# A HISTORICAL REVIEW OF FISHERIES STATISTICS AND ENVIRONMENTAL AND SOCIETAL INFLUENCES OFF THE PALOS VERDES PENINSULA, CALIFORNIA

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## ABSTRACT

A synopsis of partyboat and commercial fish and invertebrate catches is presented for the Palos Verdes region. Fifty years (1936–85) of partyboat catch, in numbers of fish and angler effort, and 15 years (1969–83) of commercial landings, in pounds, are reviewed.[1] Several hypotheses are proposed to explain fluctuations in partyboat (commercial passenger fishing vessel) and commercial fishery catches. Where possible, comparisons are drawn to relate catch information to environmental and societal influences. This report documents trends in historical resource use and fish consumption patterns, and is useful for regional fisheries management. The status of several species has improved since the early to mid-1970s. This correlates with other findings of noteworthy environmental recovery and may be associated with reduced contamination of the coastal marine environment.

## RESUMEN

Una sinopsis de la pesca de peces y mariscos por barcos comerciales y de recreo es presentada para la región de Palos Verdes. Las capturas de las embarcaciones de recreo (embarcaciones comerciales dedicadas a la pesca hecha por pasajeros) recopiladas durante 50 años (1936–85), en cuanto a número de peces y esfuerzo, así como los desembarques comerciales, en libras, recopilados durante 15 años han sido estudiados. Varias hipótesis han sido propuestas para explicar las fluctuaciones observadas en las capturas por embarcaciones de recreo y de pesca comercial. Las capturas han sido comparades con factores ambientales y sociales en los casos disponibles. Este informe presenta tendencias, a través del tiempo, en el uso de los recursos y en los patrones de consumo de pescado y es de gran utilidad para la administración pesquera regional. Los desembarques de varias especies han aumentado desde principios a mediados de los años 70. Este aumento presenta cierta relación con otros indicadores de una recuperación ambiental significativa y puede estar asociado con una reducción en la contaminación del medio ambiente marino costero.

[1]Pound and short ton usage was approved in order to allow direct comparisons to historic, statewide California Department of Fish and Game catch data.

[Manuscript received February 2, 1987.]

## INTRODUCTION

Our goals were to summarize long-term fish and invertebrate catch statistics gathered by the California Department of Fish and Game (CDFG) for the Palos Verdes Peninsula, to infer relative fish abundance and human consumption rates, and, where possible, to better understand influences from natural and human environmental perturbations. We examined total catches and common and economically important species, in addition to species with reported elevated body burdens of contaminants such as DDT and PCBs.

CDFG fish catch data from blocks 719 and 720 (Figure 1) were analyzed; together they encompassed the entire Palos Verdes Peninsula, a small portion of southern Santa Monica Bay, and northern San Pedro Bay. Block 719 covers a smaller marine area, mostly over the shelf, whereas much of block 720 is above deep canyon and channel waters. Block 719 includes the historically important Horseshoe Kelp Bed in San Pedro Bay (Schott 1976). The Los Angeles County Sanitation Districts' submarine outfall system is located at the junction of blocks 719 and 720. In this analysis, Palos Verdes total catch refers to blocks 719 and 720 combined.

The coastline of the Palos Verdes Peninsula is mainly rocky. Offshore sediments vary from gravels to silt. Sediment within the blocks is as variable as that between blocks. Around the outfall, sediments are very silty as a result of the deposition of fine-grained effluent particulates. Sediments to the east of 719 and west of 720 are also silty. The southwestern section of block 719 is sandy. Coarse sands are found near the shore from southern Santa Monica Bay to the outfall area, grading into finer sand and silt offshore (Uchupi and Gaal 1963). Gorsline and Grant (1972) further detail sediment textural patterns and hydrography. Sediment contaminant burdens vary with distance (from input sources such as the wastewater outfalls or the harbor) and with time (1975–85 levels are substantially lower than the previous decade; Stull and

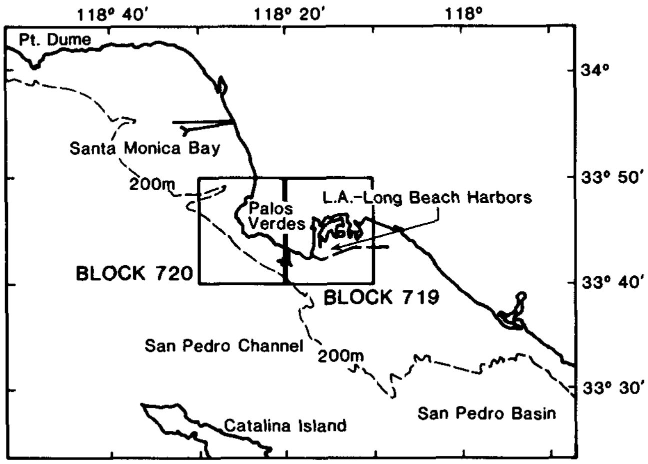


Figure 1. Study area and catch blocks off Palos Verdes Peninsula, Los Angeles County, California.

Baird 1985; Stull et al. 1986a, b). Moreover, available fish habitats (e.g., kelp distribution) have fluctuated markedly over the past 50 years (State Water Resources Control Board 1964; Meistrell and Montagne 1983; Wilson et al. 1980; Wilson and McPeak 1983; Wilson and Togstad 1983).

A number of environmental factors, both natural and societal, which potentially affect fisheries will be briefly discussed. Natural events such as temperature fluctuations, upwelling, storms, rainfall and runoff, and attendant alterations in habitat or productivity will be addressed, and some societal impacts such as environmental contamination, dumping, fishing practice, and economic forces will be reviewed.

Data on many potentially relevant factors affecting fish catches were not available. Selective and increasingly efficient fishing (and changes over time), fish migration, weather and ocean conditions, and inaccurate or inconsistent data collection may skew results. The age or size of fish caught was generally unavailable. Partyboat catches do not represent the total sport fishery, since many anglers fish from private boats, piers, and the shoreline.

Because of the many environmental and societal variables influencing fish catches, we cannot overemphasize the tenuous nature of any suggested cause-effect relationships made herein.

## METHODS

### *Environmental Factors*

To better visualize the relationships between possible causes of variation in fish catches, we plotted the following physical factors, recorded from the 1960s to 1985: water temperature at 10 m, upwelling index, rainfall, extreme wave episodes, water transparency (by Secchi disk), and wastewater mass emission rate (MER) of suspended solids, DDT, and chromium. The importance of these and other recognized or potential influences (reviewed from the literature) are alluded to in the individual species summaries.

TABLE 1
**Fish and Shellfish Species Analyzed in Palos Verdes Catch Records**

| Common name | Scientific name |
|---|---|
| Northern anchovy | *Engraulis mordax* |
| California scorpionfish | *Scorpaena guttata* |
| Rockfish complex | *Sebastes* spp. |
| Lingcod | *Ophiodon elongatus* |
| Kelp-sand bass complex | *Paralabrax* spp. |
| Ocean whitefish | *Caulolatilus princeps* |
| Yellowtail | *Seriola lalandei* |
| White seabass | *Atractoscion nobilis* |
| White croaker | *Genyonemus lineatus* |
| California (or Pacific) barracuda | *Sphyraena argentea* |
| California sheephead | *Semicossyphus pulcher* |
| Pacific (or chub) mackerel | *Scomber japonicus* |
| Pacific bonito | *Sarda chiliensis* |
| California halibut | *Paralichthys californicus* |
| | |
| Red sea urchin | *Strongylocentrotus franciscanus* |
| Purple sea urchin | *Strongylocentrotus purpuratus* |
| Rock crab | *Cancer* spp. |
| Market squid | *Loligo opalescens* |
| California spiny lobster | *Panulirus interruptus* |

### *Fisheries Data*

The California Department of Fish and Game (CDFG) gathered data from personal surveys, commercial catch landing receipts, and required partyboat catch logs (Cal. Dept. Fish and Game 1952; Heimann and Carlisle 1970; Young 1969).

Species discussed in this report (ordered phylogenetically in Table 1) were selected based on catch record, economic importance, and potential significance to public health. Species importance varies with habitat and catch method. Shellfish contribute only 0.02% to partyboat totals but form 7% of commercial landings.

*Partyboat data.* Data from CDFG's computer printouts of partyboat catch (number of fish), 1936–85 (excluding 1941–46 because partyboat fishing was suspended during World War II), were entered into computer files by month, year, block, and species. Monthly data were available for 1936–40 and 1947–78; we used annual data from 1956 through 1985. Data were analyzed by species and counts. The partyboat data included 13 of the 17 target fish species.

Although catch statistics do reflect the consumption of marine fish, they rarely provide a direct measure of fish abundance. An important influence on catch is the amount of effort expended. In this paper, partyboat fishing effort is the number of anglers carried each year. Since the partyboat fishery in the Palos Verdes area rarely targets on one species, only the total catch per total anglers can be considered to be catch per unit of effort (CPUE) in the strict sense. Examining the catch of any one species or species complex per angler reveals, at best, a measure of relative abundance between species; it does not take into account how much effort during the year could possibly have taken that species.

Angler effort was recorded differently over the years. Before 1962, one angler day was recorded if the angler went on an 8-hour trip, but half an angler day was recorded for a 4-hour trip. In 1960 and 1961, angler days and number of anglers were recorded. Number of anglers remained the effort statistic from 1962 on. In order to standardize the effort, we calculated 1960–61 conversion ratios that included both angler days and number of anglers. This approximation may skew pre-1960 data, here presented as calculated number of anglers. The equations for converting the pre-1960 data are:

| | |
|---|---|
| Block 719 | angler = 0.576 angler days (SD = 0.14) |
| Block 720 | angler = 0.628 angler days (SD = 0.08) |
| Palos Verdes (719 + 720) | angler = 0.602 angler days (SD = 0.12) |

This is the only modification made to the raw data (Figure 2).

*Commercial data.* Commercial data files (as pounds of fish per month) were created by date and by species for the period 1969–83. CPUE could not be calculated. No data manipulations were performed.

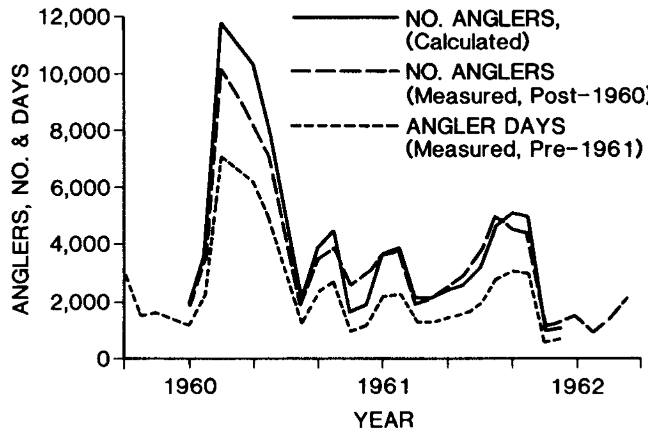


Figure 2. Conversion of Palos Verdes angler data (pre-1961) from angler days to number of anglers.

## ENVIRONMENTAL FACTORS

Specific environmental data for the Palos Verdes Shelf are limited, and therefore the following overview will first review potential (and confounding) factors affecting fisheries. Available relevant data will then be summarized. It is difficult to specifically correlate catches to natural variability or human influences, and our intent here is not to confuse the reader, but rather to list the spectrum of forces acting on the fisheries. Mearns (1978, 1980, 1984) has also summarized long-term ocean conditions, particularly for Santa Monica Bay, which lies immediately to the north of Palos Verdes.

### *Natural Events*

Temperature changes affect community structure, reproductive success, and food and habitat availability. El Niño events extend the ranges of warm-water species northward, and enhance the local pelagic fishery (e.g., Radovich 1961). Such anomalous warm-water events occurred in 1940–41, 1957–58, 1972–73, 1976–77, and 1982–84 (McLain et al. 1985).

Upwelling of cold, deep, nutrient-rich but less-oxygenated water is a seasonal phenomenon on the Palos Verdes Shelf and is strongest in the spring, although it can occur infrequently at other times of the year. It is generally suppressed by warm-water El Niño events. Fish distributions are altered by upwelling: mobile fish are forced to migrate from some shelf areas, either to shallow water or to surface layers because of unfavorable (but natural) low oxygen and temperature (SCCWRP 1973; Mearns and Smith 1976).

Rainfall and runoff were unusually heavy in 1941, 1952, 1965, 1969, 1978, 1980, and 1983 (National Climatic Service data for Los Angeles Civic Center and Long Beach, California). Nearshore habitats are most influenced by these events.

It has been estimated that there were 45 storm events with extreme wave episodes (exceeding 3 m) between 1935 and 1984 (Seymour et al. 1985). These significantly correlate with El Niño events. Fourteen of the wave episodes exceeded 6 m, and 8 of these occurred between December 1982 and February 1984, during the unusually strong El Niño event. These major storms can create exceptional damage to the coastal region, affecting fish habitats and populations (e.g., U.S. Army Corps. of Engineers and State of California 1984).

### *Societal Impacts*

Environmental contamination in these blocks includes the discharge of treated wastewaters via Los Angeles County Sanitation Districts' (LACSD) outfalls at Whites Point off Palos Verdes. Discharge began in 1937, and daily flows have been approximately 360 million gallons (15.8 $m^3$/sec) since the late 1960s. Improvements in effluent and environmental quality since 1970 are documented: for effluent, see SCCWRP reports (1973, 1974–84); for fish, Moore and Mearns (1980) and Cross (1985); for kelp, Meistrell and Montagne (1983) and Wilson et al. (1980); and for sediments and benthos, Stull and Baird (1985) and Stull et al. (1986a, b). Significant contaminants also emanate from harbors (Los Angeles-Long Beach), ocean dumping, terrestrial runoff, and other point and nonpoint sources (SCCWRP 1973; Bascom et al. 1979). Mearns (1977) found that nearly half the 1973 Southern California Bight coastal partyboat catch and one-third of the total bight catch was taken within 20 km of the largest municipal wastewater outfalls. Fishing pressure was ten times greater near outfalls than for the coast as a whole, probably because of proximity to marinas. These human impacts could contribute to changes in fish and prey populations.

In 1985, the California Department of Health Services (CDHS) posted warnings of DDT and PCB contamination of some local fish. Consumption guidelines were given for white croaker, and it was recommended that fish from certain regions, including the ocean outfall area and parts of Los Angeles-Long Beach harbors, be avoided. DDT had been discharged into LACSD sewers from 1953 until 1971, when the ecological impact of the pesticide was recognized. The diverse literature on ecological effects, distribution, and persistence of DDT is reviewed by Young (1982). Accumulation of DDT in a sediment reservoir is an acknowledged source to the biota. Matta et al. (1986) and Smokler et al. (1979) summarize declining trends in body burdens of DDT and PCBs in Palos Verdes and West Coast fauna, and Schafer et al. (1982) report on bioaccumulation and biomagnification in food webs. Surveys by Gossett et al. (1982) of sportfish contamination raised concerns for human health, particularly for those consuming white croaker. The 1985 posting was not the first time that DDT residues impacted local fishing efforts or were brought to public attention. In 1970 canned jack mackerel were condemned, and white croaker were seized by the U.S. Food and Drug Administration. In 1971 jack mackerel were withheld from distribution by packers, and jack mackerel and Pacific bonito were condemned (MacGregor 1974). Edible fish tissues in these catches exceeded the FDA's 5 ppm DDT maximum tolerance for commercial fish products. In 1985 the partyboat industry reported a loss of customers as a result of CDHS warnings.

Dumping affects fish habitats and populations. For example, pre-1930 dumping of rock, shale, and mud during harbor expansion is thought to have contributed to the deterioration of the Horseshoe Kelp Bed in San Pedro Bay (Schott 1976). Contaminant dumping has also been reported off Palos Verdes (Chartrand et al. 1985).

Fishing practice and regulations affect catches. During this century there have been a series of detailed restrictions on commercial gear types (nets, mesh sizes), which vary by species. Regional prohibitions or quotas often apply to commercial fishing, and bag limits regulate partyboat takes.

Economic influences impact catches. For example, fuel shortages of 1975–77 altered angler activity: fewer anglers fished block 720, and more fished block 719 instead of the more distant Catalina Island. Also, commercial fishing is strongly driven by economic realities.

Societal impacts on fish species depend partially on biology, habitat, food habits, and behavior. For example, demersal fish living on or near the ocean bottom are more likely to accumulate toxicants from sediments (or benthos) than are wide-ranging pelagic fish. Long-lived residents are more likely to show the effects of overfishing. Certain species are attracted to outfalls or constructed reefs (Allen et al. 1976).

Data interpretation is complicated by lag time: for example, overfishing or environmental influences on fish reproduction (e.g., Cross and Hose 1986) may not be manifested for several years, whereas other effects such as El Niño can occur within a season.

### *Environmental Data*

Figures 3 and 4 summarize Palos Verdes environmental data.

Annual mean water temperature at 10 m (from approximately weekly profiles at a 60-m Palos Verdes site near the outfall) was generally higher after 1975 (Figure 3). The more detailed monthly temperature profiles computed from bathythermograph records at the same 60-m site at the junction of blocks 719 and 720 show that positive anomalies are more prevalent in 1976–85 than in the previous decade (Figure 4). Warmest, most pro-

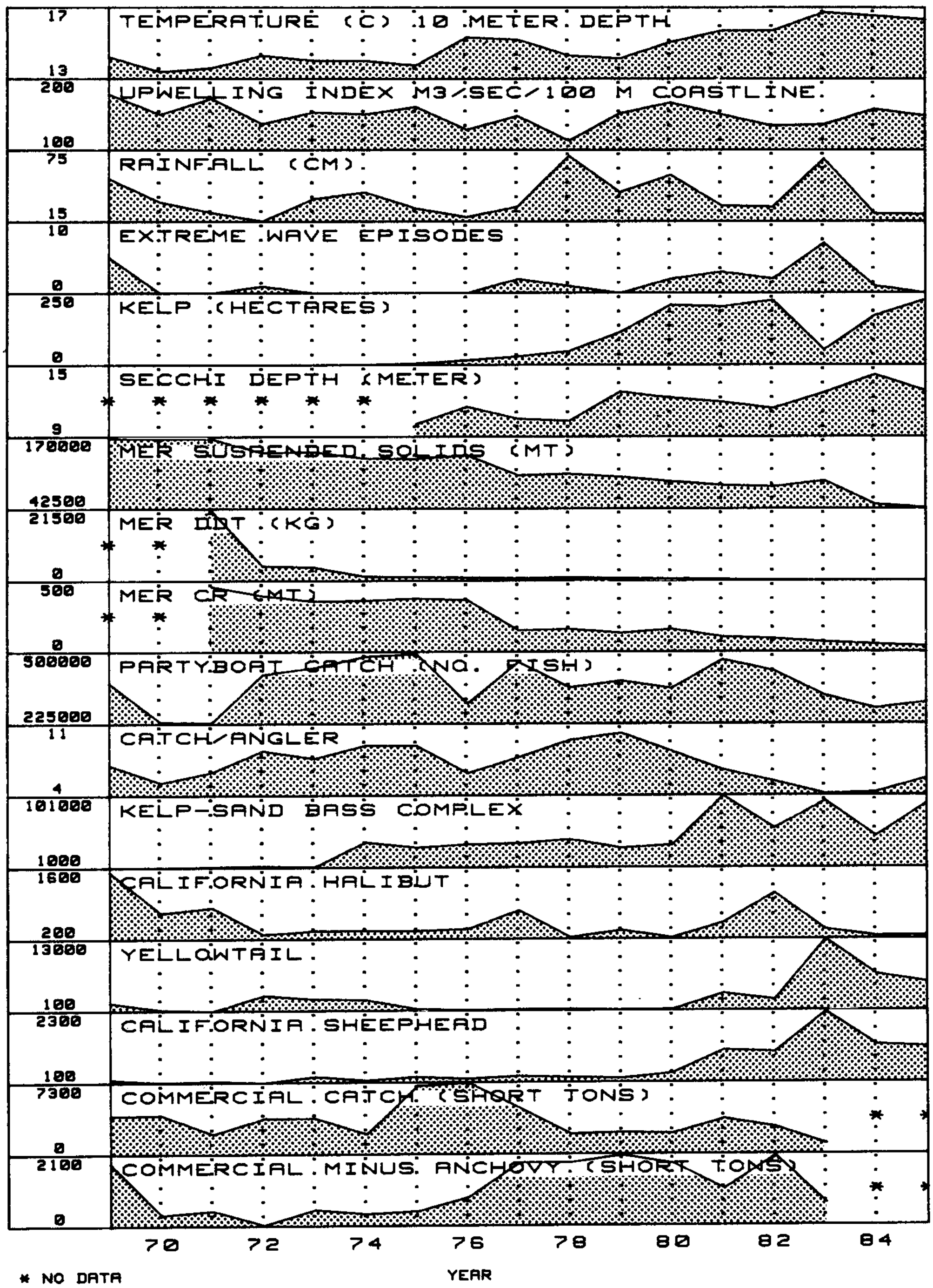


Figure 3. Temporal trends in environmental factors and representative fish catches, 1969–85. All data are annual means; ranges shown are maximum/minimum.

longed, and deepest thermal structure occurred during the 1982–83 El Niño.

Upwelling was suppressed during El Niño years 1972, 1976–78, and 1982–83 (Figure 3). (These data are annual means for 33°N 119°W from Jerrold Norton, National Marine Fisheries Service, Monterey, Calif.). Rainfall and runoff were heaviest in 1978, 1983, and 1980 (National Climatic Service data for Long Beach).

Extreme wave episodes (higher than 3 m) occurred most often during the major El Niño of 1983 and in 1969 (McLain et al. 1985).

Kelp was virtually absent from Palos Verdes through the mid-1970s and sustained major losses from 1983 storms, after which it rapidly returned to the shelf (CDFG data; Wilson and Togstad 1983).

Water clarity (Secchi depth at a 60-m site near

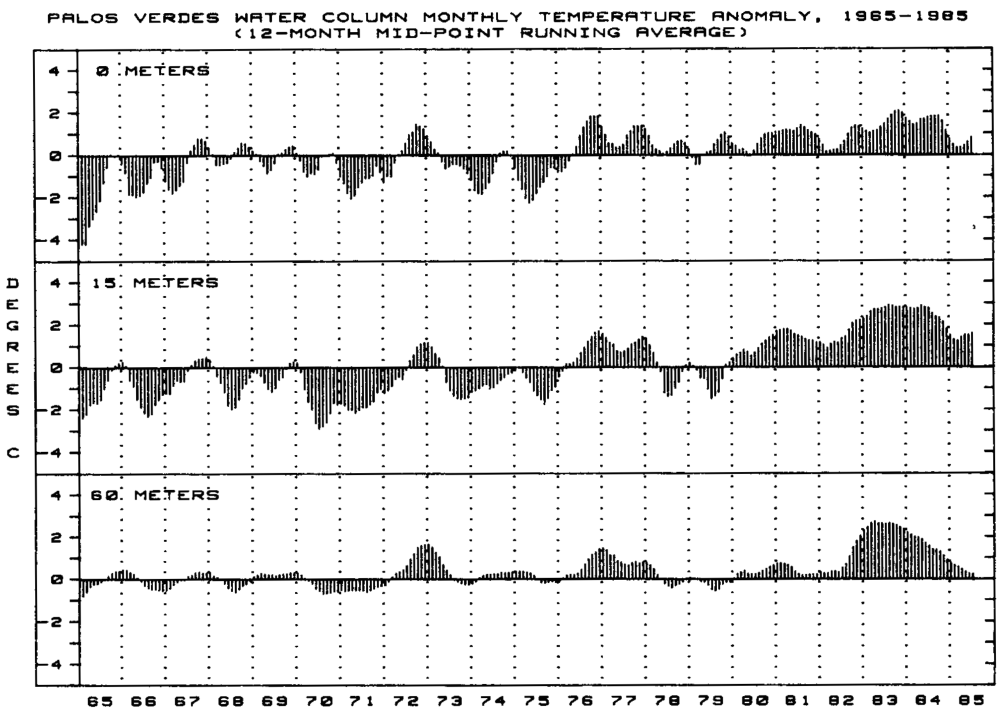


Figure 4. Palos Verdes water column temperature anomaly, 1965–85.

the ocean outfall) improved from 1978 to the mid-1980s. This Secchi trend was also observed in Santa Monica Bay, and Mearns (1984) suggests that possible reasons may be reduced phytoplankton density (from less upwelling or nutrients), low runoff, or reduced wastewater emissions (particulates and nutrients).

Mass emission rates of three wastewater constituents are shown. (1) Suspended solids, which decreased steadily from 1960 to 1985, can affect fish and their habitats by reducing light transmissibility, increasing organic matter in the water column and sediments, and transporting contaminants. (2) DDT, a persistent and bioaccumulating pesticide, was discharged into the sewer system from 1953 to 1971. (3) Chromium represents metals emission patterns, which have all decreased with improved industrial waste source control and solids removal. Effluent quality improved significantly in all components monitored between 1969 and 1985.

## ANNUAL PARTYBOAT CATCH

Between 1978 and 1984, the Palos Verdes fishery accounted for 6.8% of California's total partyboat catch (2.65 million of 38.78 million fish), while anglers represented 7.9% of the state total (418,000 of 5.28 million). The average catch per angler day was lower off Palos Verdes (6.3 versus 7.3), but varied from year to year. Data were examined as total fish for Palos Verdes, by species, and by catch block.

### *Palos Verdes Total*

Table 2 lists the Palos Verdes (blocks 719 + 720) partyboat catches in five-year increments, 1936–85, for total fish and for key species (ranked by overall abundance). Rockfish were the dominant group taken (35% of the total) over the half century; bonito, mackerel, kelp-sand bass complex, and barracuda each contributed at least 10% to the sport catch, and eleven species each generated over 1% of the total. The partyboat fishery grew from 300,000 for 1936–40 to nearly 2 million fish per five years after the late 1960s. Largest gains occurred in the late 1950s and the late 1960s–early 1970s.

The annual partyboat catch from Palos Verdes reflects an overall upward trend, with the exception of a half-dozen ephemeral decreases (Figure 5). From 1965 to 1985, approximately 400,000 fish were taken per year in the two blocks combined. Annual data for 1981–85 (Table 3) reflect the recent catches.

Total fish availability and, indirectly, total population size, are better portrayed by fish per angler (a measure of CPUE) than by numerical catch (which is strongly influenced by the number of fishermen). Generally, number of partyboat anglers is inversely related to the catch per angler (Figure 5).

The total catch per angler appears to have decreased from 1936 through 1950 (although early data may not be as representative); it rose steadily from 1951 through 1980, then decreased from 1981

TABLE 2
**Partyboat Fish Catch (in Numbers) and Effort (in Anglers), Palos Verdes Region, in 5-Year Increments**

| | 1936–40 | 1947–50* | 1951–55 | 1956–60 | 1961–65 | 1966–70 | 1971–75 | 1976–80 | 1981–85 |
|---|---|---|---|---|---|---|---|---|---|
| Rockfish complex | 6,177 | 91,295 | 395,545 | 443,505 | 86,101 | 391,024 | 1,443,729 | 901,386 | 306,448 |
| Pacific bonito | 3,324 | 10,200 | 7,062 | 297,952 | 427,181 | 506,664 | 191,922 | 213,200 | 321,596 |
| Kelp-sand bass complex | 121,038 | 141,580 | 112,218 | 127,165 | 290,042 | 386,756 | 182,176 | 129,109 | 343,061 |
| Pacific mackerel | 19,134 | 62,040 | 42,654 | 34,159 | 61,050 | 55,527 | 42,861 | 435,079 | 572,181 |
| California barracuda | 141,359 | 94,508 | 56,791 | 333,672 | 84,535 | 285,782 | 15,404 | 35,259 | 123,101 |
| California scorpionfish | 4,759 | 15,292 | 13,788 | 8,932 | 28,283 | 38,977 | 60,708 | 58,329 | 51,421 |
| Ocean whitefish | 493 | 1,224 | 807 | 1,677 | 6,084 | 13,824 | 20,943 | 52,475 | 21,066 |
| California halibut | 8,934 | 39,808 | 20,145 | 6,627 | 30,690 | 10,702 | 2,220 | 2,001 | 2,532 |
| Yellowtail | 2,780 | 202 | 807 | 60,431 | 5,506 | 4,340 | 7,654 | 1,329 | 29,987 |
| White croaker | 4,790 | 14,052 | 11,702 | 3,089 | 8,243 | 4,200 | 3,356 | 6,650 | 6,232 |
| California sheephead | 2,678 | 2,195 | 1,091 | 671 | 672 | 839 | 993 | 1,372 | 6,799 |
| White seabass | 2,420 | 2,859 | 2,101 | 2,247 | 873 | 434 | 1,373 | 426 | 693 |
| Lingcod | 387 | 833 | 396 | 254 | 56 | 74 | 1,845 | 1,561 | 185 |
| Block 719 | 35,141 | 122,880 | 101,748 | 76,975 | 151,376 | 390,731 | 707,001 | 722,793 | 658,526 |
| Block 720 | 286,990 | 373,737 | 635,353 | 1,261,590 | 915,807 | 1,261,590 | 1,352,640 | 1,154,259 | 1,162,477 |
| Total fish | 322,131 | 496,617 | 737,101 | 1,338,565 | 1,067,183 | 1,740,590 | 2,059,641 | 1,877,052 | 1,821,003 |
| Total anglers | 57,735 | 159,080 | 193,876 | 274,085 | 177,426 | 267,862 | 253,582 | 229,153 | 352,020 |
| Catch per angler | 5.58 | 3.12 | 3.80 | 4.88 | 6.01 | 6.50 | 8.12 | 8.19 | 5.17 |

*No data, 1941–46; 1947–50 is a 4-year increment.

to 1985. The 1951–80 rise could suggest growing fish populations, but improved fishing strategies may also be important. The decreases in the 1980s could be attributable to (1) El Niño and severe storms in 1982–83, which decimated kelp beds, severely impacted nearshore regions, and caused hundreds of millions of dollars in damage to local coastal areas (U.S. Army Corps of Engineers and State of California 1984), and (2) public awareness of contaminated fish tissues (1984–85).

Block 720 generated 76% of the total Palos Verdes catch since the 1930s (Figure 6), although percent taken in the two blocks varies by species (Table 4). Scorpionfish and ocean whitefish catches were higher in block 719, perhaps because these species are prevalent in the edge-effect zone provided by the Horseshoe Kelp Bed environment (Schott 1976), which consists of rock outcrops scattered on a sandy shoal. Also, wastewater discharges influence the ecology of block 720 more than block 719. Block 720's higher catch is likely due to the greater marine area, more diverse habitats, and especially the higher angler effort from more boat marinas.

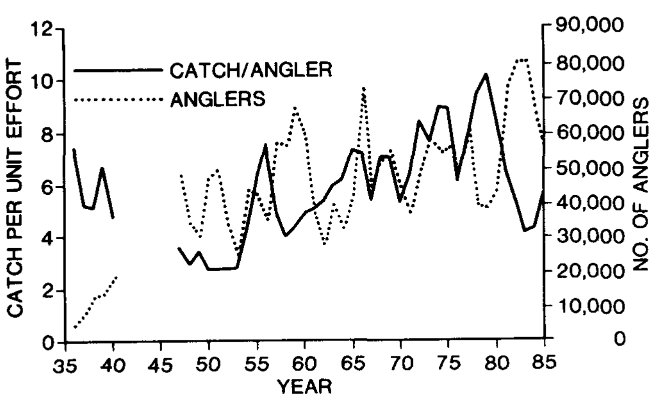


Figure 5. Partyboat anglers and catch per angler, Palos Verdes Shelf, 1936–85.

TABLE 3
**Annual Partyboat Catch for Palos Verdes Region**

| | 1981 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|
| Rockfish complex | 103,773 | 78,442 | 31,442 | 32,897 | 60,226 |
| Pacific bonito | 123,670 | 30,886 | 74,052 | 75,451 | 17,537 |
| Kelp bass* | 50,416 | 27,870 | 46,861 | 22,238 | 45,107 |
| Barred sand bass* | 22,293 | 18,263 | 44,853 | 18,447 | 46,713 |
| Pacific mackerel | 126,347 | 208,388 | 74,040 | 80,298 | 83,108 |
| California barracuda | 23,810 | 17,730 | 30,412 | 27,614 | 23,535 |
| California scorpionfish | 10,589 | 12,117 | 10,468 | 7,721 | 10,526 |
| Ocean whitefish | 2,298 | 4,345 | 1,989 | 2,458 | 9,976 |
| California halibut | 524 | 1,100 | 386 | 255 | 267 |
| Yellowtail | 3,182 | 2,025 | 12,968 | 6,624 | 5,188 |
| White croaker | 1,399 | 1,336 | 1,080 | 2,212 | 205 |
| California sheephead | 1,088 | 1,027 | 2,253 | 1,248 | 1,183 |
| White seabass | 59 | 79 | 97 | 87 | 371 |
| Lingcod | 24 | 34 | 22 | 46 | 59 |
| Total fish | 471,036 | 427,351 | 332,553 | 283,129 | 306,934 |
| No. of anglers | 72,578 | 79,470 | 80,117 | 65,765 | 54,140 |
| Catch per angler | 6.49 | 5.38 | 4.15 | 4.31 | 5.67 |

*Reported separately in these years

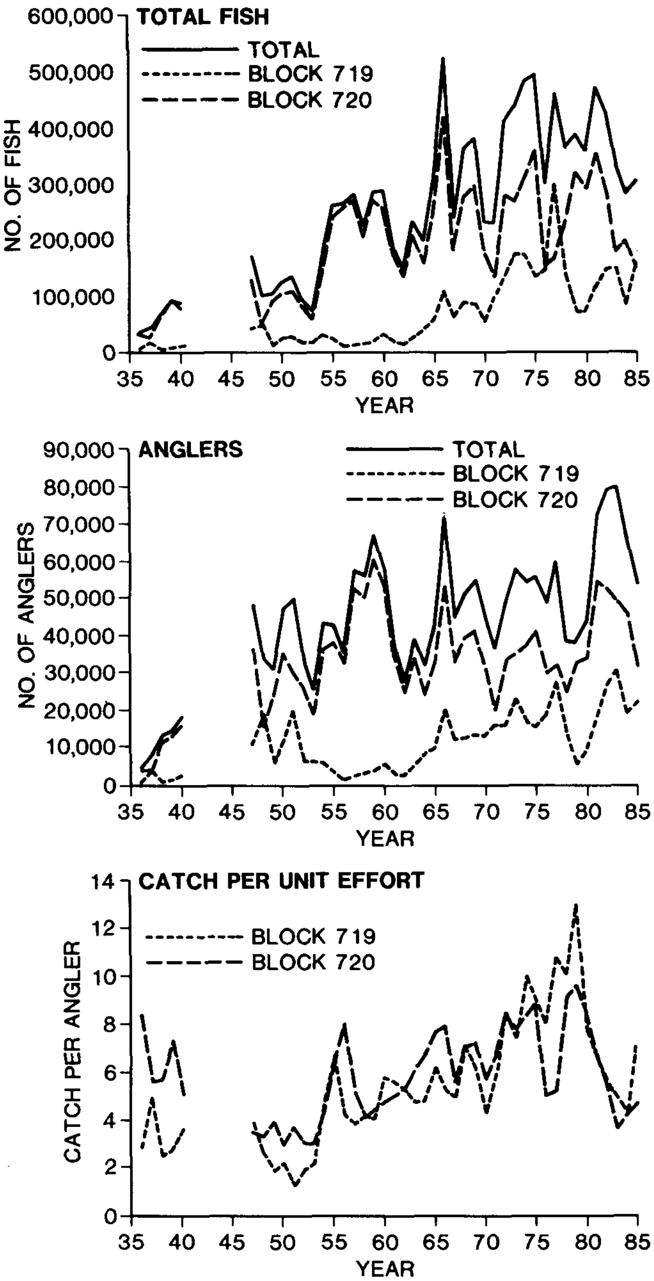


Figure 6. Annual partyboat catch, anglers, and catch per unit of effort for blocks 719, 720, and combined Palos Verdes totals, 1936–85.

Block 720 catch has fluctuated around 250,000 fish per year since 1955; previously fewer than 100,000 fish were reported taken. Block 719 generated fewer fish (under 40,000) through 1965; catch rose rapidly through 1977 to peak at about 300,000; then in the 1980s the average take was approximately 125,000. The pre-1965 rises in Palos Verdes catch were largely from block 720, whereas after 1965 the increase in regional total was from block 719. This reflects relative angler activity in the two blocks (Figure 6).

TABLE 4
**Partyboat Percentage of Total Number of Fish (1936–85)**

| | Block 719 | Block 720 | Palos Verdes* |
|---|---|---|---|
| Rockfish complex | 35 | 35 | 35 |
| Pacific bonito | 11 | 20 | 17 |
| Kelp-sand bass complex | 9 | 17 | 16 |
| Pacific mackerel | 16 | 10 | 12 |
| California barracuda | 10 | 10 | 10 |
| California scorpionfish | 5 | 2 | 2 |
| Ocean whitefish | 2.5 | 0.5 | 1 |
| California halibut | 2 | 0.9 | 1 |
| Yellowtail | 0.4 | 1 | 1 |
| White croaker | 0.9 | 0.4 | 0.5 |
| California sheephead | 0.2 | 0.1 | 0.2 |
| White seabass | 0.1 | 0.1 | 0.1 |
| Lingcod | 0.04 | 0.05 | 0.05 |

*Block 719 + block 720

Total fish and total anglers were about three times higher in block 720; however, catch per angler was more similar in the two blocks (Figure 6), with 720 slightly higher before 1971, and 719 higher more recently.

### *Individual Species*

Partyboat catch records of 13 species (95% of total Palos Verdes 1936–85 catch) were examined (Table 2). In the material that follows, species are ordered by abundance in the combined 50-year catch.

Individual species trends are typically independent of total catch trends, because of differences in habitat requirements, angler selection, angling regulations, and environmental conditions. Trends in blocks 719 and 720 are not identical. In some cases, dominant influences on species abundance can be separated; often, the factors are too complex for any to be isolated.

Catch per angler is not as useful an indicator of species population sizes; relative availability is a more appropriate term. Partyboat effort is multispecific and largely opportunistic: the species represented in the day's catch are a function of habitat, and different habitats are not fished with equal effort each year.

It is important to data interpretation that catch per angler in block 719 is almost always higher or at least equivalent to that in block 720 for all target species except three. The pelagic bonito and yellowtail have a slightly higher overall catch per angler in block 720, as does the kelp-sand bass complex. This may be related to physical structure—e.g., more offshore area and kelp in block 720.

*Rockfish complex.* Rockfish ranked highest in total partyboat catch (1936–85). Many biologically diverse *Sebastes* species are combined in this complex, including bocaccio, chilipepper, vermillion, cow, and olive. Rockfish became popular after the 1950s, with peak take in the mid-1950s (over 200,000) and mid-1970s (over 400,000). The percentage of the total partyboat catch rose from near zero in the 1930s to over 50% in the early 1950s, and 70% in the early 1970s. Low catches from 1958 to 1964 could be related to environmental deterioration (including the absence of kelp beds or sediment contaminants), to overfishing, or to El Niño effects. Poor 1980s catches may be associated with storm-related kelp losses or El Niño effects. Although catch per angler was similar in the two blocks, more fish were taken from block 720.

*Pacific bonito.* Bonito catch showed two periods of increase (post-1955 and post-1977) and low values before 1955 and from 1974 to 1977. Average take in block 719 was about 12,000 per year, as compared to about 50,000 in block 720. The relative availability was only slightly higher in block 720, and variable temporal patterns in the two blocks are similar.

*Kelp-sand bass complex (kelp bass, barred sand bass, spotted sand bass).* The status of the kelp-sand bass complex resource has been closely monitored for 50 years. *Paralabrax* spp. were first regulated in 1939, when a 15-fish limit was imposed for an aggregate of species including these bass. No *Paralabrax* could be sold or purchased from 1953 on, when the first size limits (10.5 inches, or 27 cm) were instituted. The size limits were gradually increased to 12 inches (30.5 cm) by 1959, with a limit of 10 fish in 1979.

Unfortunately, before 1975, data did not reliably or consistently differentiate between kelp bass (*Paralabrax clathratus*), barred sand bass (*P. nebulifer*), and rock bass (*Paralabrax* spp., also including the spotted sand bass, *P. maculatofasciatus*). Relative proportions of the kelp bass and barred sand bass from 1935 to 1975 cannot be estimated.

The combined total take peaked in 1968 (approximately 110,000 fish) and again in 1983 (100,000 fish); the 1968 peak was preceded (before 1960) and followed (1973–80) by catches one-third or less that size. In 1985, approximately 45,000 kelp bass and 47,000 barred sand bass were taken (Table 3).

The rise in kelp bass-barred sand bass complex from 1974 to 1985 parallels the increase in geographic distribution of kelp (*Macrocystis*) off Palos Verdes; both showed greatest recovery in 1980. Kelp forests had disappeared from the Palos Verdes nearshore region during the early 1960s, and reestablishment was largely unsuccessful until 1974. Natural environmental fluctuations and wastewater discharge are believed to have caused kelp's temporary demise (Mearns et al. 1977; Wilson et al. 1980; Meistrell and Montagne 1983). The low 1984 catch is likely related to temporary habitat loss (kelp canopy was virtually destroyed by winter storms in 1983; Wilson and Togstad 1983); by 1985 there were up to 325 hectares of kelp on the peninsula. The lack of correlation between declines of kelp and kelp-sand bass complex may be ascribed to either lag in response time or to dominance by sand bass, which are not associated with kelp.

Higher kelp bass in block 720 correlates with relative kelp/rock habitat. Between 1980 and 1985, 40,000–50,000 kelp bass were taken from the two blocks combined, with block 720 accounting for 50%–60% of the total. Before 1980, block 720 accounted for a greater proportion of the catch. Relative availability was higher in block 720 until 1979; thereafter relative availabilities were similar.

Block 719 generated more barred sand bass than did block 720. This is also a shallow-water species, but it prefers rocky, hard-bottom or sand areas. On the average, 30,000 barred sand bass were taken from the two blocks in the 1980s. Relative availability was considerably higher in block 719 after 1974.

*Pacific mackerel.* Catch of the nearshore, pelagic, migratory Pacific mackerel increased from the mid-1970s, and approximately 100,000 fish were taken in the 1980s (block 720 dominated the take). Catch was lower in 1983–85 than in 1977–82, but still surpassed pre-1976 by several orders of magnitude. Higher catches coincide with El Niño events, suggesting mackerel migration into the region (e.g., 1966, 1976–78, 1982–83). Relative availability patterns follow similar trends in the two blocks, but 719 values are generally higher. Mackerel are not always preferred or consumed by humans, and there are no bag limits.

*California barracuda.* Barracuda catches fluctuated over the half century. The 1971 decrease correlates with the imposition of a 28-inch (71-cm) size limit. The regulatory history for this species dates back to 1935 (not more than 5 fish weighing less than 3 pounds) and 1939 (inclusion in the maximum of 15 for aggregate species). The 28-inch (71-cm) size limit was introduced in 1949 (no more than

5 smaller individuals) and became more stringent in 1957 (daily maximum of 2 smaller individuals) and 1971 (none below size limit). Commercial restrictions have been consistent since 1940. The 1971 regulation may be promoting population recovery, because the catch of legal-size individuals has gradually risen. Catch appears to be related to migration from the south in warmer El Niño years: note the peaks in 1958, 1966, 1976, and 1983 (Figure 7a). Since 1971, total partyboat catch is on the order of 20,000 fish per year. Catch in block 719 was generally lower than in block 720 until 1980; the difference is accentuated in peak population years. Perhaps the rockier open coastline of block 720 is preferred. Almost identical relative availability patterns were observed in blocks 719 and 720 for over 40 years; however, availability in block 719 increased more rapidly after 1980.

*California scorpionfish (sculpin).* Fishermen were, on the average, four times more successful at catching the bottom-dwelling sculpin in block 719 than in block 720 through most of the 1970s (Figures 7a and 8); 1980–85 relative availability values were more comparable, although fewer fish were taken in block 719. Sediment contaminant burdens (Stull and Baird 1985; Stull et al. 1986 a, b) and reduced food availability (crabs, fish such as anchovies, cephalopods, shrimp; Allen 1982) may be reflected in the lower catch for block 720 and the relative availabilities of the late 1960s to late 1970s. Surface sediments in block 720 supported higher concentrations of wastewater-derived DDT, PCBs, metals, and organic matter, and less diverse infaunal and epifaunal communities. Sculpin are attracted to outfall structures (Allen et al. 1976). From 1970 to 1984 availabilities have opposite trends in the two blocks.

*Ocean whitefish.* Very few ocean whitefish were caught before 1960. In the succeeding 25 years, this species was more abundant during El Niño years, perhaps as a function of migration with warmer waters. Whitefish were more prevalent in block 719. Peak annual catch was in 1977, with about 35,000 fish taken. The typical average annual catch was less than 5,000. Block 719 had a higher relative availability, especially since 1966.

*California halibut.* Sportfishing regulations for halibut date back to 1949 (daily maximum, 10) and have been modified in response to concern for the population: 1956 (10 maximum, no more than 5 under 4 pounds); 1957 (no more than 2 shorter than 22 inches, or 56 cm); 1959 (2 maximum, no size limit); and 1971 (none shorter than 22 inches, or 56 cm, bag limit of 5). Imposition of the minimum size limit in 1971 probably explains more recent low counts of this sand-preferring bottom species. An earlier low catch (1956–57) coincided with El Niño conditions. Environmental degradation and loss of coastal and estuarine nursery areas may also impact this species. The total partyboat catch after 1971 was generally less than 500, as compared to highs of 15,000 in 1948 and 11,000 in 1964.

*Yellowtail.* Yellowtail catch was higher in major El Niño years (e.g., 1957, 1983); peak catch is consistently higher in block 720. Maximum total catch, in 1960, was approximately 32,000; the most recent peak (in 1983) was approximately 14,000 fish. In intervening years fewer than 4,000 were taken. Relative availability patterns were parallel in the two blocks, although availability in block 720 was higher, especially in 1960.

*White croaker.* In block 720, relative availability of white croaker was low from 1954 to 1961, from the mid-1960s to 1973, and in 1978. Catch generally increased after 1973, then plunged in 1985.

In block 719, relative abundance of white croaker was highest from 1950 to 1968, except for smaller catches in 1956, 1959, and 1966. Catch was generally lower in the 1970s and 1980s. The annual average partyboat take for block 720 in the 1970s and 1980s was about 750 croaker, and for block 719 was about 500. Relative abundance was clearly higher in block 719 until 1981, when it decreased below that in block 720. Since the 1950s, relative availability for block 720 has been more consistent.

White croaker are common in harbors and open coastal areas, particularly over organically enriched sediments. They are a ubiquitous, high biomass, easily taken species (Love et al. 1984). These omnivores inhabit a broad depth range. Tissues are fatty, and the lipophilic behavior of DDT and PCBs has resulted in elevated tissue concentrations of these chlorinated hydrocarbons. In 1985, the CDHS posted warnings along the shore advising that Palos Verdes and Santa Monica Bay white croaker should be avoided, and other sportfish consumption should be reduced to 1–2 meals per week. CDHS's interim guidelines further advised avoiding any fish from areas immediately around the Whites Point outfall, Gerald Desmond Bridge, and Cabrillo Pier (in Long Beach-Los Angeles harbors).

Reproductive abilities of white croaker may have been inhibited by environmental contaminants such as DDT or PCBs from treated waste-

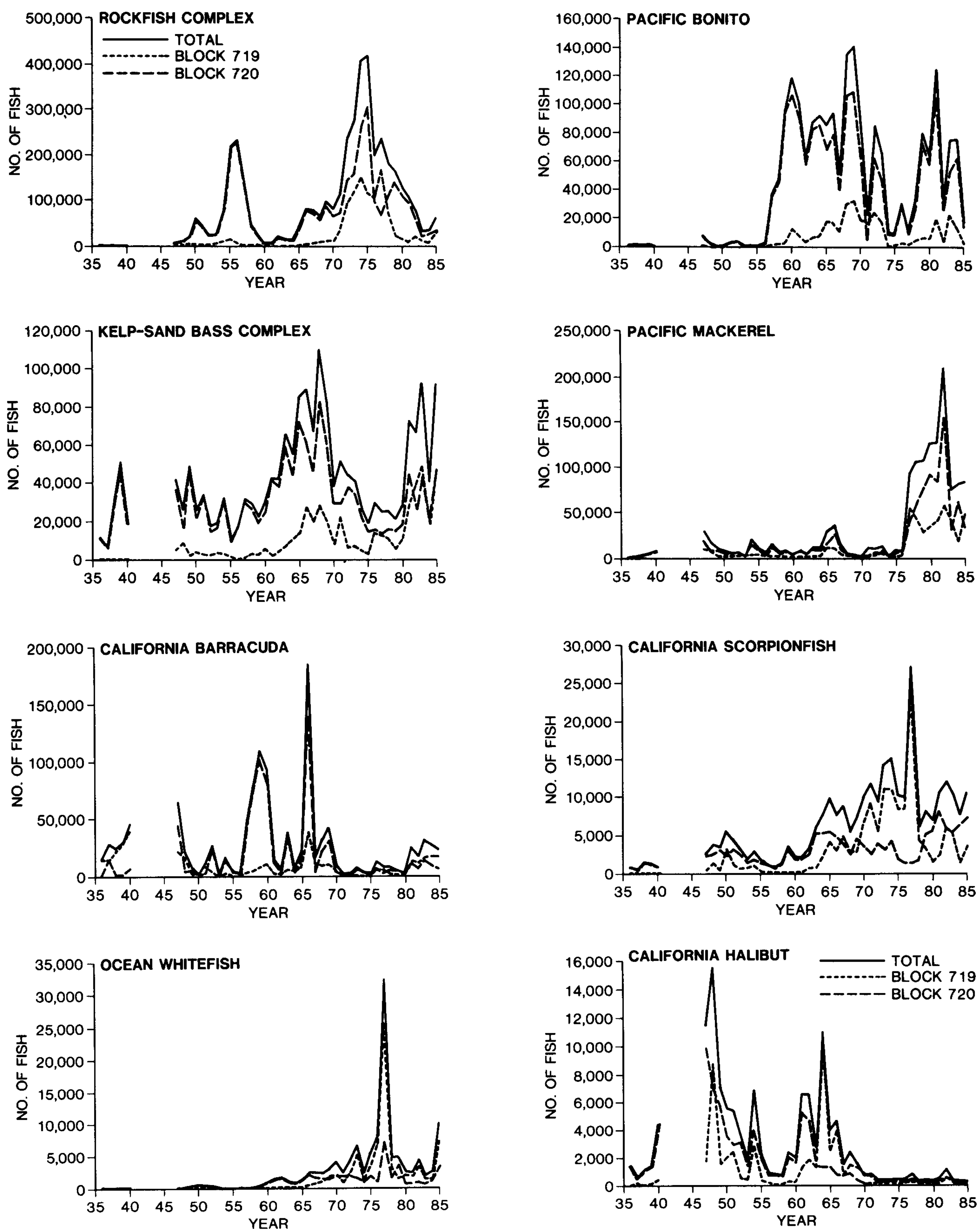


Figure 7a. Annual partyboat fish catches from Palos Verdes blocks 719 and 720, 1936–85.

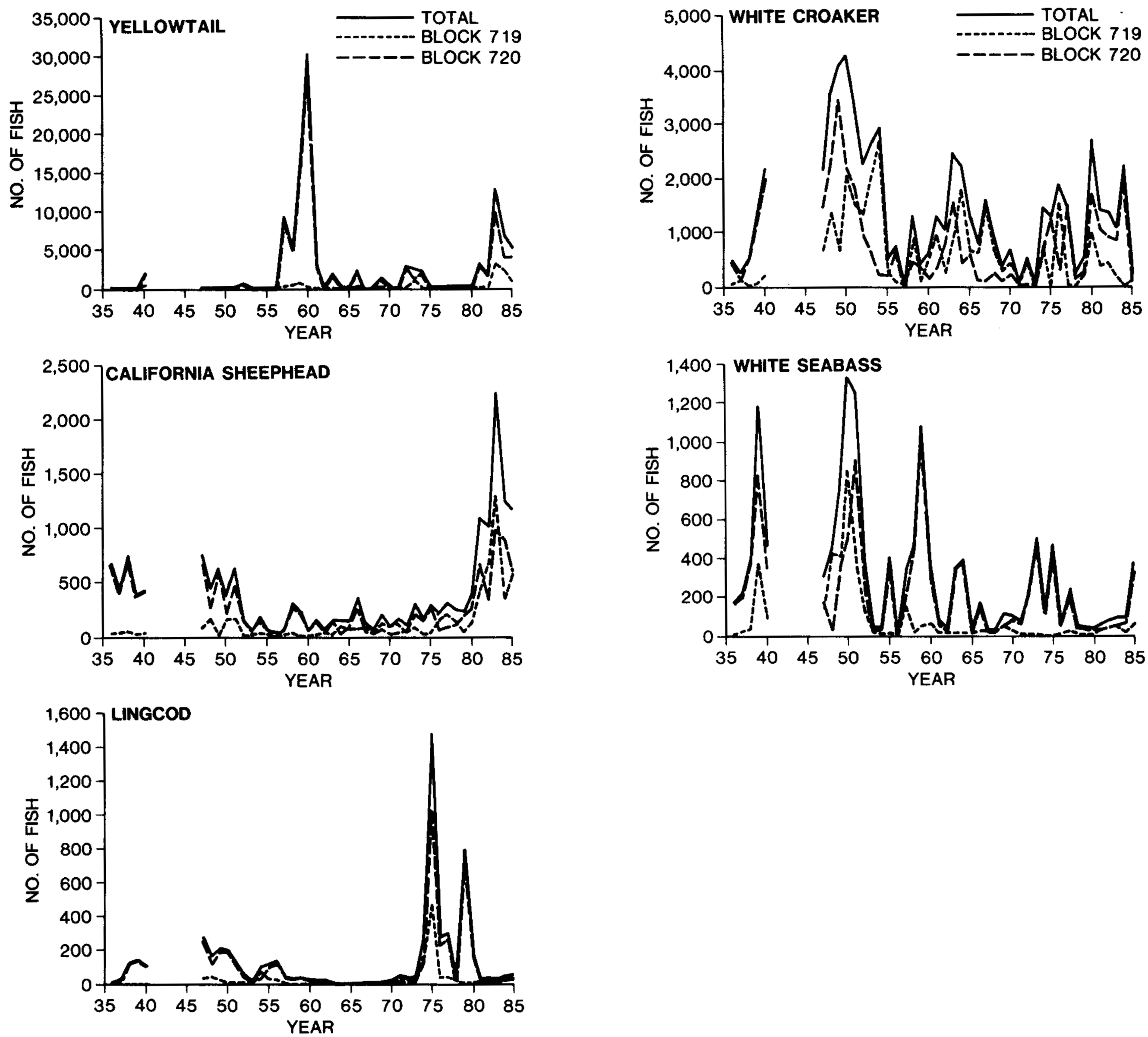


Figure 7b. Annual partyboat fish catches from Palos Verdes blocks 719 and 720, 1936–85.

waters, dumping, runoff, and aerial sources; these constituents accumulated in sediments and biota but decreased during the 1970s.

White croaker is not held in high regard by most experienced partyboat anglers. Two other potential reasons for an increase in recent recorded catches are the fish's appeal to Asian-Americans, whose numbers are probably increasing on partyboats, and increased use as bait for halibut or other predators. The recorded catch may include those kept for bait in addition to those taken home. There are no bag or size limits.

*California sheephead.* Sheephead take decreased in the 1950s and rose in the late 1970s and the 1980s. An improved nearshore environment (kelp, rocky regions) probably contributed to its stronger status (Figures 3 and 7b). Sheephead are more commonly taken in warmer years. Block 720 usually produced higher catches, and after 1955 relative availability was typically about twice as high in block 719. In the 1980s, approximately 2,300 sheephead were taken annually in the two blocks combined.

*White seabass.* White seabass catch fluctuated over the five decades, but in general its population appears to have declined off Palos Verdes, as elsewhere in the state (Vojkovich and Reed 1983). This shallow-water species has been rare in block 719

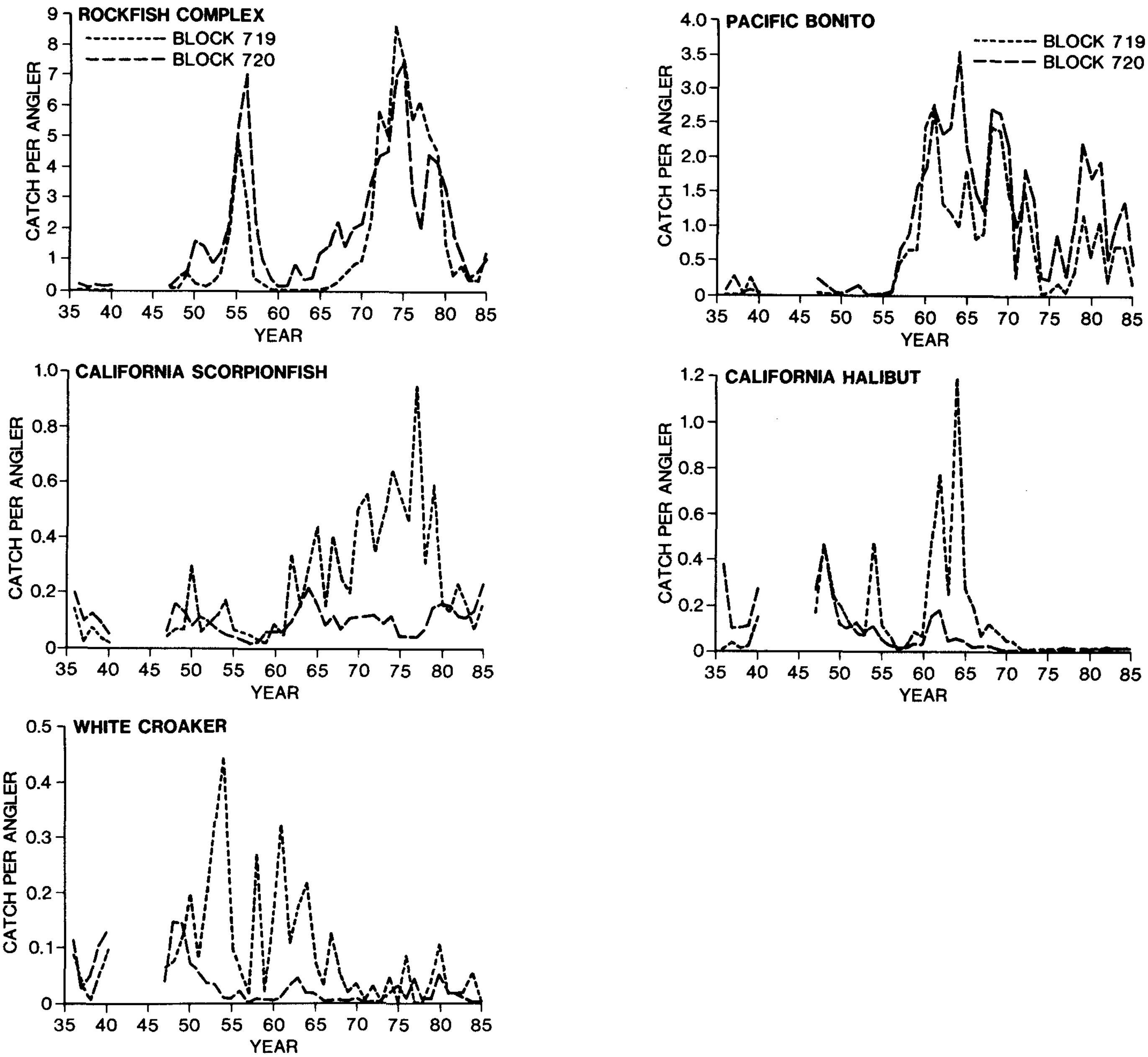


Figure 8. Relative availability of fish species off Palos Verdes, 1936–85.

since 1950; it may prefer the kelp and rocky points of block 720. Annual partyboat catch was usually less than 400 fishes from 1955 (except about 1,000 in 1959), and relative availability was low for both blocks.

*Lingcod.* Lingcod are not abundant in southern California; they are a more common game fish north of Point Conception or in areas of localized cold-water upwelling. Partyboat catch was highest from 1973 to 1980; 1975 and 1979 had sharp peaks in block 720, but there was only a 1975 peak in block 719. Maximum catch for the two blocks in 1975 and 1979 was 1,500 and 800, respectively; earlier and more recent annual catch was usually under 200 fish. There is no consistent pattern in relative availability or catch in the two blocks.

Several species (rockfish complex, sheephead, lingcod) displayed low catch records in both blocks from the late 1950s to early 1970s, and higher catch before and after this time. The low catches coincide with maximum effluent contaminant emissions and less control on other discharges into the marine environment. Kelp was virtually absent (Wilson et al. 1980; Meistrell and Montagne 1983). On the other hand, the pelagic bonito catches were highest during this period and may have diverted anglers' effort.

## MONTHLY PARTYBOAT CATCH

### *Palos Verdes Total*

There is an annual cycle of increased total catch and number of anglers during the late summer, and a decrease during the winter, shifting greatest catch availability to winter. A boat with a few experienced, resident anglers fishing for rockfish (15-fish limit, easily caught) in the winter will have a higher catch per angler than a boat filled with tourists seeking kelp bass or yellowtail (10-fish limit, high loss) during the summer. Palos Verdes fish catches and catch per angler generally show an inverse relationship: the 1970–78 portion of the catch history is magnified in Figure 9.

### *Individual Species*

Patterns vary by species. The most distinct annual catch cycle, with seasonal vulnerability, is found for bass. A similar pattern exists for halibut, barracuda, sheephead, and white croaker. Other species from Table 1 have more uniform vulnerability. Migratory habits (north/south, inshore/offshore), temporary habitat changes (e.g., kelp bed destruction by winter storms), or seasonal changes in targeted species may explain the cyclical catch patterns.

## ANNUAL COMMERCIAL CATCH

Commercial landings (in pounds or short tons), 1969–83, were also summarized by total catch, by species, and by block. Commercial fisheries are highly species selective, and more technological advancement in gear has increased fishing efficiency over the years. All commercial net fishing is prohibited in Santa Monica Bay, including a small section of block 720 north of Palos Verdes Point. Some species of fish cannot be harvested commercially (e.g., the kelp-sand bass complex, *Paralabrax* spp., since 1953). Often commercial catches parallel those from partyboats; however, economic pressures are more important in determining commercially targeted fish and effort, making it more difficult to correlate commercial catch and environmental parameters.

### *Palos Verdes Total*

Approximately 5 million pounds of fish and invertebrates were taken commercially from blocks 719 and 720 between 1969 and 1983, with peaks of over 14 million pounds in 1975 and 1976. Almost 70% of the catch, 1969–83, was northern anchovy; in 1975–76, 90% was anchovy (Figure 10). After 1978, anchovy's contribution decreased to 42%. Non-anchovy total poundage fluctuated with anchovy catch, rising in the mid- and late 1970s, and then declining in 1983, perhaps as a result of El

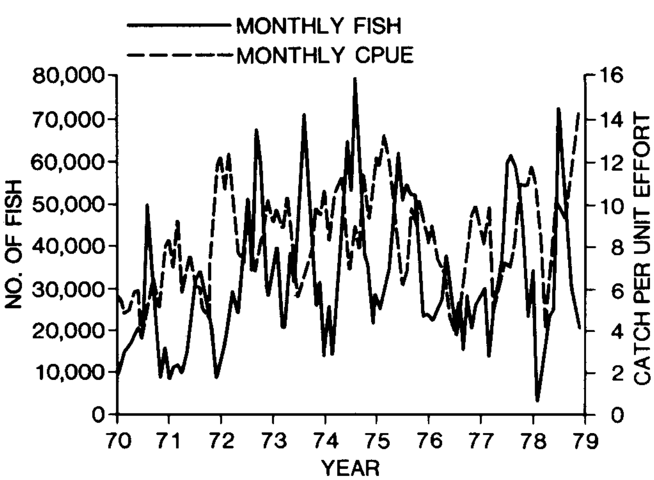


Figure 9. Monthly partyboat catch and catch per angler for Palos Verdes, 1970–79 (block 719 + 720).

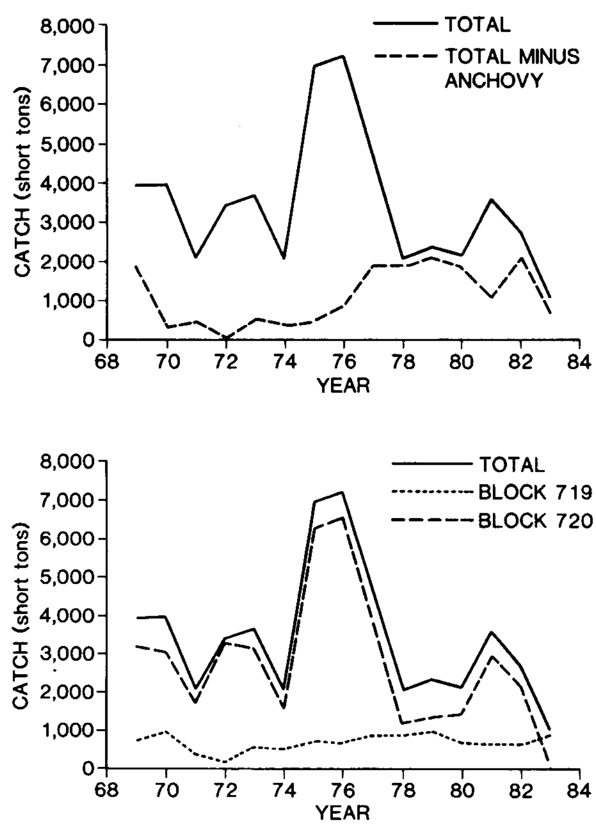


Figure 10. Annual commercial catch taken from the Palos Verdes region, including and excluding anchovy landings, 1969–83. Total catch represents a combination of blocks 719 and 720.

TABLE 5
**Commercial Percentage of Total Landings (1969–83)**

| | Block 719 | Block 720 | Palos Verdes* |
|---|---|---|---|
| Northern anchovy | 40 | 76 | 69 |
| Pacific mackerel | 9 | 4 | 5 |
| Pacific bonito | 5 | 2 | 3 |
| White croaker | 5 | 0.3 | 1 |
| White seabass | 0.3 | 0.3 | 0.3 |
| California halibut | 1.2 | 0.06 | 0.3 |
| Rockfish complex | 0.2 | 0.1 | 0.1 |
| California barracuda | 0.4 | 0.02 | 0.09 |
| California scorpionfish | 0.2 | 0.02 | 0.06 |
| California sheephead | 0.02 | 0.003 | 0.006 |
| Sea urchin | 3 | 3 | 3 |
| Rock crab | 0.8 | 2 | 2 |
| Market squid | 0.7 | 0.7 | 0.7 |
| California spiny lobster | 0.2 | 0.2 | 0.2 |

*Block 719 + block 720

Niño. Peak non-anchovy take was 4 million pounds.

Block 720 dominates both the partyboat and commercial catches. Anchovy predominates in both blocks, especially in block 720 (Table 5). A relatively steady annual catch of 500–1,000 short tons is taken from block 719; the catch from block 720 fluctuated up to 7,000 tons in peak anchovy years.

***Individual Species***

Commercial catches of ten common fish species and four invertebrates summarized below represent approximately 85% of the total poundage (Figures 11a, b).

*Northern anchovy.* From 1969 to 1983, the anchovy—a pelagic, mostly filter-feeding species—has supported an important fishery. Natural population fluctuations (especially in relation to sardine and mackerel abundances); usage (mostly as bait, meal, oil); and economic factors partly determine catch size. Forty percent of block 719 landings (0.5 million pounds) and 76% of block 720 landings (approximately 4 million pounds) were anchovy. Since 1978, catch has been below 1 million pounds, except for 1981's peak of 5 million pounds.

*Pacific mackerel.* The mackerel catch pattern reflects partyboat data and statewide trends (Klingbeil 1983) in its large rise from 1977: peak take (1.4 million pounds) occurred in 1982; the poundage plunged in 1983 (to about 175,000 pounds), possibly because of El Niño. The two blocks contributed equally.

*Pacific bonito.* Total bonito landings declined after 1969, when exceptionally high catches (almost 700,000 pounds) were taken from block 720. Total take was approximately 100,000 pounds per year from 1971, with 1975, 1982, and 1983 relatively unproductive.

*White croaker.* Eighty percent of the total commercial catch of white croaker was from block 719. Average total take over the 15 years was 75,000 pounds, with peaks in 1974 and 1979. The commercial catch pattern paralleled partyboat records. Increased use of monofilament gill nets may contribute to higher landings. Most white croaker are sold fresh, but some are used in Asian food products (Love et al. 1984).

*White seabass.* Highest numbers of white seabass were taken from 1971 to 1973 (60,000–85,000 pounds); the following decade typically generated 10,000–25,000 pounds of seabass. As with the partyboat data, block 720 was considerably more productive (82% of the 15-year catch).

*California halibut.* Commercial catch of halibut generally rose from 1974 to 1982. In 1981–82, 65,000 pounds were taken; in 1983, 50,000 pounds were collected. Eighty-three percent of the 15-year catch derived from block 719; only since 1979 have 5,000 pounds of this bottom-dwelling species been taken from block 720.

*Rockfish complex.* Annual commercial catch of rockfish showed an increasing trend from 1969 to 1980, with a maximum of 15 short tons. A statute effective in 1981 ruled that no rockfish could be taken commercially within the 50-fathom contour, unless incidentally: this probably contributed to the significant declines of the 1980s.

*California barracuda.* This species made up only 0.09% of the total 15-year Palos Verdes catch; however, its contribution has risen steadily since the early 1970s. Maxima were in 1980–82; in 1982 approximately 17,000 pounds were taken. Gear restrictions apply: no purse seining is allowed, but gill nets over 3.5 inches have been allowed since 1940.

*California scorpionfish.* On the average, total take was 1,000 pounds of sculpin between 1969 and 1980. Higher landings in 1981 (block 720, approximately 10,000 pounds) and 1982 (block 719, approximately 24,000 pounds) suggest selective fishing, as does the notable lack of sculpin in the 1970s, especially from block 719, when it was commonly taken by partyboats, although it was rarely a target species.

*California sheephead.* Total annual sheephead take was less than 200 pounds until 1978; about 600

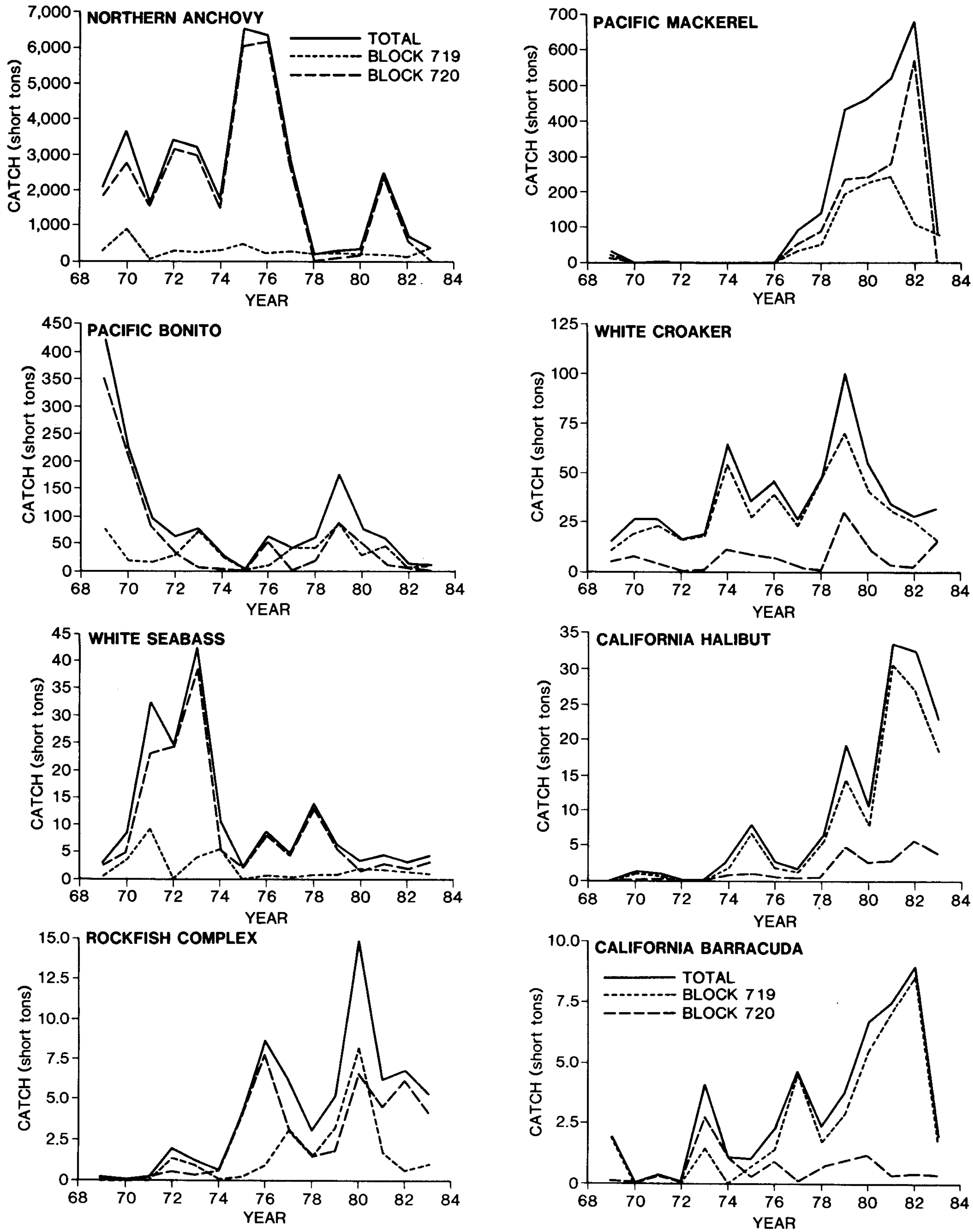


Figure 11a. Annual commercial catch of fishes and invertebrates from Palos Verdes, 1969–83: blocks 719, 720, and combined total.

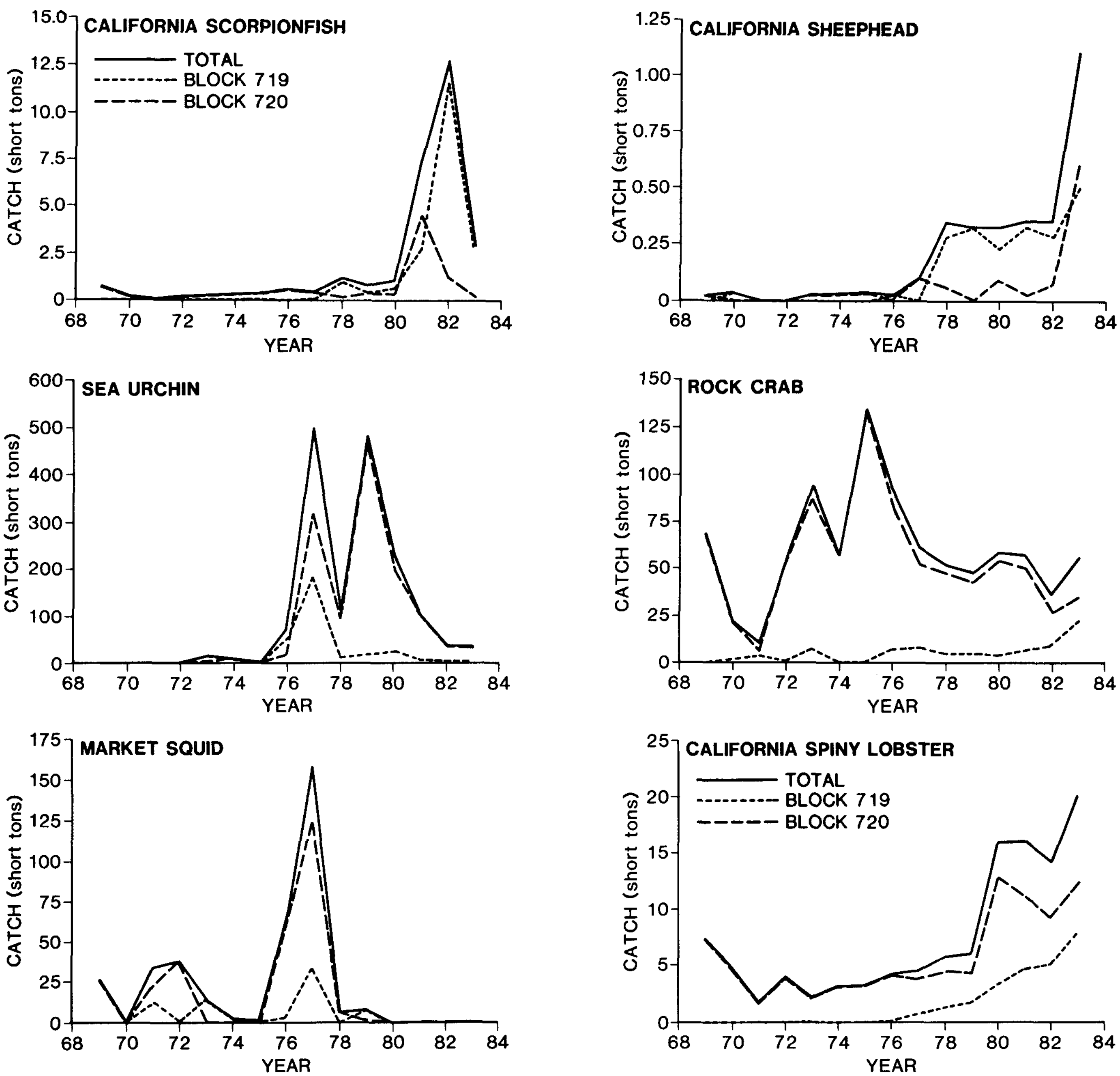


Figure 11b. Annual commercial catch of fishes and invertebrates from Palos Verdes, 1969–83: blocks 719, 720, and combined total.

pounds were taken per annum from 1978 to 1982; and 1983 generated 2,400 pounds. Block 719 catch generally exceeded that of block 720 (65%:35%); the discrepancy was most apparent from 1978 to 1982.

*Sea urchin.* The preferred species is the red sea urchin, *Stongylocentrotus franciscanus,* but the purple urchin, *S. purpuratus,* is taken coincidentally. Harvesting of sea urchins began on a large scale in 1976, and up to a million pounds were taken in 1977 and 1979. By 1982 fewer than 100,000 pounds were taken, mostly from the kelp bed regions of block 720. Only in 1977 were many taken from block 719. Both purple and red urchins were abundant on the shelf and were systematically removed (not commercially) in large numbers during initial kelp transplant efforts on Palos Verdes in the early 1970s. Red sea urchins became a harvestable resource (in terms of biomass and roe quality) following kelp restoration, when clearance and control efforts were directed toward purple urchins

(Wilson and McPeak 1983). Overharvesting of red urchins diminished stocks and gave purple urchins the competitive advantage: in the 1980s reds are scarce, and purples occupy much of the niche formerly occupied by red urchins. Severe storms in 1982–83 displaced many purple urchins. White urchins (*Lytechinus anamesus*) have also moved onto the shelf in large numbers in the 1980s (Wilson, pers. comm.).

*Rock crab.* Block 720 yielded most of the rock crabs (*Cancer* spp.) taken from the Palos Verdes region. Maximum harvest, in 1975, was over 125 tons; average take is under 50 tons.

*Market squid.* The erratic appearance of *Loligo opalescens* in the catch is probably related to water temperature and vagaries of spawning areas, where squid are caught commercially. Maximum landings occured in 1977 (over 300,000 pounds), but typical catch is less than one-third this peak. Most squid were from block 720.

*California spiny lobster.* Lobster landings increased from the early 1970s, and highest catches in the 1980s averaged over 15 tons. Monthly catch records show seasonally controlled harvesting.

*Kelp.* The giant kelp (*Macrocystis pyrifera*) was commercially harvested from four CDFG-designated kelp beds ringing the Palos Verdes Peninsula between 1916 and 1954 (State Water Resources Control Board 1964). Tonnage information is confidential; however, relative values are available as annual percentage harvest from various beds, using the year of maximum yield as 100%. Data on areal coverage of the canopy and percentage harvested show that the first thinning and disappearance occurred in areas closest to the ocean outfalls; subsequent deterioration was observed at greater distances (State Water Resources Control Board 1964). The complex combination of factors influencing the decline and subsequent restoration of kelp forests (from the mid-1970s) is summarized in Wilson and McPeak (1983). Kelp canopies provide food and refuge for larval and adult fish and for invertebrates such as urchins, lobster, and abalone. The availabilities of many potentially harvestable marine resources are related to kelp coverage.

## MONTHLY COMMERCIAL CATCH

There is a pronounced monthly cycle for commercial catch data. For most species, there is either a relatively large catch or none, depending on legal seasons, seasonal fishing effort, species availability, fish migratory patterns, and other factors. The highest totals occur in the summer.

## SUMMARY

Among the partyboat catch data, the 13 fish taxa may be grouped into several temporal patterns:

Rockfishes, ocean whitefish, sculpin, and lingcod all peaked sharply in the mid- to late 1970s, followed by steep declines and slight rises by 1985. Rockfish had an earlier maximum in 1956–57. Lingcod had a second peak in 1979.

Three pelagic fish—mackerel, bonito, and yellowtail—showed steep increases in catch in the early 1980s, but other catch histories are poorly related. For mackerel, all recorded catches were relatively low until 1977, when a rising trend began (peak of 210,000 taken). The 1983–85 catches were half that of 1982. Bonito was commonly caught from 1957 to 1973, but the catch was low in the mid-1970s and 1985. Yellowtail catches are most closely associated with water temperature: peaks in 1960 and 1983 were higher than others.

The kelp-sand bass complex declined in the 1970s but rose in the 1980s with notable habitat improvements (kelp canopy increased, sediment contamination decreased). Comparably high bass catches were recorded in the mid-1960s. Similarly, sheephead rose in the 1980s, following low counts since the early 1950s.

Halibut and barracuda takes decreased in 1971, when minimum size limits were imposed. Barracuda limits appear to have helped restore the resource, as reflected in rising catches. This species clearly prefers warmer waters. Halibut population recovery is not observed in these data. Young fish prefer estuaries and coastal wetlands, which are greatly diminished habitats in southern California.

White croaker catch fluctuated a great deal over the half century. Lows in the late 1950s, early 1970s, and 1978 may be attributed to differences in recruitment success, desirability by consumers, or reporting criteria. However, the 1985 decrease clearly coincides with concern for human health generated by CDHS warnings of chlorinated hydrocarbon contamination in fish tissues.

White seabass have generally declined since the 1950s; the appearance of this "good year-bad year" species may be related to migration, but overall this species is a source of concern.

The period from 1981 to 1985 has been characterized by higher than 50-year average takes for mackerel, sheephead, kelp-sand bass complex, yellowtail, scorpionfish, ocean whitefish, and bonito. The 1981–85 catches were lower than average for halibut, lingcod, white seabass, and rockfishes, and similar to the 50-year average for white croaker and barracuda. The mackerel represents the greatest resurgence in a fishery resource, although significant rising trends in the kelp-sand bass complex and sheephead are encouraging.

Among the commercial catches (1969–83), shorter-term temporal patterns are as follows.

Mackerel, halibut, sculpin, and barracuda landings increased steadily until 1982, and then declined sharply in 1983, possibly because target species changed during El Niño conditions. Barracuda takes rose from 1973, halibut catches rose from 1974, mackerel from 1977, and sculpin from 1981.

Rockfish take also increased over the 15 years, and landing trends were often the inverse of those for halibut.

Sheephead landings also began a rise in 1977; the best year was in 1983.

Poundage of anchovy and white croaker fluctuated continuously, but 1982 and 1983 catches were low in all cases.

Bonito take, also low in 1982–83, dropped sharply between 1969 and 1972 and never recovered to previous weights.

White seabass poundage peaked in the early 1970s, decreased in 1974–75, and low catches were reported through 1983.

The Palos Verdes Shelf has provided a substantial resource to southern California fisheries over the past half century. Total reported partyboat catches were 11.5 million fish from 1936 to 1985; commercial landings were 52,000 short tons for 1969–85. Relative species takes fluctuated in response to many environmental and societal factors, and caveats are implicit in any suggested correlations between species catches and underlying sources of variability. A multivariate analysis of long-term data might contribute to a better understanding of specific causal relationships. Also, Palos Verdes fisheries data should be compared to other urban and "control" regions, and to Southern California Bight and statewide data. Unfortunately, this was beyond the scope and effort allocated to this project.

## ACKNOWLEDGMENTS

Joyce Underhill and the personnel of Marine Fisheries Statistics, Department of Fish and Game, were helpful in providing commercial fisheries catch records. CDFG reports, including Marine Biological Consultants (1985), gave substantial guidance. Tsam Wong plotted hydrographic data. Irwin Haydock's advice and constructive reviews are appreciated.

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