DIRECTOR'S STATEMENT

I am pleased to be able to report substantial progress in the last two years towards our long-term goal of understanding the effects of marine outfalls on the coastal waters of southern California. Our scientists now take samples and make measurements of sea life in ways that are quite different from those traditionally considered to be monitoring. We examine animals in more detail, magnifying the reactions of their vital organs by means of enzymology, pathology, and molecular biochemistry, to find any effects that may exist. With these techniques for scrutinizing several subcellular components of the same animal we have learned some new things and raised some new questions. I expect this technology to have about the same impact on environmental studies that microcircuits have had on electrical engineering.

Recent investigations have disclosed higher levels of contamination than some of us had expected in tissues of animals living at considerable distances from known sources. We are not sure whether there are detrimental effects on these animals; or, if there are, whether these were produced by the man-induced contaminants or by other factors. The situation is complex, but I shall try to make some of the scientific issues understandable.

The volume of wastewater and suspended solids discharged into southern California waters has leveled off, and the amounts of associated contaminants, including chlorinated hydrocarbons, continue to drop. This is not of much scientific importance because we find little correlation between effects on sea life and present discharges, especially beyond a few kilometers from the discharge point. We do find increasing evidence that some biological effects may be associated with the large discharges of DDT compounds in the past, and possibly with petroleum hydrocarbons. Because we are now collecting new kinds of data at the subcellular level, the meaning of our finds is not yet clear. Let me explain some of the measurements separately; then I will show how they fit together.

Our scientists examine thin sections of the tissues of the vital organs of fish (liver, gonads, kidney, etc.) under the microscope to see if there are any signs of damage, or disease, or unusual features. This is not a new kind of measurement; what is different is that such examinations have become routine and that often we have precise chemical measurements on the same organs. This increases the chances of associating any effects seen with specific contaminants. We also have a method of measuring cell size that increases the objectivity of the pathological description; it will be especially useful if two distant laboratories wish to compare findings.

Chemical measurements of the concentrations of metals or total chlorinated hydrocarbons (DDTs, PCBs) in fish organs are made by many laboratories. This laboratory determines the distribution of chlorinated hydrocarbons and their primary metabolites between molecular weight fractions in the liquid component of the cells of various organs; the distribution can show whether the cell's capacity to detoxify these contaminants had been exceeded. These findings led us to investigate the quantitity and distribution of secondary, or oxygenated, metabolites of various hydrocarbons. This, in turn, required development of a new chemical extraction technique for these compounds and independant confirmation that we were, in fact, measuring oxygenated metabolites. The groundwork required considerable time and effort; but, once this measurement became routine, we were able to show that the amount of DDA and DDOH (secondary metabolites of DDT) in sediments and body organs is often greater than the amounts of primary compounds. Moreover, measurements to date indicate that, when pathologies or chronic effects are found, these correlate much better with secondary metabolites than with primary compounds of synthetic organic chemicals.

By comparing the amounts of metals and chlorinated hydrocarbons in bottom animals and sediments our scientists were able to demonstrate that, however great the metal contamination of the bottom, the amount of metals in the vital organs of fish decreased as the amount of chlorinated hydrocarbon metabolites increased. (This is presumably because the latter reduces a cell's ability to manufacture metallothionein.) This finding raised the possiblity that damage could be caused by a deficiency of needed metals (such as copper or zinc) in an animal even though it lives in a bottom where there are great excesses of these metals, but we have never found an example of that extreme case. Laboratory tests show that these oxygenated metabolites may be partly responsible for changes in enzyme activity, but we have not yet found major changes in these enzymes (either up or down) caused by contamination in the sea.

When the scientific techniques described above are applied to the creatures of the southern California region a new set of findings is generated. For example, we find that DDT and its metabolites are very widespread and that the concentrations in fish livers from as far north as San Simeon, as far south as Ensenada Bay, and as far offshore as

Cortes Bank are in the range of 0.5 to 5 parts per million (concentrations in the usually-eaten muscle tissue of these fish are much lower and no public health threat is implied). In the livers of the fish there is also evidence of vacuolation (fat globules) which could be the result of the DDT. The additional fat could also be natural, its amount depending on the reproductive cycle; or it could be caused by petroleum hydrocarbons coming from the hundreds of undersea oil seeps. There are other possible explanations.

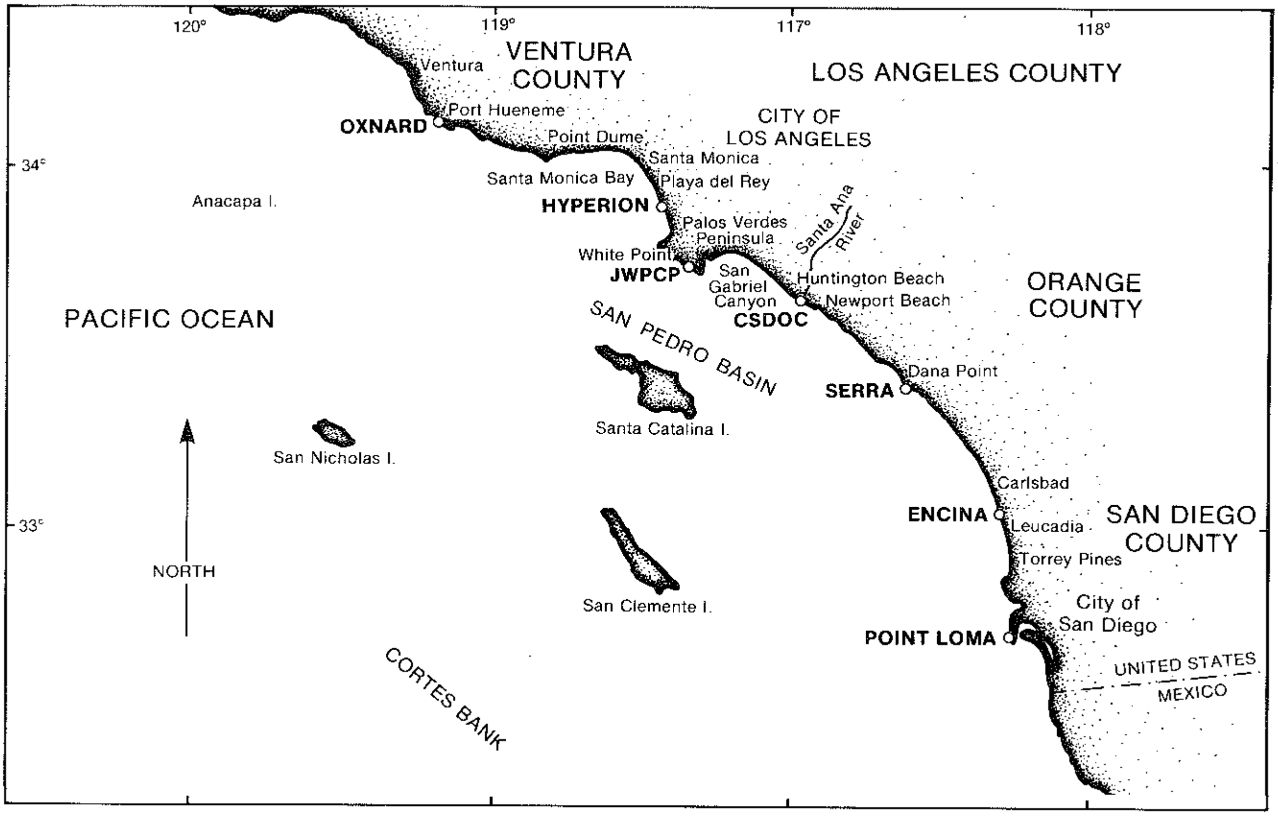
This brings me to an important point. As I have said, the search for effects at the microscopic and molecular levels puts us in a new game. Because no one really knows, a priori, what the sea or its animals are supposed to be like, environmental effects are usually determined by comparing contaminated with pristine conditions. Unfortunately we have no pristine conditions because there are oil seeps throughout the Bight and DDT is widespread throughout this region (as well as elsewhere around the Pacific). Hydrocarbons and their metabolites are persistent because they are lipid (fat) soluble and tend to accumulate in animals. Thus, as we look at more organs of more animals with the greater magnification of the new techniques, we see metabolites and their effects that were not previously noticed. Whether the liver vacuolation, for example, is natural or is caused by man-induced contamination may be answered when we know more about normal lipid cycles in sea animals.

So, the question of whether the widespread low levels of hydrocarbons have any important effect on sea life cannot, as yet, be answered. Do either synthetic or natural ones, at the levels measured, reduce life span, the population level, or the general wellbeing of sea animals? Possibly.

It is an interesting question as to whether man can take any action that would substantially improve the situation, considering that the discharge of significant amounts of DDT was stopped over a decade ago and the oil has been seeping out for at least hundreds of years. In 1971 southern California was warned about the widespread DDT problem by the deaths of pelicans on the offshore islands; SCCWRP reported on the levels in fish in coastal waters in 1973. Action was taken at once to halt DDT discharge and impose controls that will prevent a recurrence of such an ecological disaster.

I believe that this Project, now equipped with new and steadily improving techniques, will be able to answer other important ecological questions in our next report. But by that time, we will also have uncovered some even more puzzling problems. That is the nature of nature.

Willard Bascom



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119°
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VENTURA COUNTY
LOS ANGELES COUNTY
Ventura
Port Hueneme
OXNARD
Point Dume
CITY OF LOS ANGELES
Santa Monica
Santa Monica Bay
Playa del Rey
Anacapa I.
HYPERION
Palos Verdes Peninsula
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