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REGIONAL AND LOCAL VARIATION OF BOTTOM FISH AND INVERTEBRATE POPULATIONS

One of the projects included in our recently completed research for the EPA was an assessment of the abundance and distribution of demersal fish and invertebrates along most of the southern California coast (Mearns et al. 1976). As part of this work, we also evaluated the responses of the nearshore fish communities to municipal wastewater discharges.

Since 1912, public and private agencies and universities have taken thousands of otter trawl samples in southern California. During the past year, we analyzed catch statistics from over 2,400 samples taken off the coast between Santa Barbara and San Diego and near some of the offshore islands; contemporary surveys (1957 to 1975) provided the bulk of the samples analyzed. Sampling covered a depth range of 5 to 659 m, providing data on 197 species of fishes, sharks, and rays and nearly 400 species of invertebrates, mostly shrimp, crabs, echinoderms, coelenterates, and larger molluscs. Although most fishes captured were small species that are not presently of commercial interest, the young and juveniles of many sport and commercial species were also taken.

An average 10-minute otter trawl with a 7.6-m (25-ft) net, captures about 175 fish representing about 11 species and weighing 7.1 kg, with an average Brillouin diversity of 1.28 (Shannon-Weaver, 1.36; Table 1). However, regional and temporal variations are large and reflect differences in gear and fishing technique as well as real differences in abundance and diversity.

REGIONAL PATTERNS

An overview of present data suggests that fish abundance, biomass, numbers of species, and diversity increase as one approaches San Pedro Bay from San Diego in the south or Santa Barbara in the north (Table 1). Catches off Palos Verdes and in San Pedro Bay usually exceeded the average; catches at Point Loma, Santa Catalina Island, Santa Barbara, Ventura, and Oxnard were

relatively low in diversity, number of species, and abundance; and values for Santa Monica Bay were intermediate.

Although these data suggest that the Los Angeles and Orange County coastal areas have been supporting the most abundant and diverse fish fauna, some qualifications are necessary. For example, surveys in outlying areas such as Santa Barbara and Oxnard have included few samples deeper than 60 m; yet, in our synoptic survey (Mearns and Greene 1974), depths beyond 60 m yielded the largest catches.

LONG-TERM CHANGES

Catches in any area vary seasonally and from year to year. In the surveys studied, fish catch varied nearly an order of magnitude over several years, but the number of species and diversity varied considerably less. In fact, relative to abundance, the average number of species taken off Orange County (San Pedro Bay) has been remarkably stable over 26 quarterly surveys (Figure 1). The small temporal variation in numbers of species may be useful for indicating localized regional differences.

The order-of-magnitude fluctuation in abundance of fish at Orange County during the past 7 years is noteworthy. The years 1971 and 1975 produced some of the highest catches; catches were low in 1969, 1970, 1973, and early 1976. The long-term fluctuations in catch parameters, particularly fish abundance and biomass, depend largely on the overall "recruitment"—that is, the number of young individuals of various species that settle out of the plankton into the coastal area. During some years, large numbers of juveniles of certain species (particularly sanddabs (*Citharichthys* spp.) and rockfishes (*Sebastes* spp.)) successfully settled off southern California, thus greatly increasing the average fish abundance. However, successful recruitment does not occur in the same year for all species; recruitment in several species appears to be aperiodic or to occur in cycles of 2 or more years (e.g., stripetail rockfish, *Sebastes saxicola*) . Many demersal species had poor recruitment success in the warm years of 1957 to 1959 (Carlisle 1969) and the years 1974 to 1975. It appears that, when water masses from outside the area enter the Bight (as in late 1972 and early 1973), they bring planktonic juveniles of species more common to the north or south of the Bight, and the average number of fish species and diversity increases.

RESPONSES TO WASTEWATER DISCHARGE

Palos Verdes Shelf

A relatively abundant bottom-fish fauna has inhabited the Palos Verdes shelf for the past 5 years. An area of depressed fish abundance and diversity, however, exists 1 to 6 km northwest of the Whites Point outfall at depths from

60 to at least 140 m. This area is generally surrounded by areas of increased abundance and biomass, particularly near but downcoast of the outfall, where ridgeback prawn (*Sicyonia ingentis*) abundance shows an increase. Certain bottom-dwelling fishes and invertebrates common in other coastal areas and at Palos Verdes control stations have been rare or absent near the outfall, although some are replaced by ecologically similar species. The most striking effect of the discharge continues to be the high prevalence of a fin erosion disease in Dover sole (*Microstomus pacificus*) and several other species of bottom fish.

Southern San Pedro Bay

In April 1971, Orange County Sanitation Districts discontinued use of a shallow (15 m) outfall and began discharging through a deep (60 m) diffuser. The switch resulted in a rapid 50 percent decrease in fish abundance at the abandoned outfall. One year after the discharge through the new outfall was initiated, fish abundance there had increased 100 percent. In addition, a significant increase in both numbers of species and abundance occurred immediately downcoast of the new discharge pipe at 60 and 100 m depths.

Santa Monica Bay

Data collected in Santa Monica Bay from 1957 to 1963 (Carlisle 1969) and more recently reveal areas of low numbers of bottom fish species and abundance in the immediate vicinity of the ends of the 7-mile sludge and 5-mile effluent pipes of Hyperion Treatment Plant. Several common bottom fish species are also rare, although rockfish (*Sebastes* spp.) occur in abundance near the pipe (Alien et al. 1976). At depths greater than 50 m, both pipes have dense populations of a large white sea anemone (*Metridium senile*); these organisms are often most densely clustered around diffuser ports. Fin erosion disease occurs infrequently in Dover sole and greenblotched rockfish (*Sebastes rosenbtatti*) near the end of the sludge pipe.

Point Loma Shelf and Oxnard Shelf

Surveys in the vicinity of the Oxnard and Point Loma out-falls do not reveal major effects of the discharges on demersal fish and invertebrate populations. Most trawl catch parameters are relatively low in both of these regions.

REFERENCES

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Table 1. Regional values of fish catch parameters from trawl data collected from Santa Barbara to Point Loma, California, 1957 to 1975. After Mearns et al. 1976.

Region and Date	No. of Surveys	Total No. of Samples	Fish Catch Parameters (mean and standard error of means/haul/survey) No. of Individuals	Biomass* (kg)	No. of Species	Brillouin Diversity
Santa Barbara, 1967-69	2	61	95		12.2	1.50
Ventura, 1972	1	14	64	–	8.1	1.15
Oxnard, 1971-75	6	74	147 ± 63	3.5 ± 0.7	8.5 ± 0.7	0.91 ± 0.05
Santa Monica Bay, 1957-75	32	853	139 ± 17	7.6 ± 2.6	10.0 ± 0.4	1.23 ± 0.06
Palos Verdes, 1970-75	13	296	267 ± 48	10.7 ± 4.4	12.6 ± 0.7	1.28 ± 0.08
San Pedro Bay, 1969-75	32	362	420 ± 31	13.4 ± 4.1	16.1 ± 0.5	1.64 ± 0.06
Dana Point, 1971-74	13	347	150 ± 27	6.2 ± 3.5	12.5 ± 1.2	1.50 ± 0.21
Oceanside, 1969-73	4	186	192 ± 64	–	10.7 ± 0.4	1.27 ± 0.21
Point Loma, 1975	2	17	97	5.0	9.9	1.28
Santa Catalina Island, 1971-75	4	27	162 ± 46	3.3	9.6 ± 2.4	1.06 ± 0.57
All regions 1957-1975	110	2,237	173 ± 33	7.1 ± 1.4	11.0 ± 0.8	1.28 ± 0.07

*The biomass of some samples was not measured.

Figure 1. Long-term changes in abundance, number os species, and diversity of fish at Orange County, August 1969 to October 1975. Vertical lines indicates 95% confidence limits.