SUMMARY OF FINDINGS

Microcrustaceans and Echinoderms, Page 13

The opening section of this report dealing with changes in the sea off Palos Verdes points up the fact that in recent years the ecology of this region, once badly damaged by DDT and other pollutants, now has improved in several ways. First, we noticed that the DDT levels in the upper two centimeters of sediments had decreased substantially. Last year our trawls picked up certain species of fish not seen off Palos Verdes for more than 10 years. When we examined their stomachs we found large numbers of tiny shrimp-like microcrustaceans that had also been greatly reduced in this area. Apparently, the DDT had nearly wiped out this valuable fish food; once the DDT level in the upper sediments dropped, the microcrustaceans, and their predators, returned. These microcrustaceans had not been much affected at a depth of 300 m, but at 150 m they had increased 16 fold in the 5 years since 1974; at 60 m they increased 6 fold. The echinoderm population in the region did not increase in the same period.

Bottomfish Population, Page 21

The bottomfish population in the Palos Verdes area has changed in subtle ways. In the last few years the numbers of yellowchin sculpin and California tonguefish have increased. Generally speaking, however, the abundance of bottomfish declined everywhere along the southern California mainland shelf during the 1970's, probably because of higher water temperature and greater transparency. The number of species off Palos Verdes continues to be about the same.

Intertidal Algae, Page 35

The intertidal algae of the Palos Verdes peninsula have been surveyed at various times since 1908. Our study compares species lists made by several investigators over a period of 70 years with the algae present in 1980 and concludes that there are about the same number of species present now as when the first measurements were made. At some stations this is 70 species, up from a lowpoint in 1970 of 15 species. The temporary reduction in diversity has been attributed to several causes, including the effects of sewage effluents, human trampling and aerial fallout of pollutants, but no clear cause-and-effect relations are evident.

Kelp Forests, Page 77

The giant kelp *Macrocystis pyrifera*, very dense off Palos Verdes in the 1940's, disappeared completely in 1967. In 1974, after a substantial transplant effort, young kelp plants began to take hold again. By January of 1980 there were 240 hectares (593 acres) of plants, which is about the area covered 33 years earlier. The factors involved in the decline and return of these kelp beds are enumerated but no dominant cause can be identified.

Extension of the Infaunal Trophic Index, Page 95

Part 2 of this report describes some new techniques we have developed for biological and chemical analyses. The ITI (Infaunal Trophic Index), which we originally claimed was valid for depths between 20 and 200 meters (because our control data was inadequate beyond that range) has now been extented to 800 meters. This was accomplished by adding 33 new deep stations to the Bascom survey and several additional groups of animals to the ITI species list. Now, with 53 invertebrate taxa, the old ITI numbers remain essentially the same and this method is valid in depths from 20 to 800 meters.

Feeding Groups, Page 103

The Infaunal Trophic Index, which reduces the description of a soft bottom benthic community to a single number based on the feeding strategies of its members, has now been applied to over 7,000 samples. While it was under development, the biology of the individual species and the feeding groups was studied in increasing detail. We now present an explanation of why each of the taxa was selected and how they were arranged into four groups: I Suspension feeders, II Surface detritus feeders, III Surface deposit feeders, and IV Subsurface deposit feeders.

Effects and Replication on the Infaunal Trophic Index, Page 123

We ordinarily use a single, carefully taken grab sample of the bottom to determine the Infaunal Trophic Index. The question has been raised as to whether multiple replicate samples or changes in screen size would have any substantial effect on the resulting number. Therefore, we ran a series of experiments to settle the matter. We found that a single sample screened through a one millimeter screen gives an entirely satifactory result. The data show that ITI numbers are statistically accurate within $\pm$ 5 units at a confidence level of 95 percent. The coefficient of variation ranges from 1 to 4 percent.

Mass Spectrometry, Page 131

Residues of the higher molecular weight chlorinated hydrocarbons are among the most damaging contaminants found in the sea and they must be measured accurately. We have now compared our standard method of measurement GC/EC (Gas chromatograph-electron capture) with a GC/MS (Gas chromatograph-mass spectrometer) and found that liver tissue concentrations obtained by the two methods agreed very well.

No one technique for determining fish population is good at all times in all places. We have been developing techniques to supplement the information obtained from trawls, which for example, cannot be used in rocky areas.

Photographic Survey, Page 143

In the experiments reported here, a baited automatic 35 mm camera, described in an earlier publication, was used to compare fish on soft bottoms with those in rocky areas. The camera was deployed at 61 stations in Santa Monica Bay and it recorded 34 species of fish and 34 species of invertebrates, some of which would likely have been judged absent on the basis of trawl data. Rocky, hard bottoms of low relief appeared to be more productive than did adjacent soft bottoms.

Seawater Toxicity, Page 149

There has long been a need for a marine toxicity test that is sensitive, consistent, rapid and inexpensive. We have devised such a test; it can be used to detect toxicity in sea water samples having a very low concentration of contaminants. In this test, sea urchin eggs and sperm are exposed separately to water samples; then the samples are mixed and fertilization begins. After 15 minutes and again after 48 hours subsamples are taken and the success of fertilization and embryo development is assessed. Percentage fertilization and larval development are inversely related to toxicity.

Trace Pollutants, Page 163

Part 3 updates our inventory of coastal waters and the materials added to them. The discharge of the Los Angeles river during its winter floods, for example, had not been checked in 8 years and we wanted to know if its contaminant load had changed. We found that there have been only minor reductions in the concentrations of most possible pollutants during that period. However, the average value for lead decreased by a factor of 6 and that of PCB decreased by a factor of 8.

Trace Metals, Page 171

Metals in Santa Monica Bay surface sediments were measured in samples whose biological characteristics were reported previously. Very high values of metals were confined to the head of Santa Monica submarine canyon but along most of the 60 meter depth contour the levels were not much above control values.

Chlorinated Benzenes, Page 181

Chlorinated benzenes, a class of toxic synthetic organic compounds, are produced in large quantities in the U.S. and released by various outfalls into the sea. We were curious about the extent to which these might have accumulated in surficial sediments and benthic organisms near those outfalls. These relatively low molecular weight compounds tend to be water soluble and may not fall to the bottom with particulates as do the heavier organic compounds. Alternatively, if they do reach the bottom, they may be more rapidly degraded than PCB or DDT. In fish the dichloro- and trichloro-benzenes were not measurable. Hexachlorobenzene was measurable but it was 3 to 4 orders of magnitude below DDT or PCB residues.

Sludge Disposal, Page 197

The effects caused by sludge disposal in the submarine canyon in Santa Monica Bay have long been discussed, often by persons without adequate information. In this rather long piece we summarize the essential information accumulated over the last few years so that a solid data base is now available on the effects of sludge discharge in coastal waters. The geography, oceanography, chemistry and biology are discussed. About 57,000 metric tons dry weight of solids containing substantial amounts of contaminants is discharged each year. About 10 percent of the solids discharged since the beginning in 1957 is still in the canyon; the remainder has been eaten by animals or drifted away leaving no observable effect. Trawls in the canyon below the sludge outfall brought up more species of fish (17.4), more biomass (40.7 kg), and larger individual fish (59 grams) than at comparable control stations. The plume of discharged material can be toxic to certain embryonic animals and one species of fish, the Dover sole, experiences 11-32 percent fin erosion in the outfall area. However, only about 3 square kilometers of the bottom in the canyon (less than one percent of Santa Monica Bay) is affected.

Municipal Wastewater, Page 235

Every year the Project reports on the quantity and quality of the municipal wastewater discharged into southern California coastal waters. Here again is a summary of the concentrations and mass emission rates of general constituents, metals, and chlorinated hydrocarbons discharged from each outfall during 1978 and 1979 as well as a summary of the totals for the last 9 years. The 1979 total flow increased by 27 mgd but the mass emission of most constituents was the same or lower. Lead, arsenic and silver increased somewhat; PCBs and DDTs decreased by 35 percent and 15 percent from 1977 values.

Currents in Los Angeles Area, Page 243

Part 4 deals with oceanographic studies that help us understand why and when natural changes occur in the environment. The first of these shows that near-coastal currents are much the same throughout our study area and median current speeds on the continental shelf near Los Angeles, 41 meters below the mixed layer, are 10 cm/sec. Net speeds over a period of three months were between 2 and 5 cm/sec. Net direction was upcoast (north and west) except in Santa Monica Bay, where an eddy appears to exist. Major fluctuations occur in the alongshore direction; these vary more slowly than the diurnal tidal periods. Near the head of Santa Monica canyon relatively intense rapidly varying currents are observed near the bottom that are sufficiently strong to resuspend organically enriched sediments. These currents appear to result from internal waves trapped in the canyon.

Periods of Weak Currents, Page 257

The question has arisen as to whether the initial dilution of an outfall is reduced below the expected level during periods of weak currents. We have found that the maximum reduction would be about 6 percent and its duration would be a few hours. This is a minor change, virtually undetectable amid naturally changing conditions.

Phytoplankton should be useful as indicators of pollution since they increase or decrease in numbers depending on nutrients or toxicity from outfalls as well as temperature, food supply and sunlight. Unfortunately, their distribution is patchy and it is not easy to discern patterns or to explain changes. After examining 13 years of data on Santa Monica Bay obtained by the Hyperion staff we can make two generalizations: 1) The number of phytoplankters is highest in late winter-early spring and lowest in late fall. 2) Diatoms are most abundant offshore while dinoflagellates dominate nearshore waters.

Phytoplankton in Santa Monica Bay, Page 265

The largest changes in the abundance and variety of life along our coast are caused by changes in ocean climate. In some years, our local waters are clear (1979) and warm (1959) and fishing is execellent for yellowtail and albacore. Other years are cooler (1975) and more turbid (1971); bottom fishing improves. In order for us to determine whether changes are caused by man, it is necessary to know the extent of natural changes such as these. Therefore we have examined 25 years of measurements and discussed the changes in fish and plankton populations.

Changing Coastal Conditions, Page 273

Part 5 deals with ecological processes and how sea creatures live, eat, reproduce and get sick. Animals respond to food supplies in very important ways, and the Project has been carefully examining the stomachs of various animals to see what they eat. Because of a suggestion by John Isaacs some years ago, we have also made chemical measurements on the same animals to confirm the idea that the cesium-potassium ratio in muscle tissue is a measure of an animal's trophic position. Moreover, this ratio is an analog of conservative pollutants that increase with the animal's position in the food chain. We have reported on this subject before; the paper included here examines an ecosystem in San Pedro harbor. Dietary pathways have been identified and Cs/K ratios have been compared with trophic levels and with trace contaminants. We find that some degree of trophic structure exists in San Pedro harbor and that DDTs and PCBs and organic mercury increase with trophic level; metals and benze(alpha)pyrene decrease with increasing trophic level.

Pollutant Flow, Page 289

The increase in availability of microcrustaceans for fish food described earlier led us to re-examine the feeding habits of demersal fish off Palos Verdes and in Santa Monica Bay. In this study we examined the gut contents of 300 fish of 8 species. We found that although polychaete worms or molluscs dominate the sediments at all stations, crustaceans are the preferred food of most fishes and that the abundance of a species of fish depends on the location of its preferred food. The Dover sole, which had been feeding largely on polychaete worms a few years ago switched over to crustacea as soon as these became available. This gave a hint that its fin erosion problems may be caused by a

Demersal Fish Feeding, Page 311

dietary deficiency. The difference between the number and species of animals caught in our grabs and those found in fish stomachs reminds us that fish can be very good and very selective hunters.

Recruitment of Nearshore Demersal Fishes, Page 321

Our study of the recruitment of demersal fishes was intended to determine the extent to which the nearshore waters of our open coast serve as a nursery ground for these fish. We wanted to know which species were most abundant, how much young fish grew in the first year and if there had been large fluctuations in recruitment over the past decade. In each area studied, less than 10 species accounted for more than 95 percent of the trawl-caught juveniles (<60 mm). These young fish constitute about 15 percent of the total. Recruitment occurs during all seasons but is greatest in late winter and early spring. Different species recruit at different depths in the range studied (20-150 m) and a large group of successful juveniles influences the population structure for several years. The stripetail rockfish, the Pacific sanddab, and the speckled sanddab were among the most abundant species in each area sampled.

Fin Erosion Survey, Page 337

Fin erosion disease is not unique to southern California. In an effort to identify its cause by comparing our conditions with those elsewhere we sent out questionnaires to 150 marine laboratories around the world. About 40 percent responded; many said they would look into the matter. Answers from South Africa, France, Tunisia and Brazil indicated they, too, had the problem in certain polluted harbors.

W. B.