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BETTER CONTROL STATIONS: THE 60-METER SURVEY

The effects of municipal wastewater discharges can only be determined by comparing them with normal background or "control" conditions. Control locations for many monitoring programs conducted by wastewater dischargers have been the stations within their sampling grid that are located at the greatest distance from the discharge source (up to 16 km) or stations located at equivalent depths and wave exposures off one of the southern California islands. Although some of these "control stations" may actually be located far enough from the discharge to be considered "normal" for this shelf, others do not appear to be. The number of control stations monitored is relatively small compared to the number of stations in the discharge zone; therefore, there is only a small base of control data. The size of this data base makes it difficult to determine the natural variabilities of many basic parameters—a necessary prerequisite to the interpretation of data on changes occurring near sources of discharge.

This year, a new synoptic survey of the southern California shelf was conducted at a depth of 60 meters. Our objectives were to survey the trawl-captured fish and invertebrates, the benthic infauna, and various physical and chemical characteristics of the water column. We also planned to measure physical and chemical characteristics of the sediments and the tissues of selected organisms. The survey was conducted during a single season (late spring to early summer) and covered 73 stations between Point Conception and the U.S./Mexican Border (Figure 1).

Although analysis of these samples is still in pro-gress, we have already observed trends in the water-column conditions and in data from the trawls. The objectives of this report are to briefly describe our sampling plan and report initial findings.

There have been a number of synoptic intertidal surveys of plants and animals along the southern California coast. However, there have only been a few regional subtidal surveys (e.g., Jones 1969; Schoti 1975), although extensive investigations of smaller areas have been made by the local sanitation agencies and others (Carlisle 1969; Mearns and Greene 1974; Smith 1975). The Bureau of Land Management is currently sup-porting benthic studies involving stations clustered around various islands, banks, and points on the southern California shelf. However, there has not been a survey that provided data on the regions between these intensively studied areas or combined investigations of trawl-caught organisms, benthic infauna, and

water chemistry and physical and chemical analysis of sediments and tissues of organisms collected throughout the Southern California Bight.

We planned to sample stations at 10-km intervals between Point Conception and the U.S./Mexican Border, a coastline distance of 360 km. Around the outfall systems in Santa Monica and San Pedro Bays and off Palos Verdes and Point Loma, we sampled at shorter intervals (a minimum distance of 1 km) to improve the resolution of the collected data. Previous studies (Mearns et al. 1973; Stephenson et al. 1975; Greene and Smith 1975; Greene 1976) of fish and invertebrate communities had shown that depth (or factors associated with depth) was the single most important factor influencing the distribution of species and, thus, the structure of benthic communities. This variability was minimized by selecting stations at only one depth, 60 meters—the depth at which most large municipal wastewater discharges occur.

A total of 998 samples—including 55 trawl samples 174 biological grab samples, 260 water samples, 509 sediment-chemistry samples, and numerous specimens of selected species of fish and invertebrates—were collected during this survey. The collection of these samples from all stations during a short time period required the use of 6 different vessels on 12 cruises and the collaboration of the staffs of the sanitation districts. Special collections and analysis were made by each agency in addition to the work performed by Project scientists.

To date, 164 water column samples have been analyzed. Surface waters averaged 15.67 ± 1.17°C and bottom waters averaged 9.97 ± 0.51°C. Dissolved oxygen concentrations were considerably higher at the surface than at 60 meters. (9.75 ± 0.89 mg/liter vs. 4.58 ± 0.72 mg/liter). There appeared to be an overall gradual decrease in bottom dissolved oxygen concentrations and a slight rise in bottom and surface water temperatures between Point Conception and the U.S./Mexican Border (Figure 1).

Visual observations of bottom sediments collected with the Van Veen sampler revealed that they were mostly odorless, olive green or brown in color, and sandy silt or silty sand in texture. However, there were exceptional stations or areas: Sediments from some stations off Oxnard and in San Pedro Bay contained large quantities of shell debris; and sediments from several stations in Santa Monica Bay and the majority of stations off Palos Verdes were blackened and had a slight to very substantial odor of hydrogen sulfide. Petroleum-like odors were noticeable in sediments from stations between Point Conception and Coal Oil Point and from the station off Flat Rock Point on the Palos Verdes Peninsula.

Preliminary inventories of 44 trawl samples revealed a total catch of 19,707 fish representing 53 species. The average abundance (232), numbers of species (14), and diversity of fish (JL.45) were higher than the calculated Bight-wide average (Alien and Voglin 1976), but fish biomass (4.4 kg) was lower (Figure 2). Between Point Conception and the U.S./Mexican Border, fish abundance showed a significant decrease ($t = 2.2$, $0.05 > p > 0.02$), and fish diversity showed a significant increase ($t = 4.36$, $p < 0.001$). There were no significant trends in number of fish species taken.

The most common species of fish were the Pacific sanddab (*citharichthys sordidus*), stripetail rockfish (*Sebastes saxicola*), and yellowchin sculpin (*Icelinus quadpiseriatus*), which occurred in 90.9, 86.4, and 84.1 percent of the trawls, respectively. The most abundant species were juvenile stripetail rockfish. Pacific sand-dab, and the calico rockfish (*Sebastes dalli*), which accounted for 39.7, 25.9, and 8.1 percent of the total catch. Nearly one-half (43.2 percent) of the stations were dominated by Pacific sanddab (most of these stations were between Newport Beach and Encinitas). The stripetail rockfish dominated 25 percent of the stations, primarily those between Gaviota and Point Dume. The calico rockfish was dominant at 22.7 percent of the stations, most of which were between Palos Verdes and Point Loma.

Dover sole (Micvostomus pacificus) with fin erosion were collected at three stations, all of which were located off Palos Verdes. In contrast, tumor-bearing Dover sole were found at a variety of locations, including stations off rural areas as well as outfall locations.

A total of 17,746 invertebrates, representing 148 species, were taken in the 44 trawls. The average catch was 369 organisms representing 12 species. In general, invertebrate abundance and number of species decreased between Point Conception and the U.S./Mexican Border. However, this general trend was obscured by the increased numbers of species and individuals around points of head-lands and near outfalls (Figure 3). Echinoderms accounted for 67 percent of the invertebrates collected during this survey, and arthropods accounted for 29 percent. However, only 16 percent of the species taken were echinoderms; arthropods, mollusks, and other phyla were about equally represented. The most common species were Sicyonia ingentis (a shrimp), *Parastichopus catifornicus* (a sea cucumber), *Lytechinus anamesus* (a sea urchin), and *Astropectin verrilli* (a starfish); These species occurred, respectively, at 98, 73, 73 and 66 percent of the stations. The most abundant invertebrate was the sea urchin, *L. anamesus*, which accounted for 59 percent of the total catch; the next most abundant species was the shrimp *S. ingentis*, which represented 28 percent of the catch.

Lytechinus anamesus, the most abundant species, was not evenly distributed throughout the study area but was found at six stations in excess of 400 individuals (425 to 3,636). Although it was found at nearly 75 percent of the stations, over 80 percent of the individuals taken were collected at these six stations. This indicates that, although the species is common, it is occasion-ally found in large numbers.

In the Palos Verdes Peninsula area, the abundance of echinoderms was very low. Extrapolation of data from other 60-meter trawl stations indicates that nearly 2,160 echinoderms specimens should have been collected rather than the 18 actually captured. This lack of echinoderms in trawl catches taken in the immediate vicinity of this wastewater discharge has also been observed in a study of benthic infauna (see the article in this report entitled "Animals that are Indicators of Marine Pollution"), It is hypothesized that this lack of echinoderms is a response to the outfall or to some constituent contained in

the settling wastewater particulates and that the overall decrease in all echinoderms off Palos Verdes is an extreme reaction to these conditions.

The preliminary analysis of these data showed that the most common fish occurring on natural shelf bottoms of southern California at the time of this survey were Pacific sanddabs, stripetail rockfish, yellowchin sculpin, and calico rockfish. The invertebrates were *Lytechinus anamesus*, *Sicyonia ingentis*, Parastiohopus californicus, and Astropecten verrilli. These eight species represent what is probably a typical natural assembly of species at 60 meters on the southern California shelf. As noted, however, not all of these species were collected at all locations throughout the survey area nor were the species present in equivalent numbers. Perhaps one of the more significant observations made during this survey was the patchy distribution and recruitment of even these abundant and common species.

The organisms collected in 174 benthic samples are now being sorted into major taxonomic groups and are being weighed prior to identification. It is anticipated that identification of all specimens to the lowest possible taxonomic unit will be completed during the next year.

Nearly 1,000 separate samples were collected during this survey in methods standardized during many past cruises conducted by Project scientists. We believe the standardized methods employed, the extent of the area studied, and the variety of physical, chemical, and biological measurements that were made in remote control areas as well as in man-impacted environments has resulted in a unique and valuable body of data. We hope that the data will give us a better understanding of the Southern California Bight and enable us to compare a range in control parameters with the ranges of values found off the outfalls.

We thank the personnel of the sanitation districts of Los Angeles and Orange Counties and the Cities of Los Angeles, San Diego, Oxnard, and Ventura for their cooperation in this effort. We also thank all of the Project's scientific staff members who have participated in this study, especially Harold Stubbs, Mike Moore, Brad Myers, and Bob Voglin, who were most helpful in obtaining the samples at the correct locations and in the processing of the data upon its return to the Project's office.

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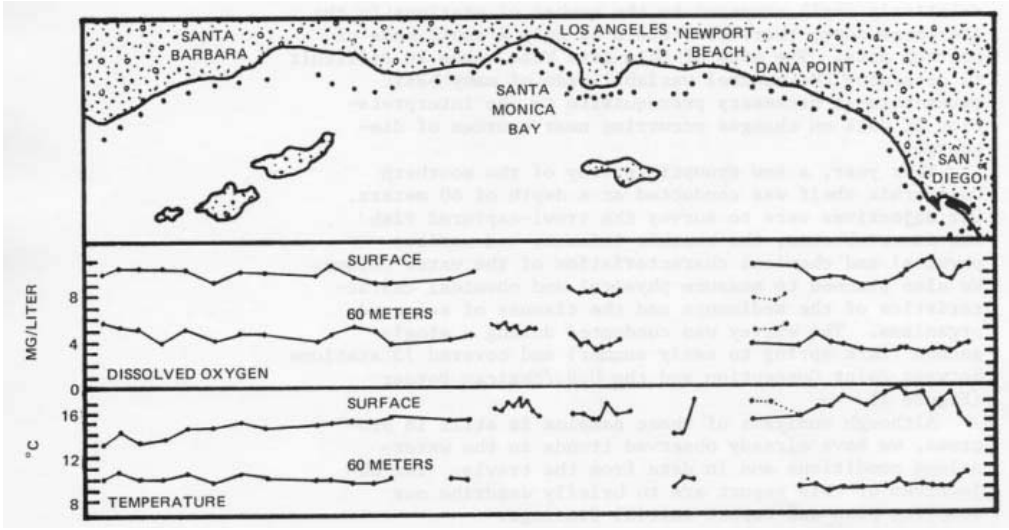

Figure 1. Water-column temperatures and dissoloved oxygen values 60 meter survey.

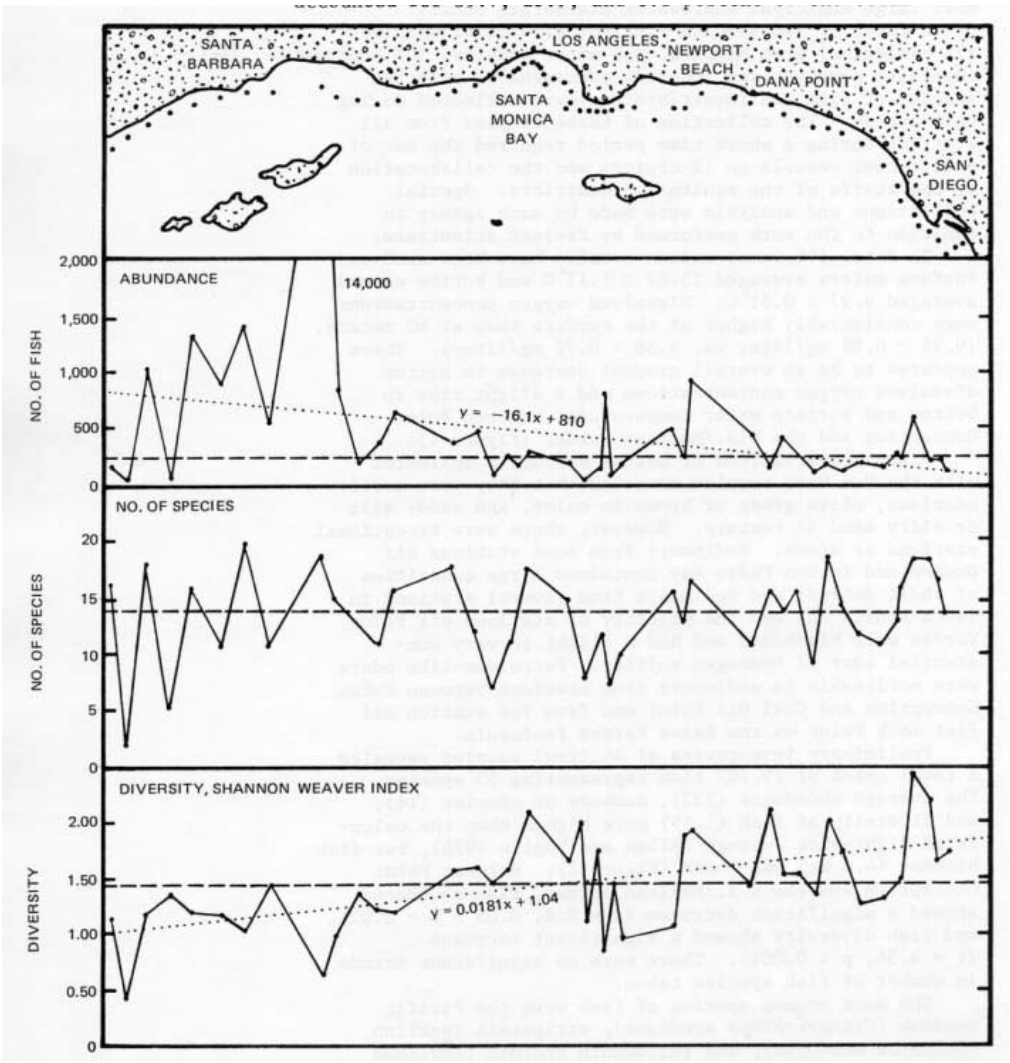

Figure 2. Catch statistics (per trawl) on fishes taken in the 60-meter survey.

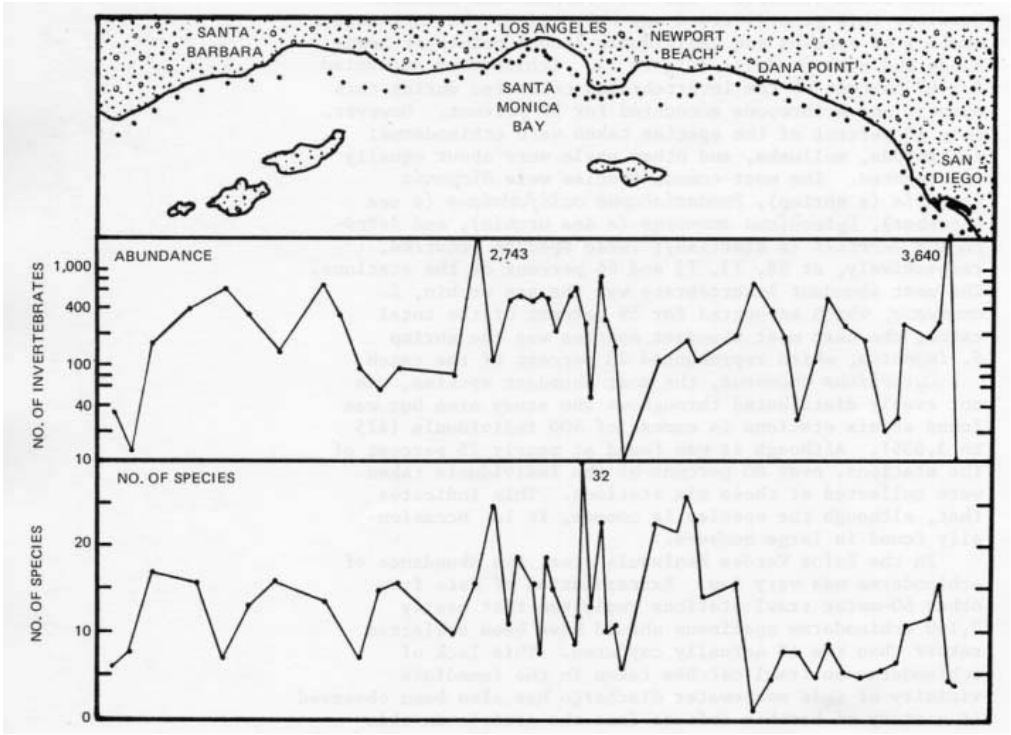

Figure 3. Abundance and number of invertebrate species collected per trawl in the 60 meter survey.

A typical trawl catch of invertebrates from the 60-meter survey, showing three of the four most common invertebrate species.

The giant kelp, *Macrocystis pyrifera*