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# SUMMARY OF FINDINGS

## CONTAMINANTS IN COASTAL WATERS

The quality of municipal waste, which are the principal source of contaminants entering our coastal waters, is steadily improving even though the total flow is 40 million gallons a day higher than in 1979. Seven of the ten metals measured are at the lowest levels reported in the last decade. DDT continues to decrease while other constituents show little change.

**Waste characteristics**  
Page 11

The pyramid-like web of life in the sea has been examined to determine whether or not there is biomagnification of some contaminants towards its apex. An extensive examination with replicated measurements of dozens of species in three food webs, including one close to an outfall and one far from land off Central America, show that in muscle tissue (eaten by man) inorganic metals do not increase with trophic level. Synthetic organic compounds such as DDT and PCB do increase and can be much higher in large animals. Organic mercury, which seems not to be related to man's discharges, also increases in the top predators.

**Contaminants in the food web**  
Page 17

In an EPA sponsored project with USC we followed the most critical pathway to man of the most toxic contaminants (DDT and PCB). It seemed possible that people who fish almost daily from fishing piers or sport boats and eat their catch might be exposed to excessive amounts of these chemicals. So we duplicated their catches and analyzed the fish flesh that would have been eaten. No realistic hazard was found to exist, even at the locations where contamination was highest.

**Seafoods hazards to man**  
Page 29

Project scientists, in close collaboration with persons representing agencies that are doing or supervising existing monitoring programs met on several occasions to devise an improved plan that would make monitoring more meaningful without increasing its costs. Much can be gained by standardizing sampling equipment, navigation, taxonomy, depths and times of sampling, reporting procedures, etc. There was agreement that synchronized regional measurements away from outfalls and including multiple control stations would produce data that would show (1) natural variations in the ocean and resulting environmental changes and (2) the extent of outfall effects and changes in the size of the area

**Regional monitoring**  
Page 39

disturbed. Data obtained by such a program would be compiled centrally where it could be processed as a whole and made readily available to all interested parties.

## INVERTEBRATES AND ALGAE

Variations in the composition of benthic infaunal assemblages for different scales of sampling and several levels of contamination were studied. The objective of this work was to determine the appropriate number of replicate grab samples necessary to detect changes. Changes in species composition can be demonstrated with single samples. However, the number of replicates needed to detect changes in number or biomass at a sample location (with probability of 0.80 and 95% confidence) even where the coefficient of variation is as little as 20% is: 8 samples to detect 30% change, 17 to detect 20% change and 66 to detect 10% change. These results have great implications for the design of monitoring programs. Large areas can be monitored by single samples to keep track of changes in species composition. If program designers expect to have other questions answered they should be very specific about their information needs so that the proper number of replicates can be taken to achieve the desired result.

**Benthic  
variabil-  
ity  
Page 45**

The lower end of the food web, including tiny invertebrates living in the bottom mud, was also investigated; Bacteria, phytoplankton, and larvae of other invertebrates are the major foods of several polychaete worms, whether they live near or away from outfalls.

**The lower  
food web  
Page 59**

The kelp forests of the Palos Verdes peninsula, which were nonexistent as recently as 1976, are steadily increasing according to measurements made by California State Fish and Game. This is the result of a combined effort by several groups to bring in new plants, kill sea urchins, and to reduce suspended solids in the water. There is a direct correlation between the reduction of suspended solids discharged from the L.A. County outfall and the increase in the size of the kelp canopy. This seems to be the result of more light penetration and less particulate material on rocky substrates.

**Kelp beds  
Page 67**

The question of whether phytoplankton and nutrient distributions in Santa Monica Bay are detectably influenced by the waste outfalls was studied again. Nothing unusual was found in the vicinity of the main outfall. However, an increase in zooplankton near the outfall was observed. Currents entering the bay from open waters (observed from satellites) and discharges from Ballona Creek and near-shore outfalls provide the nutrients to explain the phytoplankton levels observed.

**Phyto-  
plankton  
Page 71**

## FISH

Although a great many trawls have been made in this region by various agencies, universities, and monitoring groups, much of the data so obtained are incomplete. This piece summarizes 317 trawls made by this Project at 148 stations in depths of 10 to 627 m between 1977 and 1982. The most species of fish (12.6) are found in depths of 50-200 m but the most species of invertebrates (17.5) are found below 200 m. The biomass of both is greater below 200 m.

**Trawl  
catches  
Page 85**

A statistical look at trawling was taken to determine (1) how many trawls are required to obtain precise estimates of the number of species, number of individuals, and biomass of both fish and invertebrates and (2) the probabilities of detecting changes over time. It was found, for example, that one trawl is sufficient to estimate the number of species, three to obtain the number of individuals and 14 to get the biomass of fish with a precision of 0.2 in a contaminated region. In a control region the comparable numbers are 6, 29 and 80 respectively.

Evaluation  
of trawl  
data  
Page 91

Fin erosion is most prevalent in fishes collected near major outfalls. In the decade between 1971 and 1981, 10% of all fishes collected by trawl on the Palos Verdes shelf had fin erosion; 99% of these were flatfishes and rockfishes. In that same period, the incidence of the disease declined among demersal fishes, but increased among fish with swim bladders, suggesting that there are two types of fin erosion. In Dover sole, the fish most often affected, the incidence increases from the time of settlement until they reach 140 mm length.

Fin  
erosion  
Page 99

This study documented the species, habitats, and foods of intertidal fish. In more than 50 samplings, 10 species of fish were taken, of which six are regular residents of the intertidal zone. For some reason, as yet unknown, there are fewer intertidal species in southern California than elsewhere along the US Pacific coast.

Intertidal  
fishes  
Page 111

Published data on the food habits of demersal fishes are not entirely satisfactory because they provide little information about where or when fish feed or on predator-prey relationships. This investigation compared gut contents of fish with animals collected in grab samples. Invertebrates were classified on the basis of mobility and life-style. Some fish eat burrowing animals, some eat surface-motile prey. Sanddabs prefer mysids and copepods that are not found in grabs. Bivalves found in large numbers in the grab samples are rarely found in fish guts.

Fish food  
habits  
Page 119

The concept of trophic (feeding) levels of sea life can be useful in organizing one's thinking about the food web. In the past, scientists have fitted animals into five major steps ranging from plants to top carnivores; this was adequate to the problems before them. Now that we have devised chemical ways to determine trophic levels (Cs/K, Hg organic, C and N isotopes) a more precise biological method is needed for purposes of comparison. This paper described how that can be done to two decimal places.

Assign-  
ing  
trophic  
levels  
Page 125

A small, but significant, elevation in an animal's  $^{13}\text{C}/^{12}\text{C}$  relative to that of its available food has been noted by several scientists. This means that a progressive increase in  $^{13}\text{C}/^{12}\text{C}$  and  $^{15}\text{N}/^{14}\text{N}$  can be expected with increasing trophic level. These experiments confirmed the steady increase of stable isotopes relative to trophic levels that had been estimated by other means. It should be useful in understanding the flow of C and N in marine ecosystems.

Carbon  
nitrogen  
isotopes  
Page 143

## TOXICITY STUDIES

There are many thousands of synthetic organic chemicals in use today, any of which may be toxic. Even the EPA's list of about 120 organic constituents is unmanageably large for routine analysis. This research devised a means of ranking organic chemicals so that attention can be focused on those most likely to

Predict-  
ing bio-  
accumula-  
tion  
Page 149

be toxic to sea animals. It makes use of the n-octanol/water partition coefficients and available toxicity data. The discharges from southern California contain small amounts of the top seven: three DDT compounds, two PCB's, pentachlorophenol and hexachlorobenzene.

Bioaccumulation of contaminants by sea animals as a result of long term exposure to low levels of toxicants has often been measured. However, the relationship between the increase in animal tissue of a substance (that can be intoxicating under acute conditions in the laboratory) and its actual toxic effect on the animal has not been known until recently. The work described in these papers, and similar work previously published by Brown, shows that animals possess the inherent capability to detoxify metals and organic compounds that enter their bodies. They do this at the subcellular level, primarily in livers, by sequestering unneeded metals to a protein (metallothionein) and synthetic organic metabolites to a tripeptide (glutathione). In the studies of white croaker from Palos Verdes, derivatives of DDT, namely DDE, DDA and DDOH, were found to be responsible for detrimental changes in its tissues. DDA appeared to have exceeded the protective capability of the glutathione. Metals were effectively detoxified.

**Detoxi-  
fication  
of metals  
and  
organics  
Page 157**

This study determined that sea urchins use metallothionein in the same fashion as white croakers to prevent metals from reaching the sites of toxic action. Urchins were found to be able to detoxify metals; even those taken from a contaminated region (White Point) had not exceeded this capacity and showed no indication of spillover into the enzyme pool.

**Detoxi-  
fication  
by  
urchins  
Page 173**

Mussels are used as indicators of contaminant levels in coastal waters in California. Our studies of mussels at normal and contaminated stations for over a year evaluated changes in tissue concentrations of metals and organic compounds, the degree of detoxification, and histological condition. We found that seasonal changes in chemical and biological parameters were greater than the differences between stations and that there was no correlation between histopathology and contaminant level. All histopathological changes observed correlated to the reproductive stage. So many natural variations influence the uptake of contaminants that we doubt the value of mussels as an indicator of coastal conditions.

**Mussels  
as indi-  
cators  
Page 179**

Tissue samples taken from animals living in contaminated areas have invariably shown that all excess metals present were detoxified. The objective of this laboratory study was to determine how much more metal could be accumulated before the capacity of metallothionein was exceeded. Scorpionfish were exposed to ionic cadmium solutions hundreds of times higher than the most contaminated environment in a standard 96-hour acute toxicity test. The result showed that a 50 fold increase could be accommodated by the livers, kidneys, and gills of exposed fish. Above these levels "spillover" into the enzyme fractions was shown to cause damage to tissues. We concluded that less than 2% of the detoxification capacity of metallothionein for cadmium is presently being utilized by scorpionfish in these waters.

**Spillover  
in the lab-  
oratory  
Page 193**

There is evidence that after an animal's death, some metals may be redistributed within cellular material because of interactions between enzymes and proteins. Since interpretation of the results depends on an accurate assessment of the distribution of metals at the time of sampling, it is important to prevent

**Cytosol  
storage  
temper-  
ature  
Page 201**

this *post-mortem* redistribution. We determined that storage at -80°C (after transport in dry ice) was the best procedure.

A new technique for determining the toxicity of sea water is put forward that is simple, rapid, and quantitative. Other tests that determine the LD50 of fresh water animals are inappropriate for measuring the toxicity of coastal waters. In this new test, the gametes of the purple sea urchin are exposed to water of unknown toxicity. The number of gastrulated embryos is directly proportional to the amount of echinochrome produced, which can then be extracted and measured with a spectrophotometer.

**A new bioassay**  
Page 205

Using the test just described, a series of measurements were made of harbor waters, water near outfalls, and open coastal waters. The object of this work was to apply the test in real situations and determine the normal range of toxicity in the areas named. Although effluents from some of the major outfalls were found to be toxic at dilutions of 200 in the laboratory, actual samples of sea water taken close to the outfalls were not toxic.

**Water toxicity measurements**  
Page 217

This study confirmed that the substance to which metals are bound in the metallothionein-containing pool of scorpionfish is indeed metallothionein.

**Confirmation of metallothionein**  
Page 225  
**Confirmation of glutathione**  
Page 231

Our finding that synthetic organic metabolites are detoxified by conjugation with glutathione is most important in understanding their effects on animals. This contribution confirms that the conjugating material really is glutathione and that it is predominantly found in the low molecular weight pool.

## THE SEA BOTTOM

Continuing current measurements off Newport Beach, in depths of 55 to 351 m, increase our understanding of properties of currents on the slope, as well as on the shelf. The net water movement at all depths is alongshore to the north and west at speeds of 4 to 9 cm/sec. Most of this variation is associated with fluctuations longer than tidal period. The cross-shore variations are associated with tidal and shorter periods. The net flow off Palos Verdes was substantially less than that off Newport. Resuspension effects are expected to be as important on the slope at depths of 350 m as they are on the shelf at 55 m. The data collected are useful in the new sedimentation model.

**Shelf and slope currents**  
Page 237

The greatest effects of municipal waste discharge are usually associated with the dispersion and settling of effluent particles. Therefore, it is most important to be able to forecast the percent of the particles that will fall out at various distances. To this first step must be added the effects of natural sedimentation, biological stirring of the bottom, the resuspension and redistribution of the sediments, and biological or chemical alterations. This mathematical model takes all these factors into account and can be used to forecast future effects at outfalls.

**Advanced sediment quality model**  
Page 247

The Project's comprehensive survey of coastal waters was extended northwesterly from Point Dume to Port Hueneme. Seventy-three stations along 11 transects at 20 to 700 m were sampled and the top 2 cm analyzed for metals. Stations at a depth of 60 m (the same as our control survey) fall within the range of previously published control values. There is a high correlation of metal concentrations with physical components of the sediments. Metal values are higher in deeper water where the grain size is smaller.

**Metals in sediments**  
Page 259

Undisturbed samples of soft sediments up to a meter long can be taken with a corer developed by this Project. It consists of a very thin-walled steel tube and plastic liner, open at both ends, that slices down through the mud and then seals itself so the core does not come out. Comparative tests with a standard box corer show that the new one takes equivalent, undisturbed cores. The advantages of the new tool are that it is far easier to handle on a small vessel and it penetrates more deeply than a box corer.

**Improved  
corer  
Page 267**

**WILLARD BASCOM**