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BOTTOM FISH POPULATIONS BELOW 200 METERS

A few kilometers from the shores of Los Angeles and Orange Counties, the gently sloping coastal shelf steepens, descending into the cold, low-oxygen water of Santa Monica and San Pedro Basins. All of the municipal wastewater outfalls in this region discharge on the shelf at depths less than 200 meters, and most of the past trawl sampling has also been done at these depths. Some pollutants doubtless are present in sediments at greater depths, but we know little about demersal communities at those depths. Consequently, the Coastal Water Research Project conducted a series of trawl surveys this year to begin documenting biological conditions in deeper water. This article describes the abundance, diversity, and health of demersal fish populations found between the depths of 200 and 610 meters off southern California and compares this deepwater fauna to that occurring at shallower depths; the benthic invertebrate fauna seen in this survey is described in the following article.

We looked for depth-related trends in fish population and community variables and found such trends in fish abundance, biomass, size, numbers of species, species com-position, and prevalence of fin erosion disease. Fish abundance and biomass were greatest along deeper portions of the coastal shelf and along the coastal slope, but were low in shallow coastal areas and in the upper basins. Most deepwater demersal fish species were represented by relatively large individuals: Fishes found at depths greater than 200 meters weighed five times as much on the average as fishes taken in shallow water. Fewer species were taken in deep water, and the species composition changed with depth. Midwater, open-ocean species were taken incidentally in daytime bottom trawls at depths of 460 meters and greater. Fin erosion disease in Dover sole (*Microstomus pacificus*) occurred to 460 meters in the vicinity of the municipal wastewater outfall systems off Whites Point and in Santa Monica Submarine Canyon; however, we took no diseased Dover sole between Whites Point and Santa Monica Canyon along the 460-meter isobath.

The deepwater fish fauna in this area was initially sampled by beam trawl from the *Albatross* during the U.S. Fish Commission surveys of the Southern California Bight from 1888 to 1911; many of the species found at great depths were described originally from fishes collected in these surveys. Although a number of agencies and institutions have trawled the ocean floor below 200 meters, rarely have accounts of these deepwater populations been published. Fitch (1966), however, described fish and invertebrate catches taken from a series of deep trawls off Santa Catalina Island. The demersal. fish fauna at these depths is much better known along the northwest coast of the United States, where the trawl fishery often concentrates its fishing effort at depths greater than 200 meters; Day and Pearcy (1968) described deepwater fish communities off the Oregon Coast, and Alton (1972) showed depth-related trends in fish populations there.

From September 1976 to May 1977, the Project sampled stations from two transects running perpendicular to shore to study depth-related trends; one transect along the 460-meter isobath between Point Dume and Laguna Beach was also surveyed to study regional variation along a single isobath (Figure 1). The perpendicular transects were in Santa Monica Bay and on the Palos Verdes Escarpment and covered stations at 20, 60, 140, 180, 300, 460, 610, 700, and 800 meters; shallow stations (20 to 140 meters) off Palos Verdes were sampled during the fall and spring trawl monitoring cruises of Los Angeles County Sanitation Districts. In all, we took 26 samples from 22 stations; 15 of these samples were taken from depths greater than 200 meters. We sampled all stations with a 7.6-meter (head-rope length) otter trawl with a 1.25-cm cod-end mesh; the net was towed along an isobath at 3.7 km/sec (2.0 kn) for 10 minutes at stations inshore of the 200-meter isobath and for 20 to 30 minutes at stations below the 200-meter isobath. We decreased the scope ratio (ratio of towline length to depth of water) from 4:1 at 20 meters to 2:1 at 610 meters. At 700 and 800 meters, the scope ratio was less than 2:1 (the vessel's towline was only 1,340 meters in length), and the net did not touch bottom; hence, the data from these stations are on water-column fishes. We took bottom water samples with a Nansen bottle and measured temperature and dissolved oxygen (using the Winkler-azide method); however, the values obtained were anomalously low. Temperatures in the upper layers were measured with a 140-meter bathythermograph. Sediment samples were taken with a Van Veen grab.

A total of 5,848 fish, representing 69 species and weighing 433 kg, were taken; 1,903 of these (38 species weighing 215 kg) were taken at depths greater than 200 meters, and 3,945 (46 species weighing 218 kg) were taken at depths less than 200 meters. Twenty-three fish from 7 species were taken in midwater tows at depths greater than 610 meters. Fish abundance, biomass, and numbers of species (Figure 2) were relatively low below 200 meters; fish abun- dance and biomass were also low at the shallowest stations. Fish diversity showed little variation with depth, although it was somewhat lower at 60 meters (Figure 3). Although shallow stations yielded many juvenile fishes, deepwater samples included juveniles of only two demersal species— the shortspine thornyhead (*Sebastolobus atascanus*) and long-spine thornyhead (*S. altivelis*).

Deepwater samples differed in species composition from those in shallow water; 34 species were taken only at depths less than 200 meters, and 23 species were taken only at depths greater than 200 meters. The most frequently occurring deepwater species were the Dover sole and sable- fish (*Anoptopoma fimbria*), which were found in all deepwater bottom samples. Dover sole generally dominated the trawl catch off Whites Point, whereas rockfishes such as the splitnose rockfish (*Sebastes diploproa*), shortspine thorny- head, and longspine thornyhead generally dominated the catch at other deepwater stations. In all, we took 676 Dover sole, 384 longspine thornyhead, 207 shortspine thornyhead, and 150 splitnose rockfish in deep water.

The most frequently occurring shallow-water species were stripetail rockfish (*Sebastes saxicola*), which were present in 64 percent of the samples, and Dover sole, plainfin mid-shipman (*Porichthys notatus*), California scorpionfish (*Soorpaena guttata*), and shortbelly rockfish (*Sebastes jordani*), which occurred in 54 percent of the samples. The most abundant shallow-water species were the calico rockfish (*Sebastes dalli*), speckled sanddab (*Cithapiohthys stigmaeus*), and slender sole (*Lyopsetta exilis*), which were represented by 673, 624, and 620 individuals, respectively.

Although a number of similar species form depth-displacement series at depths shallower than 200 meters, only one such series was noted below this depth—the short-spine thornyhead dominates the catch at 300 meters and the longspine thornyhead at 460 and 610 meters. Dominant mesopelagic fishes at 460 meters and greater included the northern lampfish (*Stenobrachius leucopsarus*) and Mexican lamp-fish (*Triphoturus mexicanus*).

Fin erosion disease in Dover sole was found at depths of up to 460 meters off Whites Point (Figure 4), although the disease was less prevalent with increasing depth (prevalence of the disease was 52 percent at 140 meters and 23 percent at 460 meters). The disease was also seen in Dover sole taken at 460 meters in Santa Monica Canyon. In addition, fin erosion was prevalent in other fish populations in the outfall areas: 11 percent of the rex sole (*Gtyptocephatus zaohirus*) taken at 180 meters on the Palos Verdes shelf had eroded fins, as did 14 percent of the slender sole taken at a depth of 180 meters in Santa Monica Canyon. No diseased fishes were taken along the 460-meter isobath between Palos Verdes and Santa Monica Canyon.

In 1974, the Project surveyed bottom waters at depths below 200 meters in this coastal area and found them to be relatively cold (less than 9.5°C) and low in oxygen (less than 4.0 mg/liter; Mearns and Word 1975). Assuming that bottom water conditions this year were comparable to those in 1974, the bottom fishes and invertebrates captured at depths between 200 and 610 meters were living in waters with temperatures ranging from 5.5 to 9.5°C and dissolved oxygen concentrations ranging from 0.6 to 4.0 mg/liter.

Below 200 or 300 meters, fish abundance, biomass, and numbers of species appear to vary directly with decreasing temperature and dissolved oxygen. At depths less than 200 meters, this relationship does not hold—catches de-creased at the shallowest depths. The increase in average size of the fish in deeper water primarily reflects a de-crease in the number of juvenile fish with depth. The apparent inverse relationship between fish size and temper-ature and dissolved oxygen suggests that juveniles are less tolerant of physical conditions in deeper water; alternatively, the abundance of juveniles may vary directly with food availability or some other unmeasured factor that may be more favorable in shallow water.

Trawling at depths greater than 200 meters required certain adjustments to our normal trawling equipment and procedures. We found cylindrical plastic floats (3.0 cm in diameter and 13.0 cm long; No. 125, Janus, Inc., Inglewood, California) to be effective to 610 meters; the plastic ellipsoidal float (5.5 cm in diameter and 12.0 cm long) that we generally use in shallow water collapsed from the in-creased pressure at 300 meters and deeper. Because of the increased time involved in dropping and retrieving the net in deep water and the increased possibility of a poor sample, we extended the duration of the deepwater tows from 10 minutes to 20 or 30 minutes to insure a positive catch. However, fish and invertebrate catches were greater than expected: Because of the quantity of data taken at depths of less than 200 meters with 10-minute tows, we recommend that the trawl net be towed for 10 minutes to depths of at least 600 meters in future studies.

The success of these surveys is largely due to the un-tiring efforts of Harold Stubbs, head of the Project Marine Operations. We also thank Mike Moore, Jack Word, Bob Voglin, Brad Myers, and Jean Wright of the Project and the biological field staff of the Los Angeles County Sanitation Districts for their help in gathering these data. A more detailed summary of these data will be assembled in a Coastal Water Research Project technical memorandum.

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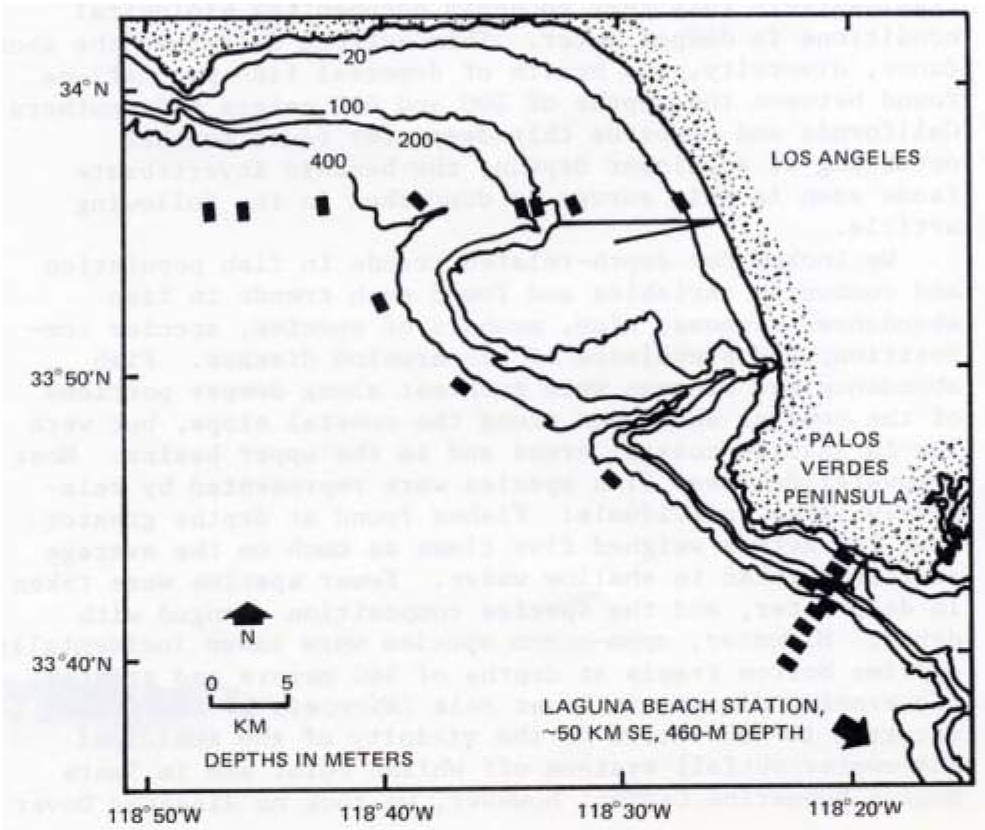

Figure 1. Shallow and deepwater trawl stations sampled during 1976-77 by the Coastal Water Research Project.

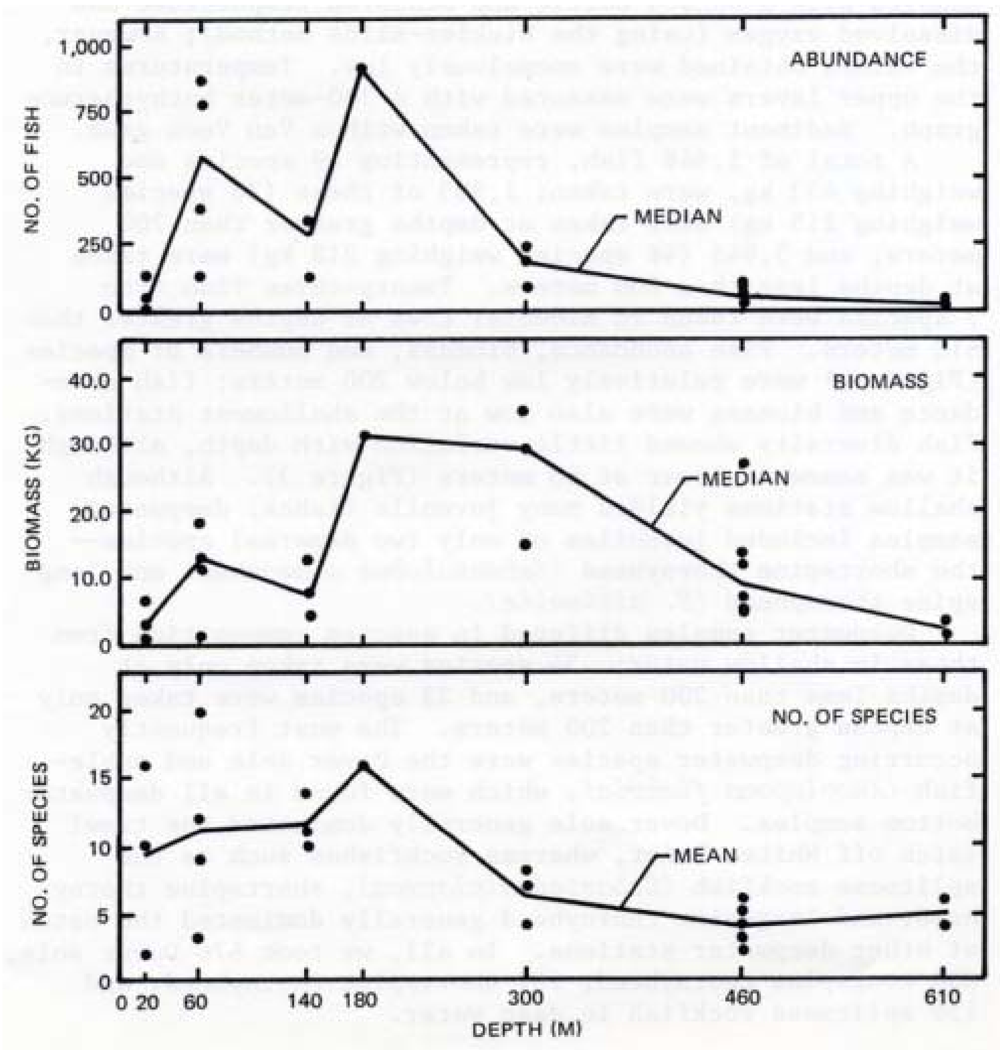

Figure 2. Fish abundance, biomass, and number of species captured per 10-minutes of trawling (about 3,200 sq km) in deepwater trawl survey, 1977.

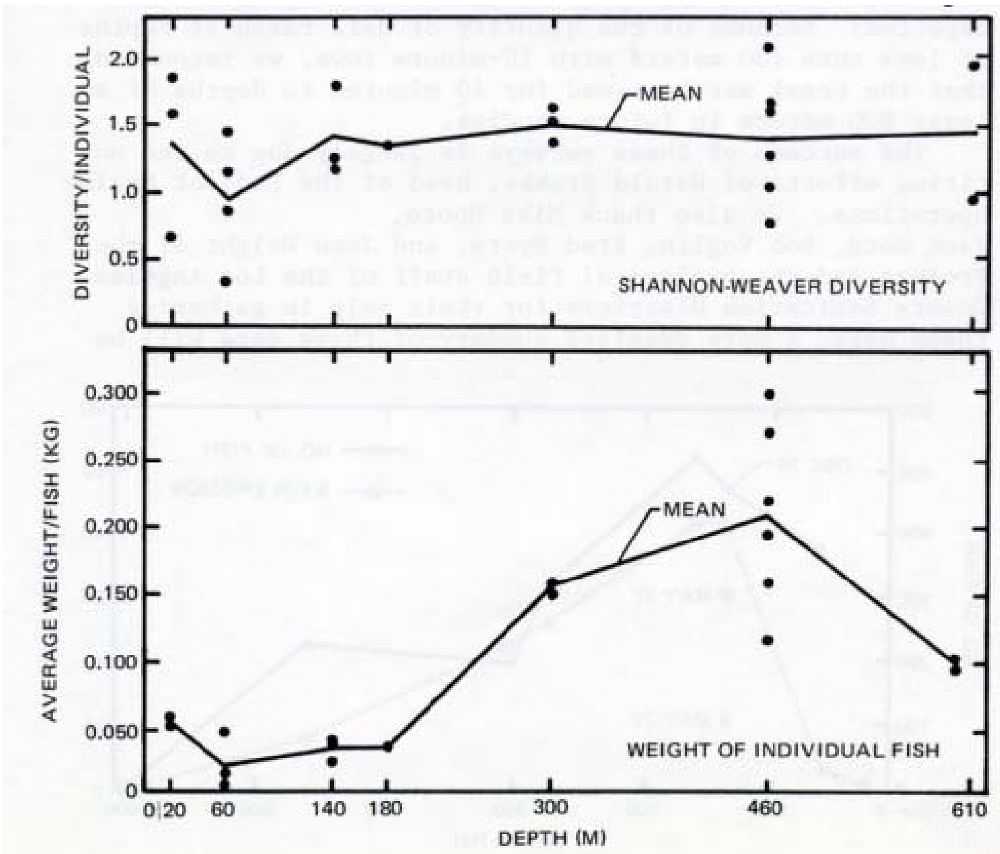

Figure 3. Shannon-Weaver diversity and weight per fish in 1977 deepwater trawl survey.

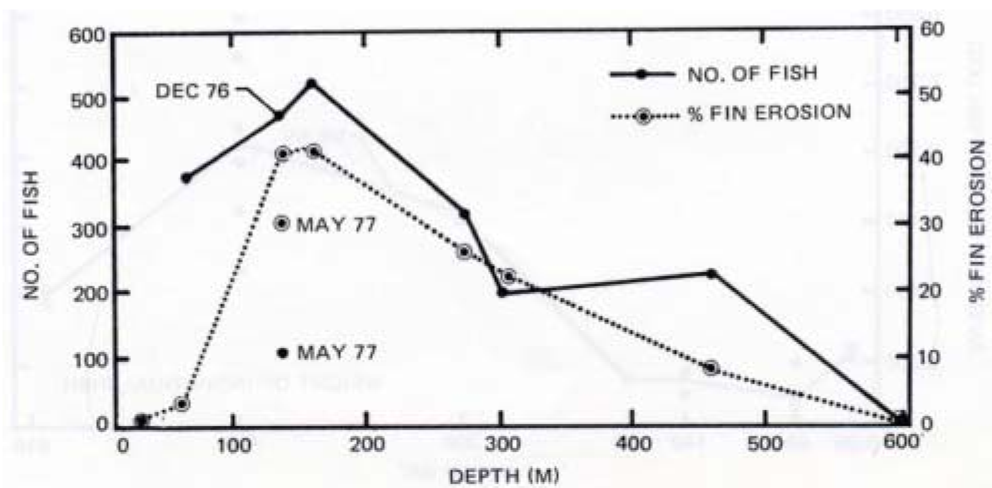

Figure 4. Prevalence of fin erosion disease in Dover sole taken in 1977 deepwater trawl survey.