary prey were soft-bottom polychaetes, living in silty, sand, or mud sediments. Suspension feeders and carnivores on sandy sediments.

Individuals less than 4 cm fed on plankton; those from 4 to 15 cm fed on plankton, epifauna, and infauna; those above 15 cm fed on infaunal organisms.

Wild, P. W. 1992. White croaker. Pages 170-171 *in* W. S. Leet, C. M. Dewees, and C. W. Haugen (eds.), California's living marine resources and their utilization. Univ. Calif., Davis, Dep. Wild. Fish. Biol., Sea Grant Extension Program, Davis, CA. Sea Grant Ext. Publ. UCSGEP-92-12.

Summary of information. Extends Frey (1971) to 1991. Before 1980, taken commercially primarily by roundhaul (mainly lampara) net, with some trawl, gillnet, and hook-and-line. Since 1980, most by gill net. Since 1980, commercial landings were greater than 5,000 mt (1.1 million lb) in all but 4 years. Prior to 1975, 73% of catch was in southern California; after 58% was in central California. Changes in methodology and location due to entrance of southeast Asian (primarily Vietnamese) in this fishery.

The sport catch is similar to the commercial catch, averaging about 4,540 mt (1 million lb) per year. Over 80% of sportcatch is in southern California. Anglers fishing from piers, breakwaters, and private boats account for 90% of the catch; considered a nuisance on commercial passenger fishing vessels.

Abundant nearshore species, found near bottom over sandy substrates. Swim in loose schools; found from surf zone to depths of 182 m and occur in shallow bays, sloughs, and lagoons. [Little evidence for this other than in outer parts of these -- MJA]. Most of time they occur offshore, from 3-30 m, sometimes abundantly to 90 m. Juveniles occur at depths of 3-7 m, migrate deeper as they mature. Live near marine waste discharges.

Young, P. H. 1969. The California partyboat fishery 1947-1967. Calif. Dept. Fish Game Fish Bull. No. 145. 91 p.

White croaker is important to pier and skiff fishermen from San Francisco south, but to the party boat fishermen, it is a nuisance 90% of the time. The entire commercial fish catch was sold fresh during the period (1947-1967) of this study. White croaker catches by partyboat anglers during this period were highest (121,053) in 1949 and lowest (6,895) in 1959.

A single angler (F. R. Hering) fishing for 492 days from February 3, 1938 to October 29, 1940 off a barge anchored off Ocean Park caught 30,344 fish of 29 species of fish, of which white croaker was the most abundant (12,342), comprising 40.7% of his catch.

DIVER OBSERVATIONS

Curtis, Mike (MBC Applied Environmental Sciences; pers. comm., 31 Aug 1999)

Mike Curtis (MBC), diving officer at his company, has done 5,450 scientific and recreational dives since 1966, mostly Orange and Los Angeles Counties (harbors, coast, reefs, kelp beds, bays) and keeps logs of his dives and observations. He has not seen white croaker during day, but has infrequently seen them at night. He has seen them over jetties and breakwaters of 45^{o} angle (LA-LB Harbor, King Harbor), but not over low slope reefs. He did not see them feeding over the jetties.

Love, Milton S. (University of California, Santa Barbara; pers. comm., 2 Sep 1999)

Milt Love (UCSB) has never seen white croaker while SCUBA diving or in a submersible; has only caught them over sand, never over rocky bottom.

Montagne, Dave (CSDLAC; pers. comm. 24 Aug 1999)

Dave Montagne has never seen a white croaker while diving. He as done 24 yr (2,500-3,000 dives) around PV reefs and outfall in monitoring studies; similarly, in recreational dives (did not state how many) (mostly in Santa Monica Bay), has never seen white croaker (or white sea bass, *Atractoscion nobilis*); he has seen yellowfin croaker (*Umbrina roncador*) off Santa Catalina Island and black croaker (*Cheilotrema saturnum*) off Palos Verdes Peninsula.

Moore, Robert (MBC Applied Environmental Sciences, pers. comm., Aug. 11, 1999)

Robert Moore has observed queenfish over hard bottoms and in kelp beds but not with white croaker. However, he has observed the two schooling together over soft bottom at depths less than 6 m, with the white croaker hovering 1.0 to 1.5 m above the bottom.

Pondella, Daniel J., II (Occidental College, *Van Tuna* Research Group; pers. comm., 30 Aug 1999)

Dan Pondella has, in association with Dr. John Stephens, conducted diver surveys of reef fishes in King Harbor, Redondo Beach, CA and off Palos Verdes Peninsula. John Stephens surveys of both areas have been conducted annually from 1974 to the present. The number of 5-minute transects per year that were conducted at each site were 130 for King Harbor and 48 for Palos Verdes. Divers observed and recorded fish within 1.5 m on either side of the diver. This study, Stephens et al. (1994), noted many (> 1000) in 1975 and 1 in 1996. Dan said that surveys were conducted along the breakwater at depths of 1.5-14 m (with a ~45^{o} angle to the breakwater from bottom to top). [Note -- this may be quite different than over a more horizontal reef -- MJA]. Dan was not involved in the 1975 survey. However, he said that he frequently seen queenfish over the rocks but seldom has seen white croaker there. When he's seen white croaker, they appeared beat up, as if they were dumped over from bait boat. He also took one (290 mm SL) at night in a gill net survey at Cat Harbor, Santa Catalina Island, CA (Pondella and Allen, in press, The nearshore fish assemblage of Santa Catalina Island. Proc. Fifth California Islands Symposium).

Ware, R. R. (Rick) (Coastal Resources Management, pers. com., Aug. 11, 1999)

Robert (Rick) Ware has never observed white croaker over rocky bottoms, has seen them occasionally over soft-bottom but never near bottom.